

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

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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>.