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Microstructure and mechanical properties of carbon fiber needled felt reinforced sol-derived YAG composite

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Abstract

The study concerning the second phase reinforced YAG matrix composites is few although YAG is well known as a desirable thermo structural ceramic. In this paper, low-cost 3D carbon fiber needled felt was used as reinforcement to improve the fracture toughness of YAG, and the carbon fiber needled felt reinforced YAG (C/YAG) composite was fabricated through ~~the route of~~ vacuum impregnation-drying-heat treatment, using the Y_2O_3-Al_2O_3 sol with a high solid content as raw material. The microstructure, mechanical properties, thermal stability and oxidation resistance of C/YAG composite were carefully investigated. Due to the characteristics of reinforcement and the microstructure, the as-fabricated C/YAG composite showed non-catastrophic failure behavior and much higher fracture toughness ~~as~~ compared with monolithic YAG ceramic~~, and the mechanical properties of composite are acceptable and have much room for improvement~~. The flexural strength of C/YAG composite was well retained after annealed at 1700 °C and 1800 °C under inert atmosphere. Although the chemical inertness between carbon fiber and YAG was confirmed up to 1800 °C, the physical bonding of interface was enhanced during annealing, which led to the decrease of fracture work, especially at 1800 °C. The oxidation resistance of C/YAG composite was related to the cracks and pores since YAG is immune to oxidation. The changes of microstructure and flexural strength after oxidation at 1200 °C, 1400 °C and 1600 °C were characterized and analyzed.

Keywords: Yttrium aluminum garnet composite; Carbon fiber needled felt; Mechanical properties; Thermal stability; Oxidation resistance

1. Introduction

Polycrystalline yttrium aluminum garnet ($Y_3Al_5O_{12}$, YAG) ceramic has been studied for many years and is widely known as an important solid-state laser host material because of its excellent optical performance [1–4].

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