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论文

多晶Cu在双向加载下的后继屈服与塑性流动分析

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摘要:

采用晶体塑性理论并结合多晶集合体模型来研究多晶Cu的塑性变形, 用双向加载方式模拟材料的双向应力状态和分段加载路径, 得到了材料的初始屈服面及在预剪切和预拉伸2种情况下的后继屈服面. 通过对后继屈服面形状及其演化趋势的研究, 探讨了用晶体塑性理论分析多晶材料塑性流动规律的方法. 结果表明: 后继屈服面的形状和是否出现尖角与屈服点的定义有关, 同时还与π平面上的预加载方向有关; 通过对多晶集合体代表性单元的塑性流动方向与后继屈服面法向的差异进行统计分析, 发现塑性流动的正交性不仅与屈服定义相关, 也与预加载方向有关.

关键词: 多晶Cu 晶体塑性 后继屈服面 塑性流动 有限元模拟

SUBSEQUENT YIELD AND PLASTIC FLOW ANALYSIS OF POLYCRYSTALLINE COPPER UNDER BIAXIAL LOADING

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Abstract:

The yield characteristic and the plastic flow direction of a polycrystal copper are investigated, in which the anisotropy and random orientation of each grain in the polycrystal are taken into account, while the microstructure evolvement and the slip deformation mechanism are also analyzed. Applying the crystal plasticity theory associated with representative volume element (RVE) of a polycrystal aggregate, which consists of 200 polyhedral grains with irregular shape and orientation, the plastic deformation of polycrystalline copper is calculated through applying biaxial load along different paths to the RVE aggregate, stage by stage to simulate the material's biaxial stress state and the sub-stage load path. Then the yield surface and the subsequent yield surface for the RVE under preloading are obtained by the simulation through FEM calculation with the user crystalline material subroutine. The calculation results of the subsequent yield surface shape and the plastic flow direction are resolved and are discussed further. According to the results of yield surface and plastic flow direction of the polycrystal RVE, it can be concluded that the corner may appear on the subsequent yield surface at the preload point and the corner's appearance is dependent on the yield definition and the preload direction on the π plane; the classical normality description for plastic flow is proved to be reasonable for the polycrystal aggregate but there is a difference between the flow direction and the surface normal vector, which is analyzed by statistical calculation, and the statistical difference between the plastic flow direction and the normal vector of subsequent yield surface is related with both the yield definition and direction of preloading.

Keywords: polycrystal copper crystal plasticity subsequent yield surface plastic flow finite element simulation

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