

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

Nuha Al Habis, Iftikhar Ahmad<sup>1</sup>

<sup>a</sup>Center of Excellence for Research in Engineering Materials, Deanship of Scientific Research, King Saud University, P.O. Box. 800, Riyadh-11421, Kingdom of Saudi Arabia

## **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 ( $\text{Al}_2\text{O}_3$ ) ceramic hybrid nanocomposite containing well-dispersed  $\text{ZrO}_2\text{np}$  (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  $\text{Al}_2\text{O}_3$ , 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  $\text{ZrO}_2\text{np}$  and mWCNT in matrix microstructure refining and inducing unique toughening mechanisms of micro-cracking by  $\text{ZrO}_2\text{np}$  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  $\text{Al}_2\text{O}_3$  matrix. The quantitative analysis confirmed the complicated physical mWCNT arrangement within the alumina matrix grains improve the mWCNT/ $\text{Al}_2\text{O}_3$  interfacial shear strength besides their chemical bonding at the interface. The contribution of fine-grained microstructure in establishing idiosyncratic mWCNT interlocking with the  $\text{Al}_2\text{O}_3$  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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<sup>1</sup> Corresponding author: Iftikhar Ahmad  
e. mail: ifahmad@ksu.edu.sa, Tel: +966 11 4699667