PhD Thesis Offer

Title : **Micromechanical characterisation of fibres from nettle grown on marginal lands**

Supervision:

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The PhD thesis is written in the continuity of a collaborative project started two years ago between INRA and FEMTO-ST. The PhD student will be co-supervised by researchers from the two institutions.

Duration 36 months (From October 2019)

Location FEMTO-ST Institute
Departments of Applied Mechanics (DMA) and Automatic Control (AS2M)
24-26 rue de l'Epitaphe – 25000 Besançon, France

Context

The proposed PhD thesis is co-funded by the Graduate School EIPHI and the European project NETFIB.

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NETFIB Project

Valorization of fibres from nettle grown on marginal lands in an agro-forestry cropping system

SusCrop – ERA-NET
Cofund on Sustainable Crop Production
FACCEJPI

HORIZON 2020

NETFIB combines experimentation for nettle biomass production on land and the processing of its fibre outputs, as well as potential constraints, for example uptake of contaminants into usable biomass, and sets all of this information in a broader context of commercial feasibility and sustainability.
https://www.suscrop.eu/projects-first-call/netfib

EIPHI-BFC
GRADUATE SCHOOL
CROSS DISCIPLINARY SCIENCE AND TECHNOLOGY

The University of Bourgogne-Franche-Comté provides a new international integrated MSc/PhD program called EIPHI standing for "Engineering and Innovation through Physical Sciences, High-technologies, and cross-dIsciplinary research". The outstanding students in this graduate school will acquire a solid background in various topics, ranging from fundamental to applied sciences, allowing them to build a successful career in R&D sectors. The program is designed to include hands-on laboratory experience during the Master years in order to strengthen the student's capability to learn actively, think independently, and work in team. Through the existing close ties to industry, the students will also be exposed to the latest developments in industrial R&D through courses given by industrial partners and internships.
https://gradschool.eiphi.ubfc.fr/

The sharp increase in demand for plant based fibre raw materials as substitute for man-made fibres in products as diverse as textiles and car parts can only be met by an increased land area given over for fibre production[1]. However, land is a scarce resource and there is perceived land-use conflict between the needs of food production and non-food production. Producing non-food crop on land marginalised for example by contamination, which is unsuitable for food production might help mitigate this conflict. Nettle (*Urtica dioica*) has a long history as a fibre crop, but has not been well used in modern times. However, the special properties of nettle fibres (length, strength) have led to increasing market interest in their use and they are now an important "new" emerging fibre crop. They also seem particularly well suited to production on marginal land. The spontaneous appearance of dioecious nettle is prevalent in short rotation coppice (SRC) cropping systems, especially at phytomanaged marginal land sites. Nettles and coppice, such as poplar coppice, provide a multilevel canopy and production of both biomass for energy (coppice) and biomass for fibre (nettle) extending the productivity of the marginal land from coppice alone, whilst still maintaining a functioning phytomanagement system of rehabilitation and risk management of the marginal land. Nettles as a fibre crop also bring land rehabilitation and ecological benefits that can be combined with low-input rehabilitation of soil functionality and mitigation of risks (e.g. to human health and the wider environment). The use of native species (e.g. nettles) creates significant habitat development and wildlife refuge opportunities. These are major sustainability gains. An industrial sector that consumes high and increasing amounts of plant fibres is the production of biocomposites, which currently make significant use of flax, hemp and other, mainly imported raw materials. To fully exploit the nettle fibre resource, a good understanding of their behaviour and mechanical properties as well as control of their durability is required under controlled environmental conditions. Despite a promising potential for applications, the establishment of nettle cultivation and use at scale remains a challenge and the limited availability of such fibres does not encourage industrial uses. NETFIB addresses this negative feedback loop. NETFIB will promote the development of a site-specific phytomanagement strategy while proposing an innovative production of crop fibre resources, representing a complementary resource of interest for the European needs and economy. The main outputs of NETFIB will largely contribute to provide pioneer territorialized-pan European data on new plant production opportunities on marginalized lands.

Objective and tasks

The main objective of this PhD thesis is the development and exploitation of instruments and methods for the automated micromechanical characterization of nettle fibres.

The main tasks related to the work will be:

- Static and dynamic characterization of single nettle fibres under various solicitation modes using micro mechatronics systems and 2D full-field measurements.
- Development and exploitation of a generic and integrated set-up for *in-situ* measurements (SEM, X-ray nanotomography).
- Development and exploitation of an innovative set-up to determine the inter-fiber shear strength.

Profile required

- Student (Master 2 or final year of engineering school) in mechanics of materials and/or mechatronics.
- Knowledge and skills in fibrous materials (manufacturing, testing and modelling).
- Curious, self-motivated, hard-worker
- English: fluent reading, writing and speaking with ease.

Application procedure

Applications can be in French or English, and addressed to vincent.placet@**univ-fcomte.fr**
Candidates should send a **CV**, a **covering letter** and **official transcripts**

[1] Mohanty AK, Vivekanandhan S, Pin J-M, Misra M. Composites from renewable and sustainable resources: Challenges and innovations. Science 2018; 362 (6414): 536.

Recent Team's Publications

- Vincent Placet, Mélissa Blot, Tine Weemaes, Hugo Bernollin, Guillaume Laurent, Fabien Amiot, Cédric Clévy, Johnny Beaugrand. Transnverse compressive properties of natural fibres determined using micro mechatronics systems and 2D full-field measurements. 4th International Conference on Natural Fibers, Porto, 1-3 July 2019.
- Del Masto A, Trivaudey F, Guicheret-Retel V, Placet V, Boubakar L. Investigation of the possible origins of the differences in mechanical properties of hemp and flax fibres: A numerical study based on sensitivity analysis. Composites Part A: Applied Science and Manufacturing 2019; 124: 105488.
- Jeannin T, Berges M, Gabrion X, et al. Influence of hydrothermal ageing on the fatigue behaviour of a unidirectional flax-epoxy laminate. Composites Part B: Engineering 2019; 174: 107056.
- Jeannin T, Gabrion X, Ramasso E, Placet V. About the fatigue endurance of unidirectional flax-epoxy composite laminates. Composites Part B: Engineering 2019; 165: 690.