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TEM analysis of Boride-based Ultra-High Temperature Ceramics

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Abstract

Hafnium and zirconium borides are leading candidate materials for use in ultra-high-temperature applications thanks to their excellent combination of physical, mechanical and oxidation resistance properties. It has been shown that the addition of $MoSi_2$ allows the densification without the application of pressure, improves the oxidation resistance and the mechanical properties at high temperatures.

Despite the use of this sintering additive for several ultra high temperature ceramics, the densification mechanisms are still unclear and matter of debate.

Transmission electron microscopy (TEM) is a powerful tool to explore microstructure at small length scale. A careful literature analysis reveals that neither detailed TEM work nor reports on densification mechanisms are available for this class of materials.

In the present work, the microstructure of pressureless sintered ZrB_2-$MoSi_2$ and HfB_2-$MoSi_2$ composites was analyzed by scanning and transmission electron microscopy in order to disclose the mechanisms leading to densification and to understand the role of $MoSi_2$ during sintering.

The formation of solid solutions was observed in ZrB_2-$MoSi_2$ system, whilst the solubility of Mo into HfB_2 lattice seems to be more limited. For both composites the presence of $(TM,Mo)_5SiB_2$, where TM=Hf or Zr, was detected. The formation of secondary phases is analysed and discussed in accordance with thermodynamical calculations and phase diagrams.