**FELLOWSHIP POSTDOCTORAL**
**OPEN POSITION**

## DESCRIPTION

**Title of the project: Numerical simulations of Phase Change Materials in composite systems for energy storage**

### Scientific context and objectives

The accelerating global demand for energy, still largely met by fossil fuels, continues to drive climate change. In response, research has focused on developing efficient and affordable latent heat thermal energy storage (LHTES) systems to promote more sustainable energy use. Among available methods for thermal energy storage, latent heat storage through phase changes is one of the most effective and promising approaches. Phase Change Materials (**PCMs**), which exhibit significant latent heat per unit volume, are essential components of LHTES systems. They absorb heat during melting and release it during solidification, offering high energy storage density, a nearly constant temperature during phase change, and reversible cycling provided ageing effects are limited. However, their practical implementation is often limited by drawbacks such as low thermal conductivity, which slows charging and discharging rates, and supercooling during solidification that delays crystallization and reduces efficiency.

To address these limitations, different types of composite systems can be developed. Examples are: (i) the encapsulation of PCM within polymer-coated microcapsules, which are then dispersed in a carrier fluid at various concentrations. This increases the PCM surface-to-volume ratio and improves heat transfer rates. Microencapsulation also prevents PCM leakage, reduces chemical reactivity with the environment, and allows the suspension to flow regardless of the PCM's phase provided the carrier fluid remains liquid. Another approach consists in (ii) embedding the PCM in thermally conductive solid matrices, such as metallic foams. These composites increase the number of PCM-solid interfaces and distribute nucleation sites, thereby reducing supercooling through enhanced heterogeneous nucleation. The thermal performance depends on the properties of each component, and heat transfer can be further enhanced by selecting materials with high thermal conductivity or by promoting convective flows within the liquid PCM.

The primary **objective** of this project is to investigate heat and momentum transfer in such PCMs-based composites systems. A key aim is to improve the understanding of the phase change processes and interfacial interactions in complex configurations under varying thermal conditions, thereby narrowing the gap between idealized systems and real-world applications.

To achieve this, numerical simulations will be performed for two representative composite configurations: **(i)** suspensions of microencapsulated PCMs, and **(ii)** PCM-saturated porous solid matrices.

For microencapsulated PCM suspensions, the focus will be on how heat transfer evolves with particle concentration, including the effects of particle migration caused by density differences, as well as the influence of natural convection on the flow dynamics and thermal behavior of the whole system. For porous media composites, the focus will be the study of how the geometry and thermophysical properties of the solid matrix, together with different heat transfer mechanisms, influence local melting dynamics and overall melting rates.

Both research lines will benefit from experimental data obtained in our laboratory on similar system configurations. These data will serve to validate the numerical models, which will then be used to perform parametric studies and extend the analysis to a wider range of conditions.

In summary, this project aims to numerically model heat and momentum transport as well as phase change dynamics in two types of PCM composites: microencapsulated PCM suspensions and PCM-saturated porous media. The expected outcomes include a detailed characterization of the mechanisms that govern system behavior and a deeper understanding of the physical processes that control phase change and thermal transport in such complex systems.

**Applicants expected backgrounds:**

Strong skills in numerical modelling, fluid mechanics, thermal sciences, phase change materials.

A good proficiency in English, both written and oral, is required.

***Contacts:***

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## TERMS AND TENURE

This one-year position will be based at the lab. ***LEMTA*** (Nancy, FR).

The target start date for the position is ***October 2025,*** with some flexibility on the exact start date.

## HOW TO APPLY

Applicants are requested to submit the following materials:

- A cover letter
- Full CV and list of publications
- Academic transcripts (unofficial versions are fine)

Deadline for application is **21/07/*2025***. Applicants will be interviewed by an Ad Hoc Commission before end of July 2025.

Applications are only accepted through email. All document must be sent to christel.metivier@univ-lorraine.fr and nicolo.sgreva@univ-lorraine.fr

## JOB LOCATION

Lab. LEMTA (Nancy, Lorraine, France)

## REQUIREMENTS

DOCUMENTS

- Curriculum Vitae - Your most recently updated C.V. including list of publications
- Cover Letter