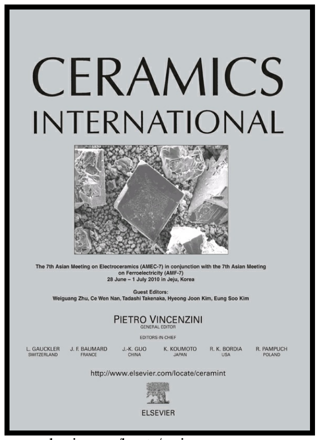

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Effect of Graphite Nanoplatelets on the Mechanical Properties of Alumina-Based Composites

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Abstract

Al_2O_3-based composites using exfoliated graphite nanoplatelets (xGnPs) have been developed by powder metallurgy (PM) route using both conventional as well as spark plasma sintering (SPS) processes. Al_2O_3-0.2, 0.5, 0.8, 3 and 5 vol. % xGnP composites have been developed, and the effect of the addition of xGnP on the density, hardness, fracture toughness and wear behaviour of the various Al_2O_3-xGnP composites have been analyzed. Conventional sintering was done at a temperature of 1650°C for 2, 3 and 4 h in inert atmosphere, whereas SPS was carried out at 1450°C under 50 MPa pressure for 5 minutes. A uniform dispersion of the xGnP in the Al_2O_3 matrix was observed in the composites upto the addition of 3 vol. % xGnP. Results indicate that a significant improvement in hardness, wear resistance and fracture toughness of the composites could be achieved by using xGnP as nanofiller. The hardness and fracture toughness of the composites developed by both conventional sintering and SPS show an increase upto the addition of 3 and 0.8 vol. % xGnP respectively. The wear resistance of the composites also shows significant improvement upto the addition of 3 vol. % xGnP. The composites developed by SPS have been found to possess superior mechanical properties as compared to the composites developed by conventional sintering. The improvement in the mechanical properties can be attributed to the strong interaction between the xGnP and the Al_2O_3 matrix at the interfaces and to the toughening mechanisms such as crack bridging and crack deflection.

Keywords: Nanocomposites, Graphite Nanoplatelets, Alumina, Fracture Toughness, Wear

1. Introduction

Since its discovery, graphene has widely attracted researchers due to its unique combination of properties such as excellent mechanical strength and exceptionally high electronic and thermal conductivities [1]. Its two-dimensional structure, large specific surface area, high aspect ratio, and excellent mechanical properties make it highly useful as nanofiller to improve the intrinsic properties of metals, ceramics, and polymers. In the last few years, graphene has emerged as a promising nanofiller to improve the mechanical properties of ceramic matrix composites (CMCs) [2, 3]. Monolithic ceramics have attractive properties like high stiffness, strength and stability at high temperatures, making them useful for various biomedical, defense and space applications.

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