



# Topology optimization for concurrent design of structures with multi-patch microstructures by level sets

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## Abstract

This paper focuses on the novel concurrent design for cellular structures consisting of multiple patches of material microstructures using a level set-based topological shape optimization method. The macro structure is featured with the configuration of a cluster of non-uniformly distributed patches, while each patch hosts a number of identical material microstructures. At macro scale, a discrete element density based approach is presented to generate an overall structural layout involving different groups of discrete element densities. At micro scale, each macro element is regarded as an individual microstructure with a discrete intermediate density. Hence, all the macro elements with the same discrete densities (volume fractions) are represented by a unique microstructure. The representative microstructures corresponding to different density groups are topologically optimized by incorporating the numerical homogenization approach into a parametric level set method. The multiscale concurrent designs are integrated into a uniform optimization procedure, so as to optimize both topologies for the macrostructure and its microstructures, as well as locations of the microstructures in the design space. Numerical examples demonstrate that the proposed method can substantially improve the structural performance with an affordable computation and manufacturing cost.

**Keywords:** Topology optimization; Cellular structures; Multiscale design; Level set method.

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