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# PhD Position

## Humidity and heat transfers in bio-based buildings

Bio-based construction materials are systems containing or formed of vegetal particles, such as wood, hemp, cellulose, flax, cotton, etc., possibly linked with a mineral paste or an organic binder. They represent a promising solution for carbon emission reduction, due to their low production cost and their partial or full recyclability. Moreover, they bring more comfort to the occupants thanks to their moisture-buffering capacity, and they require less energy for heating or cooling. These qualities are obtained through exchanges between water vapor and "bound water", i.e., water absorbed in the solid structure, combined with heat transfers. Consequently, understanding and predicting water and heat (hygrothermal) transfers in such materials is essential to selecting them appropriately, adjusting their conditions of use, and designing innovative materials. However, the current analysis of their performance is generally based on limited evaluations at a global scale or via macroscopic models lacking physical information.

Our group has recently developed original approaches and tools that allow to clarify and quantify the internal heat and mass transfers thanks to a proper description of boundary conditions, along with the development of new NMR and MRI techniques [1-4] providing spatially and temporally resolved distributions of the water in its different phases. In parallel, within the framework of the Sense-City equipment, we can use a pilot building insulated with bio-based materials and fully instrumented to follow the temperature and humidity over time.

The objective of this PhD work is to compare for the first time the effective behaviour of the building with the predictions of heat and mass transfers through the walls with the help of the detailed intrinsic properties of the materials as determined in the laboratory. The candidate will thus have to carry out an experimental characterization of the materials with the above described tools, set up specific protocols for exploring the hygrothermal behaviour of the room, and use or develop a numerical simulation of this behaviour.

This work will be carried in Laboratoire Navier, within the framework of the ERC Advanced Grant PHYSBIOMAT (2023-2028), in collaboration with the Laboratory CPDM of University Gustave Eiffel. The candidate will thus benefit of a very favorable work environment within groups of research including various students or researchers experts in the different experimental or theoretical aspects of the project, along with all equipments for material characterization.

**Skills**: The candidate is expected to have a solid background in chemical or material engineering, and a strong motivation for research.

**Duration**: 3 years

**Location:** Laboratoire Navier, Univ. Gustave Eiffel campus, Champs sur Marne, France

**Gross salary**: 2420 euros per month

**Start date**: September 2024. Selection process will start immediately and go on until the position is filled

**Supervisors**: Philippe Coussot (Navier) et Sandrine Marceau (CPDM)

**Application** to philippe.coussot@univ-eiffel.fr including a CV and a short letter of motivation

**References**:
[1] Maillet et al., *Langmuir*, 38, 15009−15025 (2022)
[2] Zhou et al., *Physical Review Research*, 1, 033190 (2019)
[3] Cocusse et al., *Science Advances,* 8, eabm7830 (2022)
[4] Zou et al., *Cellulose*, 30, 7463–7478 (2023)

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