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An experimental study of the polycrystalline plasticity of austenitic stainless steel

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Abstract

The development and validation of crystal plasticity models requires the ability to map deformation at the microstructural scale. Here, a new method of high-resolution deformation mapping is used to measure strain, material rotation and lattice rotation in austenitic stainless steel at sub-micron resolution. Electron back-scatter diffraction maps are used to link the deformation to the microstructure. Deformation occurs in domains, in which most of the plastic strain originates from the activation of a single slip system with high resolved shear stress. Within domains, slip is localized in lamellar regions that increase in number with strain. The deformation incompatibility between grains that develops as a consequence of this single crystal like behaviour is accommodated by either a gradient in slip intensity and the consequent development of lattice curvature at the grain boundary or the activation of an additional high stressed slip system and the consequent formation of a complementary deformation domain within the grain. In many cases, however, lattice curvature across grain boundaries is small because the deformation domains in neighbouring grains are