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How the viscosity and diffusivity of interfaces influence crystallite rotation rates under Coble creep

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Abstract

Inside both metallic alloys and rocks, the interfaces (or "boundaries") between adjacent crystallites (or "grains") may, under certain conditions, host most of, if not all, the microscopic deformation field. Rashinger grain boundary (GB) sliding refers to situations where the polycrystal deforms thanks to the relative motion of the constitutive grains, which preserve their shapes. Under Coble creep, if crystallites are free of any intragranular deformation process, e.g. no dislocation glide, the mismatch of velocities across the crystallite interfaces is accommodated by the diffusion of lattice species along the interfaces. A numerical model is proposed to investigate how the macroscopic viscosity and the statistics of crystallite rotation rates are influenced by microstructural parameters such as average grain shape, topological randomness and porosity. The micromechanical response is determined by the relative contributions of GB sliding and diffusion to the macroscopic strain rate, which in turn depends on how the threshold shear stress and the viscosity opposing GB sliding relate to the diffusivity along the interfaces. The opportunity to account for topological updates is discussed.

Keywords:

creep diffusion grain boundary sliding