

Preface

A lot of efforts have been made by the scientific community to create new materials with optimal combinations of properties. The capability to design and create specific microstructures is a fundamental requirement to make materials able to show the desired functional and mechanical properties. However, the design of the right combination of physical, mechanical, or functional characteristic of materials has turned out to be difficult to achieve, because these properties may barely coexist in engineering materials. For example, it is desirable to create light materials that combine both high strength and good toughness, although strength and toughness are generally mutually exclusive in metals. Hence, only some combination of properties are possible, and compromises are often needed.

In December 1959, the famed lecture “*There’s Plenty of Room at the Bottom*,” which was presented at Caltech by the Nobel Prize winner Richard Feynman, gave birth to a new branch of science: Nanotechnology. From that event on, the interest in nanoscale structures has grown rapidly among scientists and within the industrial community. Nanoengineering and nanoscience have led to an explosion of new experimental techniques for assembling and manipulating nanostructures. The availability of nano-sized particles as a result of one of these new developments, new sintering processes, and characterization techniques have brought about the creation of different feasible scenarios for preparing new materials with extremely interesting mixtures of properties. From this perspective, nanocomposite materials are believed to be potential candidates for many applications that require low weight, high mechanical strength, good ductility and toughness, damping capability, and microstructural stability at high temperature. Unfortunately, the production of such materials is not trivial with conventional melting and casting techniques. Powder metallurgy, on the other hand, provides flexibility in terms of materials selection and microstructure design. Plastic deformation-based techniques, such as hot extrusion and equal channel angular pressing (ECAP), can achieve consolidation at relatively low temperatures and shorter times than conventional sintering processes; then they are able to maintain any nanostructure created in the particles. A fine microstructure is generally considered a desirable

aspect for metals: ultrafine-grained and nanocrystalline materials revealed indeed unprecedented high strength, often several times higher than that of their coarse-grained counterparts. With this work, several efforts have been made to better understand the role of the processing parameters to produced ductile light metal nanocomposites with improved mechanical and damping properties. In particular, Al matrix composites with ultrafine microstructure reinforced with either in-situ or ex-situ alumina nanoparticles were produced through a combination of powder processing by ball milling and powder consolidation by either ECAP or hot extrusion.

Aluminum Matrix Composites Reinforced with Alumina
Nanoparticles

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