A homogenized model for size-effects in porous metals

A simple method for enriching conventional homogenized porous plasticity models with size-dependence for micron scale voids is proposed. A recent strain gradient plasticity theory with dissipative gradient effects is generalized to finite strains in order to quantify size-scale effects on void growth under different loading conditions. Based on numerical cell model studies for regularly distributed voids, the size-dependence of homogenized yield surfaces is quantified in terms of effective stress and mean stress. It is proposed to account for void size effects by two simple extensions to conventional models. One is the establishment of a new size-dependent effective void volume fraction smaller than the physical one. The other is the introduction of a size-dependent reduction of the influence of the mean stress. The results obtained are based on numerical unit cell calculations, but it is conjectured that they may be used for any isotropic yield surface for porous metals that includes explicit dependence on porosity and mean stress.

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