VIRGINIA TECH.

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9.30-10.30am
Holden Auditorium

MULTIPLE PRINCIPAL ELEMENT UHTC MATERIALS

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Abstract

After a short overview of how ONR funds S&T programs, the talk will focus on the concept of multiple principal element materials. This new approach to the discovery and development in materials science has spurred many international programs over the last few years. Unlike traditional materials development programs that favor slight compositional changes from a known single major phase, it is a fundamentally new way to develop materials where no single element dominates the composition. This vastly increases the number of materials systems, introducing over 170 million new alloy bases. Many new materials with exceptional structural and functional properties have already been discovered, and the intent of the current work is to transition the established concepts towards developing new ultra high temperature compositions. The goal of the program is to understand the physics and chemistry in these new chemical systems, through atomic-level modeling and simulation, as well as laboratory experimentation.

Fifteen high entropy carbide compositions spanning group IVB, VB, and VIB transition metals have been synthesized via high energy ball milling, spark plasma sintering, and hot pressing. These materials demonstrate hardness well above a rule of mixtures average, as well as the highest of the constituent components. The inclusion of elements from group VIB shows promise for creating rocksalt structured carbide ceramics with significantly enhanced toughness. These compositions were predicted by a first principles to be synthesizable, with lattice constants, bulk moduli and cohesive energies that can be predicted from their constituent binaries. Thermal conductivity was measured using time domain thermo-reflectance (TDTR). For the thin film carbides, both the electronic and phononic contributions to thermal conductivity can be tuned by changing the carbon concentration. In the bulk polycrystalline samples, thermal conductivity maps were measured with < 5 micron spatial areal resolution, which separated grain and grain boundary contributions. High-entropy metal diborides have also been synthesized using borocarbothermal reduction synthesis to create fully-dense, oxide-free, single-phase, high-entropy metal diborides.

Bio-sketch

Dr. Eric Wuchina has been employed at the Naval Surface Warfare Center Carderock Division since 1988, and is currently a Senior Materials Research Engineer and Subject Matter Expert for UHTC Materials. He is a Program Officer on detail to the Office of Naval Research, managing the Extreme

Environment Materials Program within the Naval Materials Division. He earned a PhD in Materials Engineering Science from Virginia Tech in 1995, and his B.S. and M.S. from Virginia Tech and the University of Maryland, respectively. His primary research interests include thermochemical modeling, phase equilibria, processing, and oxidation behavior of ultra-high temperature ceramics. Dr. Wuchina has authored over 25 publications, 80 presentations and 4 patents, served as chair of the High Temperature Materials Division of the Electrochemical Society, organized conferences, symposia and sessions for ECI, ECS, ACerS, ECerS and USACA, and been an editor on several books and journals. But most importantly, he is a proud Hokie!