A comprehensive analysis of extrusion behavior, microstructural evolution, and mechanical properties of 6063 Al-B4C composites produced by semisolid stir casting

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ABSTRACT

In this study, composites of aluminum alloy 6063 reinforced with 10 wt% boron carbide microparticles were successfully fabricated by a combination of spark plasma sintering and stir casting methods, followed by hot extrusion. A systematic study on the relationship between extrusion process variables (i.e. extrusion ratio, temperature, and punch speed) and porosity, particle refinement, particle distribution and consequently tensile properties and fracture behavior of the composites was performed. Extensive electron microscopy analysis and tensile testing of the composites revealed a multifactoral interdependency of microstructural evolution and mechanical properties on the extrusion process variables. For example, while increasing the extrusion ratio at higher temperatures led to moderate particle refinement, better densification of the composites, and improvement in mechanical properties, concurrent particle fragmentation and microvoid formation around the particles at lower temperatures had opposing effects on the mechanical behavior. We show that the dependency of mechanical properties on all such microstructural factors makes it difficult to predict optimum extrusion conditions in aluminum matrix composites. That is, unlike the common approach, extruding the composites at higher temperatures and achieving more reduction in area may not necessarily lead to the most favorable mechanical properties.

KEYWORDS: Aluminum matrix composite; Spark plasma sintering; Stir casting; Hot extrusion; Microstructure; Mechanical behavior

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