

Sintering of UHTCs and UHTCMCs: From Bulk Densification to Composite Interfaces

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Non-oxide ceramics, such as ultra-high-temperature ceramics (UHTCs), offer outstanding physical and engineering properties, but their high melting points and low self-diffusion coefficients make full densification difficult, often requiring temperatures above 2000 °C. Achieving a fine-grained, defect-free microstructure typically requires pressure-assisted techniques such as hot pressing and spark plasma sintering. Sintering aids like oxides, nitrides, or silicides can improve densification and thermo-mechanical properties but may cause residual secondary phases that are detrimental to high-temperature applications.

Recently, sintering strategies have been rethought for a specialized class of CMCs, the ultra-high-temperature ceramic matrix composites (UHTCMCs), where fiber reinforcement adds a new layer of complexity. Processing temperatures near 2000 °C and the use of additives, while beneficial for matrix densification, can threaten the structural stability of SiC or carbon fibers. Therefore, mastering the delicate interplay between sintering parameters, matrix and interface evolution, and high-temperature performance is key to enabling their application in extreme environments.

This talk provides an overview of the densification of bulk UHTCs, the densification issues of UHTCMCs reinforced with SiC or carbon fibers, and their scale-up. The extension of the sintering approach to other CMCs, such as carbon fiber – SiC composites, is also illustrated.