ParisTech

Arts et Métiers Sciences et Technologies

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

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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.