Advanced Materials Processing

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BACKGROUND

Materials with a grain size smaller than one micron, and larger than a nanometer, are known as ultra-fine grained materials. Ultra-fine grained materials are attracting considerable amounts of interest primarily due to their superior properties in strength, ductility, formability, fatigue, and wear resistance. Following the Hall-Petch relationship, as the material's grain size decreases, its strength increases. Therefore, by reducing the grain size of a material below one micron, the strength of the material will be maximized. Ultra-fine grained materials also have superplastic forming capabilities at high strain rates, which makes the strong material much easier to machine. In the 1980's, bulk ultra-fine grained materials were prepared by a variety of techniques including inert gas condensation, high energy ball milling, and sliding wear. However due to the difficulty of mass producing the ultra-fine grained materials with these techniques, sever plastic deformation methods such as high-pressure torsion, cyclic extrusion compression, and equal channel angular processing (ECAP) were developed.

TECHNOLOGY DESCRIPTION

University researchers have developed a method called In Situ Variable Equal Channel Angular Pressing (VECAP) - a system and method for producing ultra-fine grain and nanocrystalline materials with a desired gradient in microstructure. Conventional ECAP has involved the use of an extrusion die with a fixed angle that is typically in the range of 140 to 90 degrees. The present invention involves a die system in which this angle is varied during the extrusion process and possibly between extrusion passes. The major benefits are: (1) unique ability to produce materials with extremely low porosity at relatively low temperatures with a gradient in grain size that can fall within nanoscale dimensions; (2) unique ability to initiate the ECAP process at relatively low ram stress using a high die angle and then continuing the extrusion with a desired lower angle; and (3) rapid adjustment of the die angle between extrusion passes without the need for and cost of fabricating a different die for each potentially useful die angle.

APPLICATIONS

This invention can be used to produce relatively low cost advanced materials with superior properties.

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OTHER INFORMATION

CATEGORIZED AS

- **Engineering**
  - Other

RELATED CASES

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