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Novel Hybrid Ceramic Nanocomposites Fabricated by Rapid Sintering Technology

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Abstract : Alumina (Al2O3) is an attractive structural ceramic however; brittleness turns Al2O3 down for advanced applications. Development of multi-phase phase ceramics systems is promising to curtail the brittleness and the incorporation of strong/elastic graphene, as third phase, into dual phase (Al2O3-SiC) is striking for mechanical upgrading purpose. Thin graphene nanosheets (GNS) were prepared by thermal exfoliation process and reinforced into dual phase ceramic system. The hybrid nanocomposite was consolidated by novel HF-IH (high-frequency induction heating) sintering furnace at 1500 °C under 50 MPa in vacuum conditions. Structural features and grain size of the resulting nanocomposite were analyzed by SEM and TEM whilst the mechanical properties were assessed by microhardness and nanoindentation techniques. The fracture toughness of the hybrid nanocomposites was appraised by direct crack measurement method. Electron microscopic investigations confirmed the preparation of thin (< 10 nm) graphene nanosheets (GNS). HF-IH sintering route condensed the three-phase (GNS-Al2O3-SiC) hybrid nanocomposite system to > 99% relative densities. SEM of the hybrid nanocomposites fractured surfaces revealed even distribution of the nanocomposite constituents and changed in fracture-mode. Structurally, 88% grain reduction into hybrid nanocomposite was also obtained. Mechanically, enhanced fracture toughness (50%) and hardness (53%) were also achieved for hybrid nanocomposites were attained against bench marked monolithic Al2O3.

Keywords : alumina, graphene, hybrid nanocomposites, rapid sintering
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