**Design and optimization of structures and microstructures of multi-phase materials with interface effects using a level set method.**

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**Abstract:** Shape optimization methods are promising methods and are gradually becoming industrialized. They provide the ability to automatically design structures with optimal behavior. They are outstanding tools for exploration and design of new materials.

We use these methods to generate architectured multi-phased materials with prescribed thermoelastic properties. We first propose several solutions and we classify them by the mechanisms they rely on in order to control the effective properties. We also propose to evaluate the influence of an interface with a gradient of properties on the obtained architectures.

Eventually we focus on the plausible manufacturing solution to produce our architectured materials. In this context, additive manufacturing methods (often considered as the support of an incoming industrial revolution) is our main option. We introduce several strategies to circumvent some limitations and side effects of these manufacturing methods during optimization process. We particularly focus on Fiber Deposition Molding, which induce an important mechanical anisotropy in processed parts. Then we consider the problem of overhangings features in design and propose a way to handle them prior to additive manufacturing using a mechanical criteria.

Finally we take into account geometrical non linearities in optimization process. We highlight the pros and cons of this new modeling by presenting several applications of non-linear actuators design.