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The Nature of Stress and Strain Fields in Shape Memory Polycrystals

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Predicting the recoverable strains of shape memory polycrystals is a central open problem in the study of shape memory alloys. This in turn requires an understanding of the possible stress and strain fields that arise in such polycrystals. We show that for polycrystals made of materials undergoing cubic-tetragonal transformations the strains fields associated with macroscopic recoverable strains are related to the solutions of hyperbolic partial differential equations. We explore consequences of this relationship and connections to previous conjectures characterizing those polycrytals with non-trivial recoverable strain. We also show that stress fields in such polycrystals could be concentrated on lower-dimensional surfaces (planes and lines). We do this by proving a dual variational characterization of the recoverable strains of shape memory polycrystals and presenting several examples. Implications of this characterization for effective properties and the development of numerical methods are discussed.

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