Anisotropic mechanical and thermal properties of graphene nanosheets/alumina composites

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Graphene is a good candidate as a filler material for nanocomposite applications due to its unique electrical, thermal and mechanical properties, as well as its two-dimensional (2D) nature and high aspect ratio. Therefore, it has attracted attention not only in polymer-matrix composites, but also in ceramic-based composites [1-4]. In this study, graphene-based dispersions with a relatively high concentration (~1.3 mg/mL) were prepared in isopropyl alcohol (IPA) within a short sonication time (90 min) by utilizing a high surface area nanographite powder as a starting material. The dispersion of graphene nanosheets in a low boiling point solvent such as IPA is an advantage for composite applications due to its easy removal from the system. Graphene nanosheets were incorporated into α-Al_2O_3 powder with 0, 3, 5, 7 and 10 vol.% contents. The resulting graphene/Al_2O_3 powders were sintered by spark plasma sintering (SPS) at 1300-1500°C (depending on the graphene content) and at 50 MPa for 5 min. Hardness and fracture toughness values of the prepared composites were measured from Vickers indentations and the corresponding crack-length measurements of both through-thickness (parallel to the SPS pressing axis) and in-plane (perpendicular to the SPS pressing axis) directions. Similarly, through thickness and in-plane thermal diffusivity measurements were performed from room temperature up to 600°C in N_2 atmosphere. Besides the measured anisotropic mechanical and thermal properties of the graphene nanosheet/alumina composites, microstructural evaluation of alumina with graphene content, which was investigated by scanning electron microscopy, will be discussed in this presentation.

References

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