MECHANISMS CONTROLLING FORMATION OF THE ULTRA-FINE MICROSTRUCTURE IN SEVERELY DEFORMED MATERIALS

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Severe plastic deformation is one of the most effective methods of preparation of ultra-fine-structured materials with an extraordinary combination of high strength and high ductility. The microstructure of these materials consists of sub-micrometer regions of misoriented crystal lattice. It is proposed that formation of the regions is a result of a tendency to decrease the internal energy opposed by a rearrangement of crystal lattice defects. The model of the structuralization process is formulated as an energy minimization problem.

Key words: *microstructure, severe plastic deformation, internal energy*

1. Introduction

In the last decade, severe plastic deformation (SPD) processing is getting established as the innovative technique for producing bulk ultra-fine structured materials. These materials are viewed as an advanced next generation of metals and alloys. Any plastic deformation induced by conventional forming methods such as rolling, drawing or extrusion can significantly increase the strength of metals. However, this increase is usually accompanied by a loss of ductility. On the other hand, the intense plastic straining under high imposed pressure of several GPa can produce ultra-fine-grained materials of unique physical and mechanical properties. Investigation of the extraordinary strength and ductility of SPD materials is of fundamental as well as practical importance. To encourage wide applications of these materials, it is necessary to further explore efficient manufacturing techniques, conduct theoretical modelling of manufacturing process, and investigate the relationship between microstructure and materials performance [1, 2].

Prominent among the SPD techniques are high-pressure torsion and equal-channel angular pressing. The high pressure torsion has been successfully applied for microstructure refinement in metals, alloys and recently also in metal matrix composites. The important advantage of the high pressure torsion technique is the possibility to adjust accumulative strain, applied pressure and deformation speed. However, since samples, produced by this technique, are small-size, the topical problem is enlargement of their size. Another problem is an increase in the samples microstructure homogeneity.

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