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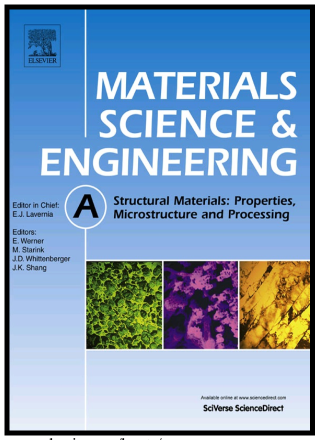

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Microtexture Analysis of Restoration Mechanisms during High Pressure Torsion of Pure Nickel

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Abstract

The grain refinement in severe plastically deformed pure metals is limited to few 100 nm and the saturated microstructure primarily depends on deformation temperature and impurities. In present study high pressure torsion (HPT) technique is used for understanding the mechanism of microstructure restoration processes at saturation state for 99.99% pure nickel between 77– 673 K. The saturation grain size increased with deformation temperature. Electron back scatter diffraction (EBSD) measurements along with microtexture evaluation show that the grain boundary (GB) misorientation distribution remains similar for all the temperatures; however, new texture components and special GB characteristics start to develop at higher temperatures. The differences in the GB migration characteristics and the resulting microtexture changes suggest that at low temperatures GB migration is facilitated by the variations in elastic strain energy density among neighboring grains; however, with increasing temperature thermally driven migration processes induced by plastic stored energy become important.

Keywords: High Pressure Torsion, EBSD, Hardness, Microtexture, Grain boundary migration, steady state

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1. Introduction

Severe plastic deformation (SPD) techniques have been widely used for synthesizing bulk high purity nanocrystalline (nc) or ultrafine grained (ufg) metals and alloys [1-3]. From the popular SPD techniques such as equal channel angular extrusion (ECAE) [4], high pressure torsion (HPT) [5, 6], accumulative roll bonding (ARB) [7, 8] and their variants [9, 10], HPT provides an unique advantage of largest possible deformation in a fairly simple manner. Moreover, the use of high pressure could enable processing of less ductile materials such as tungsten at low homologus temperatures [11].

The detailed microstructural characterization of SPD deformed materials have shown that refinement of grains occurs progressively by formation of dislocation cells, cell blocks or micro shear bands inside primary grains [12-15]. At low strains the dislocations inside a grain arrange themselves in a cellular structure with low misorientations. As the deformation of a grain is constrained by its neighbors, different sets of slip systems are activated to achieve strain compatibilty. With increasing strain, the grains are divided in several groups of cells separated by geometrically necessary dislocations. The relative size of these cellular groups

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