Thesis title: Tribological behaviour of raw & modified woods as frictionnal eco-components

Host Laboratory: Femto-ST Institute – Department of Applied Mechanics

Speciality: Applied mechanics, Tribology

Keywords: friction – wear – wooden material processes – experimental tribology

Job description

As the main cause of climatic change, anthropogenic greenhouse gas emissions have continued to break records in recent years, making it essential to reduce them. To this end, and for a wide range of industrial applications, replacing petro-sourced materials with bio-sourced ones (possibly wood) is a promising route. This is particularly relevant in the case of wearing parts subject to friction, in order to limit their manufacturing and end-of-life treatment impacts. However, apart from rare (and old) studies [1], the tribological behaviour of these materials is poorly documented.

Our pioneering studies in this field, carried out over the last few months, have already shown that: (i) the tribological behaviour of raw woods is strongly influenced by the material moisture content and by the environment hygrometry surrounding the contact; (ii) some raw wood species exhibit mechanical, microstructural and physicochemical properties that lead to very promising tribological performances (low and stable friction coefficient and very low wear); (iii) and other wood species do not reach such performances that are however required on an industrial scale.

Nonetheless, over the last decade, the literature reported the emergence of numerous new processes for transforming or functionalizing bulk raw woods (densification, delignification, stabilisation, surface treatments, etc.), making it possible to drastically modify their properties [2,3]. This leads to the development of re-engineered wooden-based materials [4]. Interestingly, the changes in properties should theoretically result in improved tribological properties (increased hardness, modulus of elasticity, mechanical strength, thermal conductivity, hydrophobicity, etc.) [5,6]. This opens up the possibility of using these renewable, biodegradable bio-sourced materials for tribological applications, replacing traditional materials whose production and life cycle lead to high greenhouse gas emissions [7].

This PhD aims: (i) to evaluate the tribological reliability of raw and modified woods, (ii) to highlight the interfacial mechanisms that drive the tribological behaviour of the contact, (iii) to identify the material properties and contact modalities leading to promising tribological behaviour from an applicative perspective. To this end, we will adopt an experimental approach based on both tribometric measurements for detecting frictional behaviour modifications, and multiple surface characterisation methods (mechanical, morphological, physicochemical).

Bibliography

[1] Atack, D., Tabor, D. (1958). The Friction of Wood. Proceedings of the Royal Society of London. Series A, *Mathematical and Physical Sciences*

[2] Song J. et al., (2018) Processing bulk natural wood into a high-performance structural material. *Nature*

[3] Frey M. et al. (2019) Delignified Wood–Polymer Interpenetrating Composites Exceeding the Rule of Mixtures. *ACS Applied Material Interfaces*

[4] Akpan, et al. (2021). Eco-friendly and sustainable processing of wood-based materials. *Green Chemistry*

[5] Tan Y. et al. (2022) High performance, shape manipulatable transparent wood based on delignified wood framework and exchangeable dynamic covalent vitrimers. *Chem. Eng. Journal*

[6] Jia S. et al. (2016) Facile and scalable preparation of highly wear-resistance superhydrophobic surface on wood substrates using silica nanoparticles modified by VTES. *Applied Surface Science*

[7] Waßmann, O. et al. (2020) Slippery Wood: Low Friction and Low Wear of Modified Beech Wood. *Tribology Letters*

Applicant profile

- Master degree in Mechanics and/or Material science
- Skills and practical experience in experimental tribology

Preferred selection criteria:

- Knowledge and skills in applied mechanics, material science, surfaces characterization, and mechanical signal post-processing
- Willingness for experimental work

Personal characteristics:

- Precision, accuracy and taste for experimentation
- Ability to report on work carried out
- Autonomy and initiative
- Motivation and enthusiasm

Funding: MESRI Etablissement

Application must be sent by **16 May 2025**
Starting date: 1 October 2025
Gross monthly salary: 2200€ (and then, from 1st january 2026: 2300€)

Thesis Supervisor
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Thesis co-Supervisor
CARBILLET Stani

Applicants are invited to submit their application **to the PhD supervisor**

Application must contain the following documents:

- CV
- Cover letter
- At least 1 reference letter
- Master's degree evaluation report
- Diplomas or certificates of achievement