Functional Properties and Applications of Advanced Consolidated Materials Made of Atomized Glassy Alloy Powders

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Abstract

Recent years, much attention has been paid to nonequilibrium metallic materials consisting of nanocrystalline or glassy structure because their structural modifications are expected to cause much improved functional properties. However, there have been some unresolved engineering problems, e.g., the nonequilibrium alloys with high functional properties are limited to small sizes which cannot utilize three dimensional shapes. More recently, glassy type alloys having a large supercooled liquid region before crystallization and large critical sizes up to 100 mm have been developed by utilizing the stabilization phenomenon of supercooled liquid. Their alloy systems have been synthesized in a number of alloy systems such as Mg-, lanthanide(Ln)-, Zr-, Ti-, Hf, Fe-, Co-, Ni-, Cu-, Pd-Cu- and Pt-Cu-bases. The high stability of supercooled liquid against crystallization implies that the glassy alloy powders can be produced over the whole particle size range even by conventional atomization techniques. The application of various consolidation processes to the glassy alloy powders enables to produce fully dense bulk alloys consisting of glassy or nanocrystalline structure even at low consolidation temperatures in the supercooled liquid region and the resulting consolidated bulk alloys exhibit useful properties. This paper aims to review our recent data on the syntheses of nonequilibrium bulk metallic materials with useful engineering properties by the sequent processes of atomization and warm consolidation in the supercooled liquid region and to demonstrate the effectiveness of the low-temperature powder metallurgy processing of nonequilibrium phase alloys on the development of advanced metallic materials.