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

Field (cf. List of fields below): Materials Science, Mechanics, Fluids

Subfield: Mechanical engineering; Material processing.

Title: Multiscale investigation of the thermal behavior of natural fiber composites for manufacturing applications

ParisTech School: Arts et Métiers (ENSAM)

Advisor(s) Name: Prof. Mohamed EL MANSORI; Dr. Faissal CHEGDANI
Advisor(s) Email:mohamed.elmansori@ensam.eu ; faissal.chegdani@ensam.eu
(Lab, website):*Mechanics, Surfaces and Materials Processing (MSMP) – EA7350*

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

Natural fiber composites arouse the interest of industry and academia thanks to many economic, ecological and technical performances of natural fibers such as flax and hemp. However, manufacturing processes of natural fiber composites present some issues related to the multiscale complex structure of natural fibers which is a cellulosic structure completely different from the conventional fibers used in composite industry such as glass and carbon. Within MSMP laboratory, the multiscale issues of natural fiber composites have been investigated for the machining process in terms of surface finish [1], [2]. The machinability qualification of natural fiber composites requires selecting a pertinent scale that corresponds to the natural fibrous structure size [3]. Indeed, the mechanical response of natural fibers involves a mechanical scale effect that influences the cutting contact during machining [4]. Moreover, the machining behavior of natural fibers shows an important dependence on the temperature induced by cutting [5]. This requires a deep investigation on the thermal behavior of natural fiber composites at their different characteristic scales to understand the thermal effect on the cutting mechanisms. Starting from the nano-scale structure (cellulose microfibrils and amorphous natural polymers) to the micro-scale cell walls structure of elementary fibers and finally the overall macro-scale structure of natural fiber structure, the Ph.D. student must characterize the thermal behavior of each structural component in the corresponding scale to understand the thermo-mechanical failure behavior of natural fiber composites during machining.

Required background of the student: (Which 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.

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

[1] F. Chegdani, S. Mezghani, M. El Mansori, and A. Mkaddem, “Fiber type effect on tribological behavior when cutting natural fiber reinforced plastics,” *Wear*, vol. 332–333, pp. 772–779, Jan. 2015.
[2] F. Chegdani and M. El Mansori, “Mechanics of material removal when cutting natural fiber reinforced thermoplastic composites,” *Polym. Test.*, vol. 67, pp. 275–283, May 2018.
[3] F. Chegdani and M. El Mansori, “New multiscale approach for machining analysis of natural fiber reinforced bio-composites,” *J. Manuf. Sci. Eng.*, Aug. 2018.
[4] F. Chegdani, M. El Mansori, S. Mezghani, and A. Montagne, “Scale effect on tribo-mechanical behavior of vegetal fibers in reinforced bio-composite materials,” *Compos. Sci. Technol.*, vol. 150, pp. 87–94, Sep. 2017.
[5] F. Chegdani, B. Takabi, B. L. Tai, M. El Mansori, and S. T. S. Bukkapatnam, “Thermal Effects on Tribological Behavior in Machining Natural Fiber Composites,” *Procedia Manuf.*, vol. 26, pp. 305–316, Jan. 2018.