Multiwall carbon nanotubes reinforcing ability in alumina/zirconia hybrid ceramic nanocomposites prepared by hot-pressing

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Abstract

Hybrid ceramic nanocomposite is a new strategy in ceramic technology for the development of new materials with a much better mechanical response and functionalities than available today. Dense hybrid alumina (Al_2O_3) ceramic hybrid nanocomposite containing well-dispersed ZrO_2np (8 vol.%) and mwCNT (4 vol.%) were fabricated by the hot-pressing method. The microstructure and mechanical properties of the resulting hybrid nanocomposites were appraised by advanced analytical techniques. Over the benchmarked monolithic Al_2O_3, the hybrid nanocomposite showed a ten-fold finer microstructure and 116% enhanced fracture toughness as well as 12% greater hardness. Better mechanical performance of the hybrid nanocomposite was associated with the synergistic role of ZrO_2np and mwCNT in matrix microstructure refining and inducing unique toughening mechanisms of micro-cracking by ZrO_2np and pull-out as well as crack-bridging by mwCNT. Qualitative and quantitative methods were used to understand the individual and combined contribution of the filling nanomaterials in improving the hybrid nanocomposite properties. Furthermore, the electron microscopes manifested a study interfacial bonding of both reinforcing constituents with the based Al_2O_3 matrix. The quantitative analysis confirmed the complicated physical mwCNT arrangement within the alumina matrix grains improve the mwCNT/Al_2O_3 interfacial shear strength besides their chemical bonding at the interface. The contribution of fine-grained microstructure in establishing idiosyncratic mwCNT interlocking with the Al_2O_3 matrix grains was thoroughly scrutinized. We also discussed the mwCNT/matrix interlocking role on the mwCNT reinforcing ability and toughening mechanisms efficiency in the hybrid nanocomposite.

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