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Identification of wavelengths of strain heterogeneities during creep deformation in Carrara Marble

Alejandra Quintanilla-Terminel and Brian Evans
EAPS, MIT, Cambridge, United States (alequte@mit.edu)

We use a new technique combining microfabrication technology and compression tests to map the strain field at a micrometric scale in polycrystalline materials. The motivation of such high-resolution mapping is to identify characteristic wavelengths of heterogeneities for different plasticity mechanisms under varying creep conditions. The micro-strain mapping technique was applied to Carrara Marble under different deformation regimes, at a confining pressure of 300 MPa and temperatures ranging from 200 to 700 °C. In samples deformed to 10% strain in compression at 400°C, 500°C and 600°C, at a 3x10^{-5} s^{-1} strain rate, strain can be up to 5 times greater along twins and grain boundaries compared to the macroscopic strain accommodated over the entire sample. Strain averaged across a particular grain may vary by as much as 100%. Moreover, there is a gradual but clear change in the accommodation of strain, from twins to grain boundaries as temperature increases. For a fixed temperature of 600°C, varying strain from 10% to 30% does not appear to increase the wavelength of heterogeneities (i.e. the strain field does not homogenize). Macroscopically, strain hardening is minimal and there seems to be a constant generation of perturbations of similar wavelength.