

## PhD Proposal:

### *Study of material responses to fluctuating environmental conditions in a civil engineering applications perspective*

Civil Engineering & Energetics team, ICube Laboratory, CNRS UMR 7357, Strasbourg (France)  
in collaboration with the Plant Biomechanic Group (Botanical Garden, Freiburg, Germany).

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#### Description:

Understanding the mechanical behaviour of material assemblies which passively react to fluctuating environmental conditions with particular respect to temperature / humidity / lighting coupling, is an important scientific challenge [1] to which this project aims to contribute. Target applications in civil engineering are numerous and relate to "smart" materials: potential innovations concern in particular the sustainable performance of the building envelope for climate control and, thus, the comfort of users.

In this context, the project proposes to look at the response of material assemblies in terms of movements induced by changing climatic environmental conditions in view of the development of actuators that could be relevantly scaled up to building applications. A biomimetic approach will be pursued by drawing inspiration from the energy-efficient and functionally resilient mechanisms present in nature [2] towards integration into civil engineering. Therefore, this thesis will be conducted in collaboration with the Plant Biomechanic Group (Botanical Garden, Freiburg, Germany).

The underlying scientific key points concern the gradient properties of material assemblies, their responses to various stimuli, as well as the mechanical amplification (notably trans-scale: from the material to the structure). To be carried out successfully, this largely experimental doctoral research project will require specifically the implementation of means concerning the exploration of the exchange surface and its topography [3, 4]; the effect of the coupling of the three stimuli; and modelling by the finite element method of the macroscopic behaviour of the actuating structure.

#### References:

- [1] J. Knippers, K. Nickel, T. Speck, *Biomimetic Research for Architecture and Building Construction*, Springer (2016).
- [2] S. Poppinga, N. Nestle, A. Šandor, B. Reible, T. Masselter, B. Bruchman, T. Speck, *Hygroscopic Motions of Fossil Conifer Cones*, *Scientific Reports* (2017), 7, 40302.
- [3] C. Dorrer, J. Rühle, *Condensation and Wetting Transitions on Microstructured Ultra-Hydrophobic Surfaces*, *Langmuir* (2007), 23, 3820-3824.
- [4] R. Dettre, R. Johnson, *Contact Angle Hysteresis. IV. Contact Angle Measurements on Heterogeneous Surfaces*, *J. Phys. Chem.* 1965, 69, 1507–1515.

#### Requirements:

We are looking for highly qualified and motivated graduates holding a master's degree (or equivalent) in mechanics, engineering, material science, civil engineering, chemistry-physics or related areas with excellent grades. Particular interest in experimental work in multi-disciplinary studies (biomimetics,...) will be highly appreciated. Applicants should have excellent proficiency in English.

Interested candidates should send by e-mail a detailed CV, a cover letter, copies of their latest transcripts (L3, M1 and M2, engineering school years). Letters of recommendation are welcome.

**Application deadline: May 7th, 2018**

**Contacts:**

The complete application file should be sent to the following persons: Vincent LE HOUEROU ([v.lehouerou@unistra.fr](mailto:v.lehouerou@unistra.fr)) and Simon Poppinga ([simon.poppinga@biologie.uni-freiburg.de](mailto:simon.poppinga@biologie.uni-freiburg.de)).

**Additional informations:**

This thesis proposal is made within the framework of a ministerial financing (MESR / ~1350 € net/month) of the MSII graduate school 269 (<http://ed.math-spi.unistra.fr>) of the University of Strasbourg.