FROM THE ATOMIC SCALE TO THE BULK: ULTRA HIGH TEMPERATURE EVALUATION OF METAL DIBORIDES MB_2 (M = Ta, Ti, Hf, Zr, Nb)

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Advancement of hypersonic vehicle technologies are severely limited due to the high heat flux generated by aerothermal effects. These high temperatures create environments which can affect or degrade even the most robust materials, leading to a reduction in system performance or even failure. The most promising candidates for these applications are Ultra-High Temperature Ceramics (UHTCs), including metal borides, carbides, and nitrides that have phase and thermal stability above 2000^{o}C. This work presents an in-depth materials study of UHTC metal diborides using *in-situ* and *ex-situ* characterization techniques that uncovers the thermochemical and thermophysical properties of these compounds. Spherical diboride beads were fabricated for *in-situ* high temperature X-ray experiments that utilizes gas levitation and a conical nozzle levitator system equipped with dual laser to heat small amounts of material up to 3000˚C. This in-depth thermally dependent phase exploration is paired with macroscale characterization (SEM, Oxy-acetylene torch testing, dilatometry, etc.) to compare the small-scale testing results and further understand the behavior of these materials at high temperatures. These experiments provide insight to the fundamental thermochemical and thermophysical material properties that are important for the engineering and design of future systems operating under extreme environments.