SYNTHESIS, DENSIFICATION, AND PROPERTIES OF HIGH ENTROPY ULTRA-HIGH TEMPERATURE CERAMICS

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High entropy ultra-high temperature ceramics are the subject of increasing research activity. Synthesis methods affect the powder particle size and purity, which also impact the ability to densify the resulting powder. Densification is typically conducted with applied pressure by spark plasma sintering. To date, the most commonly reported properties are hardness and modulus measured by nanoindentation. In our laboratory, high entropy boride and carbide ceramics were synthesized by carbothermal or boro-carbothermal reduction of oxides. The processes produce sub-micron powders with oxygen contents below 1 wt%. Densification can be accomplished by spark plasma sintering or hot pressing. A previous study focused on elevated temperature strength of (Hf,Nb,Ta,Ti,Zr)C ceramics showed that room temperature strength was retained up to ~1800°C.[1] For borides, hardness is affected by composition with $(Cr,Hf,Ta,Ti,Zr)B_2$ and $(Hf,Ta,Ti,W,Zr)B_2$ having hardness values higher than those of novel superhard materials.[2] This presentation will focus on the latest results from our laboratory on high entropy ultra-high temperature ceramics.

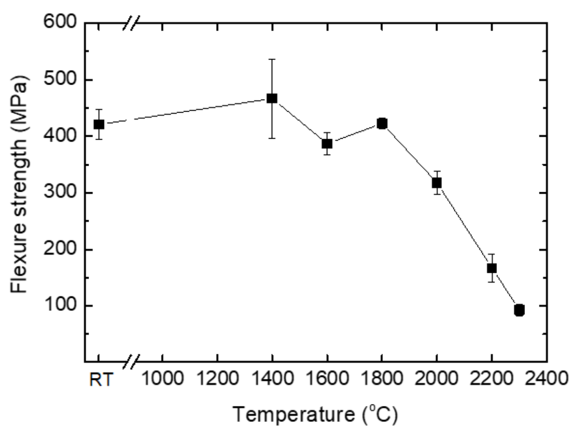

Figure 1 – Strength as a function of temperature for (Hf,Nb,Ta,Ti,Zr)C from reference 1.

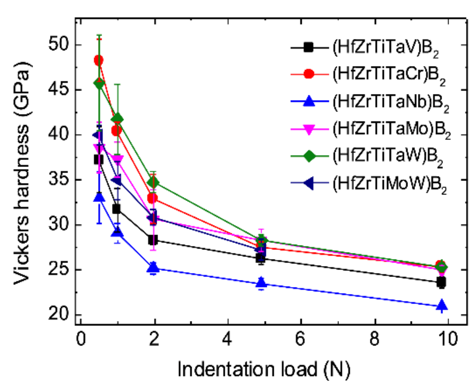

Figure 2 – Hardness as a function of indentation load for high entropy boride ceramics from reference 2.

1. Feng L, Fahrenholtz WG, Hilmas GE, Chen WT. Strength of single-phase high-entropy carbide ceramics up to 2300°C. *J Am Ceram Soc* 2021;104(1):419-427

2. Feng L, Monteverde F, Fahrenholtz WG, Hilmas GE. Superhard High Entropy AlB_2-Type Diboride Ceramics. *Scripta Materialia* 2021;199:113855