VPSC for texture and microstructure-sensitive constitutive modeling for polycrystals comprised of crystals that deform by both slip and twinning.

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The Visco Plastic Self Consistent (VPSC) model is a computer code written in FORTRAN 77 which simulates the plastic deformation of polycrystalline aggregates by Lebensohn and Tomé (Acta Mater. 1993). It was developed for application to low-symmetry materials (hexagonal, trigonal, orthorhombic, trigonal), although it also performs well on cubic materials. The simulation procedure can be applied to deformation of metals, intermetallics and geological aggregates.

VPSC accounts for full anisotropy in properties and response of the single crystals and the aggregate. It simulates the plastic deformation of aggregates subjected to external strains and stresses based on the physical shear mechanisms of slip and twinning, and accounts for grain interaction effects. VPSC can also predict the evolution of hardening and texture evolution, since it accounts for hardening, reorientation and shape change of individual grains. Another benefit of VPSC is that it can predict the active slip and twinning systems and their relative contributions in each crystal and at each moment in time or at strain level while obtaining the same microscopic information on slip and twinning activity via experiment is challenging.

The VPSC model treats the polycrystal as a set of grains each with a distinct volume fraction. Each grain is regarded as a visco-plastic inclusion embedded in, and interacting with, a "homogeneous effective medium" (HEM), which has the average properties of the aggregate. The macroscopic response of the polycrystal results from the contribution of each grain. Individual grain deformation takes place by slip and twinning, and depends on grain orientation, grain shape, and grain interaction with the surrounding homogeneous medium. The visco-plastic compliance of the HEM is given by a self-consistent condition applied on the grain averages. Comparing the texture and hardening evolution, which are updated incrementally during the simulation, comparisons with the mechanical test data and EBSD evidence enable indirect inference of the characteristics of the slip–slip and twin–slip interactions.

A few more important remarks:

1. A reliable set of hardening parameters as input is necessary for the prediction. It is best found by identifying a single set of parameters that can capture a large suite of stress-strain, microstructural and texture evolution data obtained from distinctly different mechanical tests (e.g., distinct loading orientations, temperature, strain rate, strain path changes).

2. Variations in the characterized material parameters for the activation of slip and twinning, even for the same material and the same suite of experimental data, is common due to the differences in the homogenization scheme, twin-reorientation scheme, and hardening laws can lead to.

3. When compiling VPSC, always use the double precision option