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NONLINEAR FINITE ELEMENT MODELING OF CRYSTALLINE MICROSTRUCTURAL PROPERTIES WITH APPLICATION TO ALUMINUM ALLOYS FOR MODERN ARMORS

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ABSTRACT

Often, large plastic deformation in polycrystals is influenced by the slip and its gradients, which arise at the length scales of microstructural heterogeneities, and in particular grain boundaries. In this work a non-local multiple-slip crystal plasticity formulation, i.e. augmented with gradients, is presented and applied to polycrystalline aluminum aggregates. Physically based dislocation-density mechanisms representative of different slip interactions coupled to plastic curvature have been formulated within the gradient-crystal plasticity framework. Specialized finite element methodologies that account for higher-order deformation are also presented and used to investigate how certain dislocation-density activities at grain boundaries are directly related to shear strain localization for polycrystalline aggregates which lead to damage tolerant armor alloys.

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