Deformation and fracture of ultra – high temperature high - entropy ceramics at micro/nano level

Ján Dusza

Institute of Materials Research, Slovak Academy of Sciences, Watsonova 47, Košice, Slovak Republic

jdusza@saske.sk

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The deformation and fracture characteristics of recently developed different high entropy ceramics – carbides, nitrides, carbo/nitrides, dual – phase systems, etc, were investigated using different nano/micro mechanical testing methods. The microstructure and fracture characteristics were investigated using X-ray diffraction (XRD), scanning electron microscopy (SEM) in combination with electron back scattered diffraction (EBSD) and transmission electron microscopy (TEM) and high resolution transmission electron microscopy (HRTEM) in conjunction with energy dispersive X-ray spectroscopy (EDS). Depth-sensing nano-indentation of individual grains and grain boundaries of bulk systems has been applied to study the nanohardness and deformation characteristics. Micro-compression test of micro-pillars prepared by focused ion beam from oriented facets of grains were studied. During micro-cantilever tests in bending deformation and fracture characteristics of individual grains and grain boundaries have been investigated. The indentation load-size effect during micro/nanohardness testing of HECs with different chemical composition were analysed and described. The hardness anisotropy and deformation-induced dislocations in high-entropy carbide grains of low-index facets were investigated and analysed. A strong influence of the grains orientation on compressive yield stress and rupture stress values was found during the micropillar test. The bending strength of micro-cantilevers prepared from individual grains of HECs or containing grains and grain boundaries was strongly dependent on the character/size of the present fracture origins which were in all cases in nano-metric range. The fracture toughness of the individual grains and grain boundaries of different high entropy ceramics were investigated, too.