

DIFFUSIONAL AND MICROSTRUCTURAL PROFILES IN METALLIC-TO-UHTC CONVERSION BY CARBONIZATION

C. Haas Blacksher, Metallurgical & Materials Engineering, The University of Alabama, USA
chblacksher@crimson.ua.edu

Christopher R. Weinberger, Mechanical Engineering, Colorado State University, USA
Gregory B. Thompson, Metallurgical & Materials Engineering, The University of Alabama, USA

When metal elements are exposed to high temperatures in a carbonaceous environment, the metal, which nominally has little to no carbon solubility, will convert to a carbide. In this study, a series of group IVB and VB transition metals have been resistively heated in a methane environment to promote this carbonization. In doing so, and depending on the metal type, a series of stoichiometric, sub-stoichiometric, and metal-rich carbide phases precipitated. In general, as would be expected, the outer surface is the stoichiometric monocarbide phase. As one moves further from the surface, the reaction front of the carbonization appears relatively planar for all metal types. However, rapid carbon diffusion through grain boundaries does occur and promotes metal-carbide precipitation at triple junctions, but such phase reactions do not overtake the rate at which the planar reaction front penetrates and converts the entirety of the metal to the metal carbide. Using phase diagrams and electron backscattered diffraction characterization, the phase and morphologies of this carbonization profiles are compared between transition metal types. Nanoindentation was then performed along this gradient profile to understand how both phase and microstructure contribute to hardness. The aim then links structure to mechanical behavior in ultrahigh temperature carbide ceramics as a function of carbon content. This work is supported by NSF-DMR-2026760.

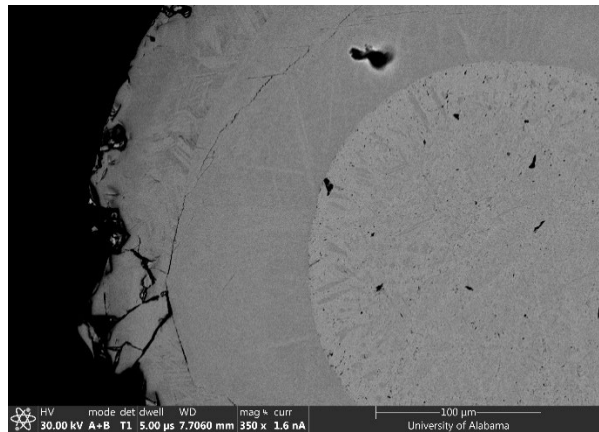


Figure 1: Representative SEM image of the carbonization formations in tantalum.