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## Thermal stability and oxidation resistance of C/Al<sub>2</sub>O<sub>3</sub> composites

### fabricated from a sol with high solid content

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#### Abstract

To improve fracture toughness of monolithic  $Al_2O_3$  ceramics, three-dimensional carbon fiber preform was used as reinforcement, and the C/Al<sub>2</sub>O<sub>3</sub> composites without interfacial coating were fabricated through vacuum impregnation-drying-heat treatment route with an  $Al_2O_3$  sol as starting material. Characteristics of the  $Al_2O_3$  sol with high solid content were firstly analyzed. Then thermal stability and oxidation resistance of the C/Al<sub>2</sub>O<sub>3</sub> composites were investigated. It is found that the  $Al_2O_3$  sol is an appropriate raw material for the fabrication of C/Al<sub>2</sub>O<sub>3</sub> composites. The C/Al<sub>2</sub>O<sub>3</sub> composites with a total porosity of 16.6% show a flexural strength of 208.5MPa and a fracture toughness of 8.1MPa·m<sup>1/2</sup>. Strength loss is observed after the composites were annealed at 1400°C and 1600°C under inert atmosphere. Oxidation resistance of the C/Al<sub>2</sub>O<sub>3</sub> composites is unsatisfactory because of the existence of open pores and microcracks. When  $Al_2O_3$  matrix was modified with SiO<sub>2</sub>, the oxidation resistance is remarkably improved due to the viscous flow effect of SiO<sub>2</sub>.

Keywords: Alumina; Composites; Sol; Oxidation resistance; Thermal stability

#### 1. Introduction

It is well known that monolithic alumina  $(Al_2O_3)$  is a kind of high performance structural material. However, the intrinsically catastrophic fracture behavior limits its application. The fracture toughness of  $Al_2O_3$  ceramics can be improved by incorporating the second phases [1-15]. Of all the second phases, continuous fiber reinforcement exhibits notable advantage due to its outstanding damage tolerance [6-15]. So far, oxide fiber has drawn much more attention than SiC fiber and C fiber for reinforcing  $Al_2O_3$  ceramics, and the well-developed fabrication technologies include slurry infiltration and heat treatment (SIH) [7,12,13,16], reaction-bonding aluminum oxide (RBAO) [9,10], sol-gel [11,14,15,17] and electrophoretic deposition (EPD) [18].

Three-dimensional (3D) fiber preform has been extensively used as reinforcement for high performance composites since it displays better flexibility in structure design, general properties and adaptability to complex shape. For the fabrication of 3D fiber reinforced Al<sub>2</sub>O<sub>3</sub> composites, especially large-size complex parts, gas

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