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Effect of strain rate sensitivity in visco-plastic modeling

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Abstract

Many crystal plasticity models use a rate sensitive law for its convenience. The rate sensitivity can be determined experimentally and input in the models. From a numerical point of view, high values of the strain rate sensitivity parameter m favor easy convergence of these models, but when m is fixed arbitrarily, which is in practice done for slightly rate sensitive materials, the physical meaning of m is lost. The present study shows that the flow stress σ , slip systems activity γ^s , strain anisotropy and simulated texture are strongly dependent on m . Precautions should be taken when predicting the mechanical behavior of polycrystals. To simulate nearly rate insensitive materials with models using a rate sensitive law, the use of the reference shear strain $\dot{\gamma}_0$ equal to the imposed strain rate is necessary but not sufficient. It is also necessary to use a high strain rate sensitivity parameter ($m=0.05$) to correctly evaluate the material parameters, i.e., the critical resolved shear stresses (CRSS). This study also provides a relationship between the CRSS determined for different values of strain rate $\dot{\epsilon}$, m and $\dot{\gamma}_0$, so that CRSS determined in different studies can be compared.

Keywords: crystal plasticity; viscoplastic material.

Introduction

Strain rate sensitivity (SRS) is a material property that can be measured experimentally by different techniques. The strain rate sensitivity parameter m is defined by equation (1.1), in

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