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

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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)