

Study on nano grain microstructure control of metallic materials by severe plastic deformation

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The purposes of this study are to clarify the nano grain formation mechanism for microstructure control and various properties of the sintering compacts of these nano grain powders. Grain refinement on metallic materials enables to obtain high strength and high toughness, and, severe plastic deformation (SPD) methods are particularly used to form ultrafine grain structure (sub-micro meter). In this method, minimum grain size depends on processing conditions, which are strain value, strain rate and etc.. In this study, we will discuss the grain refinement of metallic powder processed by SPD, mechanical milling method. The process temperature is important factor for grain refinement process, and low temperature deformation suppress the dynamic recovery of dislocation structure and further grain refinement. We used two methods for low temperature SPD (under 0.1 of melting temperature) as follows: ① Relative low temperature method: material with high melting temperature is processed by SPD at room temperature. ② Absolute low temperature method: materials are processed by SPD at liquid nitrogen temperature.

This paper is comprised of 6 chapters. Chapter 1 describes the background, studies on properties of nano grain materials and grain refinement process. Chapter 2 summarizes details of various important studies on mechanical milling (MM), and the point of this study on MM process. In chapter 3, the nano grain formation mechanism of tungsten processed by SPD is described as the study of above ① method. Chapter 4 shows sinterability and thermal, mechanical properties of nano grain tungsten formed by the same method as chapter 3. Chapter 5 describes observations of microstructure of several pure metal processed by SPD at cryogenic temperature (liquid nitrogen temperature), and discussion of the effects of processing temperature and material properties on grain refinement mechanism by SPD methods. This methods is the study corresponding to above ② method. Chapter 6, which is final chapter, summarizes the results of this study.