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Ductility limit predictions for porous materials using a damage coupled CPFEM approach

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Accurate predictions of ductility limits play a crucial role in product design and manufacturing, offering substantial cost reductions in development. In this investigation, attention is focused on the prediction of ductility limits for porous materials. Unlike previous contributions [1,2], we integrate a microscopic damage model based on thermodynamics into the crystal plasticity finite element method (CPFEM) framework in the current study. In this regard, Representative Volume Elements (RVEs) are selected to represent the porous materials at the macroscopic level and an ABAQUS Voronoi Toolbox is developed to generate these RVEs. The macroscopic behavior of these RVEs is determined from that of the constituent single crystals using the periodic homogenization multiscale scheme [1,2,3]. At the single crystal scale, the constitutive equations follow a finite strain rate-independent framework, where the damage variables are defined for each individual slip system. The plastic flow rule is governed by the classical Schmid law. The proposed model is applied to predict the ductility limits for porous materials using the Rice bifurcation criterion. The results show that the damage coupled CPFEM approach accurately predicts the ductility limits, offering valuable tools for optimizing the mechanical properties of advanced materials.

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