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Ultra-High Temperature Deformation in TaC and HfC

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Abstract

TaC and HfC bars were thermo-mechanically tested up to 2900 ºC using a non-contact loading method based on the Lorentz force. It was observed that HfC deflected more than TaC up to 2300 ºC, which has been contributed to a difference in grain size facilitating diffusional creep, either Nabarro-Herring or Coble creep. Above 2500 ºC, TaC continued to deflect more with temperature whereas HfC showed a reduced deflection. This reduced deflection was found to be an artifact of a preload plastic deformation response. Though both sets of samples were identified to have a prevalence of <110>{110} slip, at elevated temperatures, it appears that mass transport and diffusional creep mechanisms dominate evident by porosity in the grain boundaries. The activation energies of TaC were found to be 946 ± 157 kJ/mol (between 2500 - 2700 ºC) and HfC to be 685 ± 54 kJ/mol (between 2100 - 2300 ºC).

Keywords: Transmission electron microscopy (TEM), Transition metal carbides, Dislocations, creep, TaC, HfC

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