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Topology optimization of coated structures and material interface problems

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Abstract

This paper presents a novel method for including coated structures and prescribed material interface properties into the minimum compliance topology optimization problem. Several elements of the method are applicable to a broader range of interface problems. The approach extends the standard SIMP method by including the normalized norm of the spatial gradient of the design field into the material interpolation function, enforcing coating material at interfaces by attributing particular properties. The length scales of the base structure and the coating are separated by introducing a two-step filtering/projection approach. The modeled coating thickness is derived analytically, and the coating is shown to be accurately controlled and applied in a highly uniform manner over the structure. An alternative interpretation of the model is to perform single-material design for additive manufacturing. Infill is assumed to be constituted of an isotropic porous microstructure satisfying the Hashin-Shtrikman bounds and is modeled using the homogenized material properties. A range of numerical results illustrate the effectiveness of the approach.

Keywords: Topology optimization, Coating, Interface representation, Two-step filtering, Additive manufacturing

1. Introduction

The objective of this study is to design coated structures by topology optimization. Metal coating of polymer structures is commonly used to enhance functional

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