Paper ID: 62896
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advanced Materials and Structures for High Temperature Applications (4)

Author: Mr. Ved Vakharia
University of California, San Diego, United States, ved.vakharia@gmail.com

Prof. Olivia Graeve
University of California, San Diego, United States, ograeve@eng.ucsd.edu
Mr. Luyao Zhang
University of California, San Diego, United States, luz004@ucsd.edu
Mr. Sergio Sufy
University of California, San Diego, United States, sdsufy@live.com

SOLVOTHERMAL SYNTHESIS OF HIGH ENTROPY METAL CARBIDES: A NEW CLASS OF ULTRAHIGH TEMPERATURE, IRRADIATION RESISTANT CERAMICS

Abstract

High temperature ceramics are of great interest in aerospace and astronautics for hypersonic leading edges as well as re-entry vehicle structural materials. We have implemented a solvothermal synthesis process, a procedure novel for these materials, to synthesize high entropy metal carbides (HEMCs). Specifically, (MoNbTaVW)C was produced because this compound has been predicted to have a high "entropy forming ability". The solvothermal process can be used to obtain metal carbide nanopowders and can be easily modified to introduce dopants, such as nickel and iron. It is also useful for producing nanopowders of cubic morphology from which ultra-dense samples can be produced with minimal porosity. The technique consists of mixing metal chlorides, carbon powder, and lithium granules, and heating the mixture to a temperature above the melting temperature of lithium. The molten lithium helps to propagate heat homogeneously through the powder, resulting in the formation of carbides. The excess products (lithium chloride, lithium hydroxide, and loose carbon) are washed away through a rigorous centrifuge-washing procedure with hydrochloric acid, deionized water, and ethanol. En route to this HEMC, we have produced binary, ternary, quaternary, quinary, and senary metal carbides through systematic manipulation of elemental composition. Solid solutions of (NbTa)C and (NbTaW)C have been confirmed by a combination of X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS). Rietveld refinement was used to deconvolute the XRD data and obtain approximate phase compositions of the different carbides to reestablish precursor amounts and obtain a solid solution HEMC. We have also investigated the importance of vanadium as it can exist in different electronic states, helping to form the HEMC. Through a spark plasma sintering (SPS) process, dense samples of compositionally complex ceramics have been produced.