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Abstracts of the 12th International Conference on Ultrafine Grained Structures, August 2012, Shanghai, China

Published online 11 August 2012; accepted 20 October 2012

Introduction

Ultrafine-grained (UFG) materials are characterized by grain sizes and grain boundary spacings below the conventional range. In most cases, the mechanical characteristics of these new grains and microstructures are different from those of the original materials. UFG materials have many technological applications, but the understanding of their mechanical properties they are required are mostly empirical in nature and highly dependent on processing.

During the past few years, much progress has been made in the development of techniques to enhance UFG materials in many ways. The first technique involves 'bottom-up' synthesis, in which atoms, molecules and molecules participate to build up the structure of the material. The second is a 'top-down' process in which large grains are broken down into smaller grains. During the first approach, the mechanical properties of the materials are refined by controlling the growth of the grains through heavy strain rate processing. The latter approach involves the refinement of the grains.

UFG materials are currently in high demand for many applications and under research to make a better understanding of UFG mechanical behaviour.

At present, the most frequently studied UFG materials are aluminium, titanium, zirconium and copper alloys, the latter being the most ductile. UFG copper (UFG-Cu) is obtained from CG copper (CG-Cu), with the face-centred cubic (FCC) crystal structure of the latter retained through the use of a variety of different techniques. The main properties of these are electro-deposition, mechanical alloying and severe plastic deformation (SPD) techniques. The first class includes the equal channel angular pressing (ECAP) method, which involves the cold refinement of the grain structure obtained via repeated passage of a material (after through an angular die). As illustrated in Figure 1, the CG-Cu obtained from an increasing number of SPD passages presents a structure composed of fine and coarse grains but of a medium size that is greatly reduced with respect to that of the original CG-Cu. The process can also increase material tensile strength four-fold, with no damage to the ductility.

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