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Mechanical Characterization of hot-pressed alumina-zirconia hybrid nanocomposites

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Abstract

The brittle nature of alumina and other technical ceramics limits their mechanical performance under various operating conditions. Through microstructural tailoring, the fracture toughness and other mechanical attributes of alumina can be improved adding nanoscale materials such as graphene, carbon nanotubes and zirconia to form a nanocomposite. For the current studies, alumina-zirconia nanocomposites reinforced with both graphene and carbon nanotubes have been fabricated via colloidal mixing and followed by hot-pressing sintering process. The effect of 2wt% carbon nanotubes on the alumina-zirconia microstructure and mechanical properties were characterized using the single edge notched beam (SENB) test and conventional indentation fracture toughness (IFT) test. The atomic force microscopy was also used to determine the nanoscale distribution of both graphene and carbon nanotubes within the matrix, as well as elastic modulus of the nanocomposites. Typically, there is a relatively high degree of grain refinement of the nanocomposites due to the presence of carbon nanotubes. This directly influenced the physical and mechanical properties of the hybrid nanocomposite such as density, hardness and fracture toughness. Fractography studies after the SENB tests also demonstrate the toughening mechanisms of the zirconia and carbon additives, as well as their synergistic role in improving the fracture toughness of monolithic alumina. Both intergranular and transgranular fracture modes were also depicted by the hybrid nanocomposite during the bending tests.