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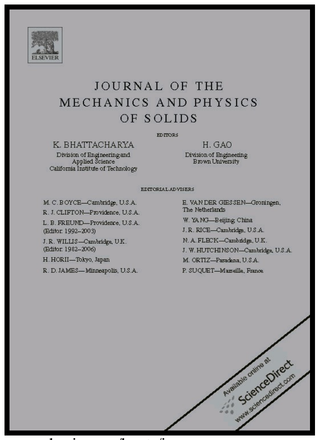

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Abstract

We present a discrete dislocation plasticity (DDP) framework to analyse the high temperature deformation of multi-phase materials (composites) comprising a matrix and inclusions. Deformation of the phases is by climb-assisted glide of the dislocations while the particles can also deform due to stress-driven interfacial diffusion. The general framework is used to analyse the uniaxial tensile deformation of a composite comprising elastic particles with dislocation plasticity only present in the matrix phase. When dislocation motion is restricted to only glide within the matrix a strong size effect of the composite strength is predicted with the strength increasing with decreasing unit cell size due to dislocations forming pile-ups against the matrix/particle interface. Interfacial diffusion decreases the composite strength as it enhances the elongation of the elastic particles along the loading direction. When dislocation motion occurs by climb-assisted glide within the matrix the size effect of the strength is reduced as dislocations no longer arrange high energy pile-up structures but rather form lower energy dislocation cell networks. While interfacial diffusion again reduces the composite strength, in contrast to continuum plasticity predictions, the elongation of the particles is almost independent of the interfacial diffusion constant. Rather, in DDP the reduction in composite strength due to interfacial diffusion is a result of changes in the dislocation structures within the matrix and the associated enhanced dislocation climb rates in the matrix.

Keywords: High temperature composites, Discrete dislocation plasticity, Interfacial diffusion, Plastic deformation

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