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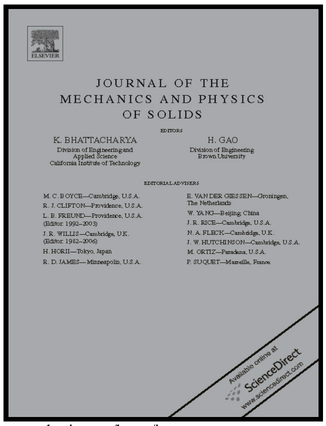

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Intra-grain orientation distributions in hot-deformed aluminium: Orientation dependence and relation to deformation mechanisms

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Abstract

The development of intra-grain orientation distributions is analysed for 92 individual grains of an aluminium polycrystal deformed in plane strain compression at 400 °C to an effective strain of $\varepsilon = 1.2$. Orientations of the crystallographic lattice were measured by using a microtexture tracking technique that combines deforming a split sample with collecting electron backscattering diffraction (EBSD) data on the internal surface at successively greater strains. In these experiments, more than 1000 orientations were taken within each of the grains at strains 0.19, 0.42, 0.77 and 1.2, as well as in the initial, undeformed state. A high-resolution finite element simulation (1000 elements per grain on average) was conducted on a polycrystal whose grains were assigned the experimental orientations. Attributes of the orientation distributions were extracted from both the experimental and simulation data, including the average disorientation angles and the preferential disorientation axes. For both experiment and simulation, the average disorientation angles were found to increase up to $\varepsilon = 0.5$ and then to saturate to values of 7–8°. It is shown that the preferential disorientation axes are distributed about the transverse direction (TD) up to $\varepsilon = 0.5$ and then migrate at large strains to directions between the rolling (extension) direction (RD) and the normal (compression) direction (ND). Detailed crystal plasticity analyses show that the distribution of preferential disorientation axes is related to two mechanisms: (i) the development of anisotropy in the orientation distributions due to the accentuated activity of particular slip systems from stress heterogeneities and (ii) the peak-shifting transformation of the distribution arising from gradients of the reorientation velocity field imposed by the deformation.

Key words: Microtexture, Crystal plasticity, EBSD, Finite element method, Aluminium

1. Introduction

The intra-grain orientation distributions that develop in plastically deformed polycrystals have a significant influence on both mechanical strength [1] and subsequent softening phenomena during annealing, e.g. recrystallization nucleation [2]. The distributions can also provide important information on local deformation mechanisms, as the orientation spreading is directly related to

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