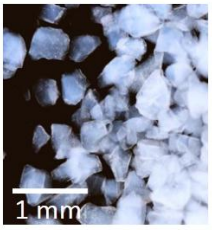
PhD offer

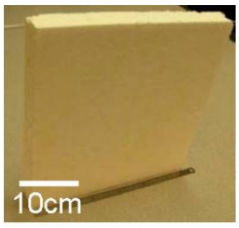
Silica aerogel based thermal super-insulation panels: mechanical properties optimization

Exceptional properties of silica aerogel

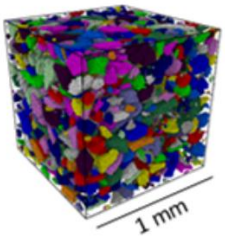


Aerogel particles

+ Binder Fibres →



Super-insulation panel



DEM model of a packing of aerogel particles

Mechanical testing of a porous brittle material

Context

As new regulations for energy efficiency are strengthening in the building sector, the required thickness for insulation with conventional materials (glass wool, polymeric foams…) may become prohibitive. This is a strong driving force for the development of a new class of products, the Super-Insulation at Atmospheric Pressure (SIAP) materials, based on the use of silica aerogel. Silica aerogels offer unprecedented low thermal conductivities thanks to their very high nanoporosity (~ 95%). However, they also exhibit very low mechanical properties. In France, EDF and ENERSENS develop SIAPs from silica aerogel particles (100µm to a few mm) industrially produced by ENERSENS. In past years, research has mainly focused on material synthesis and thermal properties, and there is a lack of knowledge on the mechanical behavior of aerogel particles and their composites.

In the framework of a regional collaborative project between SIMaP and MATeB (MATEIS + EDF) Labs, ENERSENS, and CSTB, the PhD thesis will focus on the study of composite SIAP panels to improve the mechanical properties / thermal properties compromise.

In particular, the influence of the architecture of the composite panel such as the particle packing density, the particle morphology, the particle size distribution or the addition of other elements (opacifier, binder, fibres) will be addressed. A combined numerical/experimental approach is anticipated, using the Discrete Element Method (DEM) for simulation and mechanical tests in the lab. Materials will be synthetized by ENERSENS and EDF while the mechanical characterization will be performed at MATEIS lab and the DEM simulation at SIMaP lab. Also, in order to reproduce numerically realistic particle morphologies and packing, X-ray tomography characterizations will be used. Thanks to numerical simulation results and existing work on thermal properties an optimal design will be proposed and characterized both thermally and mechanically.

Work program

- X-ray tomography characterization of composite panels and aerogel particles
- Numerical generation of composite panels structures
- Experimental mechanical characterization
- Calibration of DEM contact laws
- DEM numerical simulation to study the influence of architecture on mechanical properties
- Design, fabrication and characterization of an optimized panel

Candidate: Master of Science diploma in the field of mechanics of materials**,** willing to work both on simulation and experimental aspects, taste for collaborative and applied work.

Start: Sept. - Oct. 2018

Localization: SIMaP Lab (Grenoble-INP, Univ. Grenoble Alpes) + travel to MATEIS Lab (Lyon).

PhD advisors:

David Jauffrès, Christophe Martin (SIMaP)
Sylvain Meille (MATEIS)

Salary : 1769€/month (with social benefits, before social taxes); (1472€/month after social taxes)

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