A novel approach to electroconductive ceramics filled by graphene covered nanofibers

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Abstract

In this study, a novel approach to processing electrically conductive and comparatively cost-effective ceramics by incorporation of the graphene coated oxide ceramic nanofibers into alumina matrix is presented. The conductive fillers are produced by chemical vapour deposition of a few-layered graphene shells on a dielectric substrate of alumina nanofibers of 7-10 nm in diameter and an exceptional aspect ratio of 10^7. Our approach allows utilizing the advantages of reinforcement by fibres and high conductivity of graphene through homogeneous dispersion of the fibres within alumina matrix. The composites are densified using spark plasma sintering at 1380 °C with 40 MPa pressure for 10 min. It is shown that addition of 0.3 wt% of graphene results in increase in electroconductivity of 13 orders of magnitude as compared to the monolithic alumina. Moreover, a low graphene loading does not result in deterioration of hardness of the produced hierarchically structured composites. The strategy proposed in this work can be extended to other insulating materials to produce advanced composites suitable for high-precision electrical discharge machining.

Keywords: Nanofibers; Graphene; Alumina; Composites; SPS; Electroconductivity

1. Introduction

The potential for a wide variety of applications of advanced ceramics has triggered significant research activities on development of new classes of ceramic composites with tailorable properties. The main limiting factors for even wider ceramics usage are mechanical unreliability and poor electrical conductivity, which make the materials difficult to be processed to required shape. To fully employ outstanding mechanical properties of ceramic materials in a variety of applications, ease of shaping is one of the principal necessities. Electro-discharge machining allows producing complex-shaped parts; however, this operation can only be applied to electroconductive materials.