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Deformation-induced dislocation microstructures have been the subject of research for several decades. Typical dislocation microstructures in fcc and bcc metals of medium- to - high stacking fault energy deformed to low and intermediate strains consist of two classes of dislocation boundaries: extended planar dislocation boundaries and cell boundaries. The extended planar dislocation boundaries group cells into blocks deforming with different slip activities and therefore they are termed geometrically necessary boundaries (GNBs). The cell boundaries separate cells formed within the cell blocks and are termed incidental dislocation boundaries (IDBs) since they form as a result of mutual trapping of glide dislocations.

A systematic study has been carried out with an aim to establish the relationships between the grain orientation, slip system and the dislocation microstructure [1,2]. Aluminium and copper samples have been deformed up to medium strains by two deformation modes, namely tension and rolling, which span a wide range of grain orientations. Morphological observations and determination of the crystallographic planes of the GNBs have been made using transmission electron microscopy. The results obtained have led to the establishment of a universal pattern of structural evolution that is characterized by the formation of three microstructural types and to a firm conclusion that the grain orientation is a controlling parameter for the structural evolution. The universal patterning and the grain orientation dependence of the structural evolution in particular the crystallographic plane of the GNBs have been further analyzed in terms of the active slip systems predicted from the grain orientation and the macroscopic deformation mode, which has resulted in the establishment of an interrelation between the grain orientation, slip system and microstructural types.

References:

[1] X. Huang and G. Winther, Phil. Mag. (2007) 83 , 5189-5214.

[2] G. Winther and X. Huang, Phil. Mag. (2007) 83 , 5215-5235.