ParisTech AgroParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: **Energy, Processes**

Subfield: **Process Engineering**

Title: **Coupling and intensification of separation processes**

ParisTech School: **AgroParisTech**

Advisor(s) Name: **Irina IOANNOU**
Advisor(s) Email: **irina.ioannou@agroparistech.fr**
Research group/Lab: **URD ABI / Process engineering department (**

Lab location: **REIMS (40 min from Paris)**
(Lab/Advisor website): **https://chaire-abi-agroparistech.com/Home/**

Short description of possible research topics for a PhD:

The subject of this paper deals with the coupling of processes to improve the performance of extraction (liquid/solid) and functionalization processes. Two technologies will be mainly studied for intensification:

(i) membrane processes. Some results (Ioannou et al. (2020) have been obtained on improving the glycosylation yield of resveratrol by coupling the enzymatic reaction with a membrane process (Enzymatic Membrane Reactor). The objective will be to optimize functionalization reactions used in the chemistry department of our unit. The experiments will be carried out on a laboratory scale in small volumes (0.5 L) and then on a pilot scale (5 L).

(ii) membrane contactors. The coupling of the extraction processes with membrane contactor technology will be applied in order to increase the extraction yields but also to increase the extract purity. Extraction processes deal with vegetal biomass in order to valorize agro-industrial products.

Energy and material balances will be carried out to show the interest of the coupling of different technologies. The experiments will be carried out according to the DOE methodology (Design Of Experiments).

Required background of the student:

The student will have a background in process engineering and / or chemical engineering. Knowledge of membrane processes, extraction processes (L / L, S / L), analytical methods (HPLC, SM) and design of experiments will be required. A good level in English is obligatory.

A list of 5 (max.) representative publications of the group:

1. Ioannou *et al.* (2020) Implementation of an enzyme membrane reactor to intensify the enzymatic β-glycosylation of resveratrol. Submitted to Industrial & Engineering Chemistry Research.
2. Reungoat *et al.* (2020). Optimization of an ethanol-water based sinapine extraction from mustard bran using Response Surface Methodology. Food Bioprod. Process., 122, 322-331. https://doi.org/10.1016/j.fbp.2020.06.001
3. Chemarin *et al.* (2019) Recovery of 3-hydroxypropionic acid from organic phase after reactive extraction with amines in an alcohol-type solvent. Sep. Pur. Technol. DOI: 10.106/j.seppur.2019.02.026
4. Chemarin *et al.* (2018) Toward an in-situ product recovery of biobased 3-hydroxypropionic acid: influence of bioconversion broth components on membrane-assisted reactive extraction. J. Chem. Technol. Biotechnol. DOI: 10.1002/jctb.5845
5. Fayet *et al.* (2018) Detoxification of highly acidic hemicellulosic hydrolysate from wheat straw by diananofiltration with a focus on phenolic compounds. J.Membrane Sci. DOI: 10.1016/J.memsci.2018.08.045

ParisTech AgroParisTech

Research Topic for the ParisTech/CSC PhD Program

Field: Environment Science and Technology, Sustainable Development, Geosciences

Subfield: Biogeochemistry

Title: Soil microbial functioning in land surface models

ParisTech School: AgroParisTech

Advisor(s) Name: Matthias Cuntz, Delphine Derrien
Advisor(s) Email: *matthias.cuntz@inrae.fr*, *delphine.derrien@inrae.fr*
Research group/Lab: *UMR Silva*
Lab location: *INRAE Centre Grand-Est – Nancy, 54280 Champenoux*
(Lab/Advisor website): *https://www6.nancy.inrae.fr/silva*

Short description of possible research topics for a PhD:
Land Surface Models (LSM) are used for projections of future climate change such as in the reports of the Intergovernmental Panel on Climate Change (IPCC). Plant processes are described in great detail in LSMs while soil processes are represented only very coarsely. This project aims at an explicit vertical description of carbon (C) decomposition in soil, moving away from crude kinetically-defined soil organic matter (SOM) pools, but rather linking closer the C cycle with microbial activity, as well as water and energy distribution in soils. The LSM CABLE shall be extended with the SOM decomposition model DAMM, combining effects of temperature, soil water content, enzyme kinetics, and soluble substrate supply. This will give a framework to include new, detailed knowledge about aggregation and the influence of freezing and thawing on it, microbial population dynamics and functioning such as enzyme production.

Required background of the student: Natural sciences

A list of 5 (max.) representative publications of the group:
1. Balesdent *et al.* (2018) *Nature* 559, 599–602, doi: 10.1038/s41586-018-0328-3
2. Cuntz & Haverd (2018) *JAMES* 10, 54–77, doi: 10.1002/2017MS001100
3. Haverd & Cuntz (2010) *J Hydrolo* 388, 438–455, doi: 10.1016/j.jhydrol.2010.05.029
4. Haverd *et al.* (2016) *Geosci Model Develop* 9, 3111–3122, doi: 10.5194/gmd-9-3111-2016
5. Sainte-Marie *et al.* (in revision), *Nature comm* 11, https://go.nature.com/3ltNMOl

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Life Science and Engineering for Agriculture, Food and the Environment

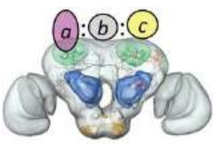
Subfield: Sensory Ecology

Title: Neural Processing of Pheromone Blend Ratio

ParisTech School: AgroParisTech

Advisor(s) Name: Abhishek CHATTERJEE, Philippe LUCAS
Advisor(s) Email: abhishekchttrj@gmail.com; philippe.lucas@inrae.fr
Research group/Lab: Neuroethology of Olfaction (NEO), iEES
Lab location: INRAe Versailles
(Lab/Advisor website):
https://ieesparis.ufr918.upmc.fr/spip.php?article244&lang=en
https://iees-paris.cnrs.fr/teams/neuroethology-of-olfaction/

Short description of possible research topics for a PhD: Moth sex pheromones are chemical cocktails produced by females to attract males for mating. Diverge moth species share subsets of the same compounds in their pheromone blend – but in different combinations, roles and/or concentration ratios. To evoke attraction of the males of *Agrotis ipsilon*, the three components of the pheromone blend must all be present, and crucially, be present in certain proportions. **Ratio coding** is a fascinating example of the moth's unique olfactory capability. While strengthening reproductive isolation, it also safeguards against large fluctuations in odor concentration that the moth faces during turbulent flight. We seek to identify how does the population-level network activity in the pheromone-processing centers of the moth brain compute the precise blend-ratio. We will employ behavioral, anatomical, electrophysiological and Ca^{2+} imaging-based methodologies to probe whether pheromone-evoked inter-glomerular synchronization play any part in ratio coding. In the end, results from this project will initiate the development of a network-level model of odor-integration which will be linked to organismal questions on adaptation.



Required background of the student: Neuroscience/ Biophysics/ Bioengineering/Biology

A list of 5 (max.) representative publications of the group:

1. A plant volatile alters the perception of sex pheromone blend ratios in a moth. Hoffmann A, Bourgeois T, Munoz A, Anton S, Gevar J, **Dacher M**, **Renou M**. *J Comp Physiol A Neuroethol Sens Neural Behav Physiol*. 2020 *Jul;206(4):553-570*.

2. Automatic tracking of free-flying insects using a cable-driven robot. Pannequin R, Jouaiti M, Boutayeb M, **Lucas P**, Martinez D. *Sci Robot*. 2020 *Jun 10;5(43):eabb2890*.

3. Reconfiguration of a Multi-oscillator Network by Light in the Drosophila Circadian Clock. **Chatterjee A**, Lamaze A, De J, Mena W, Chélot E, Martin B, Hardin P, Kadener S, Emery P, Rouyer F. *Curr Biol*. 2018 *Jul 9;28(13):2007-2017.e4*.

4. Firing and intrinsic properties of antennal lobe neurons in the Noctuid moth Agrotis ipsilon. Lavialle-Defaix C, Jacob V, Monsempès C, Anton S, **Rospars JP**, Martinez D, **Lucas P**. *Biosystems*. 2015 *Oct;136:46-58*.

5. Heterogeneity and convergence of olfactory first-order neurons account for the high speed and sensitivity of second-order neurons. **Rospars JP**, Grémiaux A, Jarriault D, Chaffiol A, Monsempes C, Deisig N, Anton S, **Lucas P**, Martinez D. *PLoS Comput Biol*. 2014 *Dec 4;10(12):e1003975*.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Biology

Subfield: ecology – neurophysiology - evolution

Title: **Evolution of the detection and metabolism of ethanol in the olfactory system of drosophilids**

ParisTech School: AgroParisTech

Advisor(s) Name: **Maïbèche Martine / ChertempsThomas**
Advisor(s) Email: martine.maibeche@sorbonne-universite.fr
Research group/Lab: iEES PARIS – Ecosens department
Lab location: Paris
(Lab/Advisor website): https://ieesparis.ufr918.upmc.fr

Short description of possible research topics for a PhD:

Ethanol (EtOH) is a known psychoactive substance but its smell also drives various behaviors in animals. Surprisingly, the processes involved in EtOH detection and detoxification in the olfactory organs are still unknown. Fermenting fruit is the social hub for Drosophila melanogaster, this insect is thus remarkably adapted to detect EtOH and to resist to EtOH stress. Interestingly, closely related species of the Sophophora group display distinct EtOH tolerances and behavioral preferences. Using D. melanogaster and two sibling species, this project aims to discover the mechanisms underlying the olfactory detection of EtOH, to decipher the processes involved in the defense of the olfactory organ against this toxic compound, and to trace the evolution of EtOH adaptation in drosophilids, in light of their respective preferences and sensitivities. Molecular actors involved in EtOH detection identified could serve as new targets for the biocontrol of insect pests, such as D. suzukii.

Required background of the student: The Phd student must have a basic knowledge of molecular biology, genetics and neurophysiology, with sensitivity to evolutionary questions.

A list of 5 (max.) representative publications of the group

1. Chertemps T., *et al*. 2015. Front Physiol. 6:315.
2. Steiner C., *et al*. 2017. Sci Rep. 7(1):12629.
3. Younus F., *et al.* 2017. Sci Rep. 7:46188.
4. Younus F., *et al.* 2014. Insect Biochem Mol Biol. 2014 Oct;53:30-43.
5. Chertemps T., et al. 2015. BMC Biol. 2012 Jun 21;10:56.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Large strain characterization and modeling for sheet metal forming

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Tudor Balan
Advisor(s) Email: tudor.balan@ensam.eu
Research group/Lab: LCFC – Laboratoire Conception Fabrication Commande
Lab location: Metz

Short description of possible research topics for a PhD:
Large strain characterization of sheet metals has become crucial as very high strength materials are being more and more employed in structural automotive components. These advanced materials come with a significantly increased strength, allowing for lightweight structures, but also with a significantly smaller ductility. Accordingly, classical tests do not allow for an accurate characterization at large strains. The only ISO-standardized large strain characterization test is the bulge test, which requires complex equipment and large amounts of materials. The project should deliver an improved version of the so-called plane strain compression test, which was very recently shown to provide a promising alternative [1]. In-depth validation of the method is aimed, along with a robust testing procedure prone for further standardization. The extension of the test to warm conditions is foreseen, depending on the candidate's progress and competences.

Required background of the student:
The candidate should have a good background in mechanical engineering, especially solid mechanics. Plasticity modeling skills would be appreciated, and/or experimental skills in mechanics or material science. Knowledge of metal forming processes would be very useful.

A list of 5 (max.) representative publications of the group:

[1] C Chermette, K Unruh, I Peshekhodov, J Chottin, T Balan, A new analytical method for determination of the flow curve for high-strength sheet steels using the plane strain compression test, Int J Material Forming 13 (2020) 269-292

[2] G Venet, T Balan, C Baudouin, R Bigot, Direct usage of the wire drawing process for large strain parameter identification, Int J Material Forming 12 (2019) 875–888

[3] Y Yang, T Balan, Prediction of the yield surface evolution and some apparent non-normality effects after abrupt strain-path change using classical plasticity, Int J Plasticity 119 (2019) 331-343

[4] Y Yang, G Vincze, C Baudouin, H Chalal, T Balan, Strain-path dependent hardening models with rigorously identical predictions under monotonic loading, Mech Research Com, in press, 10.1016/j.mechrescom.2020.103615

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mech. Engineering / Automatic control

Title: Trajectory shaping for vibration reduction of a class of non-linear non-minimum phase systems

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Olivier Thomas; Richard Béarée
Advisor(s) Email: olivier.thomas@ensam.eu; richard.bearee@ensam.eu
Research group/Lab: LISPEN
Lab location: Lille
(Lab/Advisor website): https://lispen.ensam.eu/

Short description of possible research topics for a PhD:
Compared with conventional high-stiffness structure used in robotics, the design of lightweight robots has a lot of new potential, e.g. for safe human-robot interaction (HRI) or for energy efficiency. Such mechanical structure with low stiffness faces challenges for accurate tracking of the end-effector motion. Indeed, motion-induced vibrations may exhibit sensitive non-linear and non-minimum phase phenomena. This study proposes to investigate both in theory and practice a) the modelling (reduced order non-linear lumped model) and identification stages of these phenomena and b) the adaptation of the trajectory shaping stage for the reduction of the motion-induced deformations and vibrations.

Required background of the student:
Mechanical engineering; vibration analysis; automatic control

A list of 5 (max.) representative publications of the group:
1. Besset, P., Béarée, R. (2017). FIR filter-based online jerk-constrained trajectory generation. Control Engineering Practice, 66, 169-180.
2. Béarée, R. (2014). New Damped-Jerk trajectory for vibration reduction. Control Engineering Practice, 28, 112–120.
3. Cottanceau, E., Thomas, O., Véron, P., Alochet, M., and Deligny. R. (2017). A finite element/quaternion/asymptotic numericalmethod for the 3D simulation of flexible cables. Finite Elements in Analysis and Design, 139 :14–34.
4. Thomas, O., Sénéchal, A., and Deü, J.F. (2016). Hardening/softening behaviour and reduced order modelling of nonlinear vibrations of rotating cantilever beams. Nonlinear dynamics, 86(2) :1293–1318.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids
Subfield: Mechanical/Material/Process Engineering
Title: Improving formability of lightweight metallic materials using process chaining: Incremental Forming and Friction Stir Welding
ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Pr. Philippe DAL SANTO, Dr. Tudor BALAN, Dr. Sandra CHEVRET, Dr. Idriss TIBA
Advisor(s) Email: Philippe.dalsanto@ensam.eu, tudor.balan@ensam, sandra.chevret@ensam.eu, idriss.tiba@ensam.eu
Research group/Lab: LCFC (http://lcfc.ensam.eu) / LAMPA (http://lampa.ensam.eu)
Lab location: Metz and Angers – France

Short description of possible research topics for a PhD:

Friction Stir Welding
on ABB IRB 8700 robot

SPIF
on ABB IRB 8700 robot

The current trends of the "industry of the future" include dramatic product customization (small batch production) along with optimized lightweight construction, in particular in transportation industries. Innovative technologies to answer these challenges include robotized forming and assembly processes like single point incremental forming (SPIF) and friction stir welding (FSW), in conjunction with sheet aluminum alloys. Developed during the last two decades, these promising processes still exhibit numerous scientific and technological challenges. Process chaining, on the same part and robot, would allow for a deeper optimization at an improved cost, allowing for the right material at the right place; however the impact of assembly on the residual formability is little known. Establishing the relationship between process parameters and part quality after welding and further forming would be a significant achievement. Controlling the sheet temperature is one of the promising directions to further improve the formability. The final objective is to propose a numerical approach to simulate the forming processes including the chaining effects. Depending on the abilities of the candidate, one or the other of these research directions will be further developed.

Required background of the student:
The student must have very good knowledge in forming processes of metallic materials and in numerical simulation. Some background in metallurgy will be also appreciated.

A list of 5 (max.) representative publications of the group:

1. Y. Yang and T. Balan. Prediction of the yield surface evolution and some apparent non normality effects after abrupt strain-path change using classical plasticity. Int. Journal of Plasticity (2019), 119; 331-343.
2. D. Rou et al. Experimental and numerical investigation of the mechanical behavior of the AA5383 alloy at high temperatures. Journal of Materials Processing Technology (2020), 281; art. no. 116609.
3. K. Kolegain et al. Off-line path programming for three-dimensional Robotic Friction Stir Welding based on Bézier curves. Industrial Robot: An International Journal (2018).
4. S. Boudhaouia et al. Experimental and numerical study of a new hybrid process: multi-point incremental forming (MPIF). International Journal of Material Forming (2018), 11; 815–827.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Materials Science and Manufacturing

Title: Effect of process parameters on the functional capability of High Temperature Shape Memory Alloys fabricated by laser additive manufacturing

ParisTech School: Arts et Métiers

Advisors Name: Pr. Mohamed El Mansori, Dr. Nan Kang, Dr. Mourad El Hadrouz

Advisors Email: mohamed.elmansori@ensam.eu; nan.kang@nwpu.edu.cn; mourad.elhadrouz@ensam.eu

Research group/Lab: MSMP - Mechanics Surfaces and Materials Processing
Lab location: Châlons-en-Champagne, France
Lab/Advisor website*):* https://www.msmp.eu ; https://www.researchgate.net/profile/Mohamed_EL_Mansori

Short description of possible research topics for a PhD:

Shape memory alloys (SMAs) are one class of materials exhibiting functional properties, which can return to a predetermined shape when heated. During the two last decades, intensive research has been carried out to enhance their properties at high temperature (above 100°C), thus trying to fill industrial need for applications of shape memory alloys at higher temperatures. In recent years, NiTi-based high temperature shape memory alloys (HTSMAs) have been introduced via substitution of Ni or Ti by a third element such as Hf, Zr, Pt, Pd, and Au. However, the commercialization of HTSMAs struggles as they suffer from either high elemental costs, limited workability, poor shape-recovery performance or brittleness. Recently, laser additive manufacturing (LAM) technologies, including powder feeding or powder bed, have been considered as one possible near net-shaped process to overcome these shortages.

In this project, the multi-scaled characterization methods, such as, 3D tomography, optic and electron microscopies will be employed for analysis of the densification behavior, microstructure, thermal and mechanical properties of laser additive manufactured NiTiHf HTSMAs. Nickel loss and oxygen pick up after SLM processing have been reported, which might be due to the associated high-power laser melting. This PhD program aims at optimizing the microstructure and laser power. Since the connection between manufacturing process control parameters and actual functional capability is of paramount importance, the understanding of the operational variables needs to be improved. Full-field methods (Phase-field and Level-set) will be developed to address the issue concerning the effect of process parameters on the final performance of a manufactured HTSMAs part.

Required background of the student:

The PhD candidate must have a solid knowledge of metal manufacturing process, in particular laser additive manufacturing, Materials Science, Metallurgy and Characterization methods (SEM, MET, XRD). Besides, numerical skills (Python) and good understanding of finite element methods are required.

A list of 5 (max.) representative publications of the group:

[1] N. Kang, X. Lin, M. El Mansori, Q.Z. Wang, J.L. Lu, C. Coddet, W.D. Huang, Additive Manufacturing 31 (2020) 100911.
[2] Kang, N., El Mansori, M. (2020) Tribology International, 149.
[3] Kang, N., Lu, J.L., Li, Q.G., Cao, Y.N., Lin, X., Wang, L.L., Huang, W.D., El Mansori, M. (2020) Vacuum, 179, art. no. 109557.
[4] Kang, N., Lin, X., Mansori, M.E., Wang, Q.Z., Lu, J.L., Coddet, C., Huang, W.D., (2020) Additive Manufacturing, 31, art. no. 100911.
[5] Kang, N., El Mansori, M., Lu, J.L., Lin, X., Huang, W.D. (2019) Wear, 426-427, pp. 934-941.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Materials Science and Manufacturing

Title: 4D printing of net-shape part made of Ni-Ti shape memory alloys fabricated by laser additive manufacturing

ParisTech School: Arts et Métiers

Advisors Name: Pr. Mohamed El Mansori, Dr. Nan Kang, Dr. Mourad El Hadrouz

Advisors Email: mohamed.elmansori@ensam.eu; nan.kang@nwpu.edu.cn; mourad.elhadrouz@ensam.eu

Research group/Lab: MSMP - Mechanics Surfaces and Materials Processing
Lab location: Châlons-en-Champagne, France
Lab/Advisor website*):* https://www.msmp.eu ; https://www.researchgate.net/profile/Mohamed_EL_Mansori

Short description of possible research topics for a PhD:

Nitinol is one of the most utilized alloys exhibiting the Shape Memory Effect, which makes it possible to use it in many applications, such as aerospace, automotive, biomedical and others. However, processing nitinol is highly sensitive to compositional and thermal changes, affecting the final phase structure and properties. Consequently, it shows very low machinability, which significantly impedes the manufacturing of complex components.
Recently, laser additive manufacturing (LAM) technologies, including powder feeding or powder bed, have been considered as one possible near net-shaped process to overcome these shortages. In particular, 4D printing allows creating the latest time-dependent 4D products from nitinol that can realize the Shape Memory Effect after 3D-printing. But laser, as one type of high energy beams, brings the inevitable vaporization or chemical micro-segregation, which greatly affects the thermal and mechanical behaviors of Nitinol.
In this project, the multi-scaled characterization methods, such as, 3D tomography, optic and electron microscopies will be employed for analysis of the densification behavior, microstructure, thermal and mechanical properties of laser additive manufactured Ni-Ti shape memory alloys. Then, according to the obtained process parameters-structure-properties relationship, a closed-cycling control processing will be established for the 4D printing technology. Since the connection between manufacturing process control parameters and actual functional capability is of paramount importance, the understanding of the operational variables needs to be improved. Full-field methods (Phase-field and Level-set) will be developed to address the issue concerning the effect of process parameters on the final performance of a manufactured SMAs part.

Required background of the student:

The PhD candidate must have a solid knowledge of metal manufacturing process, in particular laser additive manufacturing, Materials Science, Metallurgy and Characterization methods (SEM, MET, XRD). Besides, numerical skills (Python) and good understanding of finite element methods are required.

A list of 5 (max.) representative publications of the group:

[1] N. Kang, X. Lin, M. El Mansori, Q.Z. Wang, J.L. Lu, C. Coddet, W.D. Huang, Additive Manufacturing 31 (2020) 100911.
[2] Kang, N., El Mansori, M. (2020) Tribology International, 149.
[3] Kang, N., Lu, J.L., Li, Q.G., Cao, Y.N., Lin, X., Wang, L.L., Huang, W.D., El Mansori, M. (2020) Vacuum, 179, art. no. 109557.
[4] Kang, N., Lin, X., Mansori, M.E., Wang, Q.Z., Lu, J.L., Coddet, C., Huang, W.D., (2020) Additive Manufacturing, 31, art. no. 100911.
[5] Kang, N., El Mansori, M., Lu, J.L., Lin, X., Huang, W.D. (2019) Wear, 426-427, pp. 934-941.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering

Title: Toward a multiscale finite element modeling of the machining behavior of biocomposites

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Mohamed EL MANSORI, Faissal CHEGDANI, Mourad EL HADROUZ
Advisor(s) Email: mohamed.elmansori@ensam.eu ; faissal.chegdani@ensam.eu ; mourad.elhadrouz@ensam.eu
Research group/Lab: *Mechanics, Surfaces, and Materials Processing (MSMP – EA7350)*
Lab location: *Châlons-en-Champagne*
(Lab/Advisor website): *https://www.msmp.eu ; https://www.researchgate.net/profile/Mohamed_EL_Mansori*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Machining of natural fiber reinforced biocomposites has interested many research investigations to develop and control the process regarding the complex multiscale structure of natural fibrous reinforcement [1]. Indeed, this specific issue in natural fibers makes it difficult for the accurate prediction of the machinability of these ecofriendly materials. Thus, the research activities go toward the numerical modeling techniques in order to overcome the problem of the high variability of natural fiber properties. In the MSMP laboratory of Arts et Métiers, a 2D finite element micromechanical model has been developed to simulate the cutting behavior of each phase in the biocomposite (i.e. natural elementary fibers, polymer matrix, and cohesive interfaces) with specific consideration of the anisotropic elastoplastic behavior of natural fibers [2]. This model has then been optimized for a better prediction of the machining forces [3]. Based on these numerical works at microscale, the aim of this PhD program is to ascend the modeling scales for reaching the industrial macroscopic scale of the machining process. The PhD candidate has to define the representative volume element (RVE) of the biocomposite structure using the homogenization techniques with particular consideration to the multiscale thermomechanical behavior of natural fibers inside the composite [4,5].

Required background of the student: (What should be the main field of study of the applicant before applying?)

The PhD candidate must have a solid knowledge of mechanics of materials, finite element analysis, and programming techniques.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

[1] F. Chegdani, M. El Mansori, New Multiscale Approach for Machining Analysis of Natural Fiber Reinforced Bio-Composites, J. Manuf. Sci. Eng. Trans. ASME. 141 (2019) 11004. https://doi.org/10.1115/1.4041326.

[2] F. Chegdani, M. El Mansori, S. T. S. Bukkapatnam, J.N. Reddy, Micromechanical modeling of the machining behavior of natural fiber-reinforced polymer composites, Int. J. Adv. Manuf. Technol. 105 (2019) 1549–1561. https://doi.org/10.1007/s00170-019-04271-3.

[3] F. Chegdani, M. El Mansori, A.A. Chebbi, Numerical modeling of micro-friction and fiber orientation effects on the machinability of green composites, Tribol. Int. 150 (2020) 106380. https://doi.org/10.1016/j.triboint.2020.106380.

[4] F. Chegdani, Z. Wang, M. El Mansori, S.T.S. Bukkapatnam, Multiscale tribo-mechanical analysis of natural fiber composites for manufacturing applications, Tribol. Int. 122 (2018) 143–150. https://doi.org/10.1016/j.triboint.2018.02.030.

[5] F. Chegdani, M. El Mansori, S.T.S. Bukkapatnam, I. El Amri, Thermal effect on the tribo-mechanical behavior of natural fiber composites at micro-scale, Tribol. Int. 149 (2020). https://doi.org/10.1016/j.triboint.2019.06.024.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering

Title: Multiscale machinability analysis of biocomposites under the laser cutting process

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Mohamed EL MANSORI, Faissal CHEGDANI
Advisor(s) Email: mohamed.elmansori@ensam.eu ; faissal.chegdani@ensam.eu
Research group/Lab: *Mechanics, Surfaces, and Materials Processing (MSMP – EA7350)*
Lab location: *Châlons-en-Champagne*
(Lab/Advisor website): *https://www.msmp.eu ; https://www.researchgate.net/profile/Mohamed_EL_Mansori*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Machining of natural fiber reinforced biocomposites with the traditional processes has been revealed largely different from that of synthetic fiber composites because of the complex cellulosic structure of natural fibers that gives them an anisotropic elastoplastic behavior, leading to high transverse elasticity of elementary fibers during the contact with the cutting tool [1–3]. In the MSMP laboratory of Arts et Métiers, the multiscale issues of natural fiber composites have been investigated for the traditional machining processes in terms of surface finish, and a novel multiscale approach was developed to qualify the machinability of these ecofriendly materials [4]. The aim of this PhD program is to investigate and develop the technology of laser cutting so it can be applied to biocomposites. This requires a deep investigation of the multiscale thermomechanical comportment of the biocomposite structure that will control its laser cutting behavior. Since natural fibers have shown a particular thermomechanical behavior [5], the thermomechanical study should start from the nano-scale structure (cellulose microfibrils and natural amorphous polymers) to the micro-scale cell walls structure of elementary fibers and finally the overall macro-scale structure of the biocomposite. This work will lead to the design and development of the laser cutting technology for biocomposite materials that could be integrated into their production process chain.

Required background of the student: (What should be the main field of study of the applicant before applying?)

The PhD candidate must have a solid knowledge on mechanics of materials and should have the ability to characterize the thermo-mechanical behavior of different material types at different scale levels.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

[1] F. Chegdani, S. Mezghani, M. El Mansori, A. Mkaddem, Fiber type effect on tribological behavior when cutting natural fiber reinforced plastics, Wear. 332–333 (2015) 772–779. https://doi.org/10.1016/j.wear.2014.12.039.

[2] F. Chegdani, M. El Mansori, Mechanics of material removal when cutting natural fiber reinforced thermoplastic composites, Polym. Test. 67 (2018) 275–283. https://doi.org/10.1016/j.polymertesting.2018.03.016.

[3] F. Chegdani, B. Takabi, M. El Mansori, B.L. Tai, S.T.S. Bukkapatnam, Effect of flax fiber orientation on machining behavior and surface finish of natural fiber reinforced polymer composites, J. Manuf. Process. 54 (2020) 337–346. https://doi.org/10.1016/j.jmapro.2020.03.025.

[4] F. Chegdani, M. El Mansori, New Multiscale Approach for Machining Analysis of Natural Fiber Reinforced Bio-Composites, J. Manuf. Sci. Eng. Trans. ASME. 141 (2019) 11004. https://doi.org/10.1115/1.4041326.

[5] F. Chegdani, M. El Mansori, S.T.S. Bukkapatnam, I. El Amri, Thermal effect on the tribo-mechanical behavior of natural fiber composites at micro-scale, Tribol. Int. 149 (2020). https://doi.org/10.1016/j.triboint.2019.06.024.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanics of Materials, Phase Field Fracture, Shape Memory Alloys

Title: **Phase field fracture modelling of shape memory alloy actuators for aerospace applications**

ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Pr. Fodil MERAGHNI, Dr. Francis PRAUD, Dr. Boris PIOTROWSKI
Advisor(s) Email: fodil.meraghni@ensam.eu, francis.praud@ensam.eu, boris.piotrowski@ensam.eu
Research group/Lab: SMART research group / LEM3 UMR CNRS 7239 National Key Lab (Metz)
Lab location: Metz France
(Lab/Advisor website): http://www.lem3.univ-lorraine.fr/
Framework: Scientific collaboration with Prof. T. Baxevanis, University of Houston (USA)

Short description of possible research topics for a PhD:

Within the last decades, Shape Memory Alloys (SMAs) have demonstrated a great potential in various engineering applications in aerospace. Indeed, SMAs are particularly attractive in a wide range of actuator, energy absorption, and vibration damping devices. This is achieved thanks to their unique thermo-mechanical behaviour which results from a crystallographic phase transformation from austenite to martensite and vice-versa. In our research group several phenomenological and micromechanical models have been proposed to describe the thermomechanical response of SMAs but none of them integrate their strain localization effects and the related crack initiation and propagation.

The present work aims at formulating a model accounting for stress-induced phase transformation integrating the martensitic reorientation mechanism in conjunction with forward and reverse austenite-martensite transformation. This model will be next associated with the phase field fracture modelling framework, which has recently proven to be particularly attractive to handle fracture problems with inelastic constitutive models, like the ones traditionally employed for SMAs. The phase field fracture method is based on the variational approach to fracture, which aims at seeking both the displacement field and the crack surfaces while minimizing the potential energy of the system. Thus, by approximating the discrete topology of cracks by means of a spatially regularized scalar damage-like variable (so-called crack phase field), the problem is reduced to a set two strongly coupled partial differential equations, which is far more efficient than classical discontinuous methods. Initially developed for elastic brittle materials, the phase field fracture method has a great potential and will be extended to inelastic SMAs exhibiting phase transformations mechanisms.

Required background of the student:

Mechanical engineering, Mechanical behaviour of materials, Finite element method

A list of 5 (max.) representative publications of the group:

1. G. Chatzigeorgiou, Y. Chemisky, and F. Meraghni, “Computational micro to macro transitions for shape memory alloy composites using periodic homogenization,” Smart Mater. Struct., vol. 24, 2015.
2. F. Meraghni, Y. Chemisky, B. Piotrowski, R. Echchorfi, N. Bourgeois, and E. Patoor, “Parameter identification of a thermodynamic model for superelastic shape memory alloys using analytical calculation of the sensitivity matrix,” Eur. J. Mech. - A/Solids, vol. 45, pp. 226–237, 2014.
3. D. Chatziathanasiou, Y. Chemisky, G. Chatzigeorgiou, and F. Meraghni, “Modeling of coupled phase transformation and reorientation in shape memory alloys under non-proportional thermomechanical loading,” Int. J. Plast., vol. 82, pp. 192–224, 2016.
4. Y. Chemisky, D.-J. Hartl, and F. Meraghni, “Three-dimensional constitutive model for structural and functional fatigue of shape memory alloy actuators,” Int. J. Fatigue, vol. 112, pp. 263–278, 2018
5. D. Chatziathanasiou, Y. Chemisky, F. Meraghni, G. Chatzigeorgiou, and E. Patoor, “Phase Transformation of Anisotropic Shape Memory Alloys: Theory and Validation in Superelasticity,” Shape Mem. Superelasticity, vol. 1, no. 3, pp. 359–374, 2015.

Research Topic for the ParisTech/CSC PhD Program

Field: Energy, Processes
Subfield: Thermodynamics, fluid mechanics, heat transfer
Title: Life cycle assessment of hydrogen production and utilization in industry and mobility
ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Michael DELIGANT and Christelle PERILHON
Advisor(s) Email: michael.deligant@ensam.eu, christelle.perilhon@lecnam.net
Research group/Lab: Lifse
Lab location: Paris
(Lab/Advisor website): https://lifse.artsetmetiers.fr

Short description of possible research topics for a PhD:
Hydrogen is a promising energy vector that does not generate locally pollutants or carbon emissions. The benefits of hydrogen usages in industry and mobility in the future depend of the impact of the whole chain from production to consumption. Indeed, hydrogen can be produced from various sources ranging from methane cracking to electrolysis from renewable energy. Hydrogen production is also considered as solution for storing fluctuating renewable energy.
The objective of this study is to explore and evaluate the environmental impact of the different uses of hydrogen in the context of energy transition, industry and carbon-free transportations. This will be carried out combining the thermodynamic modelling and Life Cycle Assessment. Different case studies will be carried out taking into account the country production and its energy infrastructure.

Required background of the student: Energy, energy systems, thermodynamics, process engineering (appreciated)

A list of 5 (max.) representative publications of the group

1. C. Périlhon, D. Alkadee, G. Descombes, S. Lacour, Life cycle assessment applied to electricity generation from renewable biomass, Energy Procedia 18 (2012)
2. S. Lacour, T. Chinesea, D. Alkadee, C. Périlhon, G. Descombes, Energy and environmental balance of biogas for dual-fuel mobile applications, Renewable and Sustainable Energy Reviews, Volume 16, Issue 3, April 2012
3. P. Atta Atta, Y. N'guessan, C. Morin, A. Jaecker Voirol, G. Descombes. Calculation of greenhouse gas emissions of jatropha oil and jatropha biodiesel as alternative fuels for electricity production in Côte d'Ivoire. AIP Conference Proceedings 1814, (2017)
4. M. Specklin, M. Deligant, S. Porcheron, M. Wagner, F. Bakir Experimental study and modelling of a high-pressure ratio liquid piston compressor. HEFAT 2019, Wicklow, Ireland

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes
Subfield: Thermodynamics, fluid mechanics, heat transfer

Title: Heat transfer intensification for next generation thermal energy systems

ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Michael DELIGANT and Mathieu SPECKLIN
Advisor(s) Email: michael.deligant@ensam.eu, mathieu.specklin@lecnam.net
Research group/Lab: Lifse
Lab location: Paris
(Lab/Advisor website): https://lifse.artsetmetiers.fr

Short description of possible research topics for a PhD:
In all energy systems such as those used for electricity production, air conditioning or hydrogen compression heat transfer plays a crucial role on the efficiency of the system. This is especially important when operating in real gas conditions and in trans-critical conditions such as in heat pumps, super critical CO2 cycle and Organics Rankine cycle. Low or moderate heat transfer coefficient require higher temperature difference which destroy exergy and larger transfer area which increase the cost of the system.
In this study, we will investigate experimentally the possibilities of heat transfer intensification in trans-critical and supercritical conditions by mean of fluctuating flow rate, vibrating walls and surface treatments. For sub-critical and trans-critical conditions, the two phase flow and phase transition will also be investigated for the heat transfer enhancement. The results can be integrated in new models for CFD computations and systems modelling and will be used to carry out exergy analysis of an integrated system.

Required background of the student: Energy, energy systems, thermodynamics

A list of 5 (max.) representative publications of the group
1. M. Deligant, E. Sauret, Q. Danel, and F. Bakir. Performance assessment of a standard radial turbine as turbo expander for an adapted solar concentration ORC. Renewable Energy, 2020
2. M. Specklin, M. Deligant, S. Porcheron, M. Wagner, F. Bakir Experimental study and modelling of a high-pressure ratio liquid piston compressor. HEFAT 2019, Wicklow, Ireland
3. M. Deligant,X. Nogueira, S. Khelladi, E. Sauret, B. Reding. Toward a high resolution real gas finite volume solver with multi Optimal Order Detection. 5th International Seminar on ORC Power Systems, Athens, Greece, 2019
4. M. Deligant, M. Specklin, and S. Khelladi. A naturally anti-diffusive compressible two phases kapila model with boundedness preservation coupled to a high order finite volume solver. Computers and Fluids, 114, 2015

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng.…)

Title: Modeling of metal nanoparticles embedded in viscoelastic media using fluid-structure interaction approach.

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Adil El Baroudi, Jean-Yves Le Pommellec and Amine Ammar
Advisor(s) Email: adil.elbaroudi@ensam.eu; jeanyves.lepommellec@ensam.eu; amine.ammar@ensam.eu.
Research group/Lab: LAMPA
Lab location: Angers
(Lab/Advisor website):

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Vibration modes in nanostructures present a major interest in characterization of the materials properties. In particular, virus is known to resonate in the confined-acoustic dipolar mode with microwave of the same frequency. Indeed, investigating the vibrational modes of viruses has been motivated by the possibility of using ultrasonic waves to destroy or to inactivate a virus present in a living organism. The vibration of a free homogeneous and isotropic sphere was studied by Lamb using the theory of elastic media. However the free sphere model used to interpret the experimental results is a rough approximation of the actual environmental conditions of nanoparticles. A more general theory based on nonlocal elasticity for accurately predicting the vibration modes of nanosphere embedded in a viscoelastic media is the subject of this thesis. Several constitutive laws of the viscoelastic medium must be considered in order to obtain a more realistic model.

Required background of the student: (What should be the main field of study of the applicant before applying?)

Master Mechanics, Physics, Mathematics.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. A. El Baroudi and J. Y Le Pommellec. Bleustein-Gulyaev waves in a finite piezoelectric material loaded with a viscoelastic fluid, to appear in *Wave Motion* (2021).
2. A. El Baroudi. A note on the spheroidal modes vibration of an elastic sphere in linear viscoelastic fluid, *Physics Letters A*, 384(23), 126556 (2020).
3. X. Yang, A. El Baroudi and J. Y Le Pommellec. Analytical approach for predicting vibration characteristics of an embedded elastic sphere in complex fluid, *Archive of Applied Mechanics*, 16 pages (2020).
4. A. El Baroudi and J. Y Le Pommellec. Surface wave in a Maxwell liquid-saturated poroelastic layer, *Applied Acoustics*, 159, 6 pages (2019).
5. A. El Baroudi and J. Y Le Pommellec. Viscoelastic fluid effect on the surface wave propagation, *Sensors and Actuators A: Physical*, 291, 188--195 (2019).

Research Topic for the ParisTech/CSC PhD Program

Fields: Design & Industrialization, Information and Communication Sciences and Technologies, Mathematics and their applications.

ParisTech School : Arts et Métiers Sciences and Technologies – Laboratory LISPEN Campus of Aix-en-Provence

Title : **Deep learning and multimodal declarative modeling for fast sketching of draft CAD models in the creative design phases**

Advisor(s):
Prof. Dr. Jean-Philippe PERNOT / jean-philippe.pernot@ensam.eu / https://lispen.ensam.eu
Dr. Arnaud POLETTE / arnaud.polette@ensam.eu / https://lispen.ensam.eu
Dr. Romain PINQUIE / romain.pinquie@grenoble-inp.fr / https://g-scop.grenoble-inp.fr

Short description of possible research topics for a PhD :
This PhD program addresses the way draft CAD models can be efficiently sketched from a combination of multimodal inputs. Such an approach is particularly interesting in the creative design phases when the shapes are not yet fully defined and when the designer may be interested in describing his/her shapes using multiple modalities. The main idea relies on the development of a new declarative modeling framework which will drive an existing CAD modeler, and/or research prototype software, from a user-specified description combining the use of a dedicated vocabulary/grammar as well as the possible use of low-cost interaction devices. Several modules are foreseen. In a first step, the designer will describe his/her shape using a vocabulary and grammar and possibly using interaction devices such as a Leap Motion or a Kinect. Here, a Convolutional Neural Networks (CNN) will be trained to be able to generate coarse 3D representations from 2D sketches. This will be made possible by means of an ad-hoc combination of shape descriptors. Then, this description will be processed and transformed in a generic shape description, i.e. a set of generic geometric operations that can be used to obtain the shape whatever the CAD modeler or research prototype software are. At this stage, the system will have to manage issues related to the possible incompleteness and/or inconsistency of the user-specified description. Finally, this generic shape description will be transformed in a set of geometric operations specific to a CAD modeler and/or research prototype software. The output of this modeling process will be a draft CAD model to be used and further refined in the later stages of the design process. The proposed framework will be implemented and validated on academic as well as industrial examples.

Required background: Computer science, geometric modeling, computer-aided design.

A list of 5 (max.) representative publications of the group:
Pernot J-P., Falcidieno B., Giannini F., Léon J-C., Incorporating free-form features in aesthetic and engineering product design: State-of-the-art report, Computers in Industry, vol. 59(6), pp. 626-637, 2008.
Gouaty G., Fang L., Michelucci D., Daniel M., Pernot J-P., Raffin R., Lanquetin S., Neveu M., Variational geometric modeling with black box constraints and DAGs, Computer-Aided Design, vol. 75-76, pp. 1-12, 2016.
Décriteau D., Pernot J-P., Daniel M., Towards a declarative modelling approach built on top of a CAD modeller, Computer-Aided Design and Applications, vol. 13(6), pp. 737-746, 2016.
Lupinetti K., Giannini F., Monti M., Pernot J-P., Content-based multi-criteria similarity assessment of CAD assembly models, Computers in Industry, vol. 112, 113111, pp. 1-20, 2019.
Li Z., Giannini F., Pernot J-P., Véron P., Falcidieno B., Reusing heterogeneous data for the conceptual design of shapes in Virtual Environments, Virtual Reality, Springer, vol. 21(3), pp. 127-144, 2017.

Research Topic for the ParisTech/CSC PhD Program

***Field (cf. List of fields below):** *Mechanics, Materials Science, Fluids*
Subfield: Mechanical engineering, Computational mechanics, Mechanics of Materials.

Title: **Experimental and numerical investigation of non-local damage in polymer based composites accounting for hygro-thermo-mechanical couplings.**

ParisTech School: Arts et Metiers Institute of Technology
Advisor(s) Name: Prof. Fodil Meraghni, Dr-HDR. George Chatzigeorgiou, Dr. Adil Benaarbia
Advisor(s) Email: fodil.meraghni@ensam.eu, adil.benaarbia@ensam.eu, georges.chatzigeorgiou@ensam.eu
Research group/Lab: **SMART** Research group **/ LEM3 UMR CNRS 7239** National Key Lab (Metz)
Project in the framework of scientific collaboration with University of Freiburg (Germany)

Short description of possible research topics for a PhD:

Reinforced thermoplastics remain a very challenging research topic due to their sensitivity to the production process, as well as their actual service conditions. The proposed Ph.D. project aims at developing new experimental and multiscale modelling methodologies to characterize the thermo-hygro-mechanical behavior of these materials and to develop predictive computational tools. The new models should integrate the environmental (humidity, temperature, etc.), as well as the localization effects of the thermoplastic-based composites, addressing also their complex constitutive behavior.

The main experimental challenge is to estimate the different quantities (dissipation, internal energy variations, thermomechanical sources, etc.) necessary for the establishment of a proper energy balance. This task, which is carried out classically on mesoscopic scales, can be advantageously completed by a study of the microstructural evolution mechanisms, mechanisms at the origin of the dissipative effects and the heterogeneous development of the deformation fields. The Ph.D. hosting team has a technological platform with the required experimental techniques. The full-field measurements at different scales of observation using experimental imaging techniques (infrared thermography, digital image correlation), combined with the knowledge of evolution mechanisms at the microscale (microtomography), constitute, in fact, valuable information for research conducted on multiscale methods. All the experimental aspects will be addressed in collaboration with colleagues from I2M (Bordeaux).

The second task of this research project is to facilitate and value the transfer of the results obtained by designing predictive multiscale models, fully adaptable to numerical techniques employed in structural computations via finite element software. Most of the models commonly used in the industry belong to the family of local description models, which cannot handle non-local effects. The challenge is to develop a modelling framework that avoids the pathologies related to localization, taking also into account the environmental effects. A phenomenological thermo-viscoelastic-viscoplastic-damageable model was recently developed by the Ph.D. hosting team to integrate the dissipative and thermomechanical coupling effects observed during the fatigue deformation of a thermoplastic matrix. The developed model was also utilized in a multiscale scheme for thermoplastic woven composites. The existing local model will therefore be regularized by introducing the damage gradient at the level of the constitutive law. To this end, the team will be supported by its established collaboration with TU Bergakademie Freiberg (Germany).

Required background of the student:

Applicants should have, or expect to achieve at least a Master's degree (or an equivalent overseas degree) in Mechanical Engineering. Candidates with suitable experience in numerical modeling, experimental testing and/or measurement skills are particularly welcome to apply.

A list of 5(max.) representative publications of the group: (Related to the research topic)

1- Arif MF., Meraghni F., Chemisky Y., Despringre N., Robert G (2014). In situ damage mechanisms investigation of PA66/GF30 composite: Effect of relative humidity. Composites Part B: Engineering 58, 487-495.
2- Tikkarouchine E., Benaarbia A., Chatzigeorgiou G., Meraghni F., (2020). Non-linear FE^2 multiscale simulation of damage, micro and macroscopic strains in polyamide 66-woven composite structures: analysis and experimental validation. Composite Structures: 255: 112926.
3- Benaarbia A., Chatzigeorgiou G., Kiefer B., Meraghni F. (2019). A fully coupled thermo-viscoelastic-viscoplastic-damage framework to study the cyclic variability of the Taylor-Quinney coefficient for semi-crystalline polymers. International Journal of Mechanical Sciences 163: 105128.
4- Benaarbia A., Chrysochoos A., Robert G (2015). Thermomechanical behavior of PA6. 6 composites subjected to low cycle fatigue. Composites Part B: Engineering 76, 52-64.
5- Chatzigeorgiou G., Charalambakis N., Chemisky Y., Meraghni F (2018). Thermomechanical Behavior of Dissipative Composite Materials. Elsevier.

Research Topic for the ParisTech/CSC PhD Program

Field: Energy, Processes
Subfield: Electrical Engineering
Title: Model Order Reduction for Uncertainty Quantification in Computational Electromagnetics
ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Stéphane Clénet
Advisor(s) Email: *stephane.clenet@ensam.eu*
Research group/Lab: *L2EP*
Lab location: *Lille*
(Lab/Advisor website): *http://l2ep.univ-lille.fr/?lang=en*

Short description of possible research topics for a PhD:
To go further in the improvement of the performances of electromagnetic devices, e.g., in terms of energy efficiency or robustness, models, able to describe the device in the "real world" during its whole life cycle, are required. These models must account for imperfections, like those introduced by the manufacturing processes or due to aging. These imperfections are often difficult to characterize, or they are intrinsically dispersive because they change with time leading to uncertainties on the parameters of the model (dimensions, physical properties of the material…). "Real world" model must account for uncertainties. The objective of the PhD is to develop methods to quantify the effect of uncertainties in the case of numerical models based on the finite element method in the field of low frequency computational electromagnetics. These methods are hardly used to study "real world" applications since they require a huge computation time. Recent advances in applied mathematics in the field of model order reduction will be leveraged to overcome this issue.

Required background of the student: Numerical Analysis – Scientific Programming (Experience in Electrical Devices is not required)

A list of 5 (max.) representative publications of the group:

1. D. E. Abdelli, T. T. Nguyen, S. Clénet and A. Cheriet, "Stochastic Metamodel for Probability of Detection Estimation of Eddy-Current Testing Problem with Random Geometry," in IEEE Transactions on Magnetics, vol. 55, no. 6, pp. 1-4, June 2019, Art no. 6200604, doi: 10.1109/TMAG.2019.2893421.
2. T. Henneron, A. Pierquin and S. Clénet, "Surrogate Model Based on the POD Combined With the RBF Interpolation of Nonlinear Magnetostatic FE Model," in IEEE Transactions on Magnetics, vol. 56, no. 1, pp. 1-4, Jan. 2020, Art no. 7501504, doi: 10.1109/TMAG.2019.2949751.
3. D. Zhou, T.T. Nguyen, E. Breaz. D. Zhao, S. Clénet, F. Gao, "Global parameters sensitivity analysis and development of a two-dimensional real-time model of proton-exchange-membrane fuel cells," in Energy Conversion and Management vol. 162, pp. 276-292, doi: 10.1016/j.enconman.2018.02.036
4. M. Al Eit, S. Clénet and T. Henneron, "Finite-Element Model Reduction of Surface-Mounted Permanent Magnet Machines by Exploitation of Geometrical Periodicity," in IEEE Transactions on Magnetics, vol. 54, no. 9, pp. 1-11, Sept. 2018, Art no. 7402411, doi: 10.1109/TMAG.2018.2830753.
5. M. Farzamfar, A. Belahcen, P. Rasilo, S. Clénet and A. Pierquin, "Model Order Reduction of Electrical Machines With Multiple Inputs," in IEEE Transactions on Industry Applications, vol. 53, no. 4, pp. 3355-3360, July-Aug. 2017, doi: 10.1109/TIA.2017.2681967.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes

Subfield: Electrical Engineering

Title: Sensorless Control for Integrated Multiphase Drives applied to Transportation Systems Using Artificial Intelligence Potentiality

ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Prof. Eric Semail
Advisor(s) Email: Dr. Ngac Ky Nguyen
Research group/Lab: Laboratory of Electrical Engineering and Power Electronics (L2EP)
Lab location: ENSAM, 8 Boulevard Louis XIV, 59046 Lille, France
(Lab/Advisor website): http://l2ep.univ-lille.fr/?lang=en

Short description of possible research topics for a PhD:

This project aims to study a **compact** and **performant integrated multiphase drive**, including **fault modes**, for **automotive mass market**. In this context, price, reliability and compacity are the main criteria. Among the sensors, the end-shaft mechanical position sensor is the most expensive one and is consuming space. Using only current measurement could lead to a suppression of the end-shaft position sensor. **Sensorless control algorithms** have been proposed for three-phase drives since several decades with the increase of power calculation for signal processing. With multiphase machines, it is possible to use additionally magnetic sensors to increase the number of data of the rotor position which will be used for vector control even in fault modes.
Artificial Intelligence (AI) will be investigated for sensorless algorithm development. With multiphase machines using numerous current and magnetic sensors, we propose, by **coupling AI with expert knowledges on electrical multiphase machines**, to obtain reliable and real-time estimation of the rotor position for a use in the vector control in healthy but also in fault mode operation.

***Required background of the student*:**

Beside a good level of English, the recruited student must have:
- A strong background of electrical machines
- A good general culture of scientific research, i.e a Master Research Diploma is helpful
- A good skill for working autonomously and within a team

A list of 5 (max.) representative publications of the group (related to the topic):

1. X. Kestelyn and E. Semail, "A Vectorial Approach for Generation of Optimal Current References for Multiphase Permanent-Magnet Synchronous Machines in Real Time," IEEE Transactions on Industrial Electronics, vol. 58, pp. 5057-5065, Nov 2011.
2. N. K. Nguyen, F. Meinguet, E. Semail, and X. Kestelyn, "Fault-Tolerant Operation of an Open-End Winding Five-Phase PMSM Drive with Short-Circuit Inverter Fault," Industrial Electronics, IEEE Transactions on, vol. 63, pp. 595-605, 2016.
3. N. K. Nguyen, E. Semail, F. D. Belie, and X. Kestelyn, "Adaline Neural Networks-based sensorless control of five-phase PMSM drives," in IECON 2016 - 42nd Annual Conference of the IEEE Industrial Electronics Society, 2016, pp. 5741-5746.
4. Y. Mini, N. K. Nguyen, E. Semail, "A novel Sensorless Control Strategy Based on Sliding Mode Observer for Non-Sinusoidal Seven-phase PMSM", The 10th International Conference on Power Electronics, Machines and Drives, December 2020 (accepted)
5. D. A. T. Guzman, N. K. Nguyen, M. Trablesi, and E. Semail, "Low Speed Sensorless Control of Non-Salient Poles Multiphase PMSM," in 2019 IEEE International Conference on Industrial Technology (ICIT), 2019, pp. 1563-1568.

ParisTech   Arts Sciences et Technologies et Métiers

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: *Materials Science, Mechanics, Fluids*

Subfield: Materials Science & Engineering

Title: Improvement of surface properties by PVD-Thermochemistry hybrid treatment on metal substrates obtained by conventional manufacturing processes and by powder metallurgy

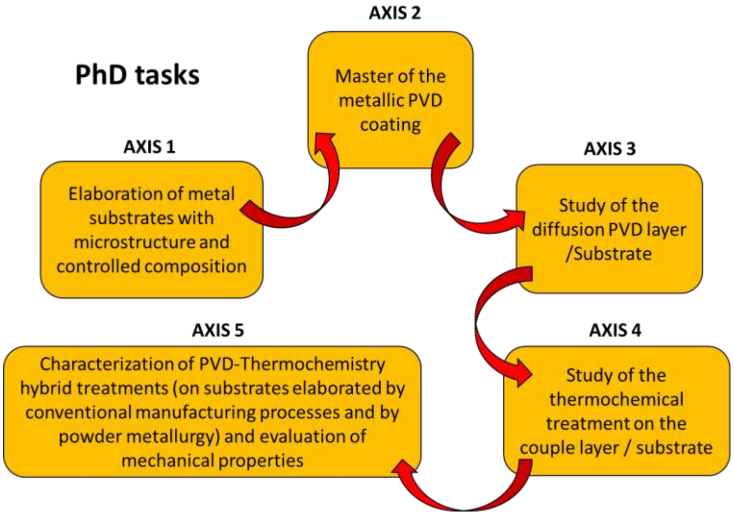
ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: NOUVEAU Corinne
Advisor(s) Email: **corinne.nouveau@ensam.eu**
Research group/Lab: Materials and Surface Engineering Team / Laboratoire Bourguignon des Matériaux et Procédés (LaBoMaP)
Lab location: Cluny, FRANCE
(Lab/Advisor website): labomap.ensam.eu

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

The LaBoMaP has a recognized expertise in vacuum treatment products, which are commonly used in numerous domains (transport, health, energy, etc.). The purpose is to improve the surface properties of the devices, in particular to protect them from severe solicitations (corrosion, abrasion, etc.). Both processes studied in the laboratory are Physical Vapor Deposition (PVD) and thermochemical treatments under vacuum, as well as their combination or "hybrid treatments". The aim is to thermochemically treat PVD metallic coatings (such as Cr, Ti..) to convert them in binary compounds (CrN, TiC etc). The objective of this PhD will be to master the numerous parameters that can influence both processes, to obtain the hard surface layer and the adequate gradient of hardness for its mechanical strength. First, substrates obtained by conventional manufacturing processes (forging, rolling) will be used. Then, the same substrates will be elaborated by metal powders in ICB laboratory (University of Burgundy, Dijon), having a reputed expertise in this field, by Spark Plasma Sintering (SPS) and the Hot Isostatic Pressing (HIP).

The project will be organized in 5 axes according to the following figure:



Required background of the student: (What should be the main field of study of the applicant before applying?)

1. A master's degree in materials science (knowledge in metallurgy, surface treatments, diffusion, characterizations techniques such as SEM, XRD, EBSD etc).
2. Ability to work independently, to plan and carry out tasks, and to be a part of a large, dynamical group.
3. Good communication skills in English and/or French, both written and spoken.
4. Experience with powder metallurgy is an advantage but not an exclusion criterion.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Influence of Substrate Bias Voltage on Corrosion and Wear Behavior of Physical Vapor Deposition CrN Coatings, Aouadi, K., Tlili, B., **Nouveau, C.**, ...Chafra, M., Souli, R., Journal of Materials Engineering and Performance, 2019, 28(5), pp. 2881-2891
2. Low-temperature plasma nitriding of martensitic stainless steel, Rao, K.R.M., **Nouveau, C.**, Trinadh, K., Transactions of the Indian Institute of Metals, 2020, 73(6), pp. 1695-1699
3. Thermal treatment effect on structural and mechanical properties of Cr–C coatings, Fellah, M., Aissani, L., Zairi, A., ...Montagne, A., Iost, A., Transactions of the Institute of Metal Finishing, 2018, 96(2), pp. 79-85
4. A study of the tribological behavior of duplex treatment, Siad A., **Nouveau C.**, Besnard A., Jacquet P, Annales de Chimie - Science Des Matériaux, 2015, 39(3-4), pp. 201-208
5. Influence of the process parameters on the microstructure of a hardfacing coating elaborated by hot isostatic pressing, Tellier, A., **Ardigo-Besnard, M.R.**, Chateau-Cornu, J.-P., Archives of Metallurgy and Materials, 2019, 64(1), pp. 33-38

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Energy, Processes

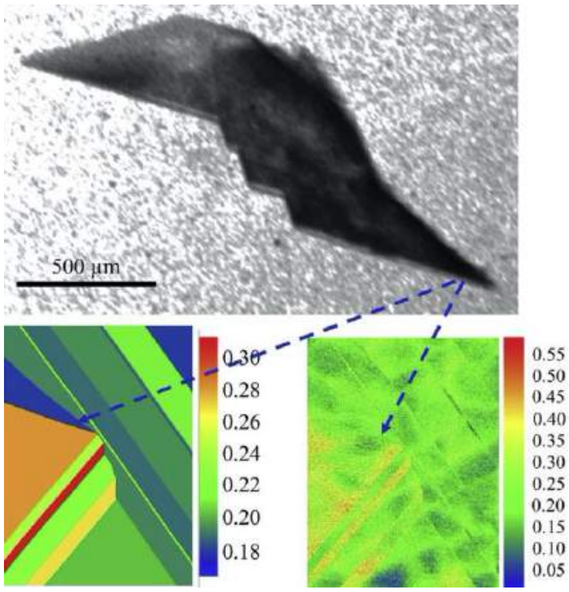
Subfield: Materials Science and Mechanical Engineering

Title: Multiscale stress/strain analysis of polycrystalline silicon for photovoltaic applications

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Pr. Laurent BARRALLIER
Advisor(s) Email: laurent.barrallier@ensam.eu
Research group/Lab: MMS Team - MSMP Lab.
Lab location: Aix-en-Provence, France
(Lab/Advisor website): msmp.eu

Short description of possible research topics for a PhD:



Strain in polycrystalline silicon [3].

Polycrystalline silicon (PS) is a raw material used by the solar photovoltaic (PV) and electronics industry. The reduction of the cost of PV cells production is largely possible by using PS. Nevertheless, the limitation of PS use is directly linked to the microstructure of the material i.e. i) the active defects such as grain boundaries, dislocation arrangements, … ii) but also the mechanical fields induced by these defects. The efficiency of PV cells is depending on the mastering of the defect generation, their repartition and the induced strain/stress fields during the fabrication of PS.
The aim of this project is to characterize the induced residual stress fields of PS in relation with their microstructure. Experimental methods used to determine residual stresses fields will be based on multiscale diffraction in-lab technics such as High-Resolution Electron Backscatter Diffraction (HR-EBSD), X-ray diffraction (XRD) of synchrotron facility. To understand the origin of residual stress fields in PS cells, the temperature HR-EBSD and XRD measurements will be coupled with polycrystalline thermo-elasto-plasticity simulation using finite element method (FEM).

Required background of the student:
Materials Science and/or Mechanical Engineering

A list of 5 (max.) representative publications of the group:

1. M. Becker, E. Pihan, F. Guittonneau, L. Barrallier, G. Regula, H. Ouaddah, G. Reinhart, and N. Mangelinck-Noël. Investigation of subgrains in directionally solidified cast mono-seeded silicon and their interactions with twin boundaries. *Solar Energy Materials & Solar Cells*, 218(110817):1-10, décember 2020.
2. N. Mangelinck-Noel, H. Ouaddah, M. Becker, T. Riberri-Beridot, M. Tsoutsouva, V. Stamelou, G. Regula, G. Reinhart, I. Péricaud, F. Guittonneau, L. Barrallier, J.-P. Valade, A. Rack, E. Boller, and J. Baruchel. X-ray based in situ investigation of silicon growth mechanism dynamics-application to grain and defect formation. *Crystals*, 10(7):1-25, july 2020.
3. T. Riberi-Béridot, M.G. Tsoutsouva, G. Regula, G. Reinhart, F. Guittonneau, L. Barrallier, and N. Mangelinck-Noël. Strain building and correlation with grain nucleation during silicon growth. *Acta Materiala*, 177:141-150, 09 2019.
4. M.G Tsoutsouva, T. Riberi-Béridot, G. Regula, G. Reinhart, J. Baruchel, F. Guittonneau, L. Barrallier, and N. Mangelinck-Noël. In situ investigation of the structural defect generation and evolution during the directional solidification of 110 seeded growth si. *Acta Materiala*, 115:210-223, August 2016.
5. T. Riberri-Beridot, N. Mangelinck-Noel, A. Tandjouai, G. Reinhart, B. Billia, B. Lafford, J. Baruchel, and L. Barrallier. On the impact of twinning on the formation of the grain structure of multi-crystalline silicon for photovoltaic applications during directional solidification. *Journal of Crystal Growth*, (418):38-44, 2015.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids
Subfield: Mechanical Engineering

Title: Study of the performance of recycled CO_2 as cryogenic assistance in machining process: experimentation and numerical simulation
ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Hélène. BIREMBAUX, Gérard POULACHON, Frédéric ROSSI
Advisor(s) Email: helene.birembaux@ensam.eu, gerard.poulachon@ensam.eu, frederic.rossi@ensam.eu
Research group/Lab: Arts et Métiers, ParisTech, LaBoMaP, UBFC
Lab location: F-71250 Cluny, France
(Lab/Advisor website): http://labomap.ensam.eu/
Short description of possible research topics for a PhD:
The machining industry is constantly looking for new solutions to increase productivity and the quality of finished products. Machining assistance is one of the most effective ways to increase chip rate and maintaining the tool-life. The traditional use of cutting fluids like lubricants oil based has a strong impact on the ecology and economy of the process (recycling, cleaning, etc.). The objective of this project is to study and optimize the cutting process under recycled supercritical CO2 as cryogenic assistance. The study will be realized on Titanium's alloys following two steps:

1- Identification of the cutting mechanisms: The intense cooling of the primary cutting zone induces modifications of the constitutive laws of materials. The shear and flow mechanisms of the material are concerned. Numerical simulation of material behaviors will be used to validate experimental tests.
2- Study the tribology of the interface between the tool and the workpiece : Experimental and numerical investigation will be carried out on tribometer, The real conditions will be taken into account to develop a wear model under cryogenic assistance.

Required background of the student:
1. A master's degree in mechanical engineering. The candidate must have a good knowledge in machining techniques and a strong taste for rigorous implantation of highly instrumented experimental procedures. He (or she) must have good programming skills in numerical simulation.
2. Ability to work independently, to plan and carry out tasks
3. Good communication skills in English, written and spoken.

A list of 5 (max.) representative publications of the group:

1. Merzouki J, Poulachon G, Rossi F, Ayed Y, Abrivard G. Effect of cryogenic assistance on hole shrinkage during Ti6Al4V drilling. The International Journal of Advanced Manufacturing Technology (2020), 108:2675–2686. https://doi.org/10.1007/s00170-020-05381-z
2. Merzouki J, Poulachon G, Rossi F, Ayed Y, Abrivard G. Method of hole shrinkage radial forces measurement in Ti6Al4Vdrilling. Procedia CIRP, 16th

CIRP conference on Modelling of machining operations (16th CIRP CMMO) (2017), 58:629–634. https://doi.org/10.1016/j.procir.2017.03.226
3. Lequien P, Poulachon G, Outeiro J.C. Thermomechanical analysis induced by interrupted cutting of Ti6Al4V under several cooling strategies. CIRP Annals, Manufacturing Technology (2018), 67(1). https://10.1016/j.cirp.2018.03.018

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Design Engineering / 3D Modeling

Title: Geometric simplification of digital CAD mock-up using substitution and envelope generation techniques exploiting explicit and implicit semantic information

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Professor Philippe VERON
Advisor(s) Email: Philippe.veron@ensam.eu
Research group/Lab: Head of Carnot ARTS institute / LISPEN Laboratory
Lab location: Aix-en-Provence
(Lab/Advisor website): lispen.ensam.eu / https://scholar.google.fr/citations?user=qZ6InYkAAAAJ&hl=fr

Short description of possible research topics for a PhD:

The digital mock-up is a key component in the innovative manufacturing product development process. It is an efficient support platform for multidisciplinary collaborative development of products which become increasingly complex and developed in an extended enterprise mode.
If the digital mock-up is mainly built the in product engineering phases, its progressive enrichment is leaded through its ability to unify all areas of the company with levels of details increasingly fine. This is an important objective to represent and simulate as close to reality the future product, manufacture it globally, but also assure its support all along its lifecycle, especially in an economic context where the supply chains are playing an increasingly critical role and where the markets targeted by companies become globalized. Therefore, this Digital Mock-Up becomes increasingly "heavy" particularly in terms of its geometric definition that is more and more detailed.
In this context, a challenge is to be able to exploit the 3D digital mock-up for all kinds of activities including computer simulation and visualization and using mobile media (tablets) more and more frequently used. For this, it is necessary to be able to simplify the 3D geometric representation of the model to make it compatible with the needs of the activity and with the associated constraints (size of problem, processing time, quality, real-time, ...).
Current simplification techniques are mainly based on defeaturing approaches (removal of characteristics forms on the parts that constitute more or less important shape details), or on decimation approaches (reduction of the number of triangles associated with the polyhedral representation of the different parts). All these approaches are generally well suited if you do not simplify too much the initial shape and they generally give poor or even unusable results when we need highly simplified form (or get a very simple shape that look like the overall initial form). In addition, all these approaches work mainly for parts and rarely for assemblies.
As a consequence, a first axis of this thesis work is to develop a new approach for the massive simplification of huge digital mock-ups based on a principle of shape substitutions (analysis of the initial shape and replacing it by one or more simple substitution shapes). Initially, work will focus on the part level (component) and can be extended / generalized to assemblies (assembly level).

Required background of the student: 3D CAD modeling, programming language, computer graphics, machine learning basics

A list of 5 (max.) representative publications of the group:

https://scholar.google.fr/citations?user=qZ6InYkAAAAJ&hl=fr

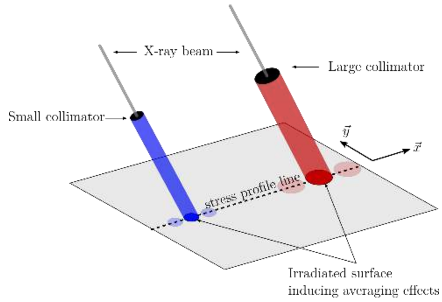
Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering

Title: Reconstruction of heterogeneous surface residual-stresses in polycrystalline materials from X-ray diffraction measurements
ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Chedly Braham & Léo Morin
Advisor(s) Email: chedly.braham@ensam.eu & leo.morin@ensam.eu
Research group/Lab: PIMM laboratory (Comet Group)
Lab location: Paris
(Lab/Advisor website): https://pimm.artsetmetiers.fr/en

Short description of possible research topics for a PhD:
Residual stresses have a significant influence on the engineering properties components such as fatigue life. X-ray diffraction (XRD) constitutes a high accuracy and non-destructive way to determine residual stresses with a very good precision and resolution in depth due to the important absorption of X-ray in metallic alloys. Despite its important success and its high precision in-depth, the X-ray diffraction method remains inaccurate in the presence of high surface stress gradients, due to averaging effects over the irradiated area. This has important consequences in processing validation because averaging effects on residual stresses measured by XRD prevent a proper comparison with the local residual stresses determined numerically by finite elements. The main purpose of this PhD is to develop a method to reconstruct heterogeneous residual-stresses at the surface of polycrystalline materials from XRD measurements. 2D maps of residual-stress will be collected on specimens obtained by several processes such as severe plastic deformation, machining or welding, using an articulated robot. A deconvolution method will be developed in order to reconstruct the local residual stress field from the average data collected. Finally, finite element simulations of the processes considered will be performed to assess the reconstructed residual stress distributions.



Required background of the student: Mechanical engineering, material science

A list of 5 (max.) representative publications of the group:

1. Peyre, P., Sollier, A., Chaieb, I., Berthe, L., Bartnicki, E., Braham, C., Fabbro, R., 2003. FEM simulation of residual stresses induced by laser Peening. The European Physical Journal - Applied Physics 23, 83-88.
2. Rhouma, A.B., Sidhom, N., Makhlouf, K., Sidhom, H., Braham, C., Gonzalez, G., 2019. Effect of machining processes on the residual stress distribution heterogeneities and their consequences on the stress corrosion cracking resistance of AISI 316l SS in chloride medium. The International Journal of Advanced Manufacturing Technology 105, 1699-1711.
3. Reyes-Ruiz, C., Figueroa, I.A., Braham, C., Cabrera, J.M., Zanellato, O., Baiz, S., Gonzalez, G., 2016. Residual stress distribution of a 6061-T6 aluminum alloy under shear deformation. Materials Science and Engineering: A 670, 227-232.
4. Ezequiel, M., Figueroa, I.A., Elizalde, S., Cabrera, J.M., Braham, C., Morin, L., Gonzalez, G., 2020. Numerical and experimental study of a 5754-aluminum alloy processed by heterogeneous repetitive corrugation and straightening. Journal of Materials Research and Technology 9, 1941-1947.
5. Ben Fredj, N., Ben Nasr, M., Ben Rhouma, A., Sidhom, H., Braham, C., 2004. Fatigue life improvements of the AISI 304 stainless steel ground surfaces by wire brushing. Journal of Materials Engineering and Performance 13, 564-574.

ParisTech

Arts Sciences et Technologies et Métiers

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Materials science and mechanics

Title: Experimental and numerical development of a High-Entropy High-Temperature Shape Memory Alloy (HE-HTSMA)

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Fodil MERAGHNI and Sophie BERVEILLER
Advisor(s) Email: fodil.meraghni@ensam.eu ; sophie.berveiller@ensam.eu
Research group/Lab: SMART/LEM3
Lab location: Metz (France). www. Lem3.unvi-metz.fr (Lab/Advisor website):

Short description of possible research topics for a PhD:

One on hand, High Entropy alloys are under development: these single-phased materials contain at least 5 chemical elements which is responsible for high mechanical properties. On the other hand, SMAs exhibit superelastic and/or shape memory effect, induced by a reversible martensitic transformation that can occur at high temperatures (leading to the so-called HTSMA). The aim of this study is to combine both behavior, HE and HTSMA, to develop a HE-HTSMA in order to improve the mechanical properties of a Ti-Nb SMA over a large range of temperature. For that purpose, two main objectives will be achieved:

- Experimental part: first, the specific composition will be chosen based on HE criteria. After elaboration, the microstructure and mechanical behavior will be characterized and optimized by thermal treatments.
- Numerical part: based on these experimental data, a micromechanical model will be developed taking into account the martensitic transformation in the behavior law.

Required background of the student: materials science, diffraction

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. PELTIER L, LOHMULLER P, MERAGHNI F, BERVEILLER S, PATOOR E, LAHEURTE P. Investigation and Composition Characterization of a “NiTi-like” Alloy Combining High Temperature Shape Memory and High Entropy. Shape Mem Superelasticity 2020. 6(2), pp. 273-283

2. CAUVIN L, RAGHAVAN B, BOUVIER S, WANG X and MERAGHNI F. Multi-Scale Investigation of Highly Anisotropic Zinc Alloys Using Crystal Plasticity and Inverse Analysis. Materials Science and Engineering: A, 2018; 729:106–118.

3 .CHEMISKY Y, HARTL DJ, MERAGHNI F. Three-dimensional Constitutive Model for Structural and Functional Fatigue of Shape Memory Alloy Actuators. International Journal of Fatigue. 2018; 112:263–278.

4. CHATZIATHANASIOU D, CHEMISKY Y, CHATZIGEORGIOU G, MERAGHNI F. Modeling of coupled phase transformation and reorientation in shape memory alloys under non-proportional thermomechanical loading. International Journal of Plasticity, 2016; 82: 192-224.

5. CHATZIATHANASIOU D, CHEMISKY Y, MERAGHNI F, CHATZIGEORGIOU G, PATOOR E. Phase Transformation of Anisotropic Shape Memory Alloys: Theory and Validation in Superelasticity, Shape Mem. Superelasticity, 2015; Vol. 1; pp. 359-374.

1.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng.…) Industrial Engineering

Title: Towards the definition of I4.0 KPIs

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Ali SIADAT, Virginie GOEPP, Nathalie KLEMENT
Advisor(s) Email: ali.siadat@ensam.eu, virginie.goepp@insa-strasbourg.fr, Nathalie.klement@ensam.eu
Research group/Lab: LCFC, ICube, LISPEN
Lab location: Metz, Strasbourg, Lille
(Lab/Advisor website): http://lcfc.ensam.eu/, http://icube.unistra.fr/en/

Short description of possible research topics for a PhD:
The Industry4.0 context drives the manufacturing companies towards the implementation of Reconfigurable Manufacturing Systems (RMS) enabling agility. In this context, assessing the performance of such systems becomes even more crucial. Generally, this requires to define a set of relevant KPIs (Key Performance Indicator) like these defined in the ISO 22400 standard and to manage them preferably on-line and dynamically.
Several indicators should be defined to help the manager to know the state of his system: indicators about reconfigurabitility or performance indicators. For instance, these indicators could help the manager to decide how to reconfigure his system, or simply to modify the allocation of resources.
Nowadays, thanks to Industry 4.0 new concepts such as decentralized control system, many information, data, are available at any moment and everywhere. How to exploit these data to better define the considered system, follow it through a dashboard, help the manager to take the right decision at the right time? This can be done through Cyber Physical Production System.
Therefore, the objective of this PhD would be to define what could be “I4.0 KPIs” that is to say which should be the relevant set of KPIs for RMSs and how to manage them dynamically that is to say how to make them change according to the system configuration.

Required background of the student: (What should be the main field of study of the applicant before applying?)
Industrial engineering, Information system, operational research

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Wu, X., Goepp, V., Siadat, A. “Concept and engineering development of cyber physical production systems: a systematic literature review” International Journal of Advanced Manufacturing Technology, 2020, 111(1-2), pp. 243-261
2. Wu, X., Goepp V., Siadat A. “The integrative link between cyber physical production systems and enterprise information systems” accepted to the 49th International Conference on Computers & Industrial Engineering conference (CIE 49), October 18-21, 2019, Beihang University, Beijing, China
3. Nieto, F. D. M., V. Goepp and E. Caillaud (2017). "From Factory of the Future to Future of the Factory: Integration Approaches." Ifac Papersonline 50(1): 11695-11700.
4. A. Beauville dit Eynaud, N. Klement, L. Roucoules, O. Gibaru and L. Durville. “Framework for the design and evaluation of a reconfigurable production system based on mobile robot integration”. In : Submitted to JMS (2020), 2nd revision.
5. Kenza AMZIL, Esma YAHIA, Nathalie KLEMENT and Lionel ROUCOULES “Causality learning approach for supervision in the context of Industry 4.0”, Springer2021, In the International Joint Conference on Mechanics, Design Engineering and Advanced Manufacturing (JCM 2020)

Research Topic for the ParisTech/CSC PhD Program

Field: Energy, Processes

Subfield: Fluid mechanics, Aeroacoustics, Turbomachinery

Title: Study of the aeroacoustic behavior of counter rotating subsonic axial flow fans

ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Name: S. Kouidri, F. Ravelet, S. Khelladi
Advisors Email: Smaine.kouidri@ensam.eu florent.ravelet@ensam.eu Sofiane.khelladi@ensam.eu
Research group/Lab: LIFSE
Lab location: Paris
Lab website: https://lifse.artsetmetiers.fr

Short description of possible research topics for a PhD:
Noise pollution has become an important environmental concern. Increasing comfort requirements and tightening the world regulations have transformed the reduction of the aerodynamic noise of turbomachines into a crucial issue for many industries. Various sectors are concerned: cooling automotive and electronic circuits, air conditioning in air transport or terrestrial as well as in the building, ventilation of industrial installations, air conditioning or refrigeration. The sound discrimination of a turbomachine is now a criterion of selection and quality. Moreover, the specifications submitted to the manufacturers fans include increasingly severe limitations of the maximum noise level. These noise limitations are often accompanied by a demand for increased power aerodynamic and compactness reduction. It is therefore necessary to predict the noise generated by a fan and particularly the master of the unsteady flow surrounding airfoils.

The aims of this PhD is to study how the counter rotating fans can help to answer to this issue. At present, the design method of counter-rotating axial flow fan taking into account the aeroacoustic behavior are insufficient and the experimental results and data are few. There are also problems such as low efficiency, structural vibration, blade stall, specific to this technology. The reason is that the design of counter-rotating axial flow need to be further investigated. The fundamental way to improve the aeroacoustic performances of counter-rotating axial-flow fan is therefore to identify the main geometrical and physical control parameters related to the noise generation mechanisms.

Required background of the student:
Fluid mechanics, Mechanical Engineering

A list of representative publications of the group:

1. S. Khelladi, S. Kouidri, F. Bakir, R. Rey, Predicting Tonal Noise from a High Speed Vaned Centrifugal Fan, Journal of Sound and Vibration, 2008
2. J. Hurault, S. Kouidri, F. Bakir, R. Rey, Experimental investigations on the wall pressure measurement on the blade of axial flow fans, Flow Measurement and Instrumentation, 2010
3. H. Nouri, F. Ravelet, F. Bakir, C. Sarraf, R. Rey, Design and experimental validation of a ducted counter-rotating axial-flow fans system. Journal of Fluids Engineering, 2012
4. H. Nouri, A. Danlos, F. Ravelet, F. Bakir, C. Sarraf, Experimental study of the instationary flow between two ducted counter-rotating rotors. Engineering for Gas Turbines and Power, 2012.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Non-destructive analysis, residual stresses, fatigue damage, X-ray

Title: Development of non-destructive characterization method using X ray diffraction line profile analysis and synthetic materials

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Lorène Héraud
Advisor(s) Email: Lorene.heraud@ensam.eu
Research group/Lab: MMS/MSMP
Lab location: Aix-en-Provence, France
(Lab/Advisor website): https://www.msmp.eu/

Short description of possible research topics for a PhD:

This project combines experimentation and modeling and aims to propose a new method for characterizing the mechanical state of a material and its damage accumulation. The mechanical properties of materials, resulting from fabrication processes, are linked to microstructure, residual stresses level and heterogeneities. During a part's life, an accumulation of damage up to failure can be induced by repeated load or temperature cycles or irradiation for example. As illustrated in the figure the heterogeneity of deformations within a microstructure can be deduced from the broadening of X ray diffraction peaks. It is thus possible to set up in-situ and non-destructive monitoring of damage using X-ray diffraction line profile analysis. Digital twins will be created by simulating the microstructure with its mechanical heterogeneities and by adding damage (FE simulation). Using diffraction laws with these digital twins will allow to link mechanical microstructural states to the shapes of diffraction peaks. This method will find its place in the R&D of materials with gradients of mechanical states and in the non-destructive characterization of fatigue damage in industrial domains such as aeronautics or automotive.

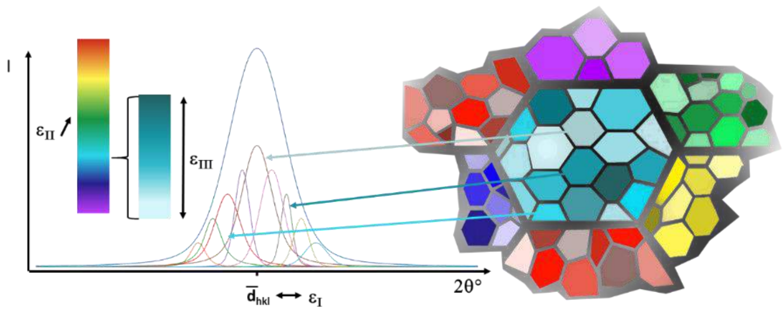


Figure: *Schematic illustration of the heterogeneity of deformation in a microstructure; 3 orders: ε_I, ε_{II}, ε_{III} respectively mean deformation, heterogeneities between grains, heterogeneities though a grain.*

Collaboration with a Chinese laboratory would be welcomed.

Required background of the student

Ideally, the applicant comes from materials science education with knowledge of mechanics of materials. He knows how to carry out experimental manipulations and is comfortable with implementation of digital models using Abaqus and Python.

A list of 5 (max.) representative publications of the group:

1. L. Heraud, L. Barrallier. Fine analysis of superelasticicitic transformation and microdeformations by in situ cyclic tensile tests under X-ray synchrotron radiation 10th Edition European Conference on Residual Stresses - ECRS10 Leuven, Belgium, 2018.
2. Depriester et R. Kubler, Calculs Éléments Finis à l'échelle des grains depuis des données EBSD, Congrès Français de Mécanique, 2019.
3. M. Kbibou, L. Barrallier, M. El Mansori, L. Héraud, In-situ characterization of the liquid-solid phase transition in small volume, Surface and coatings technology, 46th ICMCTF (International Conference on Metallurgical Coatings and Thin films), 2019.
4. C. Deleuze, L. Barrallier, A. Fabre, O. Molinas, C. Esbrard, Microstructure characterisation of biphasic titanium alloy Ti - 10V - 2Fe - 3Al and effects induced by heterogeneities on X-ray diffraction peak's broadening, Materials Science and Technology, 2010.
5. A. Fabre, S. Jégou, L. Barrallier, Qualification of the damage induced by friction using X-ray Diffractometry, 2014

ParisTech

Arts Sciences et Technologies et Métiers

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Very-high-cycle fatigue strength of metals under multiaxial stress state

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Prof. PALIN-LUC Thierry ; Prof. HONG Youshi; Prof. QIAN Guian
Advisor(s) Email: *thierry.palin-luc@ensam.eu*, *hongys@imech.ac.cn*, *qianguian@imech.ac.cn*
Research group/Lab: *Institute of Mechanics and Mechanical Engineering (I2M), UMR CNRS 5295 (France)*
and Institute of mechanics, Chinese academy of sciences (China)

Lab location: *Bordeaux and Bejin*
(Lab/Advisor website): *http://i2m.u-bordeaux.fr and*
http://sourcedb.imech.cas.cn/zw/rck0/zgjzj/fxxlx/201211/t20121129_3694914.html

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
The design of safe components capable to endure a very high number of loading cycles: 10^9 cycles and more, is a very important challenge for engineers in oder to guaranty very long life of products. If the fatigue strength of components can now be simulated up to 10^7 cycles under complex loadings that are representative of real multiaxial loadings and stress states, this is not the case in the gigacycle regime (10^9 cycles and more). Indeed, since the end of the last century it is known that there is no infinite fatigue life of metals. The crack initiation mechanisms are more and more understood under uniaxial loadings (tension, bending) and a few models only have been published to assess the fatigue strength of metals under such loadings in the gigacycle regime. But there is nothing published under multiaxial loadings that are representative of real load cases of components.
A few ultrasonic fatigue testing machine have been recently developed in our team to test metallic specimens under torsion or under biaxial bending. A quite comprehensive study on very-high-cycle fatigue of different materials has also been performed in our team. The aim of this PhD is to study the gigacycle fatigue strength of two metallic alloys (an aluminum one and a steel) under uniaxial (tension) and multiaxial (torsion and biaxial bending). The crack initiation and early crack growth mechanisms will be studied to propose a fatigue criterion capable to compute the very-high-cycle fatigue strength under multiaxial loadings.

Required background of the student: (What should be the main field of study of the applicant before applying?)

Solid mechanics, Mechanical engineering, Material science, Material physics

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. A. Nikitin, T. Palin-Luc, A. Shanyavskiy (2016) Crack initiation in VHCF regime on forged titanium alloy under tensile and torsion loading modes, International Journal of Fatigue, Vol. 93, pp. 318–325.
2. C. Brugger, T. Palin-Luc, P. Osmond and M. Blanc (2017) A new ultrasonic fatigue testing device for biaxial bending in the gigacycle regime, Internation Journal of Fatigue, vol. 100, pp. 619 – 626.
3. A. Banvillet, T. Palin-Luc and S. Lasserre (2003) A volumetric energy based high cycle multiaxial fatigue criterion. Int. Journal of Fatigue, Vol. 25, pp. 755-769.
4. G. Qian, C. Zhou and Y. Hong (2015) A model to predict S–N curves for surface and subsurface crack initiations in different environmental media, Int. J. Fatigue, Vol. 71, pp. 35-44.
5. G. Qian, C. Zhou and Y. Hong (2011) Experimental and theoretical investigation of environmental media on very-high-cycle fatigue behavior for a structural steel, Acta Materialia, Vol. 59, pp. 1321-1327.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Biomedical Engineering / Life and Health Science and Technology

Subfield: Fluid mechanics, Biomechanics, Biofluidics

Title: Modeling the control parameters of pulsed flow through a Drug elucting stent

ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Name: Smaine Kouidri, Mathieu Specklin
Advisors Email: Smaine.kouidri@ensam.eu Mathieu.specklin@ensam.eu
Research group/Lab: LIFSE
Lab location: Paris
Lab website: https://lifse.artsetmetiers.fr

Short description of possible research topics for a PhD:

Controlling blood flow and the associated pathologies is an important health issue. The practitioners in the field of cardiovascular medicine have joined forces with researchers in the field of fluid mechanics since several decades, in order to better understand and especially anticipate certain pathologies. The emergence of bioengineering and new numerical technologies through additive manufacturing or connected objects is leading to an acceleration of innovations in this field. Despite of the considerable progress, the works carried out still give unsatisfactory results and require models that are more in conformity with the proposed solutions geometrically and physically. The endoprostheses considered as the arterial geometrical singularities have been widely studied in the context of pathologies relating to the blocked blood flow caused by the reduction of artery cross section. Instead of simplified geometrical model, the practical stent and artery geometries are required necessarily to be established. The considerations of a more realistic constitution of fluid as well as taking into account the elasticity of artery wall need to be added in the model. Regarding the active stent, physics existed in the tissue are necessary to be taken in account which can greatly relate to the drug transfer process. Validation works are still not enough which need to be achieved by the experiments.

In the thesis envisaged, both theoretical and experimental research works will be dedicated to the modeling of pulsed flow through arterial geometrical singularities, relatively closer to the practical case. The manufacture of the endoprosthesis will be carried out with additive manufacturing techniques, more precisely by deposition of materials by fusion (FDM). The geometrical model of the artery will be established from the real case of diseased patient through collaborations with hospital. Fluid-structure interaction will be achieved by considering the elasticity of artery wall. Moreover, the determinations by numerical simulations of the parietal flow behaviors and validated experimentally will make it possible to quantify the influence of the geometrical characteristics of the singularities.

Required background of the student:

Fluids Mechanics, Mechanical Engineering

A list of representative publications of the group:

1. J. Song , S. Kouidri, F. Bakir, Numerical study of hemodynamic and diagnostic parameters affected by stenosis in bifurcated artery, Computer methods in biomechanics and biomedical engineering, June 2020
2. N. Abbasnezhad, N. Zirak, M. Shirinbayan, S. Kouidri, E. Salahinejad A. Tcharkhtchi F. Bakir Controlled release from polyurethane films: drug release mechanisms, Journal of Applied Polymer Science, December 2020
3. J. Song , S. Kouidri, F. Bakir, Numerical study on flow topology and hemodynamics in tortuous coronary artery with symmetrical and asymmetrical stenosis, Biocybernetics and Biomedical Engineering, January 2021
4. F. Chabi, S. Champmartin, C. Sarraf, R. Noguera, Critical evaluation of three hemodynamic models for the numerical simulation of intra-stent flows, Journal of Biomechanics, June2015

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

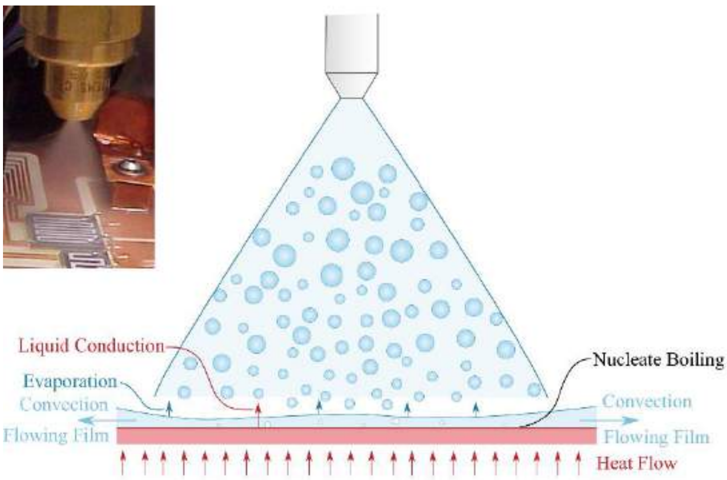
Subfield: Mechanical Engineering / Energy Engineering

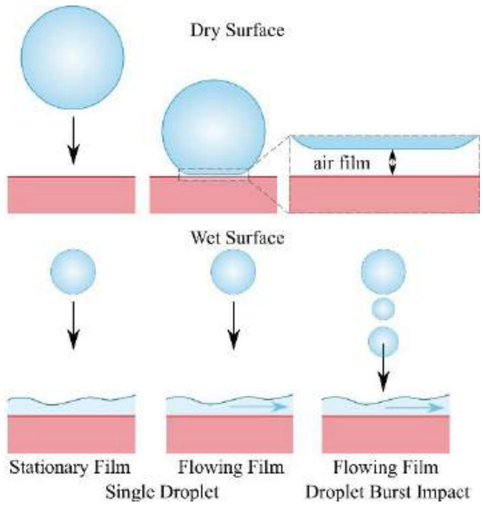
Title: Numerical Simulation of Droplet Impingement for Chip Cooling Process

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Antoine Dazin, Francesco Romanò
Advisor(s) Email: antoine.dazin@ensam.eu, francesco.romano@ensam.eu
Research group/Lab: Laboratoire de Mécanique des Fluides de Lille (LMFL)
Lab location: 8 bd Louis XIV - 59046 LILLE Cedex
(Lab/Advisor website): http://lmfl.cnrs.fr/en/home/

Short description of possible research topics for a PhD: Liquid spray cooling is widely employed as a high-heat-flux-removal method for electronic components generating an intense thermal load. The optimization of spraying technology is strongly related to the challenging fluid mechanics phenomena involving droplet-wall and droplet-liquid film interactions, heat transfer and phase changes (see figure). The aim of this project is to simulate the complex physics related to several configurations occurring in the spray dynamics. The first phases of the cooling process will involve the impingement of a droplet on a dry surface. Thereafter, when a thin film of liquid formed on the chip, the droplets will impact on a stationary liquid film coating the hot wall. Finally, for heavier coolant flow rates, the liquid film on the wall will start flowing and the droplet(s) will impinge on a moving liquid surface. The droplet(s) dynamics will be simulated using a scale-matching technique based on multiphase numerical simulations (CFD) carried out with the in-house solver developed at LMFL [1]. Capillary and Marangoni stresses, heat transfer and phase change will be considered.





Required background of the student: Fluid Mechanics or Applied Mathematics

A list of 5 (max.) representative publications of the group:

1. M. Muradoglu, F. Romanò, H. Fujioka, J. B. Grotberg, J. Fluid Mech., 872 (2019) 407–437.
2. F. Romanò, H. Fujioka, M. Muradoglu, J. B. Grotberg, Phys. Rev. Fluids, 4 (2019) 093103.

ParisTech

Arts Sciences et Technologies et Métiers

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: (Applied Mechanics)

Title: Influence of rheological and frictional slip properties on fault mechanics and localization phenomena.
ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Name: Saber EL AREM, Amine Ammar
Advisors Email: saber.elarem@ensam.eu, amine.ammar@ensam.eu
Research group/Lab: LAMPA
Lab location: Angers, France
(Lab/Advisor website):http://lampa.ensam.eu/

Short description of possible research topics for a PhD:
In the last two decades, considerable observational and theoretical work has been devoted to all aspects of earthquake prediction research, for solving fundamental questions concerning the mechanics of fault systems, as well as for answering questions regarding earthquake hazard. The european natural observatory of the Corinth Rift (http://crlab.eu), a very rapidly deforming area (opening strain rate of ~10^{-6} /yr) where one or more earthquakes with magnitudes above 6 are expected in the coming decades provides a framework in which the mechanics of faults can be studied in details. It is densely instrumented and provides an exceptional data base (seismological, GPS and strain data). All the prediction approches in the litterature rely on some probalistic description of earthquake generation and timing, through empirical laws guided, or structured, by some simplification of the underlying physical process. This requires that relevant physical models and observational constraints are put at the core of any probabilistic law seismic-hazard assessment. Based on numerical modeling of the CRL region with realistic rheology and fault geometry, our objective is to constrain these key mechanical parameters by improving our ability to model the mechanics of faults in the Corinth Rift as well as their interactions.
Required background of the student: Mechanics, Physics, Applied mathematics.

A list of 5 (max.) representative publications of the group:
1. P. Bernarda, H. Lyon-Caen, al. Tectonophysics, Volume 426, Issues 1–2, 30 October 2006, Pages 7–30

2. S. El Arem, H. Lyon-Caen, P. Bernard, J-D Garaud, F. Rolandone, and P. Briole. In EGU General Assembly Conference , volume 15, page 14477, Vienna, Austria, 2013
3. S. El Arem, H. Lyon-Caen, P. Bernard, J-D Garaud, F. Rolandone, and P. Briole. In EGU General Assembly Conference , volume 15, page 14477, Vienna, Austria, 2013

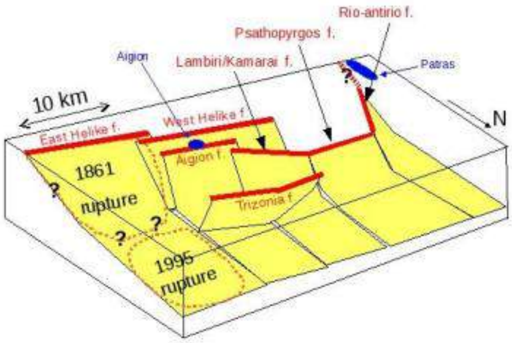


Figure 1: sketch of the major active faults of the CRL area. *Surface scarps in red. Trizonia fault is the only south dipping fault. The 1995 may have occurred on the Helike fault (uncertain dip and connectivity)*

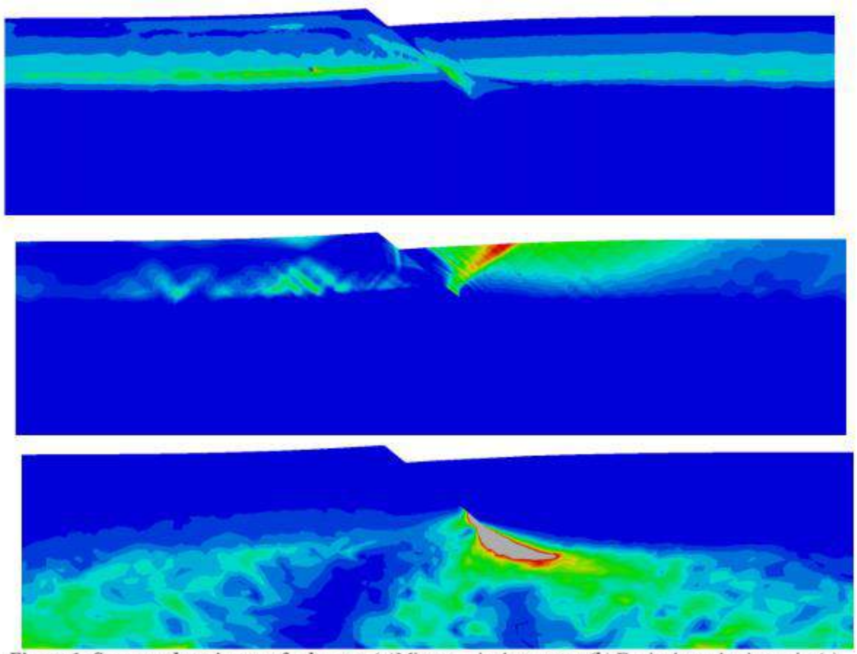


Figure 1: Stress and strain near fault zone. (a)Mises equivalent stress ***(b)*** Equivalent plastic strain ***(c)*** Equivalent creep strain.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanics of Materials

Title: Phase field modeling of damage and fracture in polycrystalline materials under thermomechanical loading

ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Names: Saber EL AREM, Amine Ammar
Advisors Email: saber.elarem@ensam.eu, amine.ammar@ensam.eu
Research group/Lab:LAMPA
Lab location: Angers, France
(Lab/Advisor website):http://lampa.ensam.eu/

Short description of possible research topics for a PhD:
In the present work, we are interested in the development of a model which is dedicated to the description of damage in polycrystalline metallic materials. This study aims at building a model that would describe how cracks initiate, propagate and interact with each other at the micro-scale.
To reach this objective, it is proposed to use the phase field method (PFM) within the context of polycrystalline plasticity. Indeed, within the framework of irreversible thermodynamics, the phase-field method has proved to be extremely powerful in the description of microstructural transformations without having to track the evolution of individual interfaces, as in the case of sharp interface models. In the present case, it is expected that the introduction of an order parameter associated with damage will allow for capturing some complex phenomena like crack kinking or crack branching.
The proposed study would therefore consists of:
(1) Defining an appropriate set of internal variables (and the associated energy potential) to deal with both elasticity, plasticity and damage in crystalline materials at the micro-scale
(2) Deriving the evolution equations associated with the different internal variables within the context of the phase field method
(3) Implementing the constitutive equations within an appropriate numerical solver (finite element solver for instance)
(4) Validating the proposed formulation by testing its ability to reproduce some known experimental results.
At the end of this PhD research program, the numerical model will allow for investigating the interactions between various physical mechanisms governing the macroscopic behavior (e.g. plasticity, damage) at different length scales.

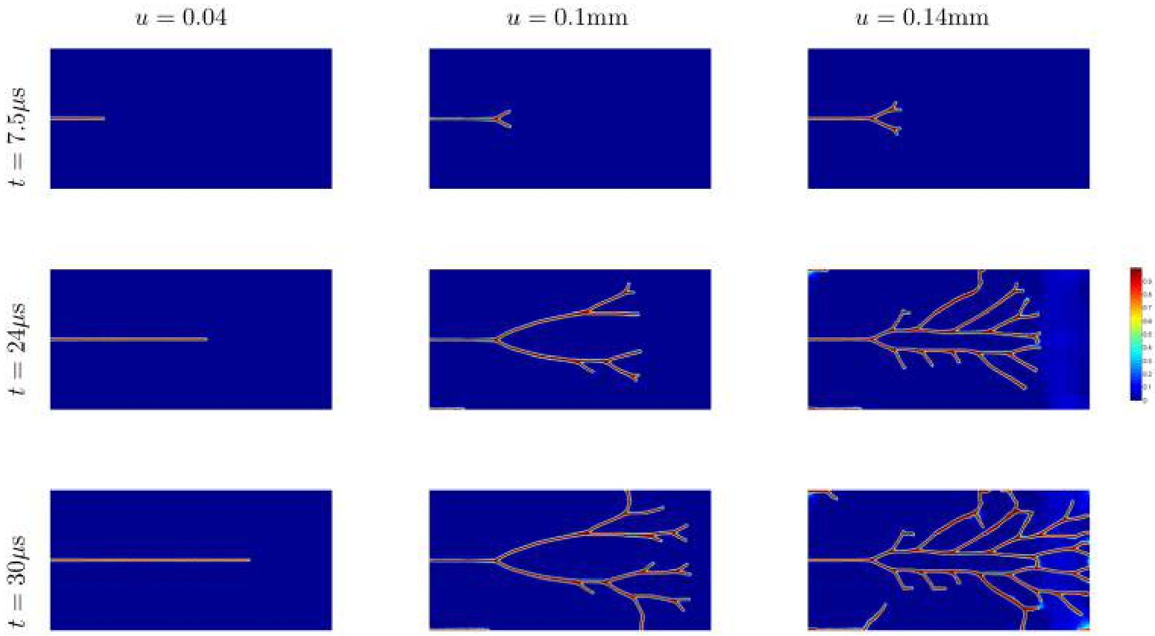


Figure 1: Notched rectangular plate under dynamic tension (Gmati 2020)

Required background of the student:
Mechanics, Physics, Applied mathematics

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Gmati,H. “Phase field modelling of fracture of elastic and elastoviscoplastic solid materials”, Thèse de doctorat ENSAM, 2020
2. Gmati, H, Mareau, C, Ammar, A, El Arem, S. A phase - field model for brittle fracture of anisotropic materials. *Int J Numer Methods Eng*. 2020; 121: 3362– 3381. https://doi.org/10.1002/nme.6361
3. H. Gmati C. Mareau,S. El Arem, A. Ammar. « Phase field modeling of damage and fracture inp olycristalline materials », MECAMAT, Aussois, France,2019
4. Modèle de champ de phase pour l'étude de l'endomagement et la rupture dans les matériaux cristallins », Colloque national MECAMAT, Aussois, France, 2018

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: (Applied Mechanics)

Title: A systematic approach for cracked rotating shaft analysis

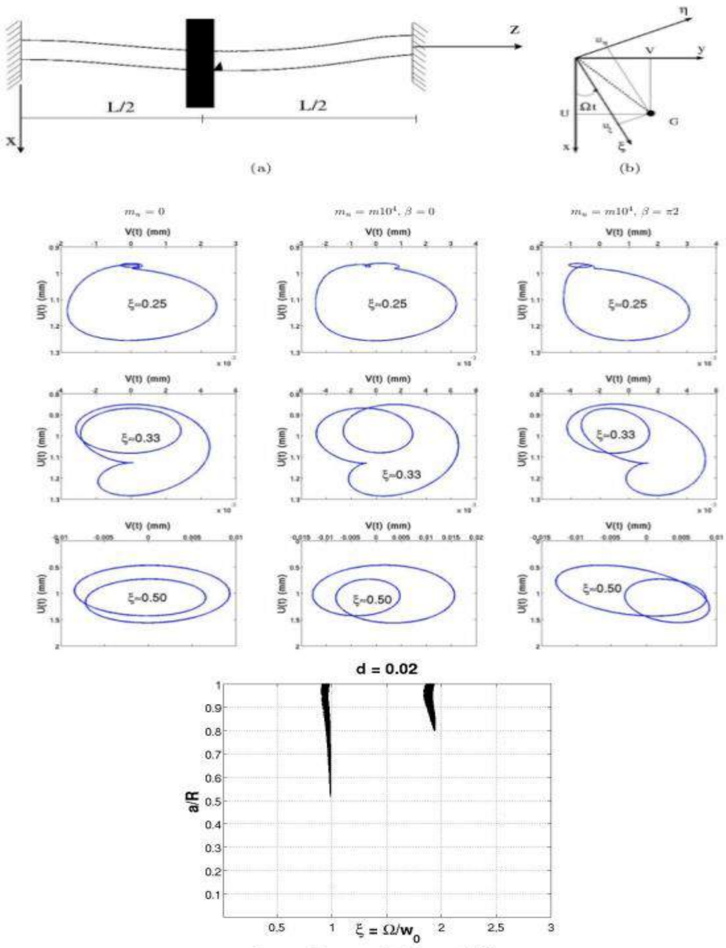
ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Names: Saber EL AREM, Amine Ammar
Advisors Email: saber.elarem@ensam.eu, amine.ammar@ensam.eu
Research group/Lab: LAMPA
Lab location: Angers, France
(Lab/Advisor website):http://lampa.ensam.eu/

Short description of possible research topics for a PhD:
For rotating shafts, a propagating fatigue crack can have detrimental effects on the reliability of a process or utility plant where these vital parts are subjected to very arduous working conditions in harsh environment. The vibration analysis and modeling of the shaft and cracks are necessary for a reliable identification of the crack location and depth to avoid catastrophic failures. In fact, cracks can develop and propagate to relevant depths without affecting consistently the normal operating conditions of the shaft. We recently have presented a systematic approach in dealing with the problem of modeling cracked rotating shafts. The breathing mechanism identification is the crucial step in the process and has been made with the greatest care. The approach presented is original and its implementation in industrial context is straight forward. The objective, based on previous development we have recently proposed, is to build a finite element of cracked rotor to be use to explore the problem of multiple cracks affecting the same shaft and to suggest an analysis methodology.
Required background of the student: Mechanics, Physics, Applied mathematics.

A list of 5 (max.) representative publications of the group:
1. S. El Arem. On the mechanics of beams and shafts with cracks : A standard and generic approach. Eur Jou Mechanics-A/Solids 85,104088, 2020

2. S. El Arem. Nonlinear analysis, instability and routes to chaos of a cracked rotating shaft. Nonlinear Dynamics , 96(1) :667-683, 2019
3. S. El Arem and M. Ben Zid. On a systematic approach for cracked rotating shaft study : breathing mechanism, dynamics and instability. Nonlinear Dynamics , 88(3) :2123-2138, 2017
4. S. El Arem and Q.S. Nguyen. Nonlinear dynamics of a rotating shaft with a breathing crack. Annals of Solid and Structural Mechanics , 3(1-2) :1-14, 2012
5. S. El Arem and H. Maitournam. A cracked beam finite element for rotating shaft dynamics and stability analysis. J. of Mechanics of Materials and Structures , 3(5) :893-910, 2008



Igure: System, Orbits, stability

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

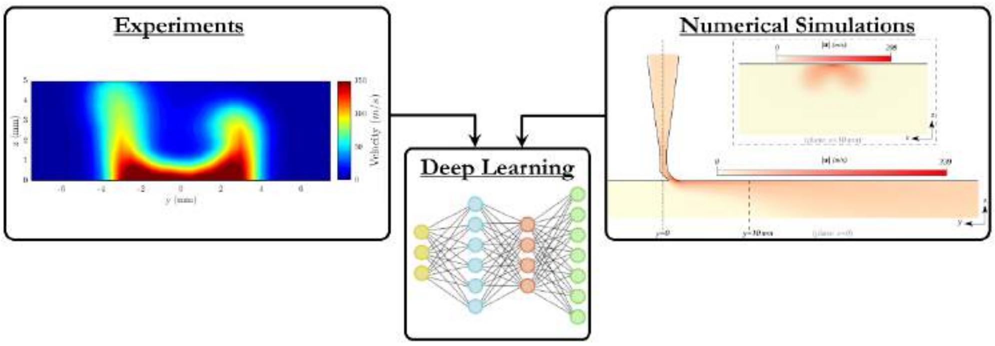
Subfield: Mechanical Engineering

Title: Optimizing flow control actuators by data-driven reduced-order models

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Francesco Romanò, Joseph Pierric, Antoine Dazin
Advisor(s) Email: francesco.romano@ensam.eu, joseph.pierric@ensam.eu, antoine.dazin@ensam.eu
Research group/Lab: Laboratoire de Mécanique des Fluides de Lille (LMFL)
Lab location: 8 bd Louis XIV - 59046 LILLE Cedex
(Lab/Advisor website): http://lmfl.cnrs.fr/en/home/

Short description of possible research topics for a PhD: Physics informed neural networks are tools recently developed to solve learning tasks within the framework of physical constraints. Starting from a set of data, the neural network can also be used to find a mathematical model (a set of partial differential equations) that well reproduces the data. The objective of this project is to apply physics-informed deep learning to find a reduced-order model that acutely describes the fluid dynamics of an active flow control device. The actuator of interest in this project is a centimeter-size device designed to inject momentum near a wall exploiting Coandă effect. It results that an optimal boundary layer control depends on the blowing regime employed for the actuator. We aim at using numerical simulations (CFD, see figure) and experimental hot-wire measurements (see figure) to synergically perform the data-driven training of a data-driven neural network. Sparse low-rank algorithms will be used to derive the reduced-order model of the actuators. Thanks to the cheap computational costs associated to the reduced-order system, a wide parameter space can be explored in order to optimize the operating conditions of the actuators.



Required background of the student: Fluid Mechanics or Applied Mathematics

A list of 5 (max.) representative publications of the group:

1. N. Mazellier, P. Joseph, F. Stella, A. Kourta, P. Sujar-Garrido, and Zhou Y., TSFP10, Chicago 2017.
2. J.-L. Aider, P. Joseph, T. Ruiz, P. Gilotte, Y. Eulalie, C. Edouard, and X. Amandolese, Int. J. Flow Control, vol. 6(1), 1-20, 2014.
3. P. Joseph, D. Bortolus, and F. Grasso, Comptes Rendus-Mécanique, vol. 342(6-7), 376-381, 2014.
4. P. Joseph, X. Amandolese, C. Edouard, and J.-L. Aider, Exp. Fluids, vol. 54(1), 1-12, 2013.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Design, Industrialization

Subfield: Industrial Engineering

Title: Ergonomic and Cognitive Decision Support System to manage daily a Reconfigurable Manufacturing System with Collaborative Robotics

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Ali Siadat, Richard Béarée, Nathalie Klement
Advisor(s) Email: ali.siadat@ensam.eu ; Richard.bearee@ensam.eu ***;*** Nathalie.klement@ensam.eu
Research group/Lab: LCFC, LISPEN
Lab location: Metz, Lille
(Lab/Advisor website): http://lcfc.ensam.eu/ ; https://lispen.ensam.eu/

Short description of possible research topics for a PhD:
In the current Industry 4.0, mass customization revolutionized production and assembly systems. Reconfigurable Manufacturing Systems (RMS) tend to be the new norm. At a strategical level, previous works helped the manager to design such systems, and to invest in new resources. Mobile and collaborative robotics are resources that allow the production system to reconfigure itself quickly. The aim of the proposed PhD is to focus at the operational level, considering the hierarchical decision taken previously, by developing a Decision Support System (DSS) to manage daily the RMS. For a given quantity and variety of products to produce, how many resources are needed the considered day, where should they be assigned and what is the best scheduling of products.
Ergonomics and cognitivity are parts of the project for different purposes: the proposed DSS should be cognitive enough so the manager can easily take the right decision; an ergonomic study should be carried out while choosing the right resources in the shop floor.

Required background of the student:
Industrial engineering, robotics, operational research

A list of 5 (max.) representative publications of the group:
1. Klement N., Silva C. (2020) A Generic Decision Support Tool to Planning and Assignment Problems: Industrial Applications and Industry 4.0. In: Sokolov B., Ivanov D., Dolgui A. (eds) Scheduling in Industry 4.0 and Cloud Manufacturing. International Series in Operations Research & Management Science, vol 289. Springer, Cham. https://doi.org/10.1007/978-3-030-43177-8_9
2. S. Ehsan Hashemi Petroodi, Amélie Beauville Dit Eynaud, Nathalie Klement, Reza Tavakkoli-Moghaddam, Simulation-based optimization approach with scenario-based product sequence in a reconfigurable manufacturing system

(RMS): A case study, IFAC-PapersOnLine, Volume 52, Issue 13, 2019, Pages 2638-2643, ISSN 2405-8963, https://doi.org/10.1016/j.ifacol.2019.11.605.

3. Amélie Beauville dit Eynaud, Nathalie Klement, Olivier Gibaru, Lionel Roucoules, Laurent Durville, Identification of reconfigurability enablers and weighting of reconfigurability characteristics based on a case study, Procedia Manufacturing, Volume 28, 2019, Pages 96-101, ISSN 2351-9789, https://doi.org/10.1016/j.promfg.2018.12.016
4. Xia, Q., Etienne, A., Dantan, J.-Y., Siadat, A., 2018. Reconfigurable machining process planning for part variety in new manufacturing paradigms: Definitions, models and framework. Computers and Industrial Engineering 115, 206–219.
5. Stief, P., Dantan, J.-Y., Etienne, A., Siadat, A., Burgat, G., 2020. Product design improvement by a new similarity-index-based approach in the context of reconfigurable assembly processes. Journal of Engineering Design 31, 349–377.
6. El Mouayni, I., Etienne, A., Lux, A., Siadat, A., Dantan, J.-Y., 2020. A simulation-based approach for time allowances assessment during production system design with consideration of worker's fatigue, learning and reliability. Computers and Industrial Engineering
7. M. Bounouar, R. Béarée, A. Siadat, N. Klement and T. Benchekroun, "User-centered design of a collaborative robotic system for an industrial recycling operation," 2020 1st International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET), Meknes, Morocco, 2020, pp. 1-6, doi: 10.1109/IRASET48871.2020.9092178.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

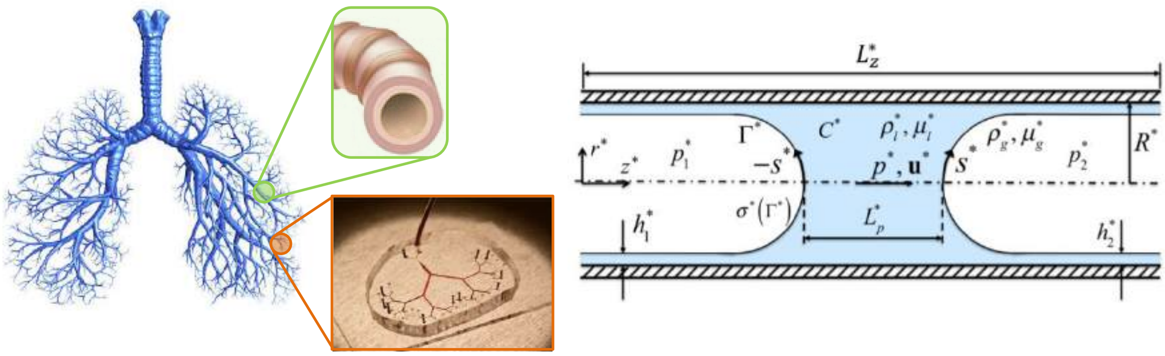
Subfield: Mechanical Engineering / Biomedical Engineering

Title: Numerical and Experimental Study of Liquid Plugs in Human Lungs

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Francesco Romanò, Amir Bahrani, Michaël Baudoin
Advisor(s) Email: antoine.dazin@ensam.eu, francesco.romano@ensam.eu
Research group/Lab: Laboratoire de Mécanique des Fluides de Lille (LMFL)
Lab location: 8 bd Louis XIV - 59046 LILLE Cedex
(Lab/Advisor website): http://lmfl.cnrs.fr/en/home/

Short description of possible research topics for a PhD: The airways are lined with a bi-layer annular liquid film consisting of mucus (elastoviscoplastic liquid) and serous layer (weakly viscoelastic liquid). When the film thickness is too high, liquid plugs can form preventing distal air exchange in human lungs. Such liquid plugs are typically observed among patients affected by chronic pulmonary pathologies (CF and COPD), and by respiratory diseases such as Covid-19. The aim of this project is to unravel how viscoelastic and viscoplastic effects interact, depending on the interplay between the three phases. This project further aims at studying the effect of deformability of the airway walls and, finally, to test the impact of surfactant replacement medical therapies. Numerical simulations will be carried out using the multiphase finite-difference/front-tracking in-house code developed by F. Romanò at Arts et Métiers, Lille [2]. Experiments will be carried out at IMT Lille Douai and IEMN under the supervision of A. Bahrani and M. Baudoin, respectively. Special attention is paid to the mucus rheology, experimentally reproduced by synthetic liquids, and to the liquid plug dynamics, characterized by flow visualization and µPIV in rigid or flexible capillary pipes. Finally, numerical simulations and experiments will be compared.



Required background of the student: Fluid Mechanics or Applied Mathematics

A list of 5 (max.) representative publications of the group:

1. Y. Hu, F. Romanò, J. B. Grotberg, J. Biomech. Eng., 142 (2020) 061007.
2. M. Muradoglu, F. Romanò, H. Fujioka, J. B. Grotberg, J. Fluid Mech., 872 (2019) 407–437.
3. F. Romanò, H. Fujioka, M. Muradoglu, J. B. Grotberg, Phys. Rev. Fluids, 4 (2019) 093103.
4. M. Baudoin, Y. Song, P. Manneville, C. N. Baroud, Proc. Nat. Ac. Sci., 110 (2013).

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Numerical modeling of solidification and high-pressure die casting process.

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Pr. Giovanni RADILLA [a]
Advisor(s) Email: giovanni.radilla@ensam.eu / youssef.souhar@ensam.eu (Corresponding author)
Co-Advisor(s) Name: Dr. Y. SOUHAR [a], Dr. M. ZALOŽNIK [b] (HDR), Dr. A. VIARDIN [c]
Research group/Lab: [a] MSMP (EA7350), [b] IJL (UMR7198), [c] Access RWTH Aachen
Lab location: Arts et Metiers, MSMP, F-51006 Châlons-en-Champagne, France
Lab website: [a] https://www.msmp.eu | [b] https://ijl.univ-lorraine.fr | [c] http://www.access.rwth-aachen.de

Short description of possible research topics for a PhD:

Approximately half of the world's production of light metal castings is obtained by High-Pressure Die Casting (HPDC). Mastering this technology is a crucial issue for the industry because of its high productivity and its ability to produce thin and solid parts.

Numerical modeling of the process is complex. This is a multi-physical problem involving fluid flows, heat transfers, chemical species transfers, phase changes, free surface flows as well as moving parts. The complex geometry of the molds and the high injection speeds lead to turbulent flows, highly three-dimensional and with very large fragments of the free surface. These high speeds and pressures are sought for good filling of the mold and for reducing the porosity of the parts produced. Solidification modeling is in itself complex because it is necessary to take into account the microstructures which greatly influence the properties of materials at the macroscopic scale. To account for these microscopic effects, the macroscopic solidification models are generally multiscale and the mushy zone is modeled by several additional phases. These methods however rely on very approximate relationships to model the interactions between grains. The so-called mesoscopic and multiscale approaches that we have developed aim to improve these relationships.

The aim of this thesis is to develop models and numerical solvers specifically optimized for the High-Pressure Die Casting process using Open-Source frameworks.

Required background of the student: PDEs applied to physics (fluid mechanics preferably), discretization methods (Finite-Volume), scientific computing (with Python/C++)

A list of 5 (max.) representative publications of the group:

1. A. Viardin, Y. Souhar, M. Cisternas Fernández, M. Apel, M. Založnik, "Mesoscopic modeling of equiaxed and columnar solidification microstructures under forced flow and buoyancy-driven flow in hypergravity: Envelope versus phase-field model", Acta Materialia, 2020, vol. 199, pp. 680-694. doi:10.1016/j.actamat.2020.07.069
2. M. Torabi Rad, M. Založnik, H. Combeau, C. Beckermann, "Upscaling mesoscopic simulation results to develop constitutive relations for macroscopic modeling of equiaxed dendritic solidification", Materialia, 2019, vol. 5, pp. 100231. doi:10.1016/j.mtla.2019.100231
3. A. Viardin, M. Založnik, Y. Souhar, M. Apel, H. Combeau, "Mesoscopic modeling of spacing and grain selection in columnar dendritic solidification: Envelope versus phase-field model", Acta Materialia, 2017, vol. 122, pp. 386-399. doi:10.1016/j.actamat.2016.10.004
4. Y. Souhar, V. F. De Felice, C. Beckermann, H. Combeau, M. Založnik, "Three-dimensional mesoscopic modeling of equiaxed dendritic solidification of a binary alloy", Computational Materials Science, 2016, vol. 112, pp. 304-317. doi:10.1016/j.commatsci.2015.10.028

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes

Subfield: Energetics, Optimization, Life cycle, Microgrids, Multi-energy,

Title: Impact of the life cycle of multi-energy micro-grid systems on their energy efficiency

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Dr. Pierre GARAMBOIS / Prof. Dr. Lionel ROUCOULES

Advisor(s) Email: pierre.garambois@ensam.eu / lionel.roucoules@ensam.eu

Research group/Lab, Lab location: LISPEN, Aix-en-Provence, France

(Lab/Advisor website): https://lispen.ensam.eu/

Short description of possible research topics for a PhD:
This research project aims at developing a decision tool that proposes various multi-energy mix compromises (electric, photovoltaic, wind, thermic, hydraulic, nuclear...) able to ensure autonomy for a given territory and optimizes environmental, technical and economic objectives, taking into account the life cycle of the mix.
Most energy optimization studies focus either on the modelling / dimensioning of a single energy system, or on long term global prospective studies of single energy mix like MARKAL-TIMES models who ignores most of the physical parameters. This work aims at developing a microgrid model of energy mix using aggregated energy models of each production, storage and grid technology, based on technological parameters that represent each device on its global life cycle. The use of metaheuristic optimization methods will result in a decision-support tool that provides a wide range of energy mix defined by technological parameters, improving objectives like the global energy consumption, gases emissions and cost.
Previous works from our research team have developed a microgrid model that mainly focuses on the operating phase [1]. The main goal of this PhD is to improve this existing innovative tool with the life cycle of the energy mix and assesse its global environmental and economic impact.

Required background of the student: Energetics, Engineering, Computer science

A list of 5 (max.) representative publications of the group:
1. N. Dougier, P. Garambois, J. Gomand and L. Roucoules, « Systemic approach for local energy mix assessment », Proceedings of JCM 2020, Aix-en-Provence.
2. T. Lambert, P. Gilman, and P. Lilienthal, « Micropower System Modeling with Homer, in Integration of Alternative Sources of Energy », F. A. Farret et M. G. Simões, Éd. Hoboken, NJ, USA: John Wiley & Sons, Inc., p. 379-418, 2006.
3. N. Maïzi, E. Assoumou, M. Bordier, G. Guerassimoff, and V. Mazauric, « Key features of the electricity production sector through long-term planning: the french case », IEEE PES Power Systems Conference and Exposition, p. 1796-1801, 2006.
4. A. Chaouachi, R. M. Kamel, R. Andoulsi, and K. Nagasaka, « Multiobjective Intelligent Energy Management for a Microgrid », IEEE Transactions on Industrial Electronics, vol. 60, no 4, p. 1688-1699, 2013.
5. E. Kuznetsova, Y.-F. Li, C. Ruiz, and E. Zio, « An integrated framework of agent-based modelling and robust optimization for micro-grid energy management », Applied Energy, vol. 129, p. 70-88, 2014.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Design, Industrialization

Subfield: Industrial Engineering

Title: Reconfigurable Process Control for Reconfigurable Production/Manufacturing Systems

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Ali SIADAT, Jean-Yves DANTAN, Lazhar HOMRI
Advisor(s) Email: *ali.siadat@ensam.eu; jean-yves.dantan@ensam.eu; lazhar.homri@ensam.eu*
Research group/Lab: *LCFC*
Lab location: *Arts et Metiers Campus of Metz*
(Lab/Advisor website): *www.lcfc.fr*

Short description of possible research topics for a PhD:
Reconfigurable production systems are becoming more and more present in manufacturing industries, in response to market and product variations. On the other hand, these systems are more and more equipped with intelligence, new technologies and generate a large amount of data during their use. For many years, academic and industrial research has been oriented towards the Industry 4.0 paradigm, with an emphasis on technological aspects and their integration. Now that these technologies are nearing maturity, we need to work on the management of these systems and their supervision. In this sense, the Process Control techniques that enable data analysis, detection of system drifts, prediction of system failures and/or product quality must be reconsidered and adapted to the reconfigurability of the system and products. The objective of this thesis is to propose a tool-based methodology allowing dynamic reconfigurability of inspection operations and process control techniques according to the system configuration.

Required background of the student: Mech. Eng. or Ind. Eng.

A list of 5 (max.) representative publications of the group:

1. Mohammadi, M., Dantan, J.-Y., Siadat, A., Tavakkoli-Moghaddam, R., 2018. A bi-objective robust inspection planning model in a multi-stage serial production system. International Journal of Production Research 56, 1432–1457.
2. Xia, Q., Etienne, A., Dantan, J.-Y., Siadat, A., 2018. Reconfigurable machining process planning for part variety in new manufacturing paradigms: Definitions, models and framework. Computers and Industrial Engineering 115, 206–219.
3. Mehrdad MOHAMMADI, Jean-Yves DANTAN, Ali SIADAT, Reza TAVAKKOLI-MOGHADDAM, «A bi-objective robust inspection planning model in a multi-stage serial production system», International Journal of Production Research, 56(4), pp. 1432-1457, 2018,
4. Meysam MOUSAVI, Shirin MIRDAMADI, Ali SIADAT, Jean-Yves DANTAN, Reza TAVAKKOLI-MOGHADDAM, «A new intuitionistic fuzzy grey model for selection

problems with an application to the inspection planning in manufacturing firms», Engineering Applications of Artificial Intelligence, Elsevier Editor, Volume 39, Pages 157-167, 2015,

5. Abdul Salam Khan, Lazhar Homri, Jean Yves Dantan, Ali Siadat, 2020, “A Multi-objective Assessment of Process Planning in a Disruptive Reconfigurable Manufacturing System: Application of Multi-heuristics” , IEEE 7th International Conference on Industrial Engineering and Applications

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Design, Industrialization

Subfield: Mech. Eng.

Title: Supervised learning for tolerance allocation

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Jean-Yves DANTAN, Lazhar HOMRI
Advisor(s) Email: *jean-yves.dantan@ensam.eu*
Research group/Lab: *LCFC*
Lab location: *Arts et Metiers Campus of Metz*
(Lab/Advisor website): *www.lcfc.fr*

Short description of possible research topics for a PhD:
Tolerancing decisions can profoundly impact the quality, the cost of the product and the number of scraps in mass production, ... Designers want tight tolerances to assure product performance; manufacturers prefer loose tolerances to reduce cost. There is a critical need for a quantitative design tool for specifying tolerances. The objective of this proposal is the tolerance allocation allowing designers to specify their functional requirements taking into consideration the impact of them on the manufacturing. Three tolerance synthesis techniques are commonly used: rules-based synthesis, knowledge-based synthesis and optimization synthesis. This proposal aims to push the frontiers of the tolerance synthesis by setting up a new methodology based on supervised learning (classification techniques) to infers the tolerance allocation model.

Required background of the student: Mech. Eng. or Ind. Eng.

A list of 5 (max.) representative publications of the group:

1. Goka, E., Beaurepaire, P., Homri, L., Dantan, J.-Y., 2019, Probabilistic-based approach using Kernel Density Estimation for gap modeling in a statistical tolerance analysis, Mechanism and Machine Theory, 139, pp. 294-309.
2. Goka, E., Homri, L., Beaurepaire, P., Dantan, J.-Y., 2019, Statistical tolerance analysis of over-constrained mechanical assemblies with form defects considering contact types, Journal of Computing and Information Science in Engineering, 19 (2), art. no. 021010-1.
3. Huang, Z., Dantan, J.-Y., Etienne, A., Rivette, M., Bonnet, N., 2018, Geometrical deviation identification and prediction method for additive manufacturing, Rapid Prototyping Journal, 24 (9), pp. 1524-1538.
4. Homri, L., Goka, E., Levasseur, G., Dantan, J.-Y., 2017, Tolerance analysis — Form defects modeling and simulation by modal decomposition and optimization, CAD Computer Aided Design, 91, pp. 46-59.
5. Etienne, A., Mirdamadi, S., Mohammadi, M., Babaeizadeh Malmiry, R., Antoine, J.-F., Siadat, A., Dantan, J.-Y., Tavakkoli, R., Martin, P., 2017, Cost engineering for variation management during the product and process development, International Journal on Interactive Design and Manufacturing, 11 (2), pp. 289-300.

Research Topic for the ParisTech/CSC PhD Program

Field: Energy, Processes
Subfield: Electrical Engineering

Title: Dynamic simulation of large transmission grid incorporating modular Multilevel converters with internal storage system

ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Prof. Kestelyn Xavier and Dr. François Gruson
Advisor(s) Email: *xavier.kestelyn@ensam.eu*, *francois.gruson@ensam.eu*
Research group/Lab: Laboratory of Electrical Engineering and Power electronics (L2EP)
Lab location: ENSAM, 8 Boulevard Louis XIV, 59046 Lille, France
(Lab/Advisor website): http://l2ep.univ-lille.fr/?lang=en

Short description of possible research topics for a PhD:

The Future transmission system leads to the increase of power electronic devices in the power system due to more and more renewable energy production systems and High Voltage Direct Current (HVDC) grids.

With the possible integration of marine renewable energy like offshore wind turbine, the concept of HVDC begins to emerge. The L2EP has worked on this subject for 10 years. A **demonstrator of Multi-terminal DC grid** has been developed during the European project Twenties. To connect These DC grids to the AC transmission grid, High voltage and power converters are required. A structure, called Modular Multilevel Converter (MMC), has emerged one decade. One **small scale HVDC/HVAC converter** has been developed in the L2ep in 2016. Based on the MMC topology, the ESS can be dispatched into MMC sub modules and can decouple the dependence between the AC system and the DC system.

To provide **ancillaries services** to the **transmission grid** like frequency regulation or supporting, flattening renewable sources production or propose an energy reserved for the realization of grid forming converter function an **Energy Storage System** (ESS) are required.

This project aims to study the capability of MMC with internal ESS to dynamically support large transmission systems of the future.

Required background of the student:

Beside a good level of English and communication, the recruited student must have:
- A Master or equivalent on Power System or Power Electronics
- Autonomy and capability to work with a team

A list of 5 (max.) representative publications of the group:

1. S. Samimi, *Modélisation et Commande des Convertisseurs MMC en vue de leur intégration dans le Réseau Electrique*. PhD dissertation, in English, Ecole Centrale de Lille, 2016.
2. COSSART Quentin, COLAS Frédéric, KESTELYN Xavier, A Novel Event and Non-Projection-Based Approximation Technique by State Residualization for the Model Order Reduction of Power Systems with a High Renewable Energies Penetration IEEE Transactions on Power Systems, 07/2020
3. Q. Cossart, "Tools and Methods for the Analysis and Simulation of Large Transmission Systems Using 100% Power Electronics," PhD dissertation, Arts et Metier Institute of Technology 09 2019.
4. H. Zhang, M. M. Belhaouane, F. Colas, R. Kadri, F. Gruson and X. Guillaud, "On Comprehensive Description and Analysis of MMC Control Design: Simulation and Experimental Study," in IEEE Transactions on Power Delivery, 2020, doi: 10.1109/TPWRD.2020.2977470.

Logo de votre école (ne garder que le bon logo)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Design, Industrialization

Subfield: Industrial Engineering

Title: Risk management of engineering products driven by artificial intelligence

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Ali SIADAT, Alain ETIENNE, Jelena PETRONIJEVIC
Advisor(s) Email: ali.siadat@ensam.eu; alain.etienne@ensam.eu; jelena.petronijevic@ensam.eu
Research group/Lab: Laboratoire de Conception, Fabrication, Commande (LCFC)
Lab location: Metz, France
(Lab/Advisor website): http://lcfc.ensam.eu/

Short description of possible research topics for a PhD:
With the pace of technological development, the complexity of industrial products is increasing. As a result, its risk management is becoming demanding and data-driven risk models are needed. However, the adoption of these approaches is still slow as risk management is highly dependent on experts whose knowledge is often captured in textual and descriptive form (e.g. FMEA and risk register) including at the same time the source of risk, interaction and effect. Building the model based on this form requires understanding of human perception and communication.
The aim of this thesis is to bridge the gap between the conventional way in which risks are represented and the desired model-based risk management. More specifically, the research involves risk identification and analysis with the use of artificial intelligence conducted in two phases. Beginning with text-based risk knowledge, the objective is to apply deep learning techniques (e.g. natural language processing) to the identification of risk drivers. Based on this step, the risk model of the engineering product is to be developed. The thesis therefore leads towards automated risk management, which minimizes the costs and time required for this process.

Required background of the student: Industrial engineering, Computer science

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Azarian, A., Siadat, A., & Martin, P. (2011). A new strategy for automotive off-board diagnosis based on a meta-heuristic engine. Engineering Applications of Artificial Intelligence, 24(5), 733-747.
2. Mili, A., Bassetto, S., Siadat, A., & Tollenaere, M. (2009). Dynamic risk management unveil productivity improvements. Journal of Loss Prevention in the Process Industries, 22(1), 25-34.
3. Petronijevic, J., Etienne, A., Siadat, A., & Bassetto, S. (2019, September). Operational Framework for Managing Risk Interactions in Product Development Projects. In 2019 International Conference on Industrial Engineering and Systems Management (IESM) (pp. 1-6). IEEE.
4. Shah, L. A., Etienne, A., Siadat, A., & Vernadat, F. (2016). Decision-making in the manufacturing environment using a value-risk graph. Journal of Intelligent Manufacturing, 27(3), 617-630.
5. ???

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Design, Industrialization

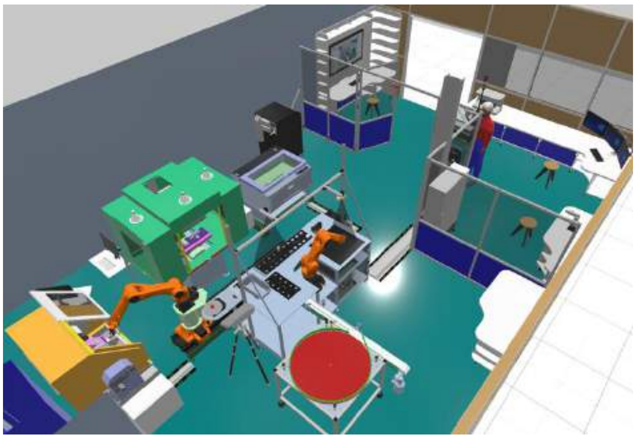
Subfield: Industry 4.0/Smart factory

Title: Cloud manufacturing

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: K BENFRIHA/A AOUSSAT
Advisor(s) Email: Khaled.benfriha@ensam.eu
Research group/Lab: LCPI
Lab location: Paris
(Lab/Advisor website):

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)



We have designed and built a new intelligent and connected robotic production workshop. Several international phd students are already working on topics such as flexibility of operations, predictive maintenance, the digital twin and network architecture (distributed system).

We invite you to join this team of researchers and contribute to advance industrialization performance. as you can see in the opposite illustration, the workshop is made up of kuka robots and several numerically controlled machine tools, as for the IoT layer is made up of different sensors and smart cameras. In addition, the controlling of the various operations is carried out by wonderware numerical platform.

The subject we propose concerns the use of the generated data in order to optimize the production in real time. This thesis offer can be carried out jointly with a partner university (cotutelle)

Required background of the student: (What should be the main field of study of the applicant before applying?)

industrial process, smart industry, industrial computer science.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Block, C., Lins, D., Kuhlenkötter, B., 2018. Approach for a simulation-based and event-driven production planning and control in decentralized manufacturing execution systems. Procedia CIRP 72, 1351–1356. https://doi.org/10.1016/j.procir.2018.03.204

2. Borangiu, T., Trentesaux, D., Thomas, A., Leitão, P., Barata, J., 2019. Digital transformation of manufacturing through cloud services and resource virtualization. Computers in Industry 108, 150–162. https://doi.org/10.1016/j.compind.2019.01.006

3. Erol, S., Schumacher, A., 2016. Strategic guidance towards Industry 4.0 – a three stage process model 8.

4. Ghobakhloo, M., 2018. The future of manufacturing industry: a strategic roadmap toward Industry 4.0. Jnl of Manu Tech Mnagmnt 29, 910–936. https://doi.org/10.1108/JMTM-02-2018-0057

5. Rojko, A., 2017. Industry 4.0 Concept: Background and Overview. Int. J. Interact. Mob. Technol. 11, 77. https://doi.org/10.3991/ijim.v11i5.7072

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Design, Industrialization

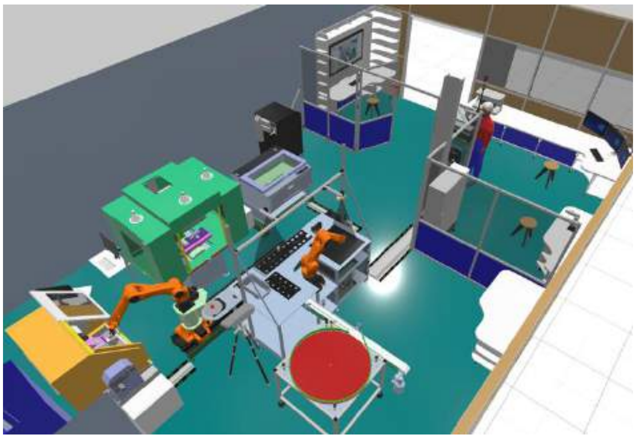
Subfield: Numerical optimization algorithms

Title: Design optimization using manufacturing processes

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: K BENFRIHA/A AOUSSAT
Advisor(s) Email: Khaled.benfriha@ensam.eu
Research group/Lab: LCPI
Lab location: Paris
(Lab/Advisor website):

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)



We have designed and built a new intelligent and connected robotic production workshop. Several international phd students are already working on topics such as flexibility of operations, predictive maintenance, the digital twin and network architecture (distributed system).

We invite you to join this team of researchers and contribute to advance industrialization performance. as you can see in the opposite illustration, the workshop is made up of kuka robots and several numerically controlled machine tools, as for the IoT layer is made up of different sensors and smart cameras. In addition, the controlling of the various operations is carried out by wonderware numerical platform.

the subject that we propose is how the data generated by the manufacturing processes can be used to optimize the design of the product?
This thesis offer can be carried out jointly with a partner university (cotutelle)

Required background of the student: (What should be the main field of study of the applicant before applying?)

design process, smart industry, industrial computer science, optimization methods

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Adjoul O., Benfriha K., Aoussat A. 2018. Algorithmic strategy for optimizing product design considering the production costs. IJIDeM. https://doi.org/10.1007/s12008-019-00571-w

2. Laudante E. 2017. Industry 4.0, Innovation and Design. A new approach for ergonomic analysis in manufacturing system. The design journal. https://doi.org/10.1080/14606925.2017.1352784

3. Przemysław Zawadzki, Krzysztof Żywicki, 2016. Smart product design and production control for effective mass customization in the industry 4.0 concept. https://doi.org/10.1515/mper-2016-0030

4. Bortolini M., Ferrari E., Gamberi M., Pilati F., Faccio M., 2017. Assembly system design in the Industry 4.0 era: a general framework. IFAC-PapersOnLine. https://doi.org/10.1016/j.ifacol.2017.08.1121

5. Hock Ang J., Goh C., Li Y., 2016. Smart design for ships in a smart product through-life and industry 4.0 environment. IEEE Congress on Evolutionary Computation (CEC). https://doi.org/10.1109/CEC.2016.7748364

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Computer Science, Virtual reality

Title: **Intuitive 3D Interactions for Mobile Mixed Reality – Application to the factrory of the future**

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Fakhreddine Ababsa
Advisor(s) Email: Fakhreddine.Ababsa@ensam.eu
Research group/Lab: LISPEN / Institut Image
Lab location: Chalon sur Saône
(Lab/Advisor website): http://institutimage.ensam.eu/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Natural User Interfaces (NUI) aim to provide multimedia applications with natural and intuitive controlling operations, such as touch, sound and motion. To provide such interfaces, special devices are necessary to detect and recognize a human's natural input signal. In recent years, several interaction techniques have been developed using human motion detection and recognition devices like Kinect or Leap Motion. However, such approaches are applied only in simple and controlled environments. Creating intuitive ways to interact with 3D content in a mobile mixed reality environment still one of the major challenges of current computer science. The aim of this PhD project is to investigate novel concepts to naturally interact with 3D virtual objects displayed on a see-through glass (e.g. Hololens). 3D gesture tracking / recognition based on machine learning approaches will be investigated as well as the selection/manipulation of virtual objects in mixed reality context. An in-depth evaluation procedure on several use cases will be carried out in order to study how these approaches would affect the user's performances.

Required background of the student: (What should be the main field of study of the applicant before applying?)

The candidate should have a Master degree or equivalent in computer science, or related disciplines. Required skills are experience in C++ software development, Machine learning and pattern recognition, applied mathematics, and a good command of English (reading/writing/speaking. In addition, the successful candidate will be highly self-motivated, passionate about his/her work, and has good ability to work both independently as well as in a team in a multidisciplinary environment.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Cyrille Migniot, Fakhreddine Ababsa: Hybrid 3D-2D human tracking in a top view. J. Real-Time Image Processing 11(4): 769-784 (2016)

2. Hajar Hiyadi, Fakhreddine Ababsa, Christophe Montagne, El-Houssine Bouyakhf, Fakhita Regragui: Adaptive dynamic time warping for recognition of natural gestures. IPTA 2016: 1-6

3. M. Ali Mirzaei, Jean-Rémy Chardonnet, Frédéric Mérienne, A. Genty: Navigation and interaction in a real-scale digital mock-up using natural language and user gesture. VRIC 2014: 28:1-28:4

4. Hamid Hrimech, Leila Alem, Frédéric Mérienne: How 3D Interaction Metaphors Affect User Experience in Collaborative Virtual Environment. Adv. Human-Computer Interaction 2011

1.

Research Topic for the ParisTech/CSC PhD Program
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Robotics, Augmented Reality

Title: **Human–Robot Collaboration in Integrated Manufacturing using Augmented Reality**

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Fakhreddine Ababsa, Full Professor, Arts & Métiers ParisTech
Advisor(s) Email: Fakhreddine.Ababsa@ensam.eu
Research group/Lab:): **Institut Image / LISPEN**
Lab location: **Chalon sur Saône**
(Lab/Advisor website): **http://institutimage.ensam.eu/**

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

In the industry of the future, robots would work in collaboration with human by jointly performing the assigned tasks and sharing the same workspace. Hence, their actions must be controlled in real time according to the human actions. Visual tracking would allow the worker to be located in the workspace and to recognize his gestures in order to anticipate the robot's control avoiding any collision with him. The aim of this PhD proposal is to investigate new approaches for human-robot collaboration using augmented reality. The idea is to develop an augmented reality system, which allows the worker to visualize simultaneously and in real time the robot's control information and also the instructions to be performed by the user. 3D human tracking and gesture recognition based on machine learning approaches will also be investigated. A depth sensor placed in top will be used, the acquired data will be analysed to detect the operator's presence area and to recognize his gesture. Natural user interface will be developed in order to control the application: changing the context/scenario of AR, stopping the robot, etc.

Required background of the student: (What should be the main field of study of the applicant before applying?)
The candidate should have a Master degree or equivalent in Robotics, computer science, or related disciplines. Required skills are experience in C++ software development, Machine learning and pattern recognition, applied mathematics, and a good command of English (reading/writing/speaking. In addition, the successful candidate will be highly self-motivated, passionate about his/her work, and has good ability to work both independently as well as in a team in a multidisciplinary environment.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Cyrille Migniot, Fakhreddine Ababsa: Hybrid 3D-2D human tracking in a top view. J. Real-Time Image Processing 11(4): 769-784 (2016)

2. Madjid Maidi, Fakhreddine Ababsa, Malik Mallem, Marius Preda: Hybrid tracking system for robust fiducials registration in augmented reality. Signal, Image and Video Processing 9(4): 831-849 (2015)

3. Hajar Hiyadi, Fakhreddine Ababsa, Christophe Montagne, El-Houssine Bouyakhf, Fakhita Regragui: A Depth-based Approach for 3D Dynamic Gesture Recognition. ICINCO (2) 2015: 103-110

4. Cyrille Migniot, Fakhreddine Ababsa: Part-based 3D Multi-person Tracking using Depth Cue in a Top View. VISAPP (3) 2014: 419-426

5. J. Chardonnet Interactive Dynamic Simulator for Multibody Systems. Chardonnet, J. International Journal of Humanoid Robotics, 9(3): 1250021–1,1250021–24. 2012.

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Applied Physics, Mech. Eng.

Title: VACUITY: innoVative mAgnetron Cathode for modUlarly deposITion sYstem

ParisTech School: Arts et Métiers Sciences et Technologies

Advisors Name: Dr.-Ing. A. Besnard, Dr.-HDR C. Nouveau
Advisors Email: aurelien.besnard@ensam.eu, corinne.nouveau@ensam.eu
Research group/Lab: LaBoMaP
Lab location: Cluny, France
(Lab/Advisor website): http://labomap.ensam.eu/

Short description of possible research topics for a PhD:
Magnetron sputtering is a PVD deposition technic that use material source, also called "targets". These targets, whatever their number, are commonly planar and fixed (one can found cylindrical ones but the problematic remains the same). The size of these planar targets varies from few centimeter to few dozens, with rectangular or disc shapes. To ensure a correct deposition on complex substrates, these substrates undergo one or two-fold rotation in front of the static cathodes.
Based on numerical simulations work, the project aims to study the discretization of a large static planar target into numerous smaller ones, with a controlled position and orientation in the chamber. After the research and design work, this modulable target will be experimentally produced and tested in a real deposition system.

Required background of the student: Mechanical engineering, Material Science.

A list of 5 (max.) representative publications of the group:
1. M. Evrard, A. Besnard, S. Lucas, Study of the influence of the pressure and rotational motion of 3D substrates processed by magnetron sputtering: A comparative study between Monte Carlo modelling and experiments, Surface and Coatings Technology 378,2019, 125070
2. B. Bouaouina, C.Mastail, A. Besnard, R. Mareus, F. Nita, A Michel, Nanocolumnar TiN thin film growth by oblique angle sputter-deposition: Experiments vs. simulations, Materials & Design 160, 2018, 338-349
3. A. Siad, A. Besnard, C. Nouveau, P. Jacquet, Critical angles in DC magnetron glad thin films, Vacuum 131, 2016, 305-311
4. D. Depla, A. Besnard, J. Lamas, The influence of the pressure on the microstructure of yttria-stabilized zirconia thin films deposited by dual magnetron sputtering, Vacuum 125, 2016, 118-122

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering, numerical simulation

Title: Measurement of residual stresses in materials: FEM-based simulation of X-ray diffraction

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Dorian Depriester (Dr) and Laurent Barralier (Pr.)
Advisor(s) Email: dorian.depriester@ensam.eu, laurent.barrallier@ensam.eu
Research group/Lab: MMS/MSMP (EA7350)
Lab location: Aix-en-Provence
(Lab/Advisor website): https://www.msmp.eu/

Short description of possible research topics for a PhD:
It is well known that, in many cases, residual stresses can improve lifespan of mechanical parts. In order to estimate those stresses in crystalline materials, one of the most used techniques is based on X-ray diffraction (XRD). The aim of this project is to build a framework for simulating the XRD experiment on a strained polycrystal. This simulation will be performed from the results of Finite Element Analysis (FEA) of a polycrystalline aggregate submitted to macroscopic stress, as illustrated in Figure 1.

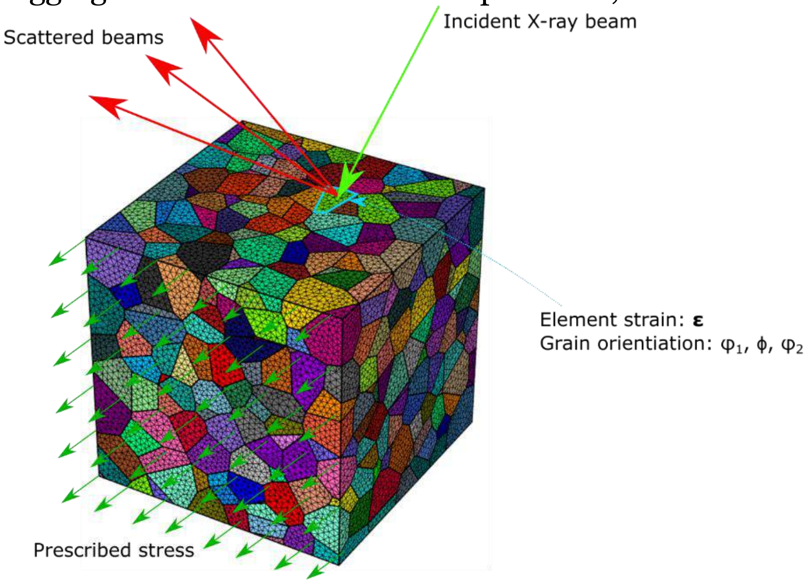


Figure 1. Schematic representation of the simulation: the scattered beams in a given element will be computed depending on the strain within the element and the orientation of the parent grain. Coulours in the mesh represent the unique grains.

Since FEA will be done at grain scale, the XRD simulation will take into account the heterogeneous strain inside each grain, due to crystalline anisotropy. The corresponding mesh will be generated with the aid of numerical tools dedicated to synthetic aggregate generation (see refs. 1 and 2).

Required background of the student:
The student must have advanced knowledge in mechanical engineering, particularly in continuum mechanics: stress, strain, generalized linear elasticity (stiffness tensor), anisotropy. Basics of mechanics of materials (crystal plasticity, crystallography etc.) is highly recommended. The student may also be familiar with FEM and Object-Oriented programming (Python or/and C++).

A list of 5 (max.) representative publications of the group:

1. Depriester, D., Kubler, R. (2019). Radical Voronoï tessellation from random pack of polydisperse spheres: Prediction of the cells' size distribution. *Computer-Aided Design*, 107:37 – 49
2. Depriester, D., Kubler, R. (2019). Resolution of the Wicksell's equation by Minimum Distance Estimation. *Image Analysis & Stereology*, 38(3):213–226.
3. Pluyette E., Sprauel J.M., Lodini A., Perrin M., Todeschini P. (1996). Residual stresses evaluation near interfaces by means of neutron diffraction: modelling a neutron spectrometer. *ECRS4*, Cluny, pp. 153-163.
4. Pluyette, E. (1997). Evaluation par diffraction de neutrons, des contraintes résiduelles dans les liaisons bi-métalliques. PhD thesis, ENSAM.
5. Pluyette E., Sprauel J. M., Lodini A., Perrin M., Ceretti M. and Todeschini P. (1996). Residual stresses evaluation near interfaces by means of neutron diffraction: modelling a spectrometer, in *Proceedings of the ECRS-4*, S. Denis et al. (eds), June 4–6, Cluny, France, pp. 153–163.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes
Subfield: Applied Physics

Title: Efficiency enhancement of the compressed air energy storage (CAES) process

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Michaël Pereira / Mathieu Specklin
Advisor(s) Email:
michael.pereira@ensam.eu
mathieu.specklin@ensam.eu

Research group/Lab: *LIFSE*
Lab location: *151 Boulevard de l'hôpital 75013 PARIS*
Lab Website: *http://lifse.preprod.intram.ensam.eu/*

Short description of possible research topics for a PhD:

The intermittent nature of renewable energy has pushed in recent years the need for efficient, reliable, low-cost and scalable energy storage technologies. Given its relatively high efficiency and its low environment impact, electro-mechanical storage appears as a good candidate. CAES (Compressed Air Energy Storage), which belongs to this family, is a promising technology but requires high compression ratio to be competitive.

This PhD research aims at analysing the CAES process and at designing versatile and innovative technologies in order to improve its overall efficiency. CAES systems involve specific mechanical devices (pumping system, compression/expansion chamber, turbines, etc) and a strong coupling between different fields of applied physics, such as thermal management, turbomachinery, multiphase flow, material science, etc. A global and systemic approach is thus necessary to carry out this research project.

The thesis will be mainly experimental, but will also involve numerical modelling. An experimental rig capable of achieving high-pressure ratio has already been set up in the LIFSE laboratory. The student will therefore be prompted to carry out tests.

Required background of the student:
Physics / Fluid Dynamics / Thermodynimics

A list of 5 (max.) representative publications of the group:

1. Specklin, M., Deligant, M., Porcheron, S., Wagner, M., Bakir, F., (2019) Experimental study and modelling of a high-pressure ratio liquid piston compressor, *14th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics* Wicklow, Ireland
2. M.A. AitChikh, I.Belaidi, S.Khelladi, J.Paris, M.Deligant}, and F.Bakir.
Efficiency of bio- and socio-inspired optimization algorithms for axial turbomachinery design.
3. Smoothed particle hydrodynamics: A consistent model for interfacial multiphase fluid flow simulations.
Journal of Computational Physics}, 358:53—87, 2018.
4. Deligant, M., Sauret, E., Danel, Q., & Bakir, F. (2020). Performance assessment of a standard radial turbine as turbo expander for an adapted solar concentration ORC. *Renewable Energy*, *147*, 2833-2841.
5. Deligant, M., Danlos, A., Podevin, P., Clenci, A., & Guilain, S. (2017, October). Surge detection on an automotive turbocharger during transient phases. In *IOP Conf. Ser. Mat. Sci. Eng.* (No. 12082).

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering

Title: Surface integrity of Ti-6Al-4V alloy components produced by SLM and machining processes: multiphysics simulations and experimental validation.

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: José Outeiro, Arts et Metiers Institute of Technology
Abdelhadi Moufki, University of Lorraine
Advisor(s) Email: jose.outeiro@ensam.eu / abdelhadi.moufki@univ-lorraine.fr
Research group/Lab: LABOMAP and LEM3
Lab location: Cluny and Metz, France.
(Lab/Advisor website): http://labomap.ensam.eu/
http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:

Selective Laser Melting (SLM) is an additive manufacturing (AM) process used to produce functional prototypes and small series of Titanium alloys components with high mechanical properties and high geometrical complexity. Additionally, to obtain a functional product with geometrical/dimensional and surface integrity requirements, the components produced by SLM need to be finished using a machining process. The rapid cooling of the material during SLM leads to thermally induced residual stresses distributions in the components. These stresses can affect the machining process, causing part distortion and poor surface integrity. This will affect the functional performance and life of the titanium components, such as fatigue life and corrosion resistance. In this work, the physical phenomena and the surface integrity of Ti-6Al-4V alloy generated by both SLM and machining processes will be investigated using Multiphysics Simulations, carefully validated by experimental tests. The aim of Multiphysics Simulations is to determine the SLM and machining processes conditions that will enhance the surface integrity of SLM-produced components.

Required background of the student:
The candidate should have a knowledge of the finite element (FE) method, MATLAB programming language and continuum mechanics.

A list of 5 (max.) representative publications of the group:

1. K.S.Djaka, A.Moufki, M.Nouari, P.Laheurte, A.Tidu. A semi-analytical modelling of cutting using crystal plasticity theory and flow line approach. Int. J. of Mechanical Sciences, 146-147, 49-59, 2018.

2. A. Moufki, D. Dudzinski, G. Le Coz, Prediction of cutting forces from an analytical model of oblique cutting, application to peripheral milling of Ti-6Al-4V alloy, International Journal of Advanced Manufacturing Technology, 81 (1-4), 615-626, 2015.
3. X. Xu, Jun Zhang, J.C. Outeiro, B. Xu, W. Zhao. Multiscale simulation of grain refinement induced by dynamic recrystallization of Ti6Al4V alloy during high speed machining. Journal of Materials Processing Technology, 286, 116834, 2020.
4. W. Cheng, J.C. Outeiro, J.P. Costes, R. M'Saoubi, H. Karaouni, V.P. Astakhov. A constitutive model for Ti6Al4V considering the state of stress and strain rate effects. Mechanics of Materials, 137, 103103, 2019.
5. I.S. Jawahir, E. Brinksmeier, R. M'Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrello, A.D. Jayal. Surface Integrity in Material Removal Processes: Recent Advances. CIRP Annals - Manufacturing Technology, keynote paper, 60 (2), 603-626, 2011.

Research Topic for the ParisTech/CSC PhD Program

Field: Information and Communication Sciences and Technologies

Subfield: Additive Manufacturing, Augmented Reality, Design Methodology, Creativity, Computer Graphics.

Title: Contribution to the integration of Additive Manufacturing and Augmented Reality in early design phases to foster Creativity

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name:	Dr. Frédéric Segonds (HDR)	Dr. Ruding Lou
Advisor(s) Email:	frederic.segonds@ensam.eu,	ruding.lou@ensam.eu
Research group/Lab:	LCPI	LISPEN: http://lispen.ensam.eu/
Lab location:	Paris	Chalon-sur-Saône
(Lab website):	http://lcpi.ensam.eu/	http://lispen.ensam.eu/

Short description of possible research topics for a PhD:
In the product design process, early stages are crucial as 80% of the design costs are engaged during these phases. Creativity is among one of the most important early activity as it allows to create breakthrough innovative products. Ideas are usually produced from inspirational sources such as images, 3D representations etc. These ideas are then retranscribed in ideas sheets to allow to select one (or more) concept to develop and industrialize.
As part of Industry 4.0, the idea generation phase can be enriched by the manipulation of physical objects made in Additive Manufacturing (AM). These objects can be produced on the fly to faithfully represent a concept to develop. In order to make this manipulation even more realistic, Augmented Reality (AR) technologies make it possible to apply a color and texture to a low-fidelity model. It allows users to see different appearances of a physical prototypes through the AR device and, at the same time, users can touch physically the object. Furthermore, with AR users can even change the shape and do some intuitive shape design activities. AR usually allows people to interact with virtual 3D mock-up integrated in the real world. The coupling of the two technologies (AM&AR) will thus favor the innovation of the design teams.
The aim of this PhD is to device and experiment AM&AR applications in the product design creativity activities in order answer the following research question : can experiencing AM&AR technologies foster creativity and innovation?

Required background of the student:
Product design, creativity, innovation, additive manufacturing.
Computer science, computer graphics, geometric modeling, computer-aided design.

A list of 5 (max.) representative publications of the group:

- Rias, A. L., **Segonds, F.**, Bouchard, C., & Abed, S. (2017). Towards additive manufacturing of intermediate objects (AMIO) for concepts generation. IJIDeM, 11(2), 301-315.
- B. Li, **F. Segonds**, C. Mateev, **R. Lou**, F. Merienne (2018), Design in context of use: An experiment with a multi-view and multi-representation system for collaborative design, Computers in Industry, 103, pp. 28-37.
- B. Faliu, A. Siarheyeva, **R. Lou**, F. Merienne (2019), Design and Prototyping of an Interactive Virtual Environment to Foster Citizen Participation and Creativity in Urban Design", LNISO (34), pp. 55 – 78.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids
Subfield: Mechanical/Material/Process Engineering

Title: Optimization of Robotic Friction Stir Welding through monitoring

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Dr. Tudor BALAN, Dr. Sandra CHEVRET, Dr. Laurent LANGLOIS
Advisor(s) Email: tudor.balan@ensam, sandra.chevret@ensam.eu, laurent.langlois@ensam.eu
Research group/Lab: LCFC (http://lcfc.ensam.eu) /
Lab location: Metz - France

Short description of possible research topics for a PhD:


Friction Stir Welding, *on ABB IRB 8700 robot*

Friction Stir Welding (FSW) is an innovative solid-state welding process which will be fully implemented in the "industry of the future" in assembly line. To reduce weight, FSW will allow to weld the entire range of aluminum alloys and to reduce production costs, the use of robot is recommended. To promote FSW in production for complex and high value added workpieces, many scientific and technological challenges needs to be solved. Based on the study of the friction stir welding forces applied during the process, many research topics to optimize the process can be driven. The first one is the optimization of the tool in order to reach a high quality weld and low process forces. It will enable to weld higher thickness with a robot or lowering the robot deflections it undergoes under the load, leading to non-acceptable tool path trajectory modification. The second one is to create a database to define a way to monitor the process thanks to the recorded forces and to detect welds with quality problems. Therefore, an automatic weld quality evaluation, based on recorded force data, will be developed and implemented on a FSW system in order to reduce control after welding. Depending on the abilities of the candidate, one or the other of these research directions will be further developed.

Required background of the student:
The student must have very good knowledge in mechanical engineering.

A list of representative publications of the group:

1. Y. YANG and T. BALAN. Prediction of the yield surface evolution and some apparent non normality effects after abrupt strain-path change using classical plasticity. Int. Journal of Plasticity (2019), 119; 331-343.
2. ZIMMER et al. Experimental investigation of the influence of the FSW plunge processing parameters on the maximum generated force and torque, International Journal of Advanced Manufacturing Technology (2010)
3. K. KOLEGAIN et al. Off-line path programming for three-dimensional Robotic Friction Stir Welding based on Bézier curves. Industrial Robot: An International Journal (2018).

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Design, Industrialization
Subfield: Robotic manufacturing, Grinding, Finishing process, Forged workpieces.

Title: Automation of a flexible and agile finishing process of forged workpieces with industrial robots.

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Pr. Régis BIGOT, Dr. Cyrille BAUDOUIN, Dr. Sandra CHEVRET,
Advisor(s) Email: regis.bigot@ensam; cyrille.baudouin@ensam.eu; sandra.chevret@ensam.eu
Research group/Lab: LCFC (http://lcfc.ensam.eu)
Lab location: Metz - France

Short description of possible research topics for a PhD:

Grinding is necessary to remove overage parts from forged workpieces (flash, surface imperfections, oxide encrustation, etc.). Finishing processes of forged workpieces are still one manually in most cases. Automation of the finishing process is expected to liminate the manual operations of high hardness that can lead to musculoskeletal disorders and productivity decrease. Greater accuracy and repeatability of operations is hoped. However, at the end of a forging operation, each piece is unique, and is the image of the accumulation of all process variabilities. The artificial intelligence would be able to control the robot to perform grinding according to observations made on the workpiece. In the meantime, this PhD consists **in creating and deploying a methodology that would allow an effective collaboration between the observation of a workpiece and the interpretation made by an operator and the realization of the expected operations by a robot** in a context of industrial productivity. The robot must be able to understand human-like instructions (by gesture, graphics or digital interface). The robotic grinding must also be able to provide a desired geometry or surface roughness despite variations originating from the upstream phases of the process. Robotic grinding has to be able to master the interactions between grinding tool and material, vibrations, robot paths, and forces applied during grinding.

Required background of the student:
Knowledge in robotics, manufacturing (grinding) if possible; computing, applied mechanics

A list of representative publications of the group:

Mohamed DIDI CHAOUI, François LEONARD, Gabriel ABBA – Improving Surface Roughness in Robotic Grinding Process. In: Arakelian V., Wenger P. (eds) ROMANSY 22 – Robot Design, Dynamics and Control. CISM International Centre for Mechanical Sciences (Courses and Lectures), vol 584. 2019. Springer, Cham. Doi:10.1007/978-3-319-78963-7_46

Laurent LANGLOIS, Sandra ZIMMER-CHEVRET, Amarilys BEN ATTAR, Nejah JEMAL, Jonathan HATSCH, Gabriel ABBA, Régis BIGOT -Robotized FSW – Evolution of forces and torque with nonlinear welds - In: 10th International Friction Stir Welding Symposium, China, 2014-05-19 - Proceedings of the 10th IFSWS' 2014 - 2014

Sandra ZIMMER-CHEVRET, Nejah JEMAL, Laurent LANGLOIS, Amarilys BEN ATTAR, Jonathan HATSCH, Gabriel ABBA, Régis BIGOT - FSW process tolerance according to the position and orientation of the tool: requirement for the means of production design – Materials Science Forum - Vol. 783-786, p.1820-1825 – 2014

Jinna QIN, François LEONARD, Gabriel ABBA - Nonlinear Discrete Observer for Flexibility Compensation of Industrial Robots - In: IFAC World Congress 2014, South Africa, 2014-08-24 - Proceedings of IFAC World Congress 2014 – 2014

Sandra ZIMMER-CHEVRET, Laurent LANGLOIS, Julien LAYE, Jean-Claude GOUSSAIN, Patrick MARTIN, Régis BIGOT - Qualification of a robotized Friction Stir Welding System - In: INTERNATIONAL CONFERENCE ON SCIENTIFIC AND TECHNICAL ADVANCES ON FRICTION STIR WELDING AND PROCESSING, France, 2010-01-27 - Proceedings of the FSWP'2010 – 2010

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids
Subfield: Mech. Engineering, Applied mathematics, Environmental sciences
Title: Simulation of biomass pyrolysis and combustion in fixed-bed reactors
ParisTech School: Arts et Métiers Sciences et Technologies
Advisor(s) Name: Azita Ahmadi; Jean Lachaud
Advisor(s) Email: *azita.ahmadi-senichault@u-bordeaux.fr; jean.lachaud@u-bordeaux.fr*
Research group/Lab: Institute of Mechanical Engineering (I2M).
Lab location: Bordeaux
(Lab/Advisor website): *https://www.i2m.u-bordeaux.fr/*

Short description of possible research topics for a PhD:
Biomass conversion techniques can be split into three main routes: biochemical, physicochemical, and thermochemical. In this work the focus will be put on thermochemical conversion, which regroups pyrolysis (production of char and bio-oil), combustion (production of heat), and gasification (production of a combustible gas). Pyrolysis allows converting second generation biomass - that is, non-food biomass in general and wood in particular. During the pyrolysis process wood releases bio-fuel and loses about 50% of its mass and volume. The solid residue is a pure carbon char. In thermochemical industrial processes, wood particles of millimeter to centimeter scales are transformed in fixed-bed reactors. The overall geometrical shrinkage and the intrinsic microstructural evolution strongly impact heat and mass transfer at the particle scale. Heating rate and pyrolysis gas transport within the pores of wood are key phenomena in the conversion process, not only affecting the rate of production but also the nature of the molecules that are produced. Understanding and modeling shrinkage in combination with heat and mass exchanges at the process scale, that is, at the fixed-bed scale, is critical to guide innovation in progress in the field of biofuel production. The objective of the PhD is to pursue the development of appropriate pyro-mechanical models at the particle scale and of volume-averaged fixed-bed models that account for particle shrinkage at the macroscopic scale. This work will be implemented in the Porous material Analysis Toolbox based on OpenFoam, released Open Source by NASA and I2M (www.pato.ac).
Required background of the student:
- Computational fluid mechanics (CFD)

Five representative publications of the group

1. J. Lachaud, N. N. Mansour. Porous material analysis toolbox based on OpenFoam and applications. Journal of Thermophysics and Heat Transfer, 28 (2): 191-202, 2014.
2. J. Lachaud, N. N. Mansour. Porous mate J. Lachaud, J. B. Scoggins, T. E. Magin, M. G. Meyer, N. N. Mansour. A generic local thermal equilibrium model for porous reactive materials submitted to high temperatures. International Journal of Heat and Mass Transfer. 108: 1406-1417, 2017.
3. Ucar, E., Mobedi, M. & Ahmadi, A., Interfacial convective heat transfer for randomly generated porous media, Heat Transfer Research 49 (1) :1–14 (2018).
4. F. Torres-Herrador, V. Leroy, B. Helber, L. Contat-Rodrigo, J. Lachaud, T. Magin. Multicomponent pyrolysis model for thermogravimetric analysis of phenolic ablator and lignocellulosic biomass. AIAA Journal. AIAA Journal, 58: 4081-4089, 2020.
5. J. Lachaud, M. Meyer, C. Metayer, M. Virey, W. Jomaa, J. Meurisse, F. Panerai. Modeling wood shrinkage during pyrolysis: a major challenge for second generation biofuels. InterPore 2020, in mini-symposium MS4: Swelling and shrinking porous media, Aug. 31 - Sept. 4, 2020.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering, computational mechanics

Title: Prediction of plastic buckling for thin structures using advanced constitutive models

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Farid ABED-MERAIM and Mohamed BEN BETTAIEB
Advisor(s) Email: Farid.AbedMeraim@ensam.eu
Mohamed.BenBettaieb@ensam.eu

Research group/Lab: Laboratoire d'Etude des Microstructures et de Mécanique des Matériaux (LEM3), *UMR CNRS 7239*

Lab location: 7 rue Félix Savart F-57070 METZ

(Lab/Advisor website): http://www.lem3.univ-lorraine.fr/

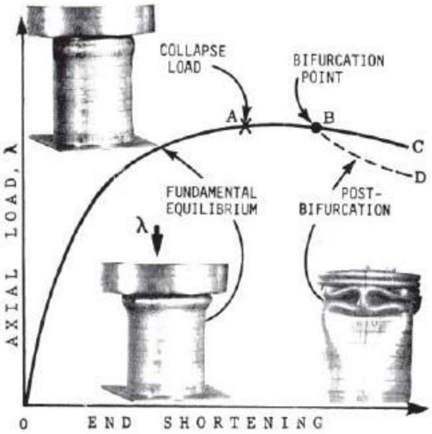
Short description of possible research topics for a PhD:

Plastic buckling is a physical phenomenon that involves a sudden loss in strength for a structure due to the resulting post-buckling shape. This catastrophic behavior is one of the most common structural instability phenomena that a thin structure may encounter during plastic loading. Hence, it is essential to carefully study this phenomenon and to develop the associated numerical tools that are capable of accurately predicting its occurrence. Despite the significant progress accomplished in this area, the existing numerical tools suffer from several limitations, such as the poor description of the mechanical behavior of buckled structures. The current project aims to overcome these limitations by developing several reliable numerical tools in standalone codes or within the Abaqus FE code. In these tools, some advanced constitutive models, allowing for an accurate description of the mechanical behavior, will be implemented and used (based on crystal plasticity approaches or phenomenological models incorporating destabilizing effects). For validation purposes, the results obtained by the developed tools will be compared to benchmarks available in the literature as well as to some theoretical or experimental published results.

Required background of the student:
- Solid background in solid mechanics and numerical methods;
- Good analytical and programming skills (e.g., Matlab, Mathematica, C/C++, Fortran);
- Experience with Finite Element modeling would be an asset.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. **M. Ben Bettaieb**, **F. Abed-Meraim (2015),** "Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses", *International Journal of Plasticity*, Vol. 65, pp. 168–190.
2. H.K. Akpama, **M. Ben Bettaieb**, **F. Abed-Meraim (2017),** "Localized necking predictions based on rate-independent self-consistent polycrystal plasticity: Bifurcation analysis versus imperfection approach", *International Journal of Plasticity*, Vol. 91, pp 205–237.
3. M.Y. Jedidi, **M. Ben Bettaieb**, **F. Abed-Meraim**, A. Bouguecha, M.T. Khabou, M. Haddar **(2019),** "Prediction of necking in HCP sheet metals using a two-surface plasticity model", *International Journal of Plasticity,* doi.org/10.1016/j.ijplas.2019.102641.
4. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Numerical investigation of necking in perforated sheets using the periodic homogenization approach", *International Journal of Mechanical Sciences,* doi.org/10.1016/j.ijmecsci.2019.105209.
5. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Investigation of the competition between void coalescence and macroscopic strain localization using the periodic homogenization multiscale scheme", *Journal of the Mechanics and Physics of Solids*, doi.org/10.1016/j.jmps.2020.104042.



Plastic buckling of a cylindrical shell subjected to axial compression.

Buckled axially compressed axially stiffened cylindrical shell.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering, computational mechanics

Title: Improved numerical multiscale approaches for the prediction of the ductility limit of polycrystalline materials

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Farid ABED-MERAIM and Mohamed BEN BETTAIEB
Advisor(s) Email: Farid.AbedMeraim@ensam.eu
Mohamed.BenBettaieb@ensam.eu

Research group/Lab: Laboratoire d'Etude des Microstructures et de Mécanique des Matériaux (LEM3), *UMR CNRS 7239*

Lab location: 7 rue Félix Savart F-57070 METZ

(Lab/Advisor website): http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:

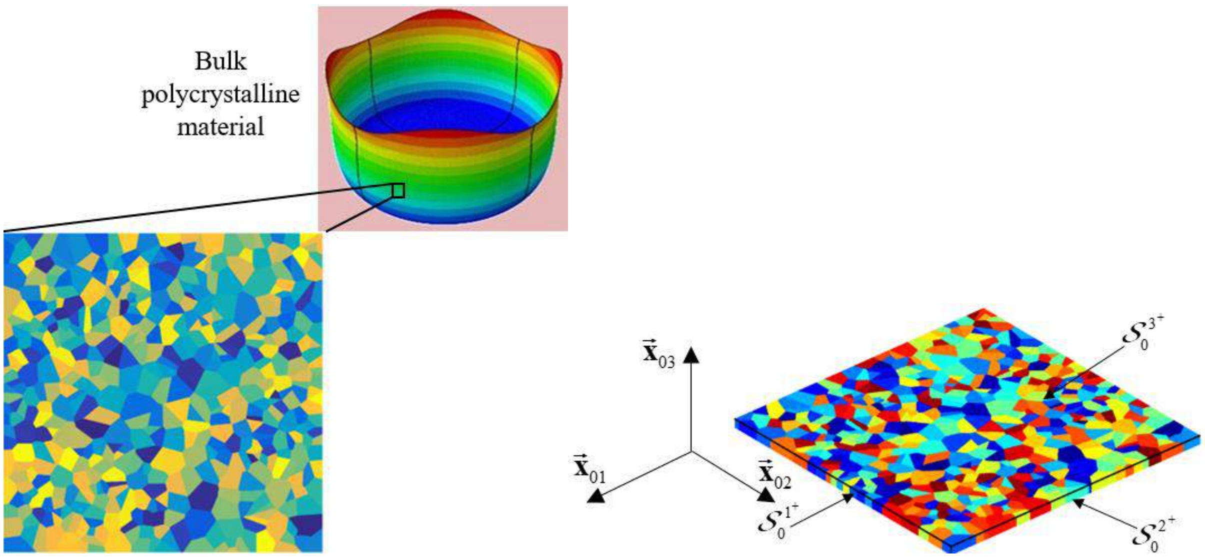
Multiscale approaches are nowadays widely used to predict and analyze the mechanical behavior, and especially the ductility limit of polycrystalline media. Full-field multiscale schemes (based on finite element method or FFT approach) are considered to be the most powerful tools able to predict the mechanical behavior of media exhibiting complex microstructures and/or mechanical behavior. In a previous research project, we have developed and used a full-field multiscale scheme (based on the periodic homogenization technique) to predict the mechanical behavior of heterogeneous materials. The first aim of the present project is to extend this scheme to be able to capture more complex phenomena not considered in the former model (such as second-order effects due to grain size…). The second aim is to improve the description of the single crystal behavior by considering physical aspects not sufficiently investigated so far (such as an adequate description of dislocation density evolution, phase transformation present in TRIP and TWIP steels…). Once validated, these numerical tools will be used, in academic and industrial contexts, to provide guidelines and assistance in the design of new generation of metallic alloys with improved ductility.

Required background of the student:
- Solid background in solid mechanics and numerical methods;
- Good analytical and programming skills (e.g., Matlab, Mathematica, C/C++, Fortran);

- Experience with Finite Element modeling would be an asset.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. **M. Ben Bettaieb**, **F. Abed-Meraim (2015),** "Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses", *International Journal of Plasticity*, Vol. 65, pp. 168–190.
2. H.K. Akpama, **M. Ben Bettaieb**, **F. Abed-Meraim (2017),** "Localized necking predictions based on rate-independent self-consistent polycrystal plasticity: Bifurcation analysis versus imperfection approach", *International Journal of Plasticity*, Vol. 91, pp 205–237.
3. M.Y. Jedidi, **M. Ben Bettaieb**, **F. Abed-Meraim**, A. Bouguecha, M.T. Khabou, M. Haddar **(2019),** "Prediction of necking in HCP sheet metals using a two-surface plasticity model", *International Journal of Plasticity,* doi.org/10.1016/j.ijplas.2019.102641.
4. J. Paux, **M. Ben Bettaieb**, **F. Abed-Meraim**, H. Badreddine, C. Labergere, K. Saanouni **(2020),** "An elasto-plastic self-consistent model for damaged polycrystalline materials: Theoretical formulation and numerical implementation", *Computer Methods in Applied Mechanics and Engineering,* doi.org/10.1016/j.cma.2020.113138.
5. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Investigation of the competition between void coalescence and macroscopic strain localization using the periodic homogenization multiscale scheme", *Journal of the Mechanics and Physics of Solids*, doi.org/10.1016/j.jmps.2020.104042.



(a) (b)

Polycrystalline aggregate: (a) Selection of a unit cell from the bulk polycrystalline material; (b) FE mesh of the unit cell generated by the Voronoi tessellation technique.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Mechanical Engineering, computational mechanics

Title: Prediction of the bendability limits during sheet metal forming processes

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name: Farid ABED-MERAIM and Mohamed BEN BETTAIEB
Advisor(s) Email: Farid.AbedMeraim@ensam.eu
Mohamed.BenBettaieb@ensam.eu

Research group/Lab: Laboratoire d'Etude des Microstructures et de Mécanique des Matériaux (LEM3), *UMR CNRS 7239*

Lab location: 7 rue Félix Savart F-57070 METZ

(Lab/Advisor website): http://www.lem3.univ-lorraine.fr/

Short description of possible research topics for a PhD:

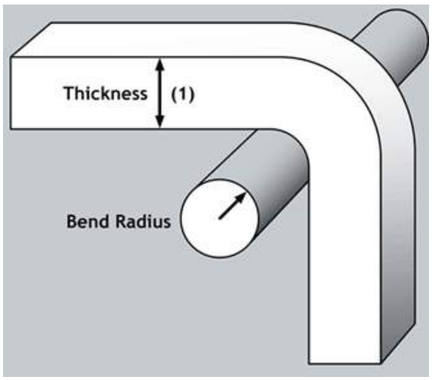
The vast majority of numerical criteria developed to predict the occurrence of diffuse or localized necking assume that the studied metal sheets remain plane during forming processes. Hence, this conventional assumption does not take into consideration the effect of sheet bending, which seems to be inadequate for analyzing the draw-type operations where sheet metal bends, slides and unbends over a draw radius. The main objective of the current project is to extend the set of numerical tools, that we have developed in our research team for the prediction of diffuse necking (maximum force criterion, ...) and localized necking (bifurcation theory, initial imperfection approach...), in order to include the bending effects. The effect of the heterogeneity of the strain through the sheet thickness on the onset of necking will be especially investigated. The mechanical behavior of the bent sheets will be also carefully analyzed by implementing elaborate constitutive models (phenomenological and multiscale models) in our numerical tools. Finite element simulations will be performed to check the accuracy of the developed tools. Once validated, these tools will be used to improve the prediction of the bendability in several industrial and academic applications.

Required background of the student:
- Solid background in solid mechanics and numerical methods;
- Good analytical and programming skills (e.g., Matlab, Mathematica, C/C++, Fortran);
- Experience with Finite Element modeling would be an asset.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. **M. Ben Bettaieb**, **F. Abed-Meraim (2015),** "Investigation of localized necking in substrate-supported metal layers: Comparison of bifurcation and imperfection analyses", *International Journal of Plasticity*, Vol. 65, pp. 168–190.
2. M.Y. Jedidi, **M. Ben Bettaieb**, **F. Abed-Meraim**, A. Bouguecha, M.T. Khabou, M. Haddar **(2019),** "Prediction of necking in HCP sheet metals using a two-surface plasticity model", *International Journal of Plasticity,* doi.org/10.1016/j.ijplas.2019.102641.
3. **M. Ben Bettaieb**, **F. Abed-Meraim**, X. Lemoine **(2019),** "Numerical investigation of the combined effects of curvature and normal stress on sheet metal formability", *International Journal of Material Forming,* Vol. 12, Issue 2, 211–221.
4. J. Paux, **M. Ben Bettaieb**, **F. Abed-Meraim**, H. Badreddine, C. Labergere, K. Saanouni **(2020),** "An elasto-plastic self-consistent model for damaged polycrystalline materials: Theoretical formulation and numerical implementation", *Computer Methods in Applied Mechanics and Engineering,* doi.org/10.1016/j.cma.2020.113138.
5. J.C. Zhu, **M. Ben Bettaieb**, **F. Abed-Meraim (2020),** "Investigation of the competition between void coalescence and macroscopic strain localization using the periodic homogenization multiscale scheme", *Journal of the Mechanics and Physics of Solids*, doi.org/10.1016/j.jmps.2020.104042.


Bendability of nanosteels



Bending of thick sheet

ParisTech | Arts et Métiers Sciences et Technologies

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Information and Communication Sciences and Technologies

Subfield: Product engineering, Computer aided design, Virtual/Augmented Reality.

Title: Development of a design approach with real-time assembly information and an enriched CAD tool

ParisTech School: Arts et Métiers Sciences et Technologies

Advisor(s) Name:	Prof. Nicolas Perry , Dr. Elise Ghuier,	Dr. Ruding Lou
Advisor(s) Email:	nicolas.perry@ensam.eu, elise.gruhier@ensam.eu,	ruding.lou@ensam.eu
Research group/Lab:	I2M	LISPEN
Lab location:	Bordeaux	Chalon-sur-Saône
(Lab website):	https://www.i2m.u-bordeaux.fr/	http://lispen.ensam.eu/

Short description of possible research topics for a PhD:
In current project, designer and assembly/manufacturing expert work in a sequential manner on a 2D screen. Close collaboration is needed between project stakeholders, as well as more **interaction** and **dynamic** way of working. At mean while the augmented and virtual reality (AR & VR) technologies became more and more widespread in industry for assisting various engineering activities. It is evident to ask whether AR & VR can assist designers by enriching current CAD tools.
The **Design For X** (DFX) tools need then to be implemented in the AR or VR application to give information of **X** in real-time. The 3D computer model displayed on the screen of CAD software will be used to compute and analyze assembly process to propose suggestions for decision making. For instance, in Design For Assembly method (DFA), a model can be set and specific algorithm using mereotopology could enable checking the consistency of the assembly sequence, highlighting the interfaces and showing the swept volume of the part move during a sequence.
Therefore, the thesis objective is to devise, prototype and experiment a digital tool allowing real-time processing of **Computer-Aided Design** (CAD). This development will be clearly seen as a **virtual whisper** to the designer. The integration of real-time expert knowledge to the designer enables the reduction of product development time, as less iteration between project stakeholders. As such, a new design approach in required.

Required background of the student:
Product design, computer aided design, product lifecycle, DFX methods, computer science, augmented reality

A list of 5 (max.) representative publications of the group:

- **Perry, N**., Bernard, A., Laroche, F., and Pompidou, S. (2012). Improving design for recycling – Application to composites. CIRP Annals – Manufacturing Technology Elsevier
- **Gruhier, E**., Demoly, F., and Gomes, S. (2017). A spatiotemporal information management framework for product design and assembly process planning reconciliation. Computers in Industry, Vol. 90, pp. 17-41
- **Gruhier E**., Demoly F., Dutartre O., Abouddi S., Gomes S., A formal ontology-based spatiotemporal mereotopology for integrated assembly design and assembly sequence planning, Advanced Engineering Informatics, 29:495-512, 2015, doi10.1016/j.aei.2015.04.004
- B. Li, F. Segonds, C. Mateev, **R. Lou**, F. Merienne, Design in context of use: An experiment with a multi-view and multi-representation system for collaborative design, Computers in Industry, 103, pp. 28-37, 2018.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Life and Health Science and Technology

Title: Design and development by continuous flow chemistry of new functionalized peptide nanoobjects for tumor diagnosis and therapy, with quantitative bioimaging monitoring

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: A. VARENNE / B.-T. DOAN
Advisor(s) Email: anne.varenne@chimieparistech.psl.eu / bich-thuy.doan@chimieparistech.psl.eu
Research group/Lab: SEISAD team, iCLeHS (Chimie ParisTech PSL / CNRS 2027)
Lab location: Chimie ParisTech, 11 rue Pierre et Marie Curie, 75231 Paris Cedex 05
(Lab/Advisor website): https://iclehs.fr/research/seisad/

Short description of possible research topics for a PhD:

The development of new alternative therapeutic strategies to fight cancer by limiting the undesirable side effects of conventional chemotherapy is essential. Nanomedicine is an effective approach to meet these requirements because the coupling and encapsulation of antitumor molecules with nanovectors will allow reducing their toxicity while improving their circulation and *in vivo* targeting. The association with imaging probes will give rise to theranostic agents for image guided therapy.

The PhD proposal aims to explore the benefits and risks brought by the design and development of new self-assembled peptide-based nanoplatforms, breaking with the classical particulate nanovectors. The use of new synthesis processes in continuous flow and microflow will allow a stringent control of amino acid sequences and grafting for a fast identification of the most relevant candidates regarding structure and dynamics of self-assembly. Imaging methods will allow to control their biodistribution and evaluate their therapeutic efficacy for further applications in nanomedicine.

Required background of the student: organic synthesis, physico-chemistry, labelling, imaging

A list of 5 (max.) representative publications of the group:

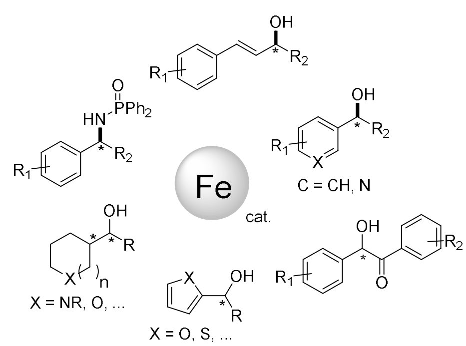
1. MOLECULAR IMAGING AND BIOLOGY, 2019, 21 : 269-278
2. ANALYTICAL BIOCHEMISTRY, 2016, 502 : 8-15
3. REACT. CHEM. ENG., 2020,**5** : 1981-1991
4. ACS APPLIED MATERIALS & INTERFACES, 2018, **10**: 17107-17116

Research Topic for the ParisTech/CSC PhD Program

Field : *Chemistry, Physical Chemistry and Chemical Engineering*
Subfield: *Organic Chemistry*
Title: *New iron complexes for enantioselective hydrogen transfer catalysis*
ParisTech School: *Chimie ParisTech*
Advisor(s) Name: *Virginie VIDAL and Guillaume LEFEVRE*
Advisor(s) Email:
virginie.vidal@chimieparistech.psl.eu; guillaume.lefevre@chimieparistech.psl.eu
Research group/Lab: *i-CLeHS – CSB2D, Chimie ParisTech*
(Lab/Advisor website): *Institute of Chemistry for Life and Health Sciences (i-CLeHS), CSB2D Team - https://www.chimie-paristech.fr/*

Short description of possible research topics for a PhD:

Asymmetric hydrogenation of unsaturated organic substrates is one of the most important synthetic tools used as an access to chiral scaffolds of pharmaceutical interest. The most powerful methods developed so far use noble metal catalysts (Ru, Rh, Ir, ...), which have a low natural abundance and are therefore expensive, and gaseous hydrogen. An important challenge is to develop new asymmetric hydrogenation methodologies which rely (i) on the use of non-noble transition metals as catalysts and (ii) on the use of liquid hydrogen vectors, which can be used as more easily-handled surrogates of H_2.



Iron appears as a good candidate for the development of new organometallic chiral catalysts, due to its low cost and toxicity. The goal of this project is to develop new chiral iron complexes which will be used in highly enantioselective hydrogenation and transfer hydrogenation of organic substrates, leading to a variety of targets of synthetic and pharmaceutical interest (Scheme 1). In order to ensure the robustness and the versatility of the system, various classic liquid hydrogen vectors will be used (e.g. formic acid, Hantzsch esters, cyclohexa-1,4-diene).

Required background of the student: experience in organic/organometallic synthesis.

A list of 5(max.) representative publications of the group:
(1) Review: Kyne, S.; Lefèvre, G.; Ollivier, C.; Petit, M.; Ramis-Cladera, V.-A.; Fensterbank, L. *Chem. Soc. Rev.*, **2020**. Iron and cobalt catalysis: new perspectives in synthetic radical chemistry, *accepted*.
(2) Rousseau, L.; Herrero, C.; Clémancey, M.; Imberdis, A.; Blondin, G.; Lefèvre, G. *Chem. Eur. J.* **2020**, *26*, 2417.
(3) Desaintjean, A.; Belrhomari, S.; Rousseau, L.; Lefèvre, G.; Knochel, P. *Org. Lett.* **2019**, *21*, 8694.
(4) Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Rec.* **2016**, *16*, 2750.
(5) Reviews : a) Echeverria, P.-G.; Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Synthesis* **2016**, *48*, 2523. b) R. Molina-Betancourt, Echeverria, P.-G.; Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Synthesis* **2020** (DOI: 10.1055/s-0040-1705918). Recent Progress and Applications of Transition-Metal-Catalyzed Asymmetric Hydrogenation and Transfer Hydrogenation of Ketones and Imines through Dynamic Kinetic Resolution.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Theoretical Chemistry

Title: DEVELOPMENT AND APPLICATION OF DENSITY BASED INDEXES FOR THE DIAGNOSTIC AND DESCRIPTION OF EXCITED STATES

ParisTech School: Chimie ParisTech | PSL
Advisor(s) Name: Ilaria Ciofini and Carlo Adamo
Advisor(s) Email: *ilaria.ciofini@chimieparistech.psl.eu and carlo.adamo@chimieparistech.psl.eu*
Research group/Lab: *CTM group; i-CLeHS*
Lab location: *Institute of Chemistry for Health and Life sciences (i-CLeHS) ChimieParisTech 11 rue P et M Curie, Paris*
Website: *https://www.quanthic.fr/* ***Twitter*** *https://twitter.com/group_ctm*

Short description of possible research topics for a PhD:
In the last years our group has developed several indexes enabling both the description of the excited states in terms of their nature (Locally Excited vs Charge Transfer) and the diagnostic of problematic cases to be treated at DFT level. These descriptors have allowed the investigation of excited state Potential Energy Surfaces of relevance to disclose the photophysical properties and the photoreactivity of molecular systems of interest in difference fields ranging from photovoltaics, to health sciences (ex. photodynamic therapy).
Within this doctoral work we aim at developing new indexes allowing to follow excited state evolution and to apply them to rationalize and predict the behavior of photo-active molecules. Homogeneous photo-catalytic reactions will be the target in terms of application.

Required background of the student: The student should have a strong background in physical and theoretical chemistry. Previous knowledge in ab-initio methods and Density Functional Theory as well programming experience will be greatly appreciated.

A list of 5 representative publications of the group in the field :

1. JCTC 7 (2011) 2498–2506
2. COORD. CHEM. REV. (2015) 304-305 166-178
3. JCTC 16 (2020) 4543–4553
4. JACS 142 (2020) 6578-6587
5. Nature Comm 11 (2020) 3262.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry
Title: Better understanding TiO_2 photocatalysis by Density Functional Theory approaches

ParisTech School: Chimie ParisTech
Advisor(s) Name: Frédéric Labat
Advisor(s) Email: *frederic.labat@chimieparistech.psl.eu*
Research group/Lab: Theoretical Chemistry and Modeling Group/i-CLeHS FRE 2027 CNRS
(Lab/Advisor website): www.quanthic.fr

Short description of possible research topics for a PhD:
Photocatalysis, where solar energy is used to drive chemical and energy processes, has received considerable attention since it is a potentially environmentally friendly energy technology, with various applications in different fields such as solar cells, water splitting and pollutant degradation. In particular, heterogeneous photocatalysis, in which the catalyst is in a different phase as the reactants, has seen considerable developments, not only to propose new photocatalysts but also to better understand and improve photocatalytic processes.
Among the different photocatalysts proposed, TiO_2 is particularly appealing since it is chemically stable, nontoxic and low-cost. Although TiO_2-based heterogeneous photocatalysis has been successful during the last years, a clear understanding of the various processes involved during a typical photocatalytic reaction in TiO_2-based photocatalysis is however still largely missing, preventing a more rational design of new photocatalysts or the detailed characterization of new photocatalytic processes.
The aim of this project is to better understand, from a modeling viewpoint, basic processes involved in TiO_2-based heterogeneous photocatalysis, and how these processes influence the whole photocatalytic reaction. Particular care will be devoted to the development of cost effective computational approaches enabling the description of both ground and excited state properties of complex interfaces using both periodic ab-initio approaches rooted on Density Functional Theory and finite cluster models in conjunction with embedding techniques and implicit solvation models to simulate the effect of the environment.
Required background of the student: Physical Chemistry, Chemical Physics and, if possible, theoretical chemistry and previous programming experience.
A list of 5(max.) representative publications of the group:
[1] F. Labat et al ”Silver-decorated CeO2 (111) as a potential anodic electrocatalyst in fuel cells: a hybrid Density Functional Theory investigation”, *J. Phys. Chem. C*, **123**, 25668-25679 (2019).
[2] F. Labat, et al ”Improving the Heterointerface in Hybrid Organic-Inorganic Perovskite Solar Cells by Surface Engineering: Insights from Periodic Hybrid Density Functional Theory Calculations”, *J. Comput. Chem.*, **41**, 1740-1747 (2020).
[3] F. Labat et al , ”On the stability issues of TiO2-based composites in view of fuel cell application: a combined experimental and theoretical investigation”, *J. Phys. Chem. C*, **123**, 12573–12582 (2019).
[4] F. Labat, et al, ”First-principles modeling of dye-sensitized solar cells: Challenges and perspectives”, *Acc. Chem. Res.*, **45**, 1268 (2012).

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

Title: 2D/3D Perovskites for Stable and High-Efficiency Solar Cells

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Thierry PAUPORTÉ
Advisor(s) Email: thierry.pauporte@chimieparistech.psl.eu
Research group/Lab: Institut de Rechreche de ChimieParis (UMR8247)
Lab location: 11 rue P. et M. Curie 75005 Paris
Website : www.pauportegroup.com

Short description of possible research topics for a PhD:

Recently, hybrid halogen perovskites (PVKs) have emerged as fascinating materials and highly versatile semiconductors. These compounds can be prepared as 2D (two-) and 3D (three-dimensional) materials, and their composition can be varied over a quite large extend. This ensures the possible fine tuning of their optoelectronic properties. Their superior properties make them especially attractive for an application to photovoltaic (PV) solar cells. If their PV power conversion efficiency is now reaching impressive values, these devices still suffer from a problem of stability.
The host group, which is leader in France on perovskite solar cells (PSCs) research, has discovered recently precursor solution chemistries that allow the preparation of highly stable 2D/3D perovskite layers. Moreover the power conversion efficiency achieved with these perovskites is very promising.
The aim of the PhD will be to get further insights into the preparation 2D/3D PVK with special stoichiometry and additive. The student will investigate the role of the additives and the effect of the composition on the layers morphological, structural, optical and electronic properties. PV cells based on these new materials will be prepared and characterized by various techniques (*J-V* curves, impedance spectroscopy, spectral response…). The objective will be to better understand the effect of chemistry and composition on the devices stability and high performances.

Required background of the student:
Material science, Chemistry, if possible: Physics of semiconductors, Photovoltaics.

A list of 5 representative publications of the group:
1- T. Zhu, D. Zheng, J. Liu, L. Coolen, Th. Pauporté, Electrical Response of High Efficiency and Stable Solar Cells Based on MACl Mediated Grown $FA_{0.94}MA_{0.06}PbI_3$ Perovskite. ACS Appl. Mater. Interfaces 12 (2020) 37197–37207.
2- T. Zhu, D. Zheng, M.-N. Rager, Th. Pauporté, Actual Organic Cations Composition Determination in Perovskite Thin Films. Application to Formamidinium Lead Iodide Stabilization for High Efficiency Solar Cell. Solar RRL 2020, 2000348.
3- T. Zhu, J. Su, F. Labat, I. Ciofini, Th. Pauporté, Interfacial Engineering through Chloride-Functionalized Self-Assembled Monolayer for High Efficiency Perovskite Solar Cells. ACS Appl. Mater Interfaces, 12 (2020) 744-752.
4- A. Leblanc, N. Mercier, M. Allain, J. Dittmer, T. Pauporté, V. Fernandez, F . Boucher, M. Kepenekian, C. Katan, Enhanced Stability and Band Gap Tuning of α-$[HC(NH_2)_2]PbI_3$ Hybrid Perovskite by Large Cation Integration. ACS Appl. Mater. Interfaces, 11 (2019) 20743-20751.
5- D. Pitarch-Tena, T.T. Ngo, M. Vallés-Pelarda, Th. Pauporté, I. Mora-Seró, Impedance Spectroscopy Measurements in Perovskite Solar Cells. Device Stability During the Measurement and Noise Reduction. ACS Energy Lett., 3 (2018) 1044–1048.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

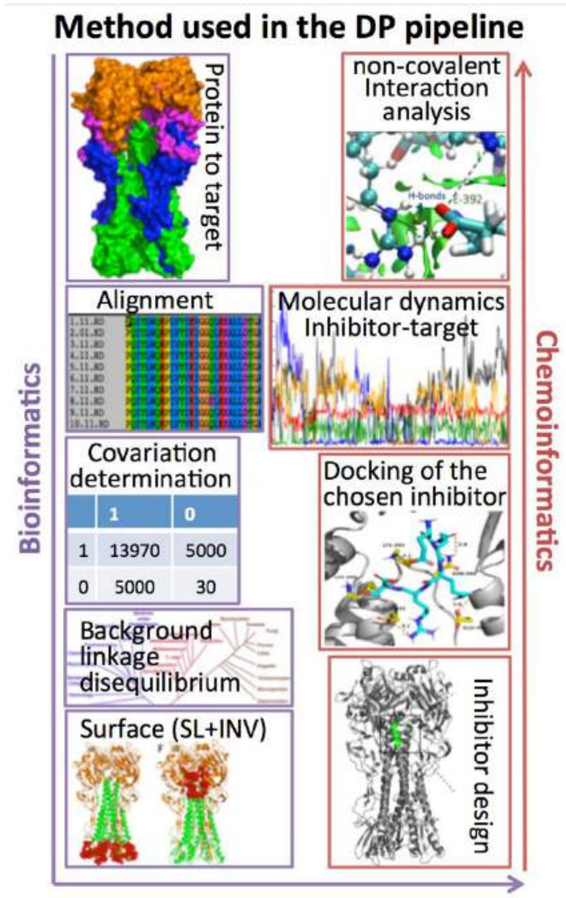
Title: In silico design of unescapable influenza therapies

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Dr. PERRIER Aurélie
Advisor(s) Email: aurelie.perrier@chimieparistech.psl.eu
Research group/Lab: *CTM / i-CLeHS*
Lab location: *Chimie Paris Tech, 11 rue Pierre et Marie Curie, F-75005 Paris*
Lab/Advisor website: *https://www.quanthic.fr/*

Short description of possible research topics for a PhD:

Influenza is a major Public Health threat. A single anti-influenza drug, oseltamivir, is available in Europe but resistance mutations against this drug can occur. Our goal is to develop anti-influenza drugs with little or no possibility of viral escape. For this purpose, *in silico* work allows us to describe new therapeutic targets that should reduce viral escape and to propose inhibitors potentially clinging to these targets. We have already defined a reusable data processing (DP) pipeline shown opposite.
During this project, the PhD student will participate to the (1) *in silico* design of antiviral targets and (2) drug design of potential inhibitors. Iterative cycles involving bioinformatics and chemoinformatics will allow us to refine both the targets (to consider the maximum of sub-types of influenza viruses) and the chemical structure of the inhibitors.



Required background of the student: Molecular modeling, computational chemistry or bioinformatics

Representative publications of the group:

1. Perrier, A. *et al*. J. Phys. Chem. B 2019,123, 582-592. DOI: 10.1021/acs.jpcb.8b10767.
2. Ozeel, V. *et al*. Symmetry 2019, 11(5), 662; DOI:10.3390/sym11050662.
3. Sharma, A. *et al*. Phys. Chem. Chem. Phys. 2016, 18, 30029-30039. DOI: 10.1039/C6CP05105G

ParisTech

Chimie Paris | PSL
ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

Title: Photocatalysis in Living Cells with Earth Abundant Metals for Cancer Therapy

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Gilles GASSER
Advisor(s) Email: gilles.gasser@chimieparistech.psl.eu
Research group/Lab: Institute of Chemistry for Life Sciences,
(Lab/Advisor website): www.gassergroup.com

Short description of possible research topics for a PhD: Photodynamic Therapy (PDT) is an approved medical technique to treat certain types of cancer. However, cancer cells have a lower amount of oxygen than healthy ones, limiting the success of PDT treatments since oxygen is one of the three required components with the presence of a photosensitizer and light. Recently, it was demonstrated that Ir(III) complexes could kill cancer cells upon light irradiation without the presence of oxygen.[1] *In this project, we aim at developing novel complexes based on biocompatible, earth-abundant metal complexes to kill cancer cells.*

Required background of the student: The applicant should have a sound knowledge (theoretical and practical) in both inorganic and organic chemistry and be proficient with analytical techniques such as NMR and MS. The applicant must be fluent in English since it is the language spoken in the Gasser group. Practical knowledge in biology would be an asset.

A list of 5 (max.) representative publications of the group:

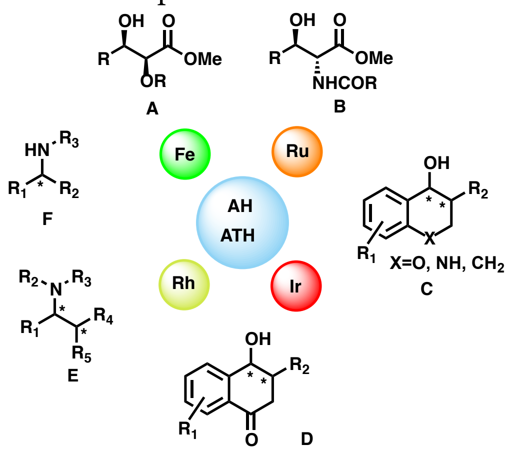
1. H. Huang, S. Banerjee, K. Qiu, P. Zhang, O. Blacque, T. Malcomson, M.J. Paterson, G.J. Clarkson, M. Staniforth, V.G. Stavros, **G. Gasser**,* H. Chao,* and P.J. Sadler,* *Nature Chem.*, **2019**, *11*, 1041-1048.
2. J. Karges, S. Kuang, F. Maschietto, O. Blacque, I. Ciofini, H. Chao,* and **G. Gasser**,* *Nature Commun.*, **2020**, *11*, 3262.
3. J. Karges, F. Heinemann, M. Jakubaszek, F. Maschietto, C. Subecz, M. Dotou, R. Vinck, O. Blacque, M. Tharaud, B. Goud, E. Viñuelas Zahínos, B. Spingler,* I. Ciofini,* and **G. Gasser,*** *J. Am. Chem. Soc.*, **2020**, *142*, 6578-6587.

Research Topic for the ParisTech/CSC PhD Program

Field : *Chemistry, Physical Chemistry and Chemical Engineering*
Subfield: *Organic Chemistry*
Title: *Asymmetric Catalysis toward BioRelevant Architecturally Novel Natural and Unnatural Products*
ParisTech School: *Chimie ParisTech*
Advisor(s) Name: *Virginie VIDAL*
Advisor(s) Email:
virginie.vidal@chimieparistech.psl.eu
Research group/Lab: *i-CLeHS – CSB2D, Chimie ParisTech*
(Lab/Advisor website): *Institute of Chemistry for Life and Health Sciences (i-CLeHS), CSB2D Team - https://www.chimie-paristech.fr/*

Short description of possible research topics for a PhD:

Our group develops new catalytic processes for the synthesis of natural products and targets of biological interest. We have been interested in the development of novel methods for synthetic efficiency and atom and step economical processes using transition metal-catalyzed reactions as they provide a direct and selective way toward the synthesis of highly valuable products. The research program will be dedicated to the development of asymmetric catalytic methods in a context of sustainable development for carbon-carbon and carbon-hydrogen bond forming reactions using asymmetric hydrogenation (AH) or asymmetric hydrogen transfer reactions (ATH) [1] through dynamic kinetic resolution (DKR)[2-4] to target scaffolds of biorelevant molecules of medicinal.[5] The PhD research program aims at developing new catalytic asymmetric approaches to address long-standing problems in the synthesis of chiral key intermediates such as A-F to access natural products and pharmaceutical drugs.



Required background of the student: experience in organic/organometallic synthesis.

A list of 5 (max.) representative publications of the group:
(1) Reviews : a) R. Molina-Betancourt, Echeverria, P.-G.; Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Synthesis* **2020** (DOI: 10.1055/s-0040-1705918; Recent Progress and Applications of Transition-Metal-Catalyzed Asymmetric Hydrogenation and Transfer Hydrogenation of Ketones and Imines through Dynamic Kinetic Resolution.
(2) He, B.; Phansavath, P.; Ratovelomanana-Vidal, V. *Org. Chem. Front.* **2020**, *7*, 975.
(3) He, B.; Phansavath, P.; Ratovelomanana-Vidal, V. *Org Lett* **2020**, *21*, 3276.
(4) a) Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Org Lett* **2019**, *21*, 2998. b) Zheng, L.-S.; Férard, C.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Commun.* **2018**, *54*, 283.
(5) Ayad, T.; Phansavath, P.; Ratovelomanana-Vidal, V. *Chem. Rec.* **2016**, *16*, 2750.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Chemistry, Physical Chemistry and Chemical Engineering

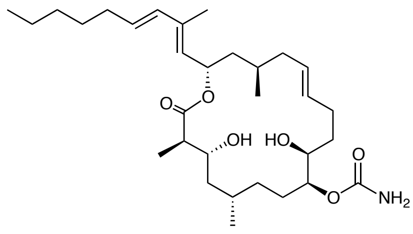
Subfield: Organic chemistry

Title: Total synthesis of tulearin A and analogues

ParisTech School: Chimie ParisTech

Advisor(s) Name: Phannarath Phansavath
Advisor(s) Email: phannarath.phansavath@chimieparistech.psl.eu
Research group/Lab: Institute of Chemistry for Life & Health Sciences (i-CLeHS), CSB2D team (Catalysis, synthesis of biomolecules and sustainable chemistry)
Lab location: i-CLeHS, Chimie ParisTech, Paris
(Lab/Advisor website): *https://www.chimieparistech.psl.eu/*

Short description of possible research topics for a PhD:



Tulearin A

Tulearins constitute a small family of macrolides isolated from a Madagascar sponge of the *Fascaplysinopsis* genus. The potent anti-proliferative activity of Tulearin A against two human leukemia cell lines made it an interesting target and two total synthesis of this compound have been reported. As part of our ongoing research directed toward the synthesis of biologically relevant compounds,[1-2] we propose in this PhD program to develop an efficient total synthesis of Tulearin A and of analogues of the natural product, using new catalytic systems to introduce the various stereogenic centers.[3-5]

Required background of the student:

Main field of study of the applicant before applying: organic chemistry.
Synthetic Organic Chemistry, Homogeneous Catalysis

A list of 5 (max.) representative publications of the group:

1. Echeverria, P.-G.; Prévost, S.; Cornil, J.; Férard, C.; Reymond, S.; Guérinot, A.; Cossy, J.; Ratovelomanana-Vidal, V.; Phansavath, P. *Org. Lett.* **2014**, *16*, 2390.
2. Perez, M.; Echeverria, P.-G.; Martinez-Arripe, E.; Ez Zoubir, M.; Touati, R.; Zhang, Z.; Genet, J.-P.; Phansavath, P.; Ayad, T.; Ratovelomanana-Vidal, V. *Eur. J. Org. Chem.* **2015**, 5949.
3. L.-S. Zheng, C. Férard, P. Phansavath, V. Ratovelomanana-Vidal *Chem. Commun.* **2018**, *54*, 283.
4. B. He, P. Phansavath, V. Ratovelomanana-Vidal *Org. Lett.* **2019**, *21*, 3276.
5. A. Westermeyer, G. Guillamot, P. Phansavath, V. Ratovelomanana-Vidal *Org. Lett.* **2020**, *22,* 3911.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng.…)

Title: Synthesis of innovative nanomaterials for hydrogen production by water splitting process and the study of its efficiency by the rotating Ring Disk Electrode method.

ParisTech School: Chimie ParisTech | PSL
Advisor(s) Name: Abdelhafed Taleb
Advisor(s) Email: abdelhafed.taleb@chimieparistech.psl.eu
Research group/Lab: IRCP-UMR 8247
Lab location: Chimie Paris Tech
(Lab/Advisor website): https://www.ircp.cnrs.fr/
Short description of possible research topics for a PhD:Hydrogen energy is considered by the scientific community as one of the potential clean energy sources to replace the pollutant fossil energy. Therefore, the hydrogen production is becoming à hot topic in material science. The present PhD proposal will focus on the synthesis and electrochemical characterization of innovative semiconductor and transition metal materials (chalcogenide, oxide, mixed) for high efficiency of water splitting. The rotating Ring Disk Electrode (RRDE) method will be used to study the oxygen vs. chlorine evolution (OER vs. CER) in alkaline media. The objective of this study is to explore the efficiency of different materials for the competitiveness of both oxygen and chlorine evolution and the influence the transition metal catalysts. The optimized electrode materials will be integrated into new generation of electrolyzes for the electrochemical decomposition of water in the dark or under illumination which mimic the artificial photosynthesis (photoelectrochemical water splitting). This research aims to the development of low cost and active electrocatalysts for hydrogen fuel production efficiency. This work will be achieved in collaboration with Pr. Ahmed Ennaoui president of the scientific council of IRESEN (the Moroccan Research Institute for Solar Energy and New Energies)
Required background of the student: Solid State chemist, electrochemist, physical chemist
A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. A. Ennaoui, and H. Tributsch, Journal of Electroanalytical Chemistry 204 (1986) 185
2. A. Ennaoui, and H. Tributsch , Solar Energy Materials and Solar Cells, 29 (1993) 289-370
3. A. Taleb, F. Mesguich, X. Yanpeng, C. Colbeau-Justin P. Dubot, Solar Energy Materials and Solar Cells, 148, 52, (2016).
4. S. Mehraz, P. Konsong, A. Taleb, N. Dokhane, L. Sikong, Solar Energy Materials and Solar Cells, 189 (2019) 254-262.
5. H. Ennaceri, D. Erfurt, L. Wang, T. Köhler, A. Khaldoun, A. El Kenz, A. Benyoussef, A. Ennaoui, A. Taleb, Solar Energy Materials and Solar Cells, 201 (2019) 110058.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield:

Title: Design of new electrode materials based on nanoparticles for electrochemical nanosensing applications with environmental interest.

ParisTech School: Chimie ParisTech | PSL
Advisor(s) Name: Abdelhafed Taleb
Advisor(s) Email: abdelhafed.taleb@chimieparistech.psl.eu
Research group/Lab: IRCP-UMR 8247
Lab location: Chimie Paris Tech
(Lab/Advisor website): https://www.ircp.cnrs.fr/

Short description of possible research topics for a PhD: In the field of material science, one of the main question is, does it make sense to define desired properties first and then design the material with the architecture that match these properties. The actual research topic of our group is within this concern, and it consist of new material design developments that emerge new properties and functions. Actually, one of the main research topics we are developing is dealing with the enhancement of detection limit and selectivity of sensing, based on nanostructure through a new design of metallic nanoparticles modified electrode. Our design strategies combine nanomaterials and different deposition methods to prepare desired material structure of required properties.
Over the years, our group has acquired expertise in nanoparticle synthesis, surface modification and deposition of thin film based on nanoparticles. Our goal in this PhD proposal is to develop hierarchical electrode material based on metallic nanoparticles. We expect that our results could be helpful in understanding the electrochemical properties of hierarchical electrode and may have potential applications in sensing. Additional, the performance of prepared electrode will be optimized.

Required background of the student: Electrochemistry, ideally with some knowledge of surface modification and/or nanomaterial synthesis.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. A. Taleb, X. Yanpeng, P. Dubot, J. Electroanal. Chem. 693 (2013) 60.
2. A. Taleb, X. Yanpeng, P. Dubot, Applied surface science, 420 (2017) 110-117.
3. Sana Falah, Xue Yanpeng, Abdelhafed Taleb, Mohamed Beji, Electrochemica Acta, 292(1) (2018) 594-601.
4. Z. Ait-Touchente, S. Falah, E. Scavetta, M. M. Chehimi, R. Touzani, D. Tonelli, A. Taleb, Molecules 25 (2020) 3903.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering, Life Science and Engineering for Agriculture, Food and the Environment

Subfield: Electrochemistry, Bio analytical chemistry

Title: Hydrogel Matrix Grafted electrochemical Aptasensors for the Detection of emerging pollutants

ParisTech School: Chimie ParisTech

Advisors Name: Cyrine Slim, Sophie Griveau, Fethi Bedioui
Advisors Email: Cyrine.slim@chimieparistech.psl.eu/sophie.griveau@chimieparistech.psl.eu
Research group/Lab: Institute of Chemistry for Life and Health Sciences, i-CLeHS
Lab location : ENSCP Chimie Paristech
11, rue Pierre et Marie Curie 75231 Paris Cedex 05, France
Lab website: https://iclehs.fr/research/seisad/

Short description of possible research topics for a PhD:
Driven by the growing concern about the release of the untreated emerging pollutants and the urgent demand of determining low level of these pollutants present in environment, novel biosensors dedicated to molecular recognition will be developed. The objective of the project is to design biosensors using a novel class of grafted polymers, surface-attached hydrogel thin films on conductive transducer as biocompatible matrix for biomolecule immobilization. From biomolecules, aptamers constitute an attractive alternative to antibodies due to their high affinity and their excellent specificity for a target or a family of selected targets. It is also possible to functionalize them with specific chemical functions and/or with tag to label the aptamers, for their further immobilization and/or for their analysis. The immobilization of the aptamer onto surface-attached hydrogel thin films by covalent attachment provides a biodegradable shelter, providing the aptamer excellent environments to preserve its active and functional structure while allowing the detection of pollutants. For improved sensitivity and higher stability of the sensor, a high density of immobilized aptamer is enabled. Within a constant miniaturization effort, we will tend towards the transposition of this work, towards microfluidic electrochemical biosensors on real samples due to their miniature, portable and low-cost systems as well as high through put and automation. The integration of electrochemical sensors into microfluidic formats with the incorporation of unique materials for detection will be explored in this project. The development of these systems would lead to significant advantages compared to the current analytic systems, in terms of simplicity, speediness, cost, and automation.

Required background of the student: Physical chemistry, ideally background in basic electrochemistry

A list of representative publications of the group:

1- Kassahun, G.; Griveau, S.; Juillard, S.; Champavert, J.; Ringuedé, A.; Bresson, B.; Tran, Y.; Bedioui, F.; Slim, C. Poly(acrylic acid) hydrogel matrix based impedimetric aptasensor for the detection of diclofenac. Langmuir 36 (2020) 827–836.
2- Quinton, D., Girard, A., Thi Kim, L. T., Raimbault, V., Griscom, L., Razan, F., Bedioui, F. (2011). On-chip multi-electrochemical sensor array platform for simultaneous screening of nitric oxide and peroxynitrite. Lab on a Chip, 11(7), 1342–1350
3- Griveau, S., & Bedioui, F. (2013). Electroanalytical methodologies for the detection of S-nitrosothiols in biological fluids. The Analyst, 138(18), 5173–81
4- Ramirez-Garcia, G., Martinez-Alfaro, M., Gutierrez-Granados, S., Alatorre-Ordaz, A., Griveau, S., & Bedioui, F. (2015). Electrochemical assessment of possible melatonin effect on nitric oxide production from kidneys of sub-acute lead treated rats. Electrochimica Acta, 166, 88–92
5- Slim, C., Ratajovà, E., Griveau, S., Kanoufi, F., Ferraro, D., Perréard, C., Bedioui, F. (2015). Two-step local functionalization of fluoropolymer Dyneon THV microfluidic materials by scanning electrochemical microscopy combined to click reaction. Electrochemistry Communications, 60, 5–8

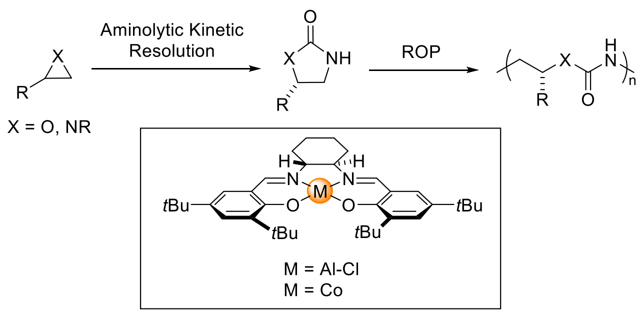
RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry and Materials Science
Title: Synthesis of Biobased Polyurethanes from Renewable Resources: A New Tandem Approach to Polypeptide Analogues

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Prof. Christophe Thomas
Advisor(s) Email: christophe.thomas@chimieparistech.psl.eu
Research group/Lab: Organometallic Chemistry and Polymerization Catalysis
Lab location: 11 rue Pierre et Marie, 75005 Paris
(Lab/Advisor website): http://www.ircp.cnrs.fr/la-recherche/equipe-cocp/

Short description of possible research topics for a PhD:



Tandem catalysis is one of the strategies used by Nature for building macromolecules.[1] However, these biological processes rely on highly complex biocatalysts thus limiting their industrial applications. In the same biomimetic spirit, we want to initiate a research effort to synthesize **biodegradable** polymers[2] via tandem **catalytic transformations**, where "activated" monomers are synthesized from raw materials (in one or more steps) and subsequently (co)polymerized. The objectives for this are clear: not only can a reduction in workload, waste and energy consumption be achieved, but also the synthesis of complex products that are otherwise difficult to obtain (*e.g.*, because of thermodynamic hurdles) comes within reach. In other words, the combination of chemistries may allow the direct synthesis of macromolecules with high structural complexity. Therefore, we want to direct investigative efforts toward the synthesis of new **renewable monomers** and the subsequent catalytic conversion of these monomers into their corresponding polymers.[3] The general idea is to use a tandem procedure of combining synthesis of new biomass derived monomers with subsequent polymerization by well-defined metal-based catalysts, aiming at novel polymeric materials.

Required background of the student: Polymer Chemistry, Catalysis

A list of 5 (max.) representative publications of the group:

1. *Nature Comm.*, **2011**, *2*, 586.
2. *J. Am. Chem. Soc.* **2017**, *139*, 6217.
3. *Angew. Chem. Int. Ed.* **2019**, *58*, 12585.

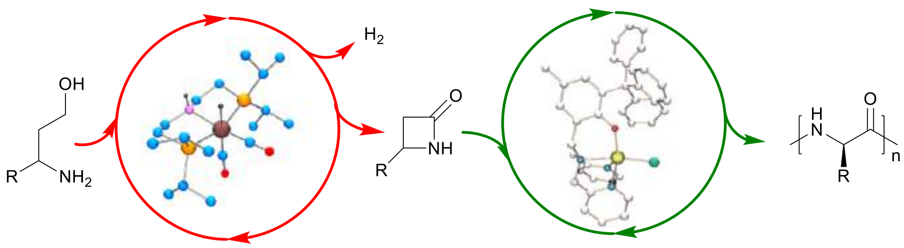
RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry
Title: Smart multi-catalytic systems for the production of biocompatible polymers

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Dr. Régis Gauvin, Prof. Christophe Thomas
Advisor(s) Email: regis.gauvin@chimieparistech.psl.eu; christophe.thomas@chimieparistech.psl.eu
Research group/Lab: Organometallic Chemistry and Polymerization Catalysis
Lab location: 11 rue Pierre et Marie, 75005 Paris
(Lab/Advisor website): http://www.ircp.cnrs.fr/la-recherche/equipe-cocp/

Short description of possible research topics for a PhD:
Biocompatible materials such as polyesters and polyamides hold a prominent position in the portfolio of specialty and commodity polymers. Controlling their structural features such as chain size and microstructure is key in establishing specific properties. In this context, **organometallic catalysis** is instrumental, thanks to its outstanding ability to achieve both high degree of stereoselectivity and mass control. Smart approaches such as **tandem catalysis** can be game changers: Combining several complementary systems is a unique opportunity to perform series of chemical reactions with higher efficiency. In this project, **hydrogen borrowing**, a clean, atom-economical technology, will be harnessed in a first step to synthesize lactones or lactames monomers from biosourced raw materials. These will then be polymerized via **stereoselective ring opening polymerization**, affording novel polyesters or polyamides. A strong emphasis will be put on the design of novel organometallic catalysts based on **Earth-abundant metals**, as well as on establishing catalysts structure and polymers' physicochemical properties relationships.



Required background of the student: organic and polymer synthesis.

A list of 5 (max.) representative publications of the group:
1. *Nature Comm.*, **2011**, *2*, 586.
2. *J. Am. Chem. Soc.* **2017**, *139*, 6217.
3. *ACS Catal.*, **2017**, *7*, 2022.
4. *Angew. Chem. Int. Ed.* **2019**, *58*, 12585.

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RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

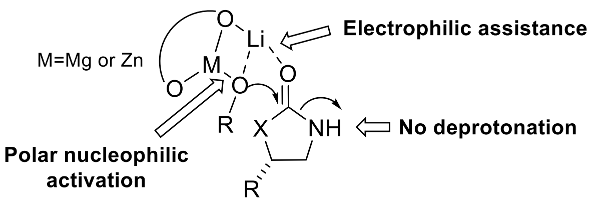
Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry and Materials Science
Title: Synthesis of Biodegradable Polymers from Renewable Resources

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Dr. Régis Gauvin, Prof. Christophe Thomas
Advisor(s) Email: regis.gauvin@chimieparistech.psl.eu; christophe.thomas@chimie-paristech.psl.eu
Research group/Lab: Organometallic Chemistry and Polymerization Catalysis
Lab location: 11 rue Pierre et Marie, 75005 Paris
(Lab/Advisor website): http://www.ircp.cnrs.fr/la-recherche/equipe-cocp/

Short description of possible research topics for a PhD:

The ring opening polymerization (ROP) of *N*-carboxyanhydrides (NCA) can yield homopolymers and block-copolymers with well-controlled structures where the repeat units are natural amino acids.[1] Similarly to proteins, these synthetic polypeptides possess well-defined secondary structures (α-helix and β-sheets), whereas synthetic polymers generally present a disordered coil structure. Therefore, these biomimetic polymers produce sophisticated superstructures with new material properties. Our aim will be to develop an efficient route from readily available reactants to synthesize new polypeptide analogues with a conserved ability to form well-defined secondary structures.



In this regard, there is growing evidence that magnesium or zinc derivatives can be effective catalysts for homogeneous polymerization. Their low toxicity, low cost, and accessibility make them attractive candidates for the development of affordable, sustainable and green catalysts. Bimetallic reagents are ideal candidates for this purpose since the polar organometallic moiety will act as a strong nucleophile with a concomitant electrophilic assistance created through the coordination of carbonyl oxygen of urea by the lithium cation. Therefore we want to use these bimetallic systems to synthesize aliphatic polyureas and polyurethanes via an auto-tandem catalytic transformation[2] where cyclic urethanes or ureas are synthesized from respectively epoxides or aziridines and subsequently polymerized by ROP.[3]

Required background of the student: Organic & Polymer Chemistry, Catalysis

A list of 5 (max.) representative publications of the group:

1. *Chem. Commun.*, **2014**, *50*, 13773.
2. *Nature Comm.*, **2011**, *2*, 586.
3. *Chem. Soc. Rev.*, **2013**, *42*, 9392.

ParisTech

Chimie Paris | PSL
ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

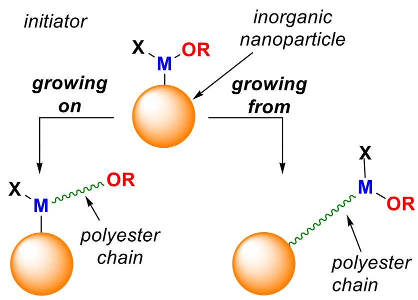
Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Chemistry and Materials Science
Title: Vectorizing nanoparticles using biocompatible and biodegradable polymer coating mediated by surface organometallic chemistry

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Dr. Régis Gauvin, Prof. Christophe Thomas
Advisor(s) Email: regis.gauvin@chimieparistech.psl.eu; christophe.thomas@chimie-paristech.psl.eu
Research group/Lab: Organometallic Chemistry and Polymerization Catalysis
Lab location: 11 rue Pierre et Marie, 75005 Paris
(Lab/Advisor website): http://www.ircp.cnrs.fr/la-recherche/equipe-cocp/

Short description of possible research topics for a PhD:

The design of efficient vectorizing agents is at the cornerstone of modern pharmaceutical agents. In this view, the tailoring of specific (molecular) objects by covalent bonding with polymer chains is of major interest, to confer them significant compatibility with physiological environments.[1]



In this view, biocompatible and biodegradable polymers are ideal candidates as components within such advanced formulations. These can be most efficiently prepared using ring opening polymerization (ROP) of lactones or lactides into polyesters or polylactic acid mediated by organometallic initiators.[2] On the top of that, immobilization of organometallics on inorganic surfaces via surface was demonstrated to boost stereoselectivity of these considered polymerization processes.[3] In this project, we propose to combine surface organometallic chemistry and ROP of polar monomers to design specific nanoobjects by "*growing from*" or "*growing on*" approaches, where chain growth is mediated by specifically designed supported organometallic entities. The ultimate goal will be the development of biopolymer-coated nanoparticles for future implementation into delivery systems.

Required background of the student: Organic Chemistry, Polymer Chemistry, Catalysis

A list of 5 (max.) representative publications of the group:

1. *Chem. Sci.*, **2020**, *11*, 2657.
2. *Angew. Chem. Int. Ed.* **2019**, *58*, 12585.
3. *Chem. Commun.* **2010**, *46*, 1032.

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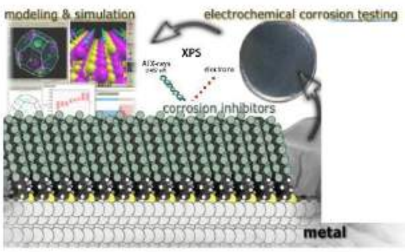
ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Chemistry, Physical Chemistry and Chemical Engineering
Subfield: Surface Science, Molecular Modeling
Title: **Organic molecules for the corrosion inhibition of Al alloys: theoretical and experimental model approach**
ParisTech School: Chimie ParisTech | PSL
Advisor(s) Name: Dominique COSTA (Dimitri Mercier, Sandrine Zanna, Philippe Marcus co-advisors)
Advisor(s) Email: *dominique.costa@chimieparistech.psl.eu*
Research group/Lab: *PSC/IRCP*
Lab location: *11 rue P et M Curie 75005 Paris*
(Lab/Advisor website): *https://www.ircp.cnrs.fr/en/la-recherche/equipe-pcs/pcs-group/*

Short description of possible research topics for a PhD:



The corrosion of metals is a universal phenomenon with significant economic and societal impacts and their protection has become a major issue. This thesis subject aims to target new organic coatings allowing an improvement in the corrosion resistance of Al alloys as well as a reduction of the environmental load compared to existing coatings. We propose to develop a rationalized search for organic inhibitors based on a combined theoretical / experimental approach aimed at understanding i) molecule / surface interactions at the atomic scale, ii) the 2D and 3D self-organization in dense layers of organic molecules on metal surfaces and iii) the corrosion resistance of the metal surfaces thus functionalized. This approach, coupling modeling by DFT, advanced characterization of surfaces (XPS, ToF-SIMS, AFM) and electrochemical measurements will be applied to Al alloys and to specific organic anchoring molecules (silanes, phosphonates), which are known to be effective in Al corrosion inhibition.

Required background of the student:

The applicant should have a solid physico-chemical (material sciences) background together with a formation in theoretical chemistry.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Cornette, P.; Zanna, S.; Seyeux, A.; Costa, D.; Marcus, P. The Native Oxide Film on a Model Aluminium-Copper Alloy Studied by XPS and ToF-SIMS. *Corros. Sci.* **2020**, *174*, 108837
2. Poberžnik, M.; Chiter, F.; Milošev, I.; Marcus, P.; Costa, D.; Kokalj, A. DFT Study of N-Alkyl Carboxylic Acids on Oxidized Aluminum Surfaces: From Standalone Molecules to Self-Assembled-Monolayers. *Appl. Surf. Sci.* **2020**, *525*, 146156.
3. Vernack, E.; Costa, D.; Tingaut, P.; Marcus, P. DFT Studies of 2-Mercaptobenzothiazole and 2-Mercaptobenzimidazole as Corrosion Inhibitors for Copper. *Corros. Sci.* **2020**, *174*, 108840.
4. I. Milošev, T. Bakarič, S. Zanna, A. Seyeux, P. Rodič, M. Poberžnik, F. Chiter, P. Cornette, D. Costa, A. Kokalj, P. Marcus - Electrochemical, Surface-Analytical, and Computational DFT Study of Alkaline Etched Aluminum Modified by Carboxylic Acids for Corrosion Protection and Hydrophobicity – J. Electrochem. Soc., **2019**,166 (11), C3131-C3146.
5. A Kokalj, D Costa, Molecular Modeling of Corrosion Inhibitors **2018** Encyclopedia of Interfacial Chemistry: Surface Science and Electrochemistry Chapter: 13444, 332-345, Elsevier Inc.

Research Topic for the ParisTech/CSC PhD Program

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Chemistry

Title: Development of new iodine(III) compounds for antibiotic applications

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: Kevin Cariou
Advisor(s) Email: kevin.cariou@chimieparistech.psl.eu
Research group/Lab: Institute of Chemistry for Life Sciences
(Lab/Advisor website): www.gassergroup.com

Short description of possible research topics for a PhD:

Resistant bacteria are becoming a worldwide threat and, unless solutions are found, global projections for 2050 lead to an estimate of 10 million deaths per year that would be attributable to antimicrobial resistance. This situation dictates the development of new antibiotics that can overcome the resistances associated with all existing treatments. *To explore uncharted chemical space in the area of antibiotics, this project aims at designing and synthesizing hypervalent iodine(III) compounds as antibacterial or anti-resistance compounds.*

Required background of the student:

The applicant should have strong theoretical and practical background in organic chemistry. Mastery of purification and analysis (NMR, MS, IR, etc.) techniques is mandatory as well as excellent written and oral communication skills and the ability to work as part of a team. The applicant must be fluent in English since it is the language spoken in the Gasser group. Practical knowledge in biochemistry would be an asset.

A list of 5 (max.) representative publications of the group:

Hypervalent iodine:
1. Habert, L.; **Cariou, K.*** *Angew. Chem. Int. Ed.*, **2020**, *just accepted*, https://doi.org/10.1002/anie.202009175;
2. Peilleron, L.; Retailleau, P.; **Cariou, K.*** *Adv. Synth. Cat.* **2019***; 361*, 1753–1769

Antibiotic compounds:
3. Romero, E.; Oueslati, S.; Benchekroun, M.; D'Hollander, A. C. A.; Ventre S.; Vijayakumar, K.; Minard, C.; Exilie, C.; Tlili, L.; Retailleau, P.; Zavala, A.. Eliséee, E.; Selwa, E.. Nguyen, L. Pruvost, A.; Naas, T.;* Iorga, B.;* Dodd, R. H.; **Cariou, K.*** **2020**, *preprint: DOI: 10.26434/chemrxiv.11897157*

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Chemistry, Physical Chemistry and Chemical Engineering

Subfield: Analytical and Physical Chemistry, Materials

Title: *In situ analytical approaches to understand environmental stability of materials for energy*.

ParisTech School: Chimie ParisTech | PSL

Advisor(s) Name: VOLOVITCH Polina
Advisor(s) Email: *polina.volovitch@chimieparistech.psl.eu*
Research group/Lab: *IRCP or IPVF (https://ipvf.fr/) or both depending on candidate*
Lab location: *Paris region (1 h travel by public transport between IRCP and IPVF)*
(Lab/Advisor website): *https://sites.google.com/site/volovitchp/home*

Short description of possible research topics for a PhD:

Weight reduction of materials and devices in mobile applications can lead to more than 25 % decrease in total CO_2 emissions. The development of stable lightweight structural materials is hence one of the up to date occupations of material science. Another big challenge for mobile devices lays in a way to produce sustainable energy, including thin layer photovoltaic cells and new rechargeable lightweight batteries. Finally, an important characteristic of the new energy devices relays on a guarantee that their efficiency is stable in time and will not decline in service by material degradation or spontaneous discharge … The stability of new materials and assemblies is strongly affected by the service conditions, in particular by the presence of electrolytes or humid films and environmental pollutants. The interactions of materials with their environment are composed complex and the environment evolves by itself. A combined multi-disciplinary, multi-scale approach able to describe the evolution of chemical, electrochemical and mechanical state of new materials/ assemblies as a function of time in presence of evolving environments with good time and spatial resolution is necessary, requiring continuous improvement of existing and development of new analytical methodologies. The research in my team is centered around the development of such analytical approaches. The type of the application (structural materials, battery materials or photovoltaic materials) chosen for the PhD will depend on the profile of the candidate.

Required background of the student: Strong background and interest in chemistry (analytical/physical) is necessary. Deep knowledge of material science, electrochemistry and/or instrumentation is a plus but not mandatory.

A list of 5 (max.) representative publications of the group: *see website*

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Environment Science and Technology, Sustainable Development, Geosciences

Subfield: Applied Physics

Title: Spatio-temporal variability of rainfall drop size distribution across scales: retrieval, characterization and uses

ParisTech School: Ecole des Ponts ParisTech

***Advisor(s) Name*:** August Gires /Ioulia Tchiguirinskaia
Advisor(s) Email: August.Gires@enpc.fr /ioulia.tchiguirinskaia@enpc.fr
Research group/Lab: *Hydrology Meteorology and complexity, ENPC*
Lab location: *École des Ponts ParisTec, 6 et 8 avenue Blaise- Pascal – Cité Descartes – Champs-sur-Marne – 77455 Marne- la- Vallée cedex 2*
(Lab/Advisor website): *https://hmco.enpc.fr/*

Short description of possible research topics for a PhD

Rainfall is a geophysical field extremely variable over wide range of spatio-temporal scales which makes it complex to analyse and even to measure. Weather radars are currently the only devices providing a spatio-temporal insight into this field. Radars basically analyse the signal backscattered by the hydrometeors of the atmosphere and derive rainfall maps from it. These conversion algorithms rely on assumed features of the rain Drop Size Distribution (DSD), and notably its homogeneity within a radar gate. DSD is also directly measured with the help of disdrometers.

The student will review and implement techniques to generate DSD maps from radar data. After, he/she develop an appropriate theoretical framework based on Universal Multifractal to explore and quantify the spatio-temporal variability of DSD. This will enable the development and validation of innovative algorithms for rain rate retrieval with weather radars which will account for the variability DSD from large scale to sub-radar gate scale.

Required background of the student: geophysics, statistics

A list of 5 (max.) representative publications of the group:

1. Brandes, E.A., G. Zhang, and J. Vivekanandan, 2004: Comparison of Polarimetric Radar Drop Size Distribution Retrieval Algorithms. J. Atmos. Oceanic Technol., 21, 584–598, https://doi.org/10.1175/1520-0426(2004)021<0584:COPRDS>2.0.CO;2
2. Gires, A., Tchiguirinskaia, I., and Schertzer, D.: Multifractal comparison of the outputs of two optical disdrometers, Hydro. Sci. J., 6, 1641–1651, https://doi.org/10.1080/02626667.2015.1055270, 2015.
3. Schertzer, D. and Lovejoy, S., 2011. Multifractals, generalized scale invariance and complexity in geophysics. International Journal of Bifurcation and Chaos, 21 (12), 3417–3456. doi:10.1142/S0218127411030647

ParisTech

École des Ponts ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Mathematics and their applications

Subfield: Applied Physics, Geosciences, Data Science, Environment Science

Title: Multiscale short-term forecasts of geophysical fields based on remotely-sensed big data

ParisTech School: Ecole des Ponts ParisTech

Advisor(s) Name: Daniel SCHERTZER, Ioulia TCHIGUIRINSKAIA

Advisor(s) Email: Daniel.Schertzer@enpc.fr, ioulia.tchiguirinskaia@enpc.fr

Research group/Lab: Hydrology Meteorology and Complexity lab (HM&Co)

Lab location: École des Ponts ParisTech, 6 et 8 avenue Blaise Pascal – Champs-sur-Marne – 77455 Marne- la-Vallée cedex 2, France

(Lab/Advisor website): *https://hmco.enpc.fr/*

Short description of possible research topics for a PhD:
We are witnessing a rapid deployment, in particular around large cities, of various recent remote sensing technologies, such as lidars and polarimetric radars, which provide more and more data (wind, precipitation, pollutants) with increasing resolutions. To take full advantage of these technologies and data, qualitatively new short-term forecasts ("nowcasts") must be developed.
It is proposed to develop stochastic nowcasts based on cascading multifractal processes which are much faster than classical deterministic forecasting methods while being closer to the multiscale and nonlinear physics of the processes involved, as well as their intrinsic limit of predictability. The 2024 Olympic Games (Paris) will be an important case of experimentation.

Required background of the student:
Stochastic processes; data science; informatics. A first part of the thesis will be devoted to update knowledge in those domains.

A list of 5 (max.) representative publications of the group:

1. Lovejoy, S. and Schertzer, D. (2013), The Weather and Climate: Emergent Laws and Multifractal Cascades. Cambridge U.K.: Cambridge University Press. pp. 491
2. Marsan, D., Schertzer, D. & Lovejoy, S. (1996), Causal space-time multifractal processes: Predictability and forecasting of rain fields. *J. Geophys. Res.* 101, 26,333-26,346
3. Paz, I., Tchiguirinskaia, I & Schertzer, D. (2020), Rain gauge networks' limitations and the implications to hydrological modelling highlighted with a X-band radar. Journal of Hydrology, 583, 124615
4. Schertzer, D. & Tchiguirinskaia, I. (2017), An Introduction to Multifractals and Scale Symmetry Groups, in Fractals: Concepts and Applications in Geosciences. Ghanbarian, B. and Hunt, A. (eds) CRC Press, 1-28
5. Schertzer, D. & Tchiguirinskaia, I. (2020), A century of turbulent cascades and the emergence of multifractal operators. *Earth Sp. Sci.* 7, e2019EA000608

ParisTech

École des Ponts ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Environment Science and Technology, Sustainable Development, Geosciences
Subfield: Hydrology

Title: Optimal implementation of Nature-Based Solutions to mitigate Urban Heat Islands

ParisTech School: Ecole des Ponts ParisTech

Advisor(s) Name: Pierre-Antoine VERSINI
Advisor(s) Email: *pierre-antoine.versini@enpc.fr*
Research group/Lab: *HM&Co*
Lab location: *Champs-sur-Marne*
(Lab/Advisor website): *https://hmco.enpc.fr/*

Short description of possible research topics for a PhD:
Urban Heat Island (UHI) is a microclimatic phenomenon occurring in urbanized spaces that tend to have higher temperatures than their surrounding countryside. In a context of climate change, the increase of heat waves, in terms of frequency and intensity, has placed the mitigation of UHI as a priority in many cities. Nature Based Solutions (NBS) as rain garden, green roofs, and parks represent some relevant infrastructures to address this challenge and make cities more resilient. As urban environments are complex and very heterogeneous in space, the implementation of NBS regarding the most vulnerable (hot) areas represents a difficult task. The objective of this PhD subject is therefore to develop a methodology, which helps to optimize NBS implementation with regard to UHI. First, temperature fields and their space-time variability will be analysed at the urban scale. For this purpose, every available data will be used, that they are produced by observation devices (satellite, public and private sensors networks) or models (simulations). A particular effort will be made to valorize crowdsourced and remote sensing data. Second, existing NBS spatial distribution will be studied. Finally, based on both fields' properties, some prospective (urban and climate) scenarios will be proposed to optimize NBS cooling effect.

Required background of the student:
Have skills in the modelling of mechanics (graduated in fluid mechanics or environmental physics), capabilities in computer simulations, and be of interest to urban geophysics.

A list of 5 (max.) representative publications of the group:
1. Versini, P.-A., Kotelnikova, N., Poulhes, A., Tchiguirinskaia, I., Schertzer, D. and Leurent, F., 2018. A distributed modelling approach to assess the use of Blue and Green Infrastructures to fulfil stormwater management requirements. Landscape and Urban Planning, 173: 60-63
2. Versini, P.-A., Gires, A., Schertzer, D. and Tchiguirinskaia, I., 2020. Fractal analysis of green roof spatial implementation in European cities. Urban Forestry & Urban Greening, 49, 126629

ParisTech

École des Ponts ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Environment Science and Technology, Sustainable Development, Geosciences

Title: Develop an innovative framework to assess the environmental performances of a new train station over time

ParisTech School: Ecole des Ponts ParisTech

Advisor(s) Name: Pierre-Antoine VERSINI
Advisor(s) Email: *pierre-antoine.versini@enpc.fr*
Research group/Lab: *HM&Co*
Lab location: *Champs-sur-Marne*
(Lab/Advisor website): *https://hmco.enpc.fr/*

Short description of possible research topics for a PhD:
Train stations appear as complex infrastructures as they can no longer be considered just as some transit points, but rather as systems advocating multimodality and multi-functionality. This complexity should also be considered when studying their environmental impacts. In this context, this PhD subject aims to study, through the example of a particular station of the Greater Paris (Grand Paris Express under construction), the necessary consideration of the interactions between the different geophysical fields (temperature, precipitation), urban form (transport network, planning and green spaces) and human flows, as well as their space-time variability. Coupling literature review, measured observations, and distributed model simulations (New tools should also be developed if necessary) will led to identify and assess the main environmental issues concerning the station. They will aim to capture the space-time variability of the involved processes and variables, but also their interactions. This work should illustrate the necessity to adopt a complex system and multi-scale approach to well understand the interaction of an infrastructure with its surrounding urban environment.

Required background of the student:
Have skills in the modelling of mechanics (graduated in fluid mechanics or environmental physics), capabilities in computer simulations, and be of interest to urban geophysics.

A list of 5 (max.) representative publications of the group:
1. Versini, P.-A., Kotelnikova, N., Poulhes, A., Tchiguirinskaia, I., Schertzer, D. and Leurent, F., 2018. A distributed modelling approach to assess the use of Blue and Green Infrastructures to fulfil stormwater management requirements. Landscape and Urban Planning, 173: 60-63
2. Versini, P.-A., Gires, A., Schertzer, D. and Tchiguirinskaia, I., 2020. Fractal analysis of green roof spatial implementation in European cities. Urban Forestry & Urban Greening, 49, 126629

Research Topic for the ParisTech/CSC PhD Program

Field: [redacted]

Subfield: Applied mathematics (scientific computing), Computational mechanics (hydraulics)

Title: Modelling and simulating complex flows for engineering puposes

ParisTech School: [redacted]

Advisor(s) Name: BOYAVAL Sébastien
Advisor(s) Email: *sebastien.boyaval@enpc.fr*
Research group/Lab: *Laboratoire d'Hydraulique Saint-Venant (LHSV)*
Lab location: *Chatou (78400)*
Website: *https://www.saint-venant-lab.fr/membres/boyaval_s%C3%A9bastien*

Short description of possible research topics for a PhD:

Continuum mechanics has provided engineers with models that are useful for numerous quantitative predictions. Navier-Stokes or Saint-Venant equations e.g. provide one with realistic numerical simulations of *fluid* flows in various practical situations. But real flows are complex, even water : in river floods for instance. And engineers are mostly interested by particular *real* situations, with specific features that are well observed but not easily predicted yet using generic models like Navier-Stokes or Saint-Venant : heat fluxes, the mixing of chemical species, the rheology of non-Newtonian fluids, the fluctuations in turbulent flows etc. That is why one keeps developing new flow models, on adding complexities to standard models.

At LHSV, given recent improved measurements of real fluid flows (see [5] and Illustration 1. below for an example regarding floods), we aim at validated new flow models, with a better quantitative description than standard models in specific engineering situations. Numerical simulations are verified first, and a sound mathematical framework is required to that aim.

Possible research topics are the construction of new models for complex flows with Partial Differential Equations (PDEs) [2,4], the construction of numerical schemes [1] (for mathematically inclined students) and the numerical simulation of new models [3] (for computer inclined students).

Required background of the student:

PDEs applied to field theories in physics (mechanics preferably), discretization methods (Finite-Volume/Finite-Element), numerical analysis, scientific computing (with Python/C++)

A list of 5 (max.) representative publications of the group:

1. John Barrett, Sébastien Boyaval, Finite element approximation of the FENE-P model, *IMA Journal of Numerical Analysis* (OUP), 2017
2. Sébastien Boyaval, Viscoelastic flows of Maxwell fluids with conservation laws, working preprint https://hal-enpc.archives-ouvertes.fr/hal-02908379 , 2020
3. Sébastien Boyaval, Alexandre Caboussat, Arwa Mrad, Marco Picasso, Gilles Steiner, A semi-Lagrangian splitting method for the numerical simulation of sediment transport with free surface flows, *Computers and Fluids, 2018 172*
4. François Bouchut, Sébastien Boyaval, Unified derivation of thin-layer reduced models for shallow free-surface gravity flows of viscous fluids, *European Journal of Mechanics - B/Fluids*, 2016
5. Sébastien Proust, Céline Berni, Martin Boudou, Antoine Chiaverini, Victor Dupuis, et al.. Predicting the flow in the floodplains with evolving land occupations during extreme flood events (FlowResANR project) 3rd European Conference on Flood Risk Management, Oct 2016, Lyon, France. Hal-01585278

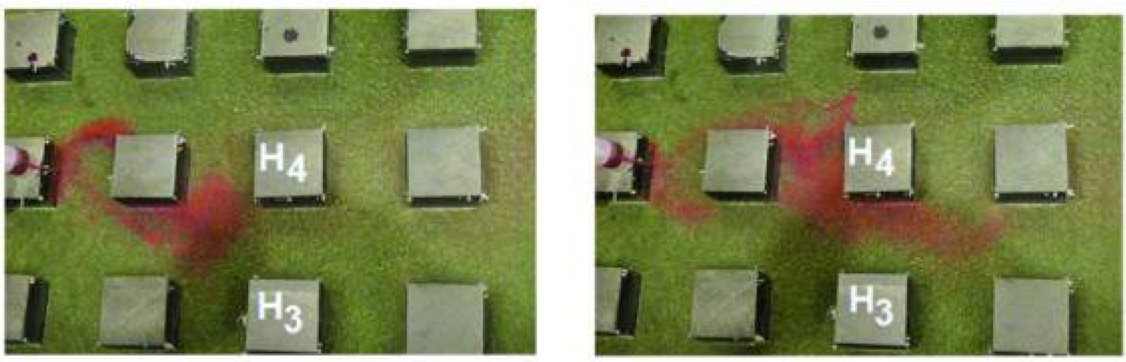


Illustration 1: PhD thesis of Marina Oukacine (p. 116). Étude expérimentale et numérique des écoulements à surface libre en présence d'obstacles émergés et faiblement submergés. Université Paris-Est, 2019. tel-02948861

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Information and Communication Sciences and Technologies

Subfield: Smart Cities, Artificial intelligence, Environment

Title: Artificial intelligence and the Internet of Things to monitor and accommodate with urban pollution in smart cities

ParisTech School: Ecole des Ponts ParisTech (ENPC)

Advisor(s) Name: Françoise Lucas (Leesu, ENPC)
Advisor(s) Email: ***francoise.lucas@enpc.fr***, ***lucas@u-pec.fr***
Co-advisor: *Sami Souihi (LiSSi, University Paris-Est Créteil)*
co-advisor Email: *sami.souihi@u-pec.fr*
Research group/Lab: consortium of 3 laboratories: *Leesu (ENPC and University Paris-Est Créteil), LISA and LiSSi (University Paris-Est Créteil)*
Lab location: *Leesu, ENPC, Champs-sur-Marne, France*
(Lab/Advisor website): *https://www.leesu.fr/* *and* *http://www.lissi.fr/*

Short description of possible research topics for a PhD:
This thesis is part of the Smart Cities paradigm. It aims to investigate the potential use of artificial intelligence to assess and reduce the pollution impact on human health in urban areas. Nowadays, the development of the Internet of Things allows the deployment of large sensor networks to monitor different aspects of Smart Cities. For instance, different applications and services inform the inhabitants of large cities about the degree of air or water pollution. This information, however, remains scattered through different databases, with very difficult interpretation and it does not take into account the cumulative impact of the various chemical, physical and biological perturbations, which remains difficult to quantify. The first objective of this research is to establish a unified knowledge plane (KP) that aggregates all the pollution data that can impact human health from aerial and aquatic monitoring programs in urban areas. The second objective is to use this KP, to produce and test an adaptive and predictive model of urban pollution assessment, which will be based on the techniques of belief functions and Deep Learning. The last objective of this thesis is to explore the possibility of an adaptive data visualization by considering a real application scenario.

Required background of the student:
- Good Python programming skills,
- Knowledge in Probabilistic theory,
- Knowledge in Machine Learning

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. ROGUET, Adélaïde, THERIAL, Claire, CATHERINE, Arnaud, et al. Importance of Local and Regional Scales in Shaping Mycobacterial Abundance in Freshwater Lakes. *Microbial ecology*, 2018, vol. 75, no 4, p. 834-846.
2. MARÉCAL, Virginie, PEUCH, V.-H., ANDERSSON, Camilla, et al. A regional air quality forecasting system over Europe: the MACC-II daily ensemble production. Geoscientific Model Development, 2015, vol. 8, no 9, p. 2777-2813.
3. MA, Jun, CHENG, Jack CP, LIN, Changqing, et al. Improving air quality prediction accuracy at larger temporal resolutions using deep learning and transfer learning techniques. *Atmospheric Environment*, 2019, vol. 214, p. 116885.
4. AMOUR, Lamine, SOUIHI, Sami, HOCEINI, Said, et al. A hierarchical classification model of qoe influence factors. In : *International Conference on Wired/Wireless Internet Communication*. Springer, Cham, 2015. p. 225-238.
5. RATHORE, M. Mazhar, AHMAD, Awais, PAUL, Anand, et al. Urban planning and building smart cities based on the internet of things using big data analytics. *Computer Networks*, 2016, vol. 101, p. 63-80.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Life and Health Science and Technology
Subfields: Neurosciences, Neuropathology

Title: **PROPAGATION OF NEURODEGENERATION IN PARKINSON'S DISEASE STUDIED IN *DROSOPHILA* MODELS**

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Serge Birman
Advisor(s) Email: serge.birman@espci.psl.eu
Research group/Lab: Genes Circuits Rhythms and Neuropathology (GCRN group) /Brain Plasticity Laboratory
Lab location: 10 rue Vauquelin, 75005 Paris
(Lab/Advisor website): (https://www.bio.espci.fr/-Serge-Birman-Genes-Circuits-29-)

Short description of possible research topics for a PhD:

In our group, we are studying the role of specific neurotransmitter systems on brain functioning and behaviour, as well as their susceptibility to ageing and neurodegenerative conditions. This involves integrated studies that combine molecular biology, genetics and behavioural analysis to identify genes, neural circuits and mechanisms controlling locomotor activity and pathogenesis. Our model is the fruit fly *Drosophila*, which is used in laboratories around the world as it offers many tools and advantages for genetic and *in vivo* studies. The topic of the PhD will be to carry out research on Parkinson's disease models, with the aim to understand the mechanisms leading to the propagation of neurodegeneration from one neuron to another by a prion-like mechanism, as this may explain the clinical progression of the disease. This study will be based on solid preliminary results recently obtained in the laboratory by a previous doctoral student of the ParisTech/CSC PhD Program.

Required background of the student: Master's degree in Life Sciences (or Agriculture), ideally with previous training in Molecular Biology.

A list of 5 (max.) representative publications of the group:

1. YON, M., DECOVILLE, M., SAROU-KANIAN, V., FAYON, F., BIRMAN, S. (2020) Localized metabolic profiling of living *Drosophila* in neurodegenerative conditions using ^{1}H magic angle spinning NMR. **Sci. Rep.** 10(1), 9516–9. http://doi.org/10.1038/s41598-020-66218-z

2. HAJJI, K., MTEYREK, A., SUN, J., CASSAR, M., MEZGHANI, S., LEPRINCE, J., VAUDRY, D., MASMOUDI-KOUKI, O.*, BIRMAN, S.* (2019) Neuroprotective effects of PACAP against paraquat-induced oxidative stress in the *Drosophila* central nervous system. **Hum. Mol. Genet.** 28(11):1905-1918 doi:10.1093/hmg/ddz031

3. ISSA A.-R., SUN J., PETITGAS C., MESQUITA A., DULAC A., ROBIN M., MOLLEREAU B., JENNY A., CHÉRIF-ZAHAR B., BIRMAN S. (2018) The lysosomal membrane protein LAMP2A promotes autophagic flux and prevents SNCA-induced Parkinson disease-like symptoms in the *Drosophila* brain. **Autophagy** 14(11):1898–1910, doi:10.1080/15548627.2018.1491489

4. VACCARO A., ISSA A.-R., SEUGNET L., BIRMAN S., & KLARSFELD A. (2017) *Drosophila* Clock is required in brain pacemaker neurons to prevent premature locomotor aging independently of its circadian function. **PLOS Genet.** 13(1):e1006507, doi:10.1371/journal.pgen.1006507

5. RIEMENSPERGER T., ISSA A.-R., PECH U., COULOM H., NGUYỄN M. V., CASSAR M., JACQUET M., FIALA A. & BIRMAN S. (2013) A single dopamine pathway underlies progressive locomotor deficits in a *Drosophila* model of Parkinson disease. **Cell Rep.** 5:952–960 doi:10.1016/j.celrep.2013.10.032

ParisTech ESPCI PARIS | PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes
Subfield: Materials for photovoltaics
Title: Material Strategies for More Stable Perovskite Solar Cells
ParisTech School: ESPCI Paris
Advisor Name: Dr. Zhuoying Chen
Advisor Email: *zhuoying.chen@espci.fr*
Research group/Lab: *Micro & Nano Characterization Group/LPEM*
Website: http://optoelec.lpem.espci.fr

Short description of possible research topics for a PhD:

Research in the field of solution-processed organic-inorganic lead perovskite halide solar cells have witnessed remarkable progress over the past decade. The majority of research efforts have been focused on the improvement of the power-conversion efficiency, leading to a significant increase of this figure-of-merit reaching 25%. This progress and additional advantageous properties, such as ease of fabrication, low-cost, light-weight, flexibility and semi-transparency make these devices a bright contender for potential new industrial applications. However, when compared to silicon-based solar panels, which typically have a lifespan of 25 years, hybrid perovskite solar cells suffer from various degrees of material degradation related to the environment they are exposed to. Device stability, thus currently represents one of the utmost pressing issues preventing their large-scale application and exploitation.

While there are existing methods (e.g. additives, different transport-layers and interface modifications) towards better perovskite solar cell stability, the fundamental processes happening in the material and the device by these methods are still to be fully understood. In addition, while perovskite solar cell stability can be slightly enhanced by current methods, it is still by far inferior compared to silicon solar cells. There is still much room for further improvement. This thesis program will therefore focus on understanding the fundamental roles of current methods in order to propose further innovative and more effective stability enhancement strategies. Specifically, the PhD candidate will first study the microstructure, chemical, and optical origins of the stability enhancement of hybrid perovskite halides when applying different materials and device modifications methods by a combination of optical, structural, microscopic, and spectroscopic investigations. Upon obtaining fundamental understandings, he/she will propose new strategies with more effective impact on the solar cell stability.

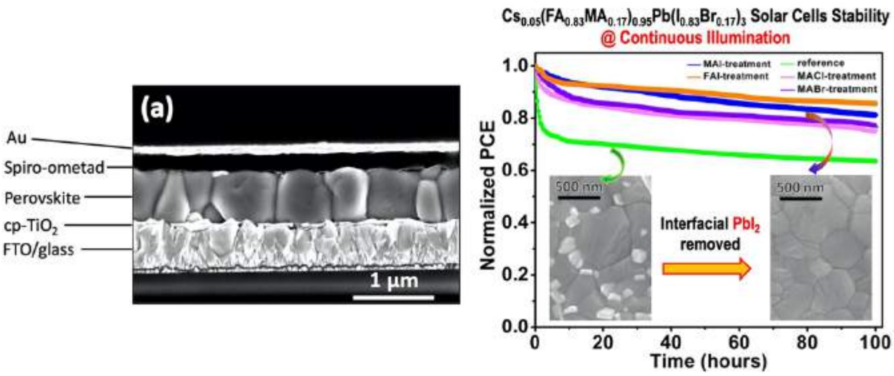


Figure: (a) Cross-sectional SEM image of a perovskite solar cell fabricated in our lab; (b) Efficiency evolution over 100 hrs of the unencapsulated $Cs_{0.05}(FA_{0.83}MA_{0.17})_{0.95}Pb(I_{0.83}Br_{0.17})_3$ perovskite solar cells with different surface treatments under continuous AM 1.5G 1-sun illumination measured inside an Ar glovebox in our lab.

Required background of the student: Solid academic background and a Master Degree on chemistry, material science, or applied physics. Good speaking & writing skills in English. Passionate in scientific experiments.

A list of representative publications of the group on this subject:

- “TiO_2 Nanocolumn Arrays for More Efficient and Stable Perovskite Solar Cells”, ACS Applied Materials & Interfaces, 12, 5979-5989 (2020)
- “Microscopic Evidence of Upconversion-Induced Near-Infrared Light Harvest in Hybrid Perovskite Solar Cells”, M. Schoenauer Sebag et al., ACS Applied Energy Materials, 1, 3537-3543 (2018)
- “Compact layer free mixed-cation lead mixed-halide perovskite solar cells”, Z. Hu et al., Chemical Communications, 54, 2623-2626 (2018)
- “Effect of Ion Migration-Induced Electrode Degradation on the Operational Stability of Perovskite Solar Cells”, ACS Omega, 3, 10042-10047 (2018)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: ***Materials***
Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng.…)
Applied Physics-Chemistry.
Title: Electrostrictive and Triboelectric fibers for Vibrational Energy Harvesting.
ParisTech School: ESPCI Paris PSL
Advisor(s) Name: COLIN Annie
Advisor(s) Email: ***annie.colin@espci.fr***
Research group/Lab: ***MIE CBI***
Lab location: ***ESPCI Paris PSL 10 rue Vauquelin 75005 Paris***
(Lab/Advisor website):https://www.cbi.espci.fr/accueil-22/
Short description of possible research topics for a PhD: The decreasing energy consumption of today's portable electronics has invoked the possibility of energy harvesting from the ambient environment for self-power supply. One common and simple method for vibration energy harvesting is to utilize triboelectricity or electrostriction. In this thesis, we propose to synthesize fibers to make smart fabrics. This fabric will be efficient and washable. Two types of fibers will be manufactured by dip-coating : electrostrictive fibers and triboelectric fibers. For this we will take advantage of the previous studies in the laboratory [1,2,3].
We will compare the performance of the two systems of fibers as a function of humidity. The second step will be to evaluate the performances of the fibers by preparing a self heating fabric. The garment will be heated by joule effect. Some conductive fibers will be used in the fabric and connected to the
In a third step we will store the produced energy and used it to cool the fabric.
Required background of the student: (What should be the main field of study of the applicant before applying?)
The student should have a solid training in chemistry , chemical formulation and be an experimentalist. Knowledge of electronics is recommended.
A list of 5 (max.) representative publications of the group:

1. M Pruvost, WJ Smit, C Monteux, P Poulin, A Colin - npj Flexible Electronics, 2019. Polymeric foams for flexible and highly sensitive low pressure capactive sensors.
2. W.Smit, C Kusina , JF Joanny, A Colin PRL 123(14) 148002. Stress field inside the bath determines dip coating with yield stress fluids in cylindrical geometry.
3. M.Pruvost, WJ Smit, C Monteux, P Poulin, A Colin Multifunctionnal Materials 1 (1) 015004 2018 Microporous electrostrictive materials for vibrational energy harvesting
4. Yuan, Jinkai, Alan Luna, Wilfrid Neri, Cécile Zakri, Annie Colin, and Philippe Poulin. "Giant electrostriction of soft nanocomposites based on liquid crystalline graphene." *ACS nano* 12, no. 2 (2018): 1688-1695.
5. Nesser, Hussein, Hélène Debéda, Jinkai Yuan, Annie Colin, Philippe Poulin, Isabelle Dufour, and Cedric Ayela. "All-organic microelectromechanical systems integrating electrostrictive nanocomposite for mechanical energy harvesting." *Nano Energy* 44 (2018): 1-6.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Physics ***Physics***

Subfield: (Applied Physics, Chemistry, Mathematics, Mech. Eng.…)

Soft Matter

Title: Characterization of the flow of concentrated suspensions under vibrations.

ParisTech School: ESPCI Paris PSL

Advisor(s) Name: COLIN Annie

Advisor(s) Email: annie.colin@espci.fr

Research group/Lab: MIE CBI

Lab location: ESPCI Paris PSL 10 rue Vauquelin 75005 Paris

(Lab/Advisor website):https://www.cbi.espci.fr/accueil-22/

Short description of possible research topics for a PhD:

Cements, sewage sludge, chocolate are dispersions, carbon suspensions are dispersions of non-Brownian particles. In industry, it is important to be able to prepare such highly concentrated dispersions in order to reduce the water impact of the processes while keeping systems with low viscosity.

In this thesis we will study the flows of highly concentrated suspensions of non Newtonian particles under vibration. Vibrating a suspension makes it possible to reduce the viscosity and to prepare dispersions with ultra high solid fraction. In this pHD, we will take advantages of the technics developed in our laboratory to characterize the features of the flow as a function of the amplitude of the external mechanical vibrations and of its frequency. We will use home made sensors to measure and characterize the shear stress map in a Couette cell[4]. These measurements will be complemented by solid fraction measurements under shear using Xray tomography [1], the friction coefficient and the forces profile between particles will be analyzed using a tuning fork[2,3,5] .

Required background of the student: (What should be the main field of study of the applicant before applying?)

The student should have a solid training in physics, fluid mechanics and be an experimentalist.***A list of 5 (max.) representative publications of the group:***

1:Ovarlez, G., Le, A.V.N., Smit, W.J., Fall, A., Mari, R., Chatté, G. and Colin, A., 2020. Density waves in shear-thickening suspensions. *Science Advances*, *6*(16), p.eaay5589.

2;Comtet, J., Chatté, G., Niguès, A., Bocquet, L., Siria, A. and Colin, A., 2017. Pairwise frictional profile between particles determines discontinuous shear thickening transition in non-colloidal suspensions. *Nature communications*, *8*(1), pp.1-7.

3.Chatté, Guillaume, Jean Comtet, Antoine Niguès, Lydéric Bocquet, Alessandro Siria, Guylaine Ducouret, François Lequeux, Nicolas Lenoir, Guillaume Ovarlez, and Annie Colin. "Shear thinning in non-Brownian suspensions." *Soft matter* 14, no. 6 (2018): 879-893.

4. Anais Gauthier, Mickael Pruvost, Olivier Gamache, Annie Colin, A new pressure sensor array for local normal stress measurement in complex fluids arXiv:2010.04474

5. Madraki, Y., A. Oakley, A. Nguyen Le, A. Colin, G. Ovarlez, and S. Hormozi. "Shear thickening in dense non-Brownian suspensions: Viscous to inertial transition." *Journal of Rheology* 64, no. 2 (2020): 227-238.

ParisTech

Logo de votre école (ne garder que le bon logo)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Physics, Optics

Subfield: (Chemistry, Colloidal Sciences)

Title: Active Colloidal Gels

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Olivier Dauchot
Advisor(s) Email: olivier.dauchot@espci.fr
Research group/Lab: Gulliver Lab
Lab location: Paris
(Lab/Advisor website): https://www.gulliver.espci.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Colloidal Gels are obtained from the aggregation of attractive colloids. Tuning the density of particles, and the attraction strength and range allow us to control the gel morphology. Embedding colloids, that can be activated by light, inside the gel, we can form an active material, the response of which is controlled by light.

The main goal of this project is to study experimentally the coupling between the activity level and the mechanical properties of the gel. In particular, one expects the strain field induced by the active forces to induce a feedback on the active units, eventually leading to some form of collective actuation. Unveiling such a process would be a major breakthrough both in our understanding of living bodies and I towards the design of new functional materials.

Required background of the student: (What should be the main field of study of the applicant before applying?)

A good knowledge of colloidal and interface science is mandatory. Being at ease with micro-manipulation, confocal microscopy is useful too. Finally mentoring data-processing using Matlab or python is important too.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. *Chemical Physics of Active Matter* O. Dauchot, H. Löwen J. Chem. Phys. **151**, 114901 (2019)
2. *Interrupted Motility Induced Phase Separation in Aligning Active Colloids*. Marjolein N. van der Linden, Lachlan C. Alexander, Dirk G. A. L. Aarts, Olivier Dauchot Phys. Rev. Lett. 123, 098001 (2019)
3. *The flow field around a confined active droplet*. C. de Blois, M. Reyssat, S. Michelin and O. Dauchot Physical Review Fluids **4,** 054001 (2019).
4. *Active versus Passive Hard Disks against a Membrane: Mechanical Pressure and Instability*, G. Junot, G. Briand, R. Ledesma-Alonso, and O. Dauchot, Phys. Rev. Lett. 119, 028002, (2017).
5. *Elastic interactions between topological defects in chiral nematic shells*, Alexandre Darmon, Olivier Dauchot, Teresa Lopez-Leon, Michael Benzaquem, *Phys. Rev. E* 94, (2016)

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RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Physics, Optics

Subfield: (Mech. Eng / Computer Science)

Title:Morphological Swarm Robotics

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Olivier Dauchot
Advisor(s) Email: olivier.dauchot@espci.fr
Research group/Lab: Gulliver Lab
Lab location: Paris
(Lab/Advisor website): www.gulliver.espci.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

In this project, we are interested in swarm robotics, where a large number of robots with limited computation and communication power are considered. Our goal is to propose new design methods, with a particular focus on collective decision making using both morphological and logical computation.

To do so, we aim at new kind of swarm bots, where the shape factor guarantees the group dynamics, while each robot embeds a lightweight system-on-chip, sensors and actuators that can be used to modulate the robot behaviors on-the-fly.

We will then look for specific educated collective behaviors: starting from the spontaneous phase obtained from the purely physical interactions of our robots we aim at applying minimal control from embodied capabilities on each bot, to induce specific collective behavior, which we will refer to as operational phases. Optimizing such behavior, we will aim at the realization of complex collective tasks.

Required background of the student: (What should be the main field of study of the applicant before applying?)

Our approach towards this topic is definitely the one of physicists; it is therefore important to have a good background in physics. At the same time, the object of studies, the robot swarm, requires a good knowledge of Fablab tools, such as 3D printers, laser cutter, electronics, which is closer to mechanical engineering. Finally being familiar with computer sciences, sensor-controllers is important too.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

This is a new topic of the group. Before the group was focusing on physical active matter (not involving robots). This is why in the five publication below, only one is directly related to robotics.

1. *Distributed On-line Learning in Swarm Robotics with Limited Communication Bandwidth*. Nicolas Fontbonne, Olivier Dauchot and Nicolas Bredeche. Proceedings of the IEEE Congress on Evolutionary Computation (CEC), 2020
2. *Dynamics of a Self-Propelled Particle in a Harmonic Trap*. O. Dauchot, and V. Démery. Phys. Rev. Lett. **122,** 068002 (2019).
3. *Spontaneously Flowing Crystal of Self-Propelled Particles*. G. Briand, M. Schindler and O. Dauchot. Phys. Rev. Lett 120**,** 208001 (2018).
4. *Active versus Passive Hard Disks against a Membrane: Mechanical Pressure and Instability*, G. Junot, G. Briand, R. Ledesma-Alonso, and O. Dauchot, Phys. Rev. Lett. 119, 028002, (2017).
5. *Self-propelled hard disks: implicit alignment and transition to collective motion* Khanh-Dang Nguyen Thu Lam, Michael Schindler, Olivier Dauchot New Journal of Physics (2015)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: (Applied Physics and electrical engineering)

Title: Contact effects at metal/insulator interfaces

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Stéphane Holé
Advisor(s) Email: stephane.hole@espci.fr
Research group/Lab: Physics and Material Study (LPEM)
Lab location: ESPCI – 10, rue Vauquelin – 75005 Paris – France
(Lab/Advisor website):

Short description of possible research topics for a PhD:
When two materials are brought into contact, electric charge transfer from one material to another occurs at the interface. This gives rise to a contact potential. Though it is well described when metals and semiconductors are concerned, this is still not well established when an insulator is concerned, because no measurement can be carried out.
We have proposed a new measurement method for directly accessing the contact voltage in the case of metal/insulator contacts based on an electro-elastic coupling. The advantage of the method is that no material model is required to obtain the information.
The aim of the PhD is to improve the calibration procedure, test various metal/insulator interfaces and propose an interface model from the observed results.

Required background of the student: (What should be the main field of study of the applicant before applying?)
The applicant should have skills in solid state physics, instrumentation (in electronics bases at least) and matlab or python language.

A list of 5 (max.) representative publications of the group:

1. Holé S., *Contact potential measurement at metal/insulator interface*, ISE, p. 51, 2019. available at https://ise2019.mosaicteam.eu/wp-content/uploads/2019/09/ISE17_2019_AbstractBook.pdf.
2. Salamé B. and Holé S., *Elasto-electric coupling for direct electric field distribution measurement in semiconductor structures*, J. Appl. Phys., vol. 120, p. 175702 (2016)
3. Salamé B.and Holé, S, *The pressure wave propagation method for the study of interface electric field*, EIC, pp. 53-56 (2015)
4. Salamé B. and Holé, S., *Electrode induced signal with Pressure-Wave-Propagation Method*, ISE, p. IX.7 (2014)
5. Ravat C., Absil, É., Holé, S. and Lewiner, J., *Acoustoelectric coupling for direct electrical characterization of semiconductor devices*, J. Appl. Phys., vol. 99, pp. 063712-1-5 (2006)

ParisTech ESPCI PARIS | PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Materials Science, Mechanics, Fluids

Subfield: Applied Physics and electrical engineering

Title: High spatial resolution space charge distribution measurement by electro-acoustic reflectometry (EAR)

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Stéphane Holé
Advisor(s) Email: stephane.hole@espci.fr
Research group/Lab: Physics and Material Study (LPEM)
Lab location: ESPCI – 10, rue Vauquelin – 75005 Paris – France
(Lab/Advisor website):

Short description of possible research topics for a PhD:
Insulating materials should prevent electric charges from flowing. However, charges enter and become trapped resulting in damage to the system in which the material is included. This is particularly problematic to high voltage integrated devices, but existing measurement methods have not a sufficient spatial resolution for studying this problem.
LPEM has developed a new measurement method based on the material impedance variation due to electromechanical couplings. It allows to greatly increase the spatial resolution, but still needs to be improved to obtain even better resolution. This implies working with micro-wave techniques up to 10 GHz.

Required background of the student: (What should be the main field of study of the applicant before applying?)
The applicant should have skills in electronics, microwave and interested in advanced instrumentation.

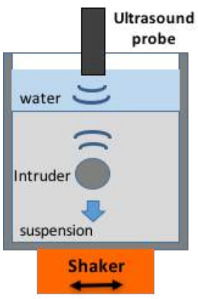
A list of 5 (max.) representative publications of the group:

1. Hamidouche L., Holé S. and Géron E., An overview on the sensitivity of Electro-Acoustic-Reflectometry (EAR) method, IEEJ Trans. FM, vol. 139, pp. 99-104 (2019)
2. Hamidouche L., Géron E. and Holé, S., Physical investigation of the Electro-Acoustic-Reflectometry method for space charge measurements, Phys. Scr., vol. 94, pp. 115006-1-9 (2019)
3. Hamidouche L., Géron E. and Holé S., Very high spatial resolution space charge measurement using electro-acoustic reflectometry (EAR), IEEE Electrical Insulation Magazine, vol. 33, pp. 9-16 (2017)
4. Hamidouche L., Géron E. and Holé S., Electro-Acoustic Reflectometry, a new method toward very high spatial resolution space charge measurements, ICD, vol. 1, pp. 46-48 (2016)
5. Hamidouche L., Géron E., Ditchi T. and Holé S., High Frequency Spectroscopy for High Spatial Resolution Space Charge Measurements, ISE, p. IX.8, (2014)

Research Topic for the ParisTech/CSC PhD Program

Field: Physics, Optics; **Materials Science, Mechanics**
Subfield: Applied Physics, Acoustics
ParisTech School: ESPCI Paris – PSL University
Title: Acoustic imaging and pumping in granular sediments
Advisor: Professor Xiaoping JIA
Advisor Email: xiaoping.jia@espci.fr
Research group/Lab: Institut Langevin
Lab location**:** 1 rue Jussieu, 75005 Paris
Website: https://www.institut-langevin.espci.fr

Short description of possible research topics for a PhD:
Imaging and understanding the motion of an intruder or buried object inside opaque dense suspensions such as quicksand or ocean sediments are of practical and fundamental importance. In this PhD project, we use the ultrasonic echography with one or multiple elements to monitor the sinking dynamics of a steel ball in vibrated dense glass bead packings (3D) saturated by water [1,2]. Unlike a falling ball reaching a terminal velocity in Newtonian liquids (viscometer), the ball in gravitational granular suspensions may stop sinking at a given depth due to the yield stress, which depends on the packing density and confining pressure. We will investigate the ball motion fluidized by horizontal vibration (Fig. a) or by acoustic pumping within the framework of granular rheological models [3]. In particular, we will focus on the transition of granular sediments from solid state to liquid state resulted from a mechanism of acoustic lubrication that reduces the inter-particle friction and shear contact stiffness due to the micro-slip [4], without visible macroscopic rearrangement of grains as in usual liquefaction phenomena. This work also help a better understanding of landslides and avalanches caused by vibrations, related to human activities or to natural events such as volcanoes [5].



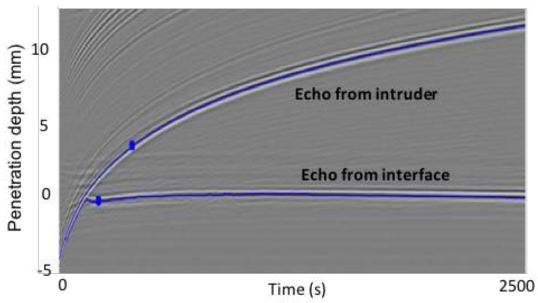


Figure : (a) Diagram of experimental setup *(b)Intruer sinking tracked by ultrasound*

Required background of the student: a good background in physics in general and particularly acoustics and mechanics

A list of 5 (max.) representative publications of the group: **author(s)** of the group in **bold**
[1] S. van den Wildenberg, **X. Jia**, J. Léopoldès, and A. Tourin, *Sci. Rep.* 9, 5460 (2019)
[2] J. Brum, J.L. Gennisson, M. Fink, A. Tourin & **X. Jia**, Phys. Rev. E 84, 020301 (2019)
[3] B. Andreotti, Y. Forterre & O. Pouliquen, Granular Media (Cambridge University Press, 2013)
[4] **X. Jia,** T. Brunet, J. Laurent, *Phys. Rev. E* 84, 020301(R) (2011); P. Johnson and **X. Jia**, *Nature* 437, 871 (2005)
[5] J. Léopoldès, **X. Jia**, A. Tourin, A. Mangeney, Phys. Rev. E 102, 042901 (2020)

ParisTech ESPCI PARIS PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Physics, Optics
***Subfield*:** Condensed Matter

***Title*:** Local electronic properties of a remarkable ionic conductor

***ParisTech School*:** ESPCI Paris | PSL
***Advisors Name*:** Guillaume LANG, Brigitte LERIDON
Advisors Email: guillaume.lang@espci.fr brigitte.leridon@espci.fr
Research lab: LPEM (CNRS, ESPCI Paris, PSL, Sorbonne Université)
Lab location: ESPCI Paris, 10 rue Vauquelin, 75005 Paris
Advisor website: https://em.lpem.espci.fr/home/

The 2D oxide $Rb_2Ti_2O_5$ has a **colossal low-frequency dielectric constant** ($\simeq 10^9$) and an **exceptional electric polarization** ($0.1\ C/cm^2$). This is related to the very large ionic conductivity of this electronic insulator and to the accumulation of charges at its boundaries. While $Rb_2Ti_2O_5$ is promising for super-capacitors and memory applications, the transport properties of the diffusing ionic species and the spatial variations of the electronic properties are not well understood.

In the context of a joint study (LPEM Paris, ICCMO Orsay), we rely on Nuclear Magnetic Resonance (NMR), **an excellent probe of the spin and charge properties at the atomic scale**. It allows here to show that, contrary to expectations in an electronic insulator, the nanoscale charge and magnetic fluctuations are quantitatively similar as well as correlated with one another. A tentative scenario is that of the ionic diffusion inducing electronic changes in the Ti/O layers.

Using NMR and cryogenics, the Ph.D. student will focus on studying:

- Ionic diffusion and its connection to the local electronic properties.
- The *macro-scale* variation of the *nano-scale* electronic properties in samples having undergone macroscopic electrical polarization.
- How the observations hold in related compounds, to help develop an optimization strategy with an eye towards applications.

***Required background*:** Education in condensed matter (or solid-state) physics. Interest in experimental physics. Knowledge of NMR is NOT needed.

Representative publications of the group:

1 R. Rani *et al.*, Materials Letters 258, 126784 (2020)
2 G. Lang *et al.*, Phys. Rev. B 94, 014514 (2016)
3 S. de Sousa Coutinho *et al.*, Solid State Ionics 333, 72 (2019)
4 R. Federicci *et al.*, Journal of Applied Physics 124, 152104 (2018)
5 R. Federicci *et al.*, Phys. Rev. Materials 1, 032001 (2017)

ParisTech ESPCI PARIS | PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Mathematics and their applications

Subfield: (Statistical mechanics, statistics, applied mathematics)

Title: Irreversible algorithms for molecular modeling

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Anthony Maggs
Advisor(s) Email: anthony.maggs@espci.fr
Research group/Lab: *Gulliver*
Lab location: ESPCI, 10 rue Vauquelin Paris 75005
(Lab/Advisor website): https://www.gulliver.espci.fr/

Short description of possible research topics for a PhD:

Molecular modeling (research rooted in particle-based computation) is central to our understanding of the material world. Its methods allow one to investigate complex phenomena in biophysics and materials research, and to describe the fundamental phase behavior of the universe that surrounds us. Molecular modeling has provided methods for many other fields, from astrophysics to hydrodynamics, statistical mechanics and field theory. Molecular modeling is an interdisciplinary research field, in which the development of algorithms plays an important role. Improved sampling methods, constrained ensembles, and novel approaches beyond molecular dynamics stand out in their promise for the future.

Although the principal methods have been developed for over half a century, disruptive development continues to take place. An example is the irreversible Markov-chain Monte Carlo methods which violate the fundamental detailed-balance condition yet converge towards equilibrium. They illustrate that past algorithms were overly restrictive. Radically new Markov-chain Monte Carlo algorithms have already led to the resolution of long-standing controversies (as for example in two-dimensional melting studied through the use of irreversible Markov chains). We wish to extend these methods to standard interaction potentials in soft-matter physics, in the belief that this can lead to highly efficient codes that explore equilibrium configurations using irreversibility flows.

Required background of the student:
We are looking for students with background in statistical mechanics, applied mathematics or statistics who are interested in joining an open collaboration between several groups in the historic center of Paris.

A list of 5 (max.) representative publications of the group:

All-atom computations with irreversible Markov chains, M.F. Faulkner, Liang Qin, A.C. Maggs and Werner Krauth, J.Chem Phys (2018).
https://aip.scitation.org/doi/10.1063/1.5036638

Event-chain Monte Carlo with factor fields, Ze Lei, Werner Krauth, and A. C. Maggs, PRE (2019). https://doi.org/10.1103/PhysRevE.99.043301

Research Topic for the ParisTech/CSC PhD Program

Field : Physical chemistry, Chemical engineering

Subfield: material sciences, mechanics, fluids

Title: **Bio inspired hydrogels for water filtration**

ParisTech School: ESPCI Paris

Advisor(s) Name: Cecile Monteux
Advisor(s) Email:cecile.monteux@espci.fr
Research group/Lab: SIMM, Soft Matter Science and Engineering
(Lab/Advisor website):

Short description of possible research topics for a PhD: Hydrogels are polymer based materials composed of a network of polymer chains in water, which are covalently or physically bound. In nature, some bio-hydrogels have outstanding filtration properties. As an example, mucus prevents the entrance of toxic nanoparticles into the lungs. In the kidney, the glomerular barrier, which is composed of collagen fibers, filters proteins and nanoparticles. Such hydrogels are highly permeable to water but very efficiently filter nanoparticles. Our goal is to conduct a biomimetic approach to design bioinspired hydrogels that present similar properties to natural hydrogels. Our challenge will be to tune the toughness of the hydrogels so that they can sustain high filtration pressures. Indeed we expect that the deformation of hydrogels under pressure and their eventual compression may lead to a permeability decrease. Moreover we will design hydrogels with controlled spatial heterogeneity to control the water permeability.

Required background of the student: background in chemical engineering or materials science

A list of 5(max.) representative publications of the group:
Foaming of Transient Polymer Hydrogels, Deleurence, R., Saison, T., Lequeux, F. & Monteux*, C. *ACS Omega* **3**, 1864–1870 (2018). 10.1021/acsomega.7b01301

Cross-flow filtration for the recovery of lipids from microalgae extracts: membrane screening and filtration of model and real products, E. Claveijo, C. Monteux, E. Couallier*, *Process Biochemistry*, in press (10.1016/j.procbio.2019.10.016)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Biology, Biophysics and Bio Chemistry

Subfield: Biophysics, Soft-Matter, Synthetic Biology, Chemistry, Applied Physics

Title: A microfluidic reactor for the emergence, assembly and evolution of life's biopolymers and cellular structures

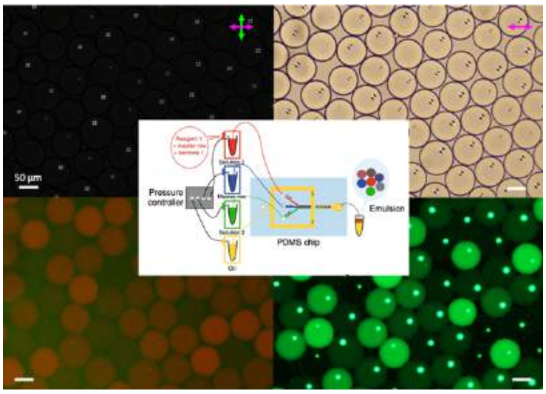
ParisTech School: ESPCI Paris | PSL

Advisors Name: Philippe Nghe, Tommaso Fraccia
Advisors Email: philippe.nghe@espci.psl.eu, tommaso.fraccia@espci.fr
Research group/Lab: Laboratoire de Biochimie / CBI
Lab location: IPGG, 3rd and 6th floors, 6 rue Jean Calvin, 75005, Paris
Lab/Advisor websites: blog.espci.fr/nghe, blog.espci.fr/tfraccia, www.lbc.espci.fr

Short description of possible research topics for a PhD:

It remains unknown how biological building blocks can polymerize and self-organize into compartmentalized reaction networks capable of evolution, thus making the bridge between physico-chemistry and biology. Solving this problem requires considering the self-assembly of such molecules into phases typical of soft-matter, such as liquid crystals and coacervates[1,2]. Indeed, these phases have been shown to template polymerization[3] and allow evolution through compartmentalization[4,5].

We will set-up an experiment to test for the emergence, assembly and evolution of life's biopolymers and cellular structures in complex mixtures of biomolecular building blocks (RNA, peptides, lipids) submitted to cyclical variations of different physico-chemical conditions (concentration, temperature, pH, ionic strength and valence). To achieve this goal, this project exploits cutting-edge optical microscopy techniques coupled to innovative microfluidic platforms allowing the high throughput screening of reaction conditions in parallel.



Liquid crystal coacervates produced with a high-throughput multi-parameter automated titration method based on microfluidics

Required background of the student:
Supramolecular chemistry or Biochemistry or Soft-Matter Physics or Biophysics

A list of 5 (max.) representative publications of the group:

1. Fraccia, T. P.; Jia, T. Z. Liquid Crystal Coacervates Composed of Short Double-Stranded DNA and Cationic Peptides. *ACS Nano* **2020**, *xxx*, xxx–xxx, doi:10.1021/acsnano.0c05083

2. Smith, G. P.; Fraccia, T. P. & al. Backbone-free duplex-stacked monomer nucleic acids exhibiting Watson–Crick selectivity. *Proc. Natl. Acad. Sci. U. S. A.* **2018**, *115*, E7658–E7664, doi:10.1073/pnas.1721369115.
3. Todisco, M.; Fraccia, T. P. & al. Nonenzymatic Polymerization into Long Linear RNA Templated by Liquid Crystal Self-Assembly. *ACS Nano* **2018**, *12*, 9750-9762, doi:10.1021/acsnano.8b05821.
4. Matsumura, S. & al.Transient compartmentalization of RNA replicators prevents extinction due to parasites. *Science* **2016**, *354*, 1293-1296, doi:10.1126/science.aag1582.
5. Blokhuis, A. & al. Selection Dynamics in Transient Compartmentalization. *Phys. Rev. Lett.* **2018**, *120*, 158101, doi:10.1103/PhysRevLett.120.158101.

Research Topic for the ParisTech/CSC PhD Program

Field : Life and Health Science and Technology; Physics, Optics

Subfield*: *High resolution eye imaging

Title*: *Imaging and dynamic of the retina cells

ParisTech School: ESPCI

Advisor(s) Name*: *Olivier Thouvenin, Pedro Mece, Claude Boccara
Advisor(s) Email:olivier.thouvenin@espci.fr pedro.mece@espci.fr claude.boccara@espci.fr
Research group/Lab: Institut Langevin
(Lab/Advisor website): https://www.institut-langevin.espci.fr/home?lang=en

Short description of possible research topics for a PhD:

The goal of this research will be to design a dynamic in-vivo cell imaging device to observe microscopic changes in single neurons, called ganglion cells, in the retina of patients. By combining an optical interference imaging technique, such as full-field optical tomography, with wavefront shaping approaches, and the extraction of new contrasts linked to the metabolic activity of cells, this project promises to open up promising perspectives in the following fields: physics, engineering, biology, neuroscience, pharmacology and medicine.
This work will be carried out the Langevin Institute, ESPCI Paris laboratory in connection with Quinze-Vingt Eye Hospital in Paris.

Required background of the student:

The recruitment of a doctoral student with a good background in physics in general and particularly optics as well as a marked interest in the interface with ophthalmology, or medicine, through imaging methods is desired.
The candidate will have initial experience in optics with a taste for microscopy and image processing. Knowledge of biology would be appreciated.
The management and interpretation of images generally use the MATLAB and / or Python language with which the candidate should be familiar.

A list of 5(max.) representative publications of the group:

Dynamic full-field optical coherence tomography: 3D live-imaging of retinal organoids
Scholler, J., K. Groux, O. Goureau, J. A. Sahel, M. Fink, S. Reichman, C. Boccara, and K. Grieve
Light: Science and Applications **9**, 140 (2020)

Real-time non-contact cellular imaging and angiography of human cornea and limbus with common-path full-field/SD OCT
Mazlin, V., P. Xiao, J. Scholler, K. Irsch, K. Grieve, M. Fink, and A. C. Boccara
Nature Communications **11**, 1868 (2020)

Coherence gate shaping for wide field high-resolution in vivo retinal imaging with full-field OCT
Pedro Mecê, Kassandra Groux, Jules Scholler, Olivier Thouvenin, Mathias Fink, Kate Grieve, and Claude Boccara. Biomedical Optics Express 11, n°9, 4928 (2020)

High-resolution in-vivo human retinal imaging using full-field OCT with optical stabilization of axial motion. Pedro Mecê, Jules Scholler, Kassandra Groux, and Claude Boccara. Biomedical optics express, 11(1), 492-504 (2020).

Probing dynamic processes in the eye at multiple spatial and temporal scales with multimodal full field OCT
Scholler, J., V. Mazlin, O. Thouvenin, K. Groux, P. Xiao, J. A. Sahel, M. Fink, C. Boccara, and K. Grieve
Biomedical Optics Express 10, no. 2, 731-746 (2019)

Please choose one or more from the following fields:

1. Biology, Biophysics and Bio Chemistry
2. Chemistry, Physical Chemistry and Chemical Engineering
3. Economics, Management and Social Sciences
4. Energy, Processes
5. Environment Science and Technology, Sustainable Development, Geosciences
6. Information and Communication Sciences and Technologies
7. Life and Health Science and Technology
8. Materials Science, Mechanics, Fluids
9. Mathematics and their applications
10. Physics, Optics
11. Design, Industrialization
12. Life Science and Engineering for Agriculture, Food and the Environment
13. Urban planning, Transport

Research Topic for the ParisTech/CSC PhD Program

Field: Physics, Optics

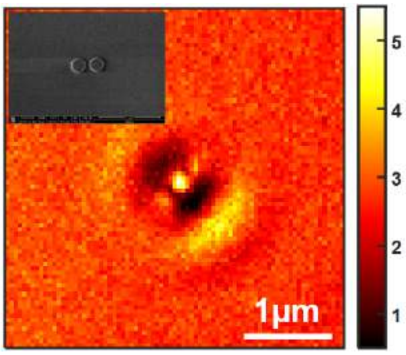
Subfield: Applied Physics

Title: Nanostructures fabrication and characterization for implementation in optoelectronic devices

ParisTech School: ESPCI Paris | PSL

Advisor(s) Name: Lionel Aigouy / Zhuoying Chen
Advisor(s) Email: *lionel.aigouy@espci.fr / zhuoying.chen@espci.fr*
Research group/Lab: MNC Group / LPEM
Lab location: ESPCI
(Lab/Advisor website): https://www.lpem.espci.fr

Short description of possible research topics for a PhD:



Optoelectronic devices such as solar cells, photodetectors constantly need to be improved and optimized in terms of sensitivity and detection range. For that, conventional, 'flat', devices are often associated to nanostructures whose presence change the local optical, electronic, or thermal properties of the devices and lead to better performances. Nano-antenna, meta-surfaces, plasmonic or dielectric nanostructures can be used but the visualization of their effect at the sub-micron scale is necessary for a fundamental comprehension and final device optimization. As seen in the figure, the near-field around two adjacent plasmonic nanodisks exhibit a strong increase in their gap which can lead to better absorption and a local temperature increase. The goal of this thesis is to design and study plasmonic and dielectric nanostructures with particular local properties able to modify and improve the characteristics of a real device like a solar cell, a photodetector, or a photothermo-electric detector. The local optical and thermal properties will be correlated to the device tested in operation, so that a direct optimization will be made.

Required background of the student: master degree in Chemistry, Physics, Materials Science.

A list of 5 (max.) representative publications of the group:

- 'Mapping plasmon-enhanced upconversion fluorescence of Er/Yb-doped nanocrystals near gold nanodisks.', L. Aigouy, M.-U. González, H.-J. Lin, M. Schoenauer-Sebag, L. Billot, P. Gredin, M. Mortier, Z. Chen and A. García-Martín. Nanoscale 11, 10365-10371 (2019)
- 'TiO2 nanocolumn arrays for more efficient and stable perovskite solar cells.', Z. Hu, J.-M. García-Martín, Y. Li, L. Billot, B. Sun, F. Fresno, A. García-Martín, M.-U. González, L. Aigouy, Z. Chen. ACS Applied Materials & Interfaces 12(5), 5979-5989 (2020).
- 'Exploring the Magnetic and Electric Side of Light through Plasmonic Nanocavities.', C. Ernandes, H.-J. Lin, M. Mortier, P. Gredin, M. Mivelle, and L. Aigouy. Nano Letters 18 (8), 5098-5103 (2018)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Physics
Subfield: Hydrodynamics
Title: Micro-helices in flows
ParisTech School: ESPCI Paris | PSL
Advisor(s) Name: Anke Lindner and Olivia du Roure
Advisor(s) Email: anke.lindner@espci.fr, Olivia.duroure@espci.fr
Research group/Lab: Complex Suspensions/PMMH
Lab location: Campus Jussieu, 75005 PARIS
(Lab/Advisor website): https://blog.espci.fr/alindner/ or oliviaduroure/

Short description of possible research topics for a PhD:
The study of fluid structure interactions between helix-shaped particles and viscous flows is of importance for both fundamental science and technological applications. The chirality of such particles induces breaking of the time reversal symmetry associated with viscous flows; an effect exploited by microorganisms, such as E. coli bacteria, which propel themselves through viscous media by rotating helically shaped flagella. Particle chirality has also been shown to induce a lateral drift in shear flows, responsible for example for bacterial rheotaxis. Possible applications include swimming micro-robots for targeted drug delivery or flow micro-sensors. We have recently developed several experimental model systems to investigate the interaction between helical micro-particles and viscous flows (see figure). These micro-objects are put under flow in specifically designed microchannels and followed during their transport.

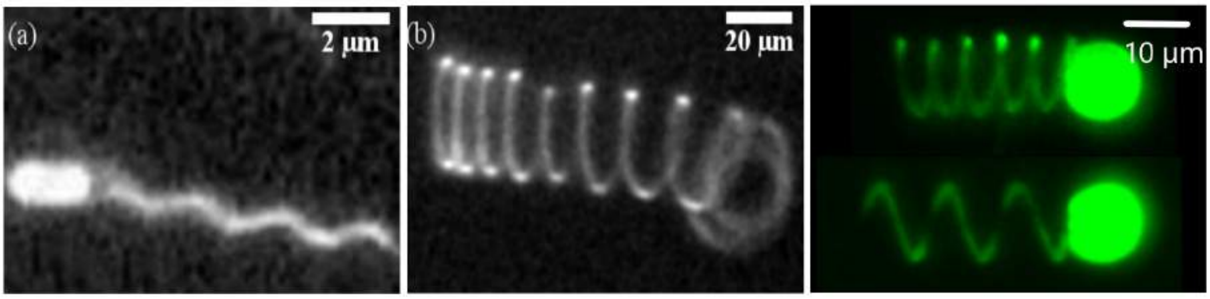


Figure 1a) Fluorescent imaging of E-coli bacteria, (copyright H. C. Berg). (b) Flexible helix observed under fluorescent microscopy, clamped on its right. (c) Microprinted helix with a head.

In this PhD we suggest tackling some of the many questions still open in this field, using one of our model systems. These questions include determining the magnitude of the chirality induced drift as a function of helix shape, using microprinted helices or flagella of different micro-organisms. Another possibility is to study the role of flexibility using the nano-ribbon helices on their transport in chosen microflows.

Required background of the student: Physics, if possible, Hydrodynamics, Complex fluids or Soft Matter. Taste for performing experiments is necessary and skills in microfabrication or microfluidics would be a plus.

A list of 5 (max.) representative publications of the group:
Chakrabarti, et al. Nature Physics 16 (6), 689-694
du Roure, et al Annual Review of Fluid Mechanics. 51:539
Pham, J. et al. Physical Review E, 92, 011004(R)
Liu et al. PNAS 115 (38) 9438-9443.
Cappello et al. Physical Review Fluids 4, 034202

Research Topic for the ParisTech/CSC PhD Program

Subfield: Polymer materials and chemistry, Mechanics, Material science
ParisTech School: ESPCI Paris-PSL
Title: Cutting soft materials
Advisors: Matteo Ciccotti (matteo.ciccotti@espci.fr), Frederic Lechenault (frederic.lechanault@phys.ens.fr)
Website: http://www.simm.espci.fr/

Short description of possible research topics for a PhD:

Cutting is a ubiquitous process with wide ranging implications, culturally and technologically. Experimenting on the kitchen table, we quickly learn that the easiest way to cut soft solids with a knife is by a slicing action, i.e., dragging the sharp blade over the soft surface without pushing too strongly into it; indeed, pushing the edge of a knife too strongly into a soft solid only squashes it. Moreover, applying a compression in a plane orthogonal to the direction of cutting can be of great help for guiding the cut. However, more generally the forces applied for both cutting and holding the object are responsible for uncomfortable large strains, which induce strong perturbations in the final shape of the parts. Beyond these everyday examples, the cutting of soft materials is of great interest in industrial food processing, in tissue analysis in the context of histology, etc..

The initial developments of cutting science and technology were mostly devoted to metal machining and focused on plastic deformations induced by the motion of the blades though the material. The importance of fracture toughness in cutting was only acknowledged in the 60's after the development of linear elastic fracture mechanics, leading to important advances in the understanding of cutting mechanics of more brittle materials. However, a unifying physical view of cutting that may be suitable for a larger class of materials is still lacking, especially for soft materials. The standard tools of linear elastic fracture mechanics are not suited to treat a problem where the driving arises directly at the crack lips instead of remotely. The local crack fields are strongly coupled with the shape and motion of the blade, involving subtle adhesion and friction problems. In this context the fracture energy and direction of propagation are not independent of shape of the blade and new tools have to be developed to describe them. Although the case of soft materials is of particular importance for many industrial applications, very few tools are available to deal with the very strong nonlinear deformations at different scales, which make it difficult to cut parts of the desired shape and with good surface finish.

This project aims at performing cutting experiments on model soft materials in controlled situations, in order to bridge this gap, while profiting of the significant advances that have recently been made on fracture and adhesion of soft dissipative materials. On the one hand, we aim at clarifying the relevant notions of cutting energy and directionality of the cut as a function the shape and motion of the blade. On the other hand, we intend to develop tools for predicting the final shape of the cut parts in order to allow forward design.

Required background of the student: polymer materials, mechanics, soft matter physics

A list of 5 representative publications of the group:

1. Creton C., Ciccotti M. *Rep Prog Phys* **2016,** 79, (4), 046601.
2. Chopin J., Villey R., Yarusso D., Barthel E., Creton C., Ciccotti M. Macromolecules 51 (21), 8605-8610
3. Ciccotti M. Journal of physics D: Applied physics 42 (21), 214006.
4. Lechenault F., Dauchot O., Biroli G., Bouchaud JP. EPL 83 (4), 46003.
5. Lechenault F., Thiria B., Adda-Bedia M. Physical Review Letters 112 (24), 244301

Research Topic for the ParisTech/CSC PhD Program

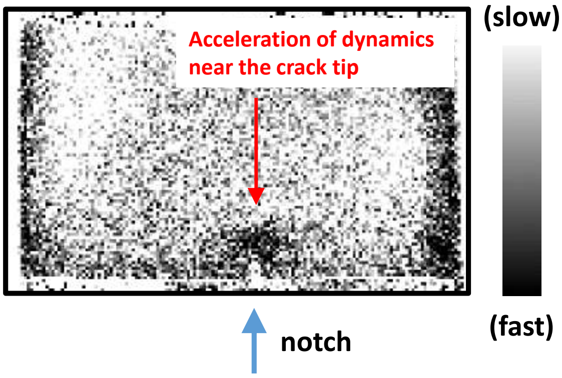
Subfield: Polymer materials and chemistry, Mechanics, Material science
ParisTech School: ESPCI Paris-PSL
Title: Bridging Chemistry, Physics and Mechanics: Understanding how needles and blades damage chemical bonds in soft materials
Advisors: Tetsuharu Narita (tetsuharu.narita@espci.fr, Costantino Creton (costantino.creton@espci.fr), Matteo Ciccotti (matteo.ciccotti@espci.fr)
Website: http://www.simm.espci.fr/

Short description of possible research topics for a PhD:
Hydrogels, networks of crosslinked polymers swollen in water, are soft squishy solids abundant in nature and everyday life and in food and biomedical industries. Although hydrogels are generally brittle, some tough hydrogels that are resistant to fracture have been developed. Especially for medical applications, biological tissues or artificial implants need to be incised, sutured and punctured by sharp blades or needles. While very common, this kind of mechanical damage combining very large deformations and chemical bond scission of the polymer is poorly understood and very multiscale. (1) molecules break at the nanometric scale, (2) local damage occurs at the microscopic scale, and (3) stress strain relation are at the macroscopic scale.

Recently our laboratory developed a low-force indentation by sharp needles, and a non-invasive optical technique MSDWS (multi-speckle diffusing-wave spectroscopy), to map the local dynamics change felt by probe nanoparticles in the network, related to the damage at the microscopic scale.

<u>The objective of this thesis is to combine mechanical (see left figure) and dynamic light scattering optics (right figure), to map the local damage (to know when and where chain breaking occurs) of the gel as it is indented or cut with a sharp object like a needle, blade or sharp edged cylinder and ultimately design better puncture and cutting resistant gels.</u>

The overall thesis project involves preparing well defined model soft hydrogels, developing an original setup combining the two techniques, and characterizing the fracture properties of the model systems.



Required background of the student: polymer materials, mechanics, soft matter physics

A list of 5 representative publications of the group:

1. Mayumi, K.; Guo, J.; Narita, T.; Hui, C. Y.; Creton, C. *Extreme Mechanics Letters* **2016,** 6, 52-59.
2. Mayumi, K.; Marcellan, A.; Ducouret, G.; Creton, C.; Narita, T. *ACS Macro Letters* **2013,** 2, (12), 1065-1068.
3. Rose, S.; Dizeux, A.; Narita, T.; Hourdet, D.; Marcellan, A. *Macromolecules* **2013,** 46, (10), 4095-4104.
4. Creton, C.; Ciccotti, M. *Rep Prog Phys* **2016,** 79, (4), 046601.
5. Ducrot, E., Chen, Y., Bulters, M., Sijbesma, R.P., Creton, C. Science 2014, 344(6180), 186.

Research Topic for the ParisTech/CSC PhD Program

Field: ***Materials Science, Mechanics, Fluids***

Subfield: Physics, Applied Physics

Title: Electronic and Thermoelectrical properties of dilute metals

ParisTech School: ESPCI Paris PSL

Advisor(s) Name: Benoît Fauqué,Kamran Behnia
Advisor(s) Email: benoit.fauqué@espci.fr, kamran.behnia@espci.fr
Research group/Lab: LPEM
Lab location: ESPCI,(Lab/Advisor website): https://qm.lpem.espci.fr/

Short description of possible research topics for a PhD:

In presence of a magnetic field, the electronic spectrum an electrons gas is quantized in Landau levels. At high enough magnetic field, only one or two Landau levels are occupied, this is the quantum limit. This limit has been extensively studied in two dimension systems in the context of the quantum Hall effect. It has been however poorly studied in three dimension since this regime can only achieved in low carrier density metals. In the last years we have shown that, beyond this limit, 3D dilutes metals displays a rich variety of electronic phase transitions ranging from : a succession of a many body field induce state in the semi-metals graphite [1,2,3] or a metal-insulator transition in the narrow gap semi-conductor InAs [4].
In both case this transition is accompanied by a remarkable electrical and thermoelectrical properties. To date the largest magnetoresistance has been reported in the semi-metal, Sb, at high magnetic field [5] and a giant thermoelectrical power accompanied the field induced MI transition in InAs [4]. In this internship/PhD we propose to understand the parameters which pinned down the amplitude of these giant responses in dilute metals. The internship/PhD work will be to measure the electrical and thermoelectrical properties in a large range of temperature, magnetic field and to develop a new experimental set up to track the current distribution in these high mobile conductors.

Required background of the student: material science, solid state physics

1. B.Fauqué et al, PRL, 110, 266601 (2013)
2. D. LeBoeuf, Nat. Com. 8, 1337 (2017)
3. Z. Zhu et al., PRX, 9, 011058 (2019)
4. A.Jaoui et al, arXiv:2008.06356
5. B. Fauqué and al., PRM, 2, 11420 (2018)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: ***Materials Science, Mechanics, Fluids***

Subfield: Physics, Applied Physics

Title: Bad metals and soft mode in the quantum paralectrics

ParisTech School: ESPCI Paris PSL

Advisor(s) Name: Benoît Fauqué, Philippe Bourges
Advisor(s) Email: benoit.fauqué@espci.fr, philippe.bourges@cea.fr
Research group/Lab: LPEM, LLB
Lab location: ESPCI, Université Paris-Saclay
(Lab/Advisor website): https://qm.lpem.espci.fr/

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Doped SrTiO3 is a bad metal where the electrical resistivity does not saturate at high temperature when the mean free path is of the order of interatomic distances. Our recent preliminary results of neutron scattering show that the proximity of the ferroelectric instability, so-called quantum paraelectric phase, play an essential role in the increase of the carriers mass at high temperature (C. Collignon, Ph. Bourges, B. Fauqué and K. Behnia, Phys. Rev. X 10, 031025 (2020)). Further, the tendency towards that structural instability (associated with a soft phonon) is assumed to favour superconductivity in SrTiO3 for dilute doping, even if both types of orders have a priori nothing in common. Motivated by these results, we propose a PhD research plan to study the effect of electronic doping in quantum paraelectric systems, that will follow two research paths: i) study of the electronic structure via electric and thermoelectric transport measurements ii) study the atomic structure and lattice dynamics by neutron scattering measurements. We will first focus on the doped SrTiO3 compound (substitution with La and Nb, reduction in oxygen) and next to doped compounds of KTaO3 and PbTe. These measurements will allow to understand the nature of the new electronic states of matter that occur in doped quantum paraelectric materials.

Required background of the student: material science, solid state physics

1. C. Collignon, Ph. Bourges, B. Fauqué et K. Behnia, Phys. Rev. X 10, 031025 (2020)
2. Xiaokang Li and al., Phys. Rev. Lett. 124, 105901 (2020)
3. C. W. Rischau and al., Nature Physics, 3, 643–648(2017
4. X. Lin and al., NPJ Quantum Materials 2: 41 (2017)
5. X. Lin and al., Science 349, 945 (2015)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Physics, Optics

Subfield: Applied Physics

Title: Highly sensitive sensors for detection of pollutants based on optical nanofibers

ParisTech School: Institut d'Optique Graduate School

Advisor(s) Name: Lebrun
Advisor(s) Email:sylvie.lebrun@institutoptique.fr
Research group/Lab: Laboratoire Charles Fabry
Lab location: Palaiseau
(Lab/Advisor website): https://www.lcf.institutoptique.fr/

Short description of possible research topics for a PhD: Our research group is working since more than 10 years on non linear effects in optical nanofibers. We have developed a pulling machine with performances at the state of the art that enabled us to realize several first ever experimental demonstrations. As shown on the fig., the nanofiber is linked to the two unstretched parts of a standard fiber through two tapers. At these small diameters the optical mode shows a high evanescent field around the nanofiber which is very sensitive to the external environment. In this thesis we propose to study a new type of sensor using Raman scattering in the evanescent field of nanofibers immersed in liquids or gas to detect pollutants. This sensor will be highly compact, low cost and sensitive compared to other techniques.

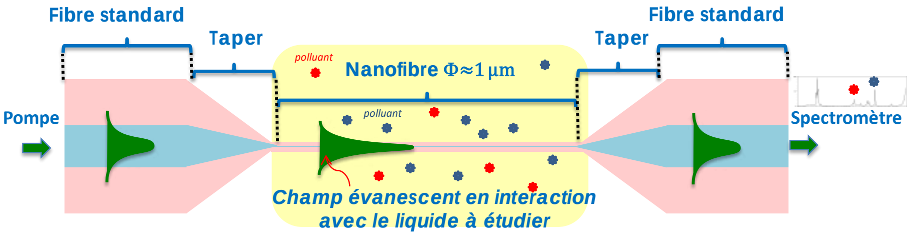


Figure 1. Scheme of the pollutant sensor based on a silica nanofiber.

Required background of the student: Master in physics with a pronounced interest in optics and experimental work. Knowledge in non linear optics and/or guided optics and/or sensors are welcome.

A list of 5 (max.) representative publications of the group:

1. L. Shan, G. Pauliat, G. Vienne, L. Tong, and S. Lebrun, Appl. Phys. Letters, 102, (2013).
2. M. Bouhadida, J. C. Beugnot, P. Delaye, K. Phan Huy and S. Lebrun, Appl. Phys. B 125,228 (2019).
3. J.-C. Beugnot, S. Lebrun, G. Pauliat, H. Maillotte, V. Laude, and T. Sylvestre. Nature Communications, 5:5242, October 2014.

Research Topic for the ParisTech/CSC PhD Program

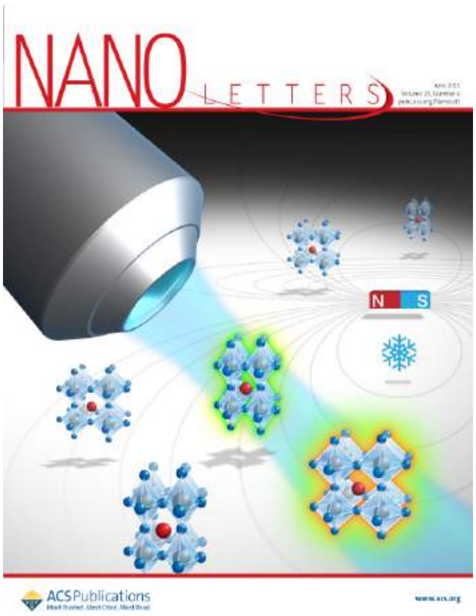
Field: Physics, Optics ***Subfield***: Nanophotonics

Title: **Exploring the optical properties of perovskite single nanocrystals and superlattices**

ParisTech School: Institut d'Optique Graduate School
Advisor(s) Name: Brahim LOUNIS, Philippe TAMARAT
Advisor(s) Email: brahim.lounis@u-bordeaux.fr; philippe.tamarat@u-bordeaux.fr
Research group/Lab: LP2N, UMR5298/Nanophotonics group
Lab location: Bordeaux
(Lab/Advisor website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

Lead halide perovskites exhibit outstanding optical and electronic properties for a wide range of applications in optoelectronics and for light-emitting devices. Yet, the physics of the band-edge exciton, whose recombination is at the origin of the photoluminescence, is the subject of ongoing debate. In particular, the long-lived ground exciton of lead halide perovskite nanocrystals plays a major role in the quantum properties of the emitted light, since it promotes the formation of biexcitons and thus the emission of correlated photon pairs. Future investigations will aim at reducing the dephasing rate and spectral diffusion in these materials and improve the indistinguishability character of the emitted photons. With a view to the realization of ideal sources of entangled photons, we will aim at achieving degenerate bright triplet emission. We will also study the quantum optical properties of the photoluminescence stemming from lead halide NCs that are self-organized into highly ordered three-dimensional superlattices. We will investigate the spectroscopic and temporal signatures of collective coupling of the nanocrystals, which should give rise to the many-body quantum phenomenon of superfluorescence. Such entangled multi-photon quantum light sources should fuel the development of next-generation devices for quantum technologies.



These activities will be led in close collaboration with the group of chemists of M. Kovalenko (ETH Zürich).

Required background of the student: quantum physics, optics, solid-state physics, lab training.

A list of representative publications of the group:

1. « The ground exciton state of formamidinium lead bromide perovskite nanocrystals is a singlet dark state », P. Tamarat et al. Nature Materials, 18 (2019) 717.
2. « Neutral and charged exciton fine structure in single lead halide perovskite nanocrystals revealed by magneto-optical spectroscopy », M. Fu et al., Nanoletters, 17 (2017) 2895.
3. "Unravelling exciton-phonon coupling in individual $FAPbI_3$ nanocrystals emitting near-infrared single photons", M. Fu et al., Nature Communications, 9, 3318 (2018).
4. « Spectroscopy of Single Nanocrystals», M.J. Fernée, P. Tamarat, B. Lounis, Chem. Soc. Rev. 43 (2014) 1311.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

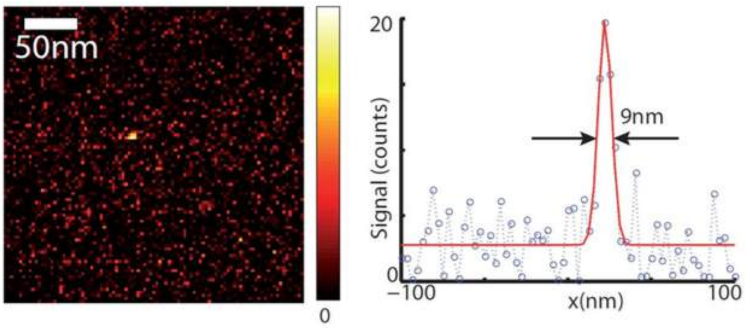
Field: Physics, Optics ***Subfield***: Quantum Optics

Title: **Coherent dipole-dipole coupling of organic molecules at cryogenic temperatures**

ParisTech School: Institut d'Optique Graduate School
Advisor(s) Name: Brahim LOUNIS, Jean-Baptiste Trebbia
Advisor(s) Email: brahim.lounis@u-bordeaux.fr
Research group/Lab: LP2N, UMR5298/Nanophotonics group
Lab location: Bordeaux
(Lab/Advisor website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

The controlled, coherent manipulation of quantum systems is an important challenge in modern science, with significant applications in quantum technologies. Solid-state quantum emitters such as single molecules, quantum dots and defect centers in diamond are promising candidates for the realization of quantum bits and quantum networks. Collective quantum dynamics resulting from coherent dipole–dipole coupling is challenging, since they require nanometric distances between emitters, the degeneracy of their optical resonances and low temperatures. We will aim at developing experimental schemes to find coupled quantum emitters and manipulate their degree of entanglement with external fields. The optical super-resolution nanoscopy technique built in the group (with sub 10-nm far-field optical resolution at cryogenic temperatures) will be used to reveal the rich space-frequency signatures of coherent coupled quantum emitters. The formation of collective quantum states from coupled optical emitters being a general phenomenon, these experimental schemes can also be useful for the study of many other systems including light harvesting complexes polymer conjugates, quantum dots molecules and hybrid systems.



Required background of the student: quantum physics, optics, light-matter interaction, lab training. The thesis will be mainly experimental. The candidate will also develop theoretical simulations and acquire a strong background in laser spectroscopy, single photon detection, quantum optics...

A list of representative publications of the group:

1- A solid state source of photon triplets based on quantum dot molecules, M. Khoshnegar *et al.*, Nature Communications 8 (2017) 15716.
2- Optical Manipulation of Single Flux Quanta, I. S. Veshchunov *et al.,* , Nature Communications 7 (2016) 12801.
3- Optical Nanoscopy with Excited State Saturation at Liquid Helium Temperatures B. Yang, *et al.*, Nature Photonics, 9 (2015) 658-662.
4- Indistinguishable near-infrared single photons from an individual organic molecule J.-B. Trebbia *et al.*, Phys. Rev. A. 82 (2010) 063803.
5- 3D optical nanoscopy with excited state saturation at liquid helium temperatures, J.-B. Trebbia, R. Baby, P. Tamarat, and B. Lounis, Optics Express, 27 (2019) 23486

Research Topic for the ParisTech/CSC PhD Program

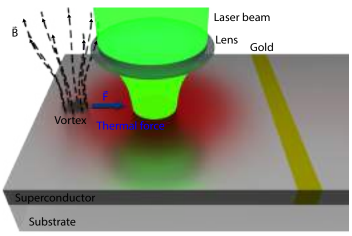
Field: Physics, Optics ***Subfield***: Superconductivity and magnetism, Josephson transport

Title: **Fast Josephson-junction control by optical manipulation of a flux quantum**

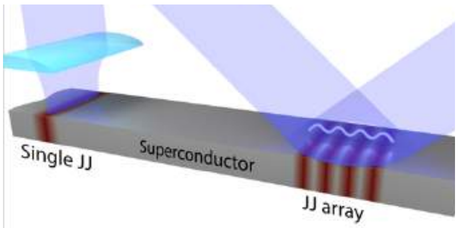
ParisTech School: Institut d'Optique Graduate School
Advisor(s) Name: Brahim LOUNIS, Philippe Tamarat
Advisor(s) Email: brahim.lounis@u-bordeaux.fr
Research group/Lab: LP2N, UMR5298/Nanophotonics group
Lab location: Bordeaux
(Lab/Advisor website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

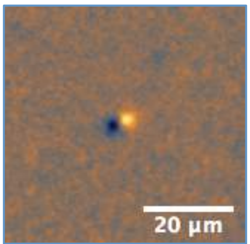
The miniaturization of semiconductor-based electronic components could reach its limits within a decade. Superconducting electronics, based on quantum flux superconducting logic circuits (Josephson junctions), is a promising alternative offering both high operating rates and low switching energies. Full optical control of Josephson junctions would enable low-power, wideband communication between logic circuits at cryogenic temperatures and room-temperature mass memories. In this context, the thesis objective is the fundamental exploration of the interplay between optics, magnetism and superconductivity, an emerging research field. Innovative optical methods of individual Abrikosov vortex manipulation recently developed in our group offer promising perspectives such as fast optical Josephson junction control by moving a quantum of flux near a junction by photo-thermal effect.



Control of a Josephson junction with a single vortex.



Sculpting a normal region in a superconductor with light.



Generation of a vortex-antivortex pair with a laser pulse.

We will also aim at creating the Josephson junction itself by photo-thermal effect, by illuminating the section of a superconducting ribbon. The Josephson electrical transport signatures will be studied according to the geometry and power of the laser beam used to locally weaken the superconductivity. Finally, in the perspective of an all-optical control of superconducting electronic devices, part of the thesis will be dedicated to the creation of flux quanta with a laser pulse, using the inverse Faraday effect.

Required background of the student: quantum physics, optics, light matter interaction, superconductivity and magnetism.

A list of representative publications of the group:
« Optical Manipulation of Single Flux Quanta», I. S. Veschunov et al. Nature Communications 7 (2016) 12801.
Patent "Control of the displacement of an individual Abrikosov vortex », A. Bouzdine, B. Lounis, P. Tamarat.
“Anomalous Josephson effect controlled by an Abrikosov vortex”, S. Mironov et al., PRB 96, 214515 (2017).
“On-Demand Optical Generation of Single Flux Quanta” A. Rochet et al. Nano Letters 20 (2020) 6488.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

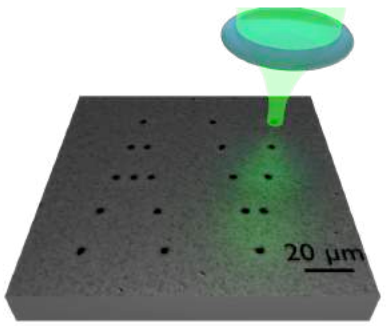
Field: Physics, Optics ***Subfield***: Quantum physics, molecular physics, condensed matter

Title: **Towards single spin control with an optically driven Abrikosov vortex**

ParisTech School: Institut d'Optique Graduate School
Advisor(s) Name: Brahim LOUNIS, Philippe Tamarat
Advisor(s) Email: brahim.lounis@u-bordeaux.fr
Research group/Lab: LP2N, UMR5298/Nanophotonics group
Lab location: Bordeaux
(Lab/Advisor website): https://sites.google.com/site/bordeauxnanophotonicsgroup/home

Short description of possible research topics for a PhD:

Abrikosov vortices are the most compact magnetic objects, with a size of a few tens to a few hundred nanometers. These flux tubes, which penetrate type II superconductors (such as Niobium), carry a quantum of flux h/2e and are surrounded by super-currents. Recently, our group demonstrated the ability to manipulate single flux quanta with a laser beam, as simply as with optical tweezers.



The main goal of the doctoral project is to explore the magnetic interaction between an optically manipulated individual Abrikosov vortex and a single spin present in a quantum nano-emitter such as the nitrogen-vacancy color center in diamond. The entanglement between the vortex mesoscopic system and the spin will be studied. The 3D optical nanoscopy methods developed in our group will be applied to precisely map the distribution of magnetic field (or electric field) around a vortex. Finally, we will investigate the ability to manipulate the spin state with the magnetic field carried by the vortex.

Required background of the student: quantum physics, optics, light matter interaction, superconductivity and magnetism. The thesis will be mainly experimental. The candidate will also develop the theoretical simulations and acquire a strong background in laser spectroscopy, single photon detection, quantum optics...

A list of representative publications of the group:

1- Ivan S. Veshchunov et al., Optical Manipulation of Single Flux Quanta, Nature communications 7 (2016) 12801.
2- Bin Yang, et al., Optical Nanoscopy with Excited State Saturation at Liquid Helium Temperatures, Nature Photonics, 9 (2015) 658-662.
3- « Anomalous Josephson effect controlled by an Abrikosov vortex », S. Mironov et al. PRB 96, 214515 (2017).
4- "Optical nanoscopy with excited state saturation at liquid helium temperatures", Yang et al. Nature Photonics 9 (2015) 658.
5- "On-Demand Optical Generation of Single Flux Quanta" A. Rochet et al. Nano Letters 20 (2020) 6488.

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Physics, Optics

Subfield: Mechanical Engineering, Energy

Title: Controlling thermal emission

ParisTech School: Institut d'Optique Graduate School

Advisor(s) Name: Jean-Jacques GREFFET
Advisor(s) Email: *jean-jacques.greffet@institutoptique.fr*
Research group/Lab: *Plasmonics/Laboratoire Charles Fabry*
Lab location: *Palaiseau, France*
(Lab/Advisor website): *https://www.lcf.institutoptique.fr/groupes-de-recherche/nanophotonique/themes-de-recherche/plasmonique-et-nanophotonique-quantique*

Short description of possible research topics for a PhD:

Since the eigteenth century and the work of Kirchhoff, it has been taken for granted that thermal radiation is quasi isotropic and broadband, with a spectrum being characterized by the Planck function. In the last twenty years, with the advent of nanophotonics, the scientific community has learn how to control thermal emission. Directional and narrow band sources have been reported [1-3]. New research frontiers deals with the design of sources modulated at high frequency [4-5] or emitting circularly polarized. The research topic consists in designing mid infrared thermal sources that can be modulated faster than 10 MHz and emitting circularly polarized light.

Required background of the student: Optics/Mechanical engineering (thermal radiation)

List of representative publications of the group:

1. Coherent emission of light by thermal sources, J.J. Greffet, R. Carminati, K. Joulain, J.P. Mulet, S. Mainguy and Y Chen, Nature **416** p 61 (2002).
2. High efficiency quasi-monochromatic infra red emitter, G. Brucoli, P. Bouchon, R. Haidar, M. Besbes, H. Benisty, J.J. Greffet, Appl.Phys.Lett. **104**, 081101 (2014)
3. Plasmonic metasurface for directional and frequency-selective thermal emission, D Costantini, A. Lefebvre, A.L. Coutrot, I. Moldovan-Doyen, JP Hugonin, S. Boutami, F. Marquier, H. Benisty, JJ Greffet, Phys. Rev. Applied **4**, 014023 (2015)
4. Enhancing thermal radiation with nanoantennas to create infrared sources with high modulation rates, E. Sakat, L. Wojszvzyk, J.P. Hugonin, M. Besbes, C. Sauvan, J.J. Greffet, Optica **5**, 175 (2018).
5. Light emission by nonequilibrium bodies: local Kirchhoff law, J.J. Greffet, P. Bouchon, G. Brucoli, F. Marquier, Phys.Rev.X **8**, 021008 (2018).

ParisTech MINES ParisTech | PSL

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: *Materials Science, Mechanics, Fluids*

Subfield: Bio-based polymers, Biomaterials, Aerogels, Fluid mechanics

Title: 3D printing of gels and aerogels for biomedical applications

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Tatiana BUDTOVA, Co-advisors: Sijtze BUWALDA and Rudy VALETTE

Advisor(s) Email: *Tatiana.Budtova@mines-paristech.fr*

Research group/Lab: *Center for Materials Forming (CEMEF), Biobased Polymers and Composites group (BIO) and Computing and Fluids group (CFL)*

Lab location: *Sophia Antipolis*

(Lab/Advisor website): https://www.cemef.mines-paristech.fr/en/homepage/

Short description of possible research topics for a PhD:

Additive manufacturing is a very promising technology for biomedical applications such as regenerative medicine, tissue engineering and drug delivery. In this project 3D printing will be used to make bio-based gels in complex shapes, which will then be transformed into bio-aerogels. The goal is to use bio-aerogels as matrices for drug delivery in smart patches. Bio-aerogels are 100% bio-based ultra-lightweight nanostructured materials with a high internal surface area.

Two approaches for printing gels from polysaccharide solutions will be considered: either printing in a fluid in which the polymer is cross-linked, or printing in a non-solvent which induces phase separation. The rheology of solutions in the capillary of the printer nozzle and near its exit will be studied experimentally and modelled using finite element analysis approaches developed in CEMEF. Special attention will be paid to solution liquid-“solid” (gel) transitions. Bio-aerogels will be characterized, loaded with drugs and their release kinetics studied.

Required background of the student: polymer chemical physics; materials science

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. F. Chen, W. Xiang, D. Sawada, L. Bai, M. Hummel, H. Sixta, T. Budtova «Exploring Large Ductility in Cellulose Nanopaper Combining High Toughness and Strength », *ACS Nano*, 14, 11150 (2020)
2. S. Buwalda, T. Vermonden, W. Hennink, «Hydrogels for therapeutic delivery: current developments and future directions», *Biomacromolecules*, 18, 316 (2017)
3. L. Druel, P. Niemeyer, B. Milow, T. Budtova, “Rheology of cellulose-[DBNH][CO2Et] solutions and shaping into aerogel beads”, *Green Chem.*, 20, 3993 (2018)
4. S. Zhao, W. J. Malfait, A. Demilecamps, Y. Zhang, S.L Brunner, L. Huber, P. Tingaut, A. Rigacci, T. Budtova, M. M. Koebel “Strong, Thermally Superinsulating, Biopolymer-Silica Aerogel Hybrids by Cogelation of Silicic Acid with Pectin”, *Angew. Chemie Intl. Edition*, 54, 14282 (2015)
5. A. Pereira, R. Valette, E. Hachem, « Inertia-dominated coiling instabilities of power-law fluids”, *J. Non-Newt. Fluid Mech.*, 282, 104321 (2020)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes

Subfield: Electrical engineering, applied mathematics, smart grid

Title: Big data based forecasts for the electric power system

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Andrea Michiorri,
Advisor(s) Email: andrea.michiorri@mines-paristech.fr
Research group/Lab: *PERSEE*
Lab location: *Sophia Antipolis*
(Lab/Advisor website): http://www.mines-paristech.eu/Research-valorization/Fields-of-Research/Energy-and-processes/PERSEE-Centre-for-processes-renewable-energies-and-energy-systems/

Short description of possible research topics for a PhD:
Context: This research is based on the following considerations: 1) Energy forecasts are used for decision making by system's actors. 2) They are partially correlated, and this can be used to improve their precision. 3) Data sources increase in terms of size, variety and quality.
Objectives: The objectives of this research are: A) to develop forecast models for the state of the electric power system (production, consumption, prices) with attention to extreme and rare events. B) To integrate alternative data sources such as climate models or natural language processing.
Methodology: The research will be organized according to the following plan: i) preparation (bibliographic research, learning tools and datasets, with attention to open data). ii) A second phase regarding the development of the forecast models (point A). iii) A third phase for the evaluation of the models.

Required background of the student: Applied mathematics, informatics, machine learning

A list of 5 (max.) representative publications of the group:
1. Andrea Michiorri, Huu-Minh Nguyen, et al., "Forecasting for dynamic line rating", Renewable and Sustainable Energy Reviews, 2015/12/31, Vol 52, pp 1713-1730
2. Andrea Michiorri, Philip C Taylor, "Forecasting real-time ratings for electricity distribution networks using weather forecast data", Electricity Distribution-Part 1, 2009. CIRED 2009. 20th International Conference and Exhibition on
3. Arthur Bossavy, Robin Girard, Andrea Michiorri, Georges Kariniotakis, "The impact of available data history on the performance of photovoltaic generation forecasting models", Electricity Distribution (CIRED 2013), 22nd International Conference and Exhibition on
4. Romain Dupin, Andrea Michiorri, Georges Kariniotakis, "Dynamic Line Rating Forecasting and Evaluation", EWEA Technology Workshop, Wind Power Forecasting 2015

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RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes

Subfield: Electrical engineering, applied mathematics, smart grid

Title: Dynamic Line Rating: risk and impact on investment planning

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Andrea Michiorri,
Advisor(s) Email: andrea.michiorri@mines-paristech.fr
Research group/Lab: *PERSEE*
Lab location: *Sophia Antipolis*
(Lab/Advisor website): http://www.mines-paristech.eu/Research-valorization/Fields-of-Research/Energy-and-processes/PERSEE-Centre-for-processes-renewable-energies-and-energy-systems/

Short description of possible research topics for a PhD:
Context: Dynamic line rating (DLR) is a technology able to modify in real time the current carrying capacity of power system components such as overhead lines, power transformers and electric cables. It has the potential to reduce network charges, but several challenges needs to be addressed before its implementation.
Objectives: This thesis is focused on two points: 1) to develop a methodology to safely determine DLR to be applied. 2) To study the impact of the application of DLR on investment planning, both for the network (network reinforcements) and for network users (reduced connection cost).
Methodology: The focus will be kept on overhead lines, but transformers and electric cables can be investigated as well. For point 1) several approaches will be considered and/or combined: a) the use of historical data, weather reanalysis and climate projections to create a DLR climatology, b) the use of daily probabilistic forecasts, c) a risk-based approach. For point 2) simulations will be carried out on well-defined use cases comparing the benefits and drawbacks of the application of DLR. Examples are: a) retarding network reinforcements following load or renewable production increase, b) reducing renewable's connection cost.;

Required background of the student: Electrical engineering (power systems)

A list of 5 (max.) representative publications of the group:
1. Andrea Michiorri, Huu-Minh Nguyen, et al., "Forecasting for dynamic line rating", Renewable and Sustainable Energy Reviews, 2015/12/31, Vol 52, pp 1713-1730
2. Andrea Michiorri, Philip C Taylor, "Forecasting real-time ratings for electricity distribution networks using weather forecast data", Electricity Distribution-Part 1, 2009. CIRED 2009. 20th International Conference and Exhibition on
3. Romain Dupin, Andrea Michiorri, Georges Kariniotakis, "Dynamic Line Rating Forecasting and Evaluation", EWEA Technology Workshop, Wind Power Forecasting 2015

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Computer Science

Title: Scaling Up Polarized Deduction Modulo Theory

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Olivier Hermant
Advisor(s) Email: olivier.hermant@mines-paristech.fr
Research group/Lab: Centre de recherche en informatique
Lab location: Fontainebleau, France
(Lab/Advisor website): http://www.cri.mines-paristech.fr

Short description of possible research topics for a PhD:
Formal methods aims at ensuring *provably bug-free* software. An industrial benchmark of ten of thousands of problems has given us the opportunity to jointly develop automated theorem provers and proof checkers.
The research subject aims at extending those tools and their logical foundations in the direction of polarized rewriting, where conditional computation steps are embedded into reasoning step, a feature that gave excellent preliminary results on the benchmark. Our tools are also critically dependent on the strategy adopted. As this strategy is dependent on the shape of the problem, another part of the research subject is to learn automatically how to trigger the best heuristics.

Required background of the student: an M.Sc.-level specialization in any field of computer science or in the foundations of mathematics. More specialized courses, among which machine learning, compilers, logics, theoretical computer science, or functional programming are a plus.

Representative publications of the group:
1. G. Burel, G. Bury, R. Cauderlier, D. Delahaye, P. Halmagrand, and O. Hermant. *Automated deduction: When deduction modulo theory meets the practice*. Journal of Automated Reasoning 64(6), pp. 1001–1060, 2020.
2. M. Boespflug, Q. Carbonneaux, and O. Hermant. *The λΠ-calculus modulo as a universal proof language*. In Second Workshop on Proof Exchange for Theorem Proving (PxTP), volume 878, pp. 28–43, CEUR-WS.org, 2012.
3. G. Dowek. *Polarized deduction modulo*. In IFIP Theoretical Computer Science, 2010.
4. The BWare Project, 2012. http://bware.lri.fr/

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Materials Science, Mechanics, Fluids

Subfield: (Mechanics of materials, physical metallurgy)

Title: A Self consistent crystal plasticity model coupled to a mean field model for microstructural evolution predictions

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: François Bay, Daniel Pino Muñoz, Charbel Moussa
Advisor(s) Email: *francois.bay@mines-paristech.fr*, *daniel.pino_munoz@mines-paristech.fr*, *charbel.moussa@mines-paristech.fr*
Research group/Lab: *Centre de mise En Forme des matériaux (CEMEF)*
Lab location: *06904 Sophia Antipolis, France*
(Lab/Advisor website): *www.cemef.mines-paristech.fr*

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)

Controlling the microstructures of metallic alloys can lead to an improvement of in use properties. Therefore, prediction of the microstructure evolution during thermomechanical treatments is of utmost importance in many industrial applications. Physical mechanisms responsible for microstructural evolution take place at different scales. At the structural parts scale, it is not possible model explicitly all those mechanisms. For this reason, simplified models based on an implicit description of the microstructure, so-called mean-field models, can be used. Because of the complexity and the heterogeneity of the thermomechanical conditions, mean-field models predictions need to be built on strong physical basis. In this project we aim at implementing mechanical homogenization techniques, based on self-consistent approaches, in order to accurately describe the mechanical response of a polycrystal. This accurate mechanical response will then be used to propose reliable mean-fields models of the evolution of the microstructure. The developed technique will be applied to thermo-mechanical loading paths induced by electromagnetic forming processes.

Required background of the student: (What should be the main field of study of the applicant before applying?)
Mechanics of materials, Material Science, Numerical methods

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Maire L., Fausty J., Bernacki M., Bozzolo N., De Micheli P., Moussa C., "A new topological approach for the mean field modeling of dynamic recrystallization", Materials and Design, 146 (2018) p.194-207
2. Maire L., Scholtes B., Moussa C., Bozzolo N., Pino Muñoz D., Settefrati A., Bernacki M., "Modeling of dynamic and post-dynamic recrystallization by coupling a full field approach to phenomenological laws", Materials and Design, 133 (2017) p.498-519
3. Ruiz Sarraloza D.A., Maire L., Moussa C., Bozzolo N., Pino Muñoz D., Bernacki M., "Full field modeling of Dynamic Recrystallization in a CPFEM context - Application to 304L steel", Computational Materials Science, 184 (2020) p.109892
4. Ruiz Sarraloza D.A., Pino Muñoz D., Bernacki M., "A new numerical framework for the full field modeling of dynamic recrystallization in a CPFEM context", Computational Materials Science, 179 (2020) p.109645
5. Alves Zapata J., Bay F., “Modeling and Analysis of Electromagnetism in Magnetic Forming Processes”,IEEE Transactions on Magnetics, Volume: 52, Issue: 5 , (2016)

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Economics, Management and Social Sciences

Subfield: Logistics and Supply Chain and Management

Title: Performance of interconnected logistics networks under uncertainty

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Eric BALLOT, Shenle PAN
Advisor(s) Email: eric.ballot@mines-paristech.fr; shenle.pan@mines-paristech.fr
Research group/Lab: Centre de gestion Scientitique
Lab location: 60, boulevard Saint-Michel, 75006 Paris, France
(Lab/Advisor website): www.cgs.mines-paristech.fr

Short description of possible research topics for a PhD: (10-15 lines in English + optional figure)
Due to economic globalization, today's supply chain and logistics networks are more complex and stringent than ever before, and facing many uncertainties like market volatility, global transportation service and lead-time, or global or local disruptions like the COVID pandemic. How to effectively and efficiently manage supply chains and the operations under such uncertainties remains a major challenge in the field of supply chain management (SCM). Physical Internet, aiming at the interconnection of independent logistics or supply networks via physical and informational interoperability, is a recent breakthrough logistics paradigm, and that seems promising. Its potential on improving logistics efficiency and sustainability has been demonstrated by former research works. However, the question of how it could alleviate the uncertainties by enhancing the agility and resilience is not yet studied in the literature. The thesis will focus on the later question, and apply modelling approaches (especially, robust optimization, coupling optimization-simulation) for quantitative and qualitative research. The PhD candidate will join the team and the Physical Internet Chair, in order to work closely with researchers and industrial partners.

Required background of the student: (What should be the main field of study of the applicant before applying?)
The applicant should have master degree in logistics or supply chain management. Solid knowledge on mathematic modelling is also required, for example, Operational Research, multi-agent or discrete event simulation.

A list of 5 (max.) representative publications of the group: (Related to the research topic)

1. Pan S, Trentesaux D, Ballot E. and Huang G. (2019). "Horizontal collaborative transport: survey of solutions and practical implementation issues". International Journal of Production Research, 57 (15-16). 10.1080/00207543.2019.1574040.
2. Lafkihi M., Pan, S. & Ballot, E. (2019). "Freight Transportation Service Procurement: A literature review and future research opportunities in Omnichannel E-commerce". Transportation Research Part E, 125, 348-365 doi.org/10.1016/j.tre.2019.03.021
3. Yang Y, Pan S, and Ballot E (2016). "Mitigating supply chain disruptions through interconnected logistics services in the Physical Internet". International Journal of Production Research, 55(14): 3970-3983.
4. Sarraj R, Ballot E, Pan S, Montreuil B. and Hakimi D. (2014). "Interconnected logistic networks and protocols: simulation-based efficiency assessment." International Journal of Production Research. 52(11): 3185-3208
5. Pan S, Ballot E. and Fontane F. (2013). "The reduction of greenhouse gas emissions from freight transport by merging supply chains." International Journal of Production Economics. 143(1): p. 86-94

Research Topic for the ParisTech/CSC PhD Program

Field: Materials Science, Mechanics, Fluids

Subfield: Applied Physics, Structure Design, Organic & hybrids Materials

Title: Digital Crystallization of Organic-based systems: from Spherulites to Dendrites

ParisTech School: MINES ParisTech | PSL

Advisor(s) Name: Charles-André GANDIN, Patrice LAURE, Séverine A.E. BOYER
Advisor(s) Email: *Charles-Andre.Gandin@mines-paristech.fr*, Patrice.Laure@mines-paristech.fr**, Severine.Boyer@mines-paristech.fr****
Research group/Lab: *CEMEF CNRS 7635, MINES ParisTech PSL*
Lab location: *1, rue Claude DAUNESSE, 06 904 SOPHIA ANTIPOLIS (FRANCE)*
(Lab/Advisor website): *https://www.cemef.minesparis.psl.eu/en/homepage/*
**2MS team: https://www.cemef.minesparis.psl.eu/en/presentation/team-2ms/*
***CFL team: https://www.cemef.minesparis.psl.eu/en/presentation/team-cfl/*
****BIO team: https://www.cemef.minesparis.psl.eu/en/presentation/team-bio/*

Short description of possible research topics for a PhD:
The physics of the growth kinetics (GK) of polymer structures is lagging behind in certain points compared to that developed in metallurgy [1-3]. Indeed, if numerical model of the GK of structures (e.g., dendrite, eutectic) is a major research topics in physical metallurgy since decades [3], the theories of polymer GK remain rare [1,2].
To address this scientific barrier, in this thesis proposal, polymer & metal cross-fertilization is highlighted (**Figure 1**). Phase field methods will be developed to **i-** give a description of growth and a criterion of transition between spherulitic and dendritic crystals in accordance with the experiments carried out on carefully selected model organic systems (**b** & **c**), **ii-** identify the phase diagram of systems and correlate it to microstructural evolutions (**d**), and **iii-** integrate a new thermodynamic parameter including the effect of pressure (CRISTAPRESS cell, etc.) [4].

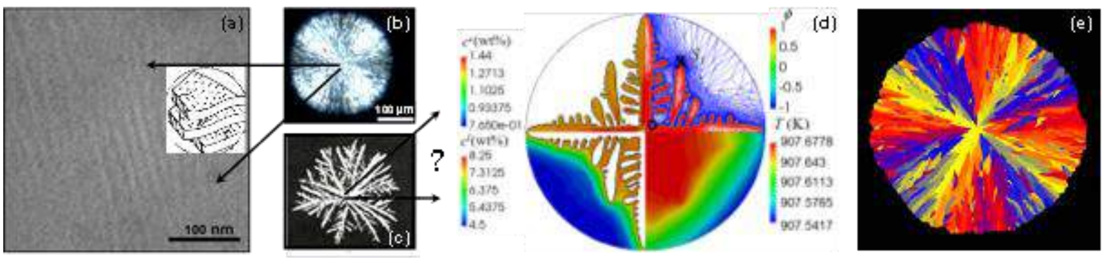

Figure 1 **(a)** Crystalline lamellae (nano), **(b)** spherulite (micro) (iPP, *Boyer*, MINESParis PSL); **(c)** branches of dendrites in polymer mixtures (iPP/aPP, *Keith & Padden*); phase field simulation of **(d)** dendritic growth (*Sarkis*, MINESParis PSL thesis [3]), **(e)** polycrystalline spherulitic growth (*Gránásy* [DOI: 10.1103/PhysRevE.72.011605]

Fallout

- New breakthrough in crystallization of organic systems
- Physics based on model polymer systems (petro-sourced, bio-sourced) [1,5]

- Development of numerical and experimental methods
- Thermodynamic/kinetic coupling (diffusion of energy and species) & structure
- Application to other morphologies (transcrystalline structure, foam, multi-transformations design, etc.) [1,5]

Required background of the student:
Main fields required are in Computational Mechanics and Materials Science.
The applicant will be involved in digital and experimental works.

A list of 5 (max.) representative publications of the group:

1. S.A.E. Boyer, J.-P.E. Grolier, H. Yoshida, J.-M. Haudin, J.-L. Chenot, "*Thermodynamic and Thermokinetics to model phase transitions of polymers over extended temperature and pressure ranges under various hydrostatic fluids*" in "Thermodynamics-Interactions Studies-Solids, Liquids and Gases", J.C. Moreno-Pirajan (Ed.), 2011. DOI: 10.5772/24402 - J.-M. Haudin, S.A.E. Boyer, *"Crystallization of Polymers in Processing Conditions: An Overview"*. International Polymer Processing, 32: 545-554, 2017. DOI: 10.3139/217.3415
2. D. Hoffman, R.L. Miller, "Kinetic of crystallization from the melt and chain folding in polyethylene fractions revisited: theory and experiment". Polymer, 38: 3151-3212, 1997. DOI: 10.1016/S0032-3861(97)00071-2
3. C. Sarkis, "Modélisation de la solidification dendritique d'un alliage Al-4.5%pdsCu atomisé avec une méthode de champs de phase anisotrope adaptative". PhD thesis *MINESParisTech CEMEF, 2016*
4. S.A.E. Boyer, F.E.J Fournier, Ch.-A. Gandin, J.-M. Haudin, *"CRISTAPRESS: An optical cell for structure development in high-pressure crystallization"*. Review of Scientific Instruments, 85: 013906 1-8, 2014. DOI: 10.1063/1.486(2473-6646)
5. S.A.E. Boyer, J.-Marc Haudin, V. Song, V. Bourassier, P. Navard, C. Barron. "Transcrystallinity in maize tissues/polypropylene composites: First focus of the heterogeneous nucleation and growth stages versus tissue type". Polymer Crystallization, Wiley, In press, DOI: 10.1002/pcr2.10155