National Aeronautics and Space Administration

Ultra High Temperature Ceramics (UHTC) Composites with SiC Reinforcements

Future generation materials for use on space transportation vehicles require substantial improvements in material properties leading to increased reliability and safety as well as intelligent design to allow for current materials to meet future needs. Ultra high temperature ceramics (UHTC), composed primarily of metal diborides, are candidate materials for sharp leading edges on hypersonic re-entry vehicles. NASA has demonstrated that it is possible to form high aspect ratio reinforcement phases in-situ during the processing step for both ceramic composites and UHTCs. Initial characterization of these systems has demonstrated that crack deflection along the matrix-reinforcement interface is observed yielding a system of improved toughness over the baseline system leading to improved mechanical performance. The reinforced composites should therefore reduce the risk of catastrophic failure over current UHTC systems.

This invention is available for licensing from NASA's space program to benefit U.S. industry.

Patent

This technology has been patented.
U.S. Patent No. 8,409,491
(Reference No. ARC- 15903-1DIV)

Benefits

- Improved mechanical properties
- Higher thermal shock resistance
- Improved lower oxidation resistance
- Uniform distribution of high- aspect-ratio reinforcement microstructures
- Reduced risk of catastrophic failure
- Improved fracture toughness

Technology Details

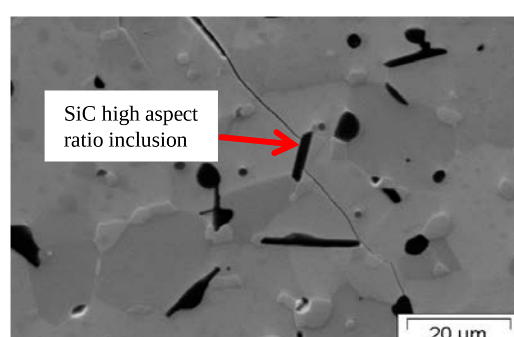
This invention generally relates to ceramic compositions and processes of obtaining a ceramic product, especially ultra-high temperature ceramics. It specifically relates to consolidated ceramic composites comprising a microstructure of a ceramic matrix incorporating a reinforcing ceramic phase with a uniform distribution of the reinforcing phase and controlling the growth of these phases.

A tough ultra-high temperature ceramic (UHTC) composite is comprised of grains of UHTC matrix material, such as HfB2 or other metal boride, carbide, nitride, etc. These are surrounded by a uniform distribution of acicular high aspect ratio reinforcement ceramic rods or whiskers, such as SiC, formed from uniformly mixing a powder of the UHTC material and a pre-ceramic polymer selected to form the desired reinforcement species, then thermally consolidating the mixture by hot pressing.

UHTCs are a family of ceramic materials with very high melting temperatures and reasonable oxidation resistance in re-entry environments. Ground bases arc-jet testing has demonstrated their potential for applications at temperatures approaching 4,000° F or 2,200° C.

Commercial Applications

- Re-entry vehicles for Aerospace and Defense applications
- Reusable launch vehicles
- Hypersonic vehicle leading edge
- Better alternatives in microstructure
- Commercial space craft for enhanced aerodynamic performance



SiC inclusions enhance fracture toughness

Contact the Ames Technology Partnerships Office at 1-855-627-2249 or ARC-TechTransfer@mail.nasa.gov