

Interfacial Investigation and Chemical Bonding in Graphene Reinforced Alumina Ceramic Nanocomposites

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Abstract : Thermally exfoliated graphene nanomaterial was reinforced into Al₂O₃ ceramic and the nanocomposites were consolidated using rapid high-frequency induction heat sintering route. The resulting nanocomposites demonstrated higher mechanical properties due to efficient GNS incorporation and chemical interaction with the Al₂O₃ matrix grains. The enhancement in mechanical properties is attributed to (i) uniformly-dispersed GNS in the consolidated structure (ii) ability of GNS to decorate Al₂O₃ nanoparticles and (iii) strong GNS/Al₂O₃ chemical interaction during colloidal mixing and pullout/crack bridging toughening mechanisms during mechanical testing. The GNS/Al₂O₃ interaction during different processing stages was thoroughly examined by thermal and structural investigation of the interfacial area. The formation of an intermediate aluminum oxycarbide phase (Al₂OC) via a confined carbothermal reduction reaction at the GNS/Al₂O₃ interface was observed using advanced electron microscopes. The GNS surface roughness improves GNS/Al₂O₃ mechanical locking and chemical compatibility. The sturdy interface phase facilitates efficient load transfer and delayed failure through impediment of crack propagation. The resulting nanocomposites, therefore, offer superior toughness.

Keywords : ceramics, nanocomposites, interfaces, nanostructures, electron microscopy, Al₂O₃

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