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Sandia National Laboratories and the University of New Mexico

Ultrahigh Temperature Ceramics for Advanced Thermal Insulation

University of Missouri-Rolla Ceramic Engineering Seminar Series Speaker
Wednesday December 3, 2003

McNutt Hall, Room 204
3:30pm

Biography:

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Dept. of Energy under Contract DE-AC04-94AL85000

Abstract:

Materials with improved properties are needed for thermal protection of hypersonic vehicles proposed for next generation space and reentry vehicles. Sharp leading edges and nose tips will have to withstand exposure to high temperatures (> 2200°C) and severe thermal cycling in both neutral and oxidizing environments. These extreme conditions will require materials that possess superior oxidation resistance, low creep, and excellent thermal shock properties.

Ultrahigh temperature ceramics (UHTCs) are promising candidates for such applications. ZrB_2 and HfB_2 and composites of them with SiC are two families of UHTCs that are currently under development as high temperature thermal insulation. These materials are appealing because their melting temperatures are 3245°C for ZrB_2 and 3380°C for HfB_2 and because they may form protective, oxidation resistant coatings in use. Both types of UHTCs have been tested in flight experiments with generally unsatisfactory results.

After a short review of previous work, this talk will present recent results on ZrB_2 – SiC and HfB_2 – SiC UHTCs. We find that in spite of their potentially superior properties these diborides can be degraded by impurities and unwanted second phases. Furthermore, processing defects and machining flaws can lead to premature failure. These points will be illustrated with results of scanning and transmission electron microscopic studies of Zr and Hf diboride ceramics prepared under different conditions. We used results on microstructure and composition to develop improved processing methods that have produced high quality ZrB_2 – SiC and HfB_2 – SiC UHTCs with SiC contents from 2 to 20 vol%. We presently are studying the thermal and mechanical properties of those ceramics to correlate properties with compositions and microstructures. One ZrB_2 – 20%SiC specimen that was tested in the arc jet facility at NASA Ames Research Center showed essentially no degradation over time at 1800°C. Our results are leading us to believe these improved materials can realize the potential of UHTCs for advanced thermal protection systems.

A meeting of the UMR Chapter of the American Ceramic Society and the Missouri Chapter of Keramos will follow the Seminar in McNutt 211.

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