SEVERE PLASTIC DEFORMATION (SPD), A TOP-DOWN METHOD FOR PRODUCING NANOMATERIALS

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Abstract

It is now established that materials with ultrafine grain (UFG) microstructures may be fabricated using two different approaches which are generally termed the ‘‘bottom-up” and ‘‘top-down” procedures. Processing by severe plastic deformation (SPD), as a ‘‘top-down” approach, is defined as those metal forming procedures in which a very high strain is imposed on a bulk solid without the introduction of any significant change in the overall dimensions of the solid and leading to the production of exceptional grain refinement. The processing of metals through the application of severe plastic deformation (SPD) has become important in materials research over the last twenty years. This interest has arisen because SPD processing provides an opportunity for refining the grains of conventional bulk solids to produce grain sizes within the submicrometer (100 nm-1.0 μm) or even the nanometer (<100 nm) range. Since many of the fundamental characteristics of polycrystalline materials are dependent upon the grain size, SPD processing has the capability of producing materials having unusual and attractive properties. For example, it is anticipated that materials having very small grain sizes will exhibit high strength and, if these ultrafine grains are reasonably stable at elevated temperatures, it should be possible to achieve an excellent superplastic forming capability.
Among various SPD processes, Equal Channel Angular Pressing (ECAP), High pressure Torsion (HPT) and Accumulated Roll Bonding (ARB) have been widely used for a large range of metals and alloys. In the present work, we present an overview of the most used methods of severe plastic deformation, with the objective of assessing recent advances in the production of bulk nanomaterials. In order to examine the potential for using ECAP to refine the grain size and improve the mechanical properties, the commercial 5754 Al alloy, was selected for study. It has been found that processing by ECAP through up to 7 passes in the ECAP die, gives a reduction in the grain size and an increase in the microhardness of the alloy, and in the 0.2% proof stress by a factor of three times.

Keywords: *Nanostructured materials, Severe Plastic Deformation, Equal Channel Angular Pressing (ECAP), Mechanical properties*