

Research Topic for the Arts et Métiers ParisTech - CSC PhD Program

Subfield: Mechanical Engineering / Materials Science & Engineering

ParisTech School: Arts et Métiers-ParisTech

Title: Computational design and optimization of architected materials

Advisor(s):

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Short description of possible research topics for a PhD: Architected materials are an emerging class of advanced materials that bring new possibilities in terms of functional and structural properties. Their improved specific properties are due to a thoughtful topological design. In the context of a project aiming at developing additive manufacturing for architected materials, we intend to investigate lightweight materials with the ability to deform with a large amplitude in the elastic domain. The goal of the present project is to perform a parametric study for optimizing the effective (homogenized) behaviour of an auxetic (negative Poisson's ratio) periodic cell, obtained through additive manufacturing, which is also well-studied in the literature, and seems a rather good candidate regarding the set of requirements defined, e.g. crashworthiness, acoustic damping, actuation (cf. Fig.1). Various geometric parameters will be considered in this computational experiment study, using FEA. Effective properties for each configuration will be obtained through computational homogenization. A finite deformation anisotropic thermo-elastic framework will be adopted in order to account for material and geometric non-linearities of the unit-cell.



Fig.1 auxetic actuated wingbox (left) and AM optimized parts (Airbus, right)

Keywords: Architected materials, topology optimization, additive manufacturing, aerospace.

Required background of the student: The candidate should have obtained a Master's degree with a strong background in mechanical engineering, numerical methods or any related field; although prior knowledge of the French language is not mandatory, spoken and written English proficiency is needed. A strong interest for programming and/or scripting is expected from the successful candidate. **The candidate should be keen on computational methods.**

3 representative publications of the group:

Dirrenberger, J., Forest, S., & Jeulin, D. (2012). Elastoplasticity of auxetic materials. *Computational Materials Science*, **64**, 57-61.

Dirrenberger, J., Forest, S., & Jeulin, D. (2013). Effective elastic properties of auxetic microstructures: anisotropy and structural applications. *International Journal of Mechanics and Materials in Design*, **9**(1), 21-33.

Auffray, N., Dirrenberger, J., & Rosi, G. (2015). A complete description of bi-dimensional anisotropic strain-gradient elasticity. *Int. Journal of Solids and Structures*, **69**, 195-206.

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