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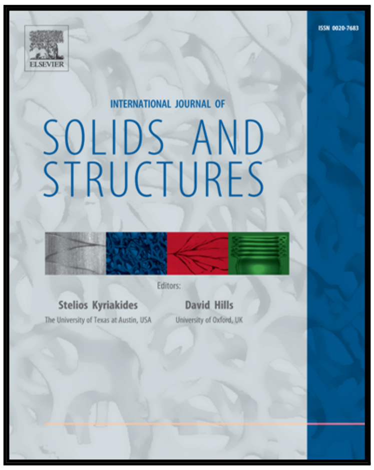

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Computationally-Efficient Modeling of Inelastic Single Crystal Responses via Anisotropic Yield Surfaces: Applications to Shape Memory Alloys

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Abstract

Phenomenological constitutive models of inelastic responses based on the methods of classical plasticity provide several advantages, especially in terms of computational efficiency. For this reason, they are attractive for the analysis of complex boundary value problems comprising large computational domains. However, for the analysis of problems dominated by single crystal behavior (e.g., inclusion, granular interaction problems or inter-granular fracture), such approaches are often limited by the symmetry assumptions inherent in the stress invariants used to form yield-type criteria. On the other hand, the high computational effort associated with micro-mechanical or crystal plasticity-type models usually prevents their use in large structural simulations, multi-scale analyses, or design and property optimization computations. The goal of the present work is to establish a modeling strategy that captures micro-scale single-crystalline sma responses with sufficient fidelity at the computational cost of a phenomenological macro-scale model. Its central idea is to employ an anisotropic transformation yield criterion with sufficiently rich symmetry class—which can directly be adopted from the literature on plasticity theory—at the *single crystal level*. This approach is conceptually fundamentally different from the common use of anisotropic yield functions to capture tension-compression asymmetry and texture-induced anisotropy in polycrystalline SMAs. In our model, the required anisotropy parameters are calibrated either

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