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Material design with predefined elasticity tensor

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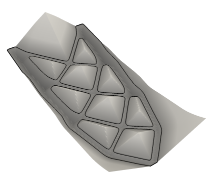
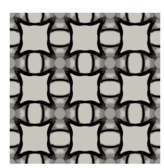
Topological optimization is a key issue to reduce structure weight while preserving suitable mechanical properties. The latest developments of 3D printing techniques make it possible nowadays to design more innovative materials with suitable optimized micro-architectures. For many engineering applications it is critical to master the mechanical behaviour of the material used. Such an objective can be achieved by optimizing the distribution of the matter constituing the material, namely, the micro-architecture.
Using computational homogeneization approaches [1], we compare two methods. The SIMP (Solid Isotropic Material with Penalization) method [2] based on the introduction of a density parameter as the design variable, and the level set method [3] which consists in moving interfaces between material and voids using shape derivative. Based on an initial topology guess the optimization algorithm leads to an optimized cell with predefined consitutive parameters.
Those two optimization methods are intrinsically different as the first one allows the apparition of new holes in the simulation domain whereas the second one only optimize the shape. This step allows the constructions of parametric computational vadamecums of optimized microarchitectures that can be further used [4] in a multi-scale optimization problem, that is, the optimization of both the structure (under given boundary conditions and external loadings) and the micro-architecture.



Structural optimization



Micro-architecture optimization

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