Microstructural design using stress–based topology optimization

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New additive manufacturing techniques break the limitations encountered for years when producing components descending from topology optimization. Classical design procedures focus on macro-structural optimization to sustain given loads but today innovative manufacturing processes allow considering structures exhibiting tailored microstructures, *i.e.* the well known microstructural design. The practical applications of structures including material design is mainly motivated by the greater performances that can be achieved compared to classical solutions.

Microstructural design has been shown a great interest as attested by recent works[1, 2]. However, stress–based topology optimization has not yet been extensively exploited when addressing microstructural design using numerical homogenization though stress constraints is an important feature and have gained in interest in the field of topology optimization as pointed out by [3].This contribution investigates the problem of material design enforcing stress constraints within periodic microstructures by considering a representative volume element (RVE) subject to prescribed strain fields.

The SIMP approach is adopted as material interpolation law while the optimization problems are solved using a sequential convex programming approach. In particular the well known method of moving asymptotes (MMA) is considered. Numerical homogenization is used to assess the effective elastic properties of the microstructures. The Von Mises stress criterion is used to impose the constraints on the stress level. This work discusses the formulation of a well-posed design problem as well as some numerical issues encountered. The developed solution procedure is first validated by comparison against analytical results, *e.g.* the single inclusion of Vigdergauz microstructure. Finally the optimized layouts are fabricated using a multimaterial inkjet polymer printing (Connex by Stratasys) to test the actual performances of optimized designs.

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