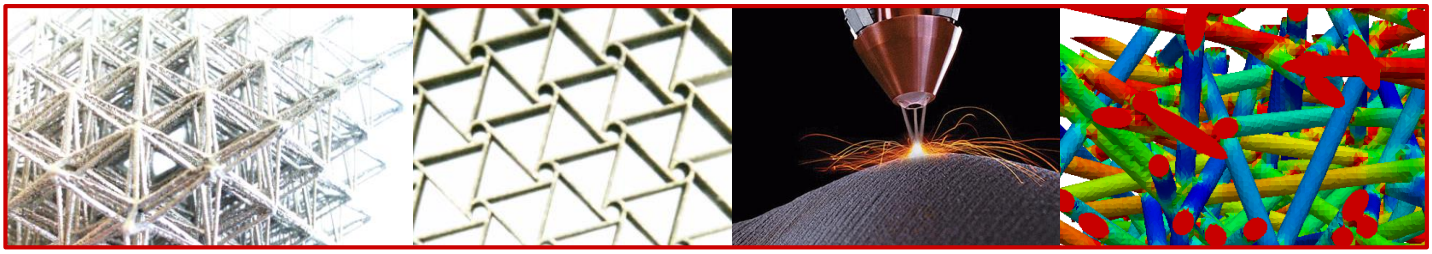
PhD opportunity: Topology optimization of architectured materials obtained by additive manufacturing



Abstract: Architectured materials are an emerging class of advanced materials that bring new possibilities in terms of functional properties, filling gaps in material performance maps [1]. The term architectured materials describes any heterogeneous material that exhibits improved specific properties due to a thoughtful and predetermined morphology and/or topology design. Additive manufacturing has been fostering the development of such materials in recent years.

In the context of the ALMARIS project (ANR funded) aiming at developing additive manufacturing for architectured materials, we intend to investigate lightweight metallic materials with the ability to deform with a large amplitude in the elastic domain.

The concept relies on the conjugate effect of an internal architecture generating structural ensemble effects, such as negative apparent Poisson's ratio (auxetics), as well as the inner constitutive material, a NiTi alloy obtained by additive manufacturing, which is a shape-memory alloy exhibiting superelastic behavior. Applications are focused on the aerospace domain for the structural design of drones, with the perspective of mechanical actuation.

The goal of the present PhD project is to perform topology optimization while taking into account the nonlinear constitutive behavior of additively manufactured NiTi, which seems to be a rather good candidate regarding the defined actuation set of requirements. To do so, finite element analysis will be coupled with a level-set optimization approach. Effective properties for each configuration will be obtained through computational homogenization [2,3]. A finite deformation anisotropic thermo-elastic framework will be adopted in order to account for material and geometric non-linearities of the unit-cell, especially between passive and active states.

Keywords: architectured materials, topology optimization, finite element analysis, additive manufacturing, aerospace engineering.

Background of the candidate: computational methods, engineering, materials science, applied mathematics, physics, or any other relevant field.

Location: Laboratoire PIMM, Arts et Métiers-ParisTech, CNAM, CNRS, 151 bd de l'Hôpital, 75013 Paris, France.

Funding: Fixed-term contract (CNRS), with a salary of ~1450€ net per month, or ~1750€ with teaching duties.

Starting date: ASAP

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References:

[1] O. Bouaziz, Y. Bréchet, J. D. Embury, Advanced Engineering Materials, **10**(1-2), pp. 24-36, 2008.
[2] J. Dirrenberger, S. Forest, D. Jeulin, Computational Materials Science, **64**, pp. 57-61, 2012.
[3] J. Dirrenberger, S. Forest, D. Jeulin, Int. Journal of Mechanics and Materials in Design, **9**, pp. 21-33, 2013.