Numerical investigation of void growth with respect to lattice orientation in bcc single crystal structure

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ABSTRACT

Failure of ductile metals has widely been observed to occur by nucleation, growth and coalescence of voids [1]. Plastic anisotropy has a key importance on the growth and strain distribution leading to coalescence of the voids in addition to the stress state [2,3]. In this study, growth of pre-existing voids in bcc single crystals were investigated by using rate independent crystal plasticity framework. Deformation of bcc crystal structure was modeled by using two different approaches, namely, with 24 potential slip systems of $\{110\}<111>$ and $\{112\}<111>$ types and with non-Schmid effects on $\{110\}<111>$ slip system and the resultant deformation was compared with respect to each other [4,5]. Finite element simulations were conducted based on 2D plane strain calculations of a unit cell with one cylindrical void. Fully periodic boundary conditions were employed during the deformation of the unit cell under uniaxial and biaxial loading conditions. Unit cell with one hole was used to investigate the effect of lattice orientation on the growth and shape change of the voids. It was observed that the lattice orientation had an immense effect on the distribution of strain within the unit cell. Furthermore, various hole sizes were used to model the effect of inter-void spacing in order to investigate strain distribution between voids, which may lead to coalescence and failure.

REFERENCES