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Tensile properties and strengthening effects of 6061Al/12wt.%B₄C composites reinforced with Nano-Al₂O₃ particles

Xiaoxuan Pang^a, Yajiang Xian^a, Wei Wang^a, Pengcheng Zhang^{a,b*}

^aChina Academy Engineering Physics, Mianyang, 621900, Sichuan, PR China

^bScience and Technology on Surface Physics and Chemistry Laboratory, Mianyang, 621907, Sichuan, PR China

Abstract:

Aluminum matrix Boron carbide composites is an important thermal neutron shielding material. In order to prepare 12wt.% B₄C/6061Al composite with higher mechanical properties by powder metallurgy method, the new composite reinforced by Nano-Al₂O₃ particles was fabricated by hot isostatic pressing in the semi-solid temperature range. The tensile properties and strengthening effects of the composite were investigated in this research. The tensile stress-strain curve of the composites was tested by material testing machine, and the microstructure and tensile fracture morphology of composites were analyzed by scanning electron microscopy (SEM) and transmission electron microscopes (TEM). The results indicated that the tensile strength of the composite was greatly improved by the addition of Nano-Al₂O₃, but the elongation decreased obviously. Nano-Al₂O₃ particles had seriously affected the microstructure and fracture morphology of the composite and lead to the more obvious brittle fracture characteristics. Strengthening mechanisms of Nano-Al₂O₃ particles reinforced 6061Al/B₄C composite have been discussed, which reveals that grain boundary strengthening mainly plays the most important role.

Key words: Al/B₄C composite; Nano-Al₂O₃; properties; strengthening mechanism.

Introduction

Boron carbide (B₄C) possesses high melting point, super-hardness, relatively good mechanical properties, low specific weight and great resistance to chemical agents [1, 2]. The use of B₄C in the structural material field was severely limited because of the brittleness associated with the material [3]. Making B₄C as particulate reinforcement in metal materials is one of the mainly usage[4]. A typical application is aluminum matrix boron carbide composites (Al/B₄C) [5, 6]. Due to low density, high strength, high specific stiffness, good damping capacity and excellent thermal conductivity, Al/B₄C composites have been widely used in the fields of aviation industry, cycling industrial, electronic communication [7], etc.

For containing the isotope of ¹⁰B, Al/B₄C composites have also been concerned as thermal neutron shielding material for high-density storage of spent nuclear fuel [8]. And which have been commercialized successfully by several corporation such as Boral, Holtec and Alcan [9-11]. In terms of the physical function of thermal neutron absorption of Al/B₄C composites, it was mainly used in the condition of spent fuel pool

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