

CHALLENGES AND OPPORTUNITIES WITH ULTRA-HIGH TEMPERATURE CERAMICS

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Ultra high temperature ceramics (UHTC's) are a class of ceramics with a melting point in excess of 3000 °C and researchers expect that these materials will be used in structural applications at temperatures in excess of 2000 °C. UHTC 's are therefore an exclusive group of materials with extreme thermal endurance and hence candidate materials for thermal protection systems for fast space re-entry or leading edges for hypersonic flight. High temperature materials come with their own challenges as both mechanical properties such as strength, stiffness, toughness and creep resistance needs to be measured to very high temperatures but also the thermo-physical properties such as thermal expansion and thermal conductivity. It will be shown that a combination of self-equilibrating hardness measurements and three point bend tests can give a fairly good initial assessment of the deformation mechanisms operating in this material. Near application testing such as arc heater testing is even more difficult and tends to be very expensive. However, alternative tests such as laser heating can offer insight in the materials performance. This will be illustrated by discussing a range of laser heating tests and a model developed to predict the behaviour during these laser tests at substantial heat fluxes (up to 100 MW m⁻²). It is found that for short exposure times to high heat fluxes, the material has a remarkable ability to retain its shape. However, as the exposure time is increased, the material oxidises and this reduces the melting point and the thermal conductivity leading to loss of shape stability at very high heat fluxes.