ADDITIVE MANUFACTURING OF CHOPPED FIBER ULTRA-HIGH CERAMIC COMPOSITES

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Ultra-high temperature ceramics (UHTC) and their composites (UHTCMCs) are of interest for use in harsh environments encountered by next-generation Air Force systems. Still, they are limited by their ability to be processed into complex-shaped components. A solution is through additive manufacturing (AM) via direct ink writing (DIW), which allows for the complex shaping of ceramics and composites with high feature resolution. To create complex ceramic shapes, shear-thinning, visco-elastic tailored inks are developed with aqueous slurries and are extruded layer-by-layer. Two sets of inks were developed, one set with zirconium diboride (ZrB_2), an UHTC, and another with silicon carbide (SiC). Both sets of inks were loaded with varying amounts of chopped carbon fibers (C_f) as a reinforcing phase. Finally, functionally graded structures are made with the two inks, and different grading compositions are explored. Figure 1 shows a simplified version of the printing and mixing process. This study includes an analysis of the rheology and printability of inks, the effects of printing parameters on final ceramic development, and C_f alignment along the deposition direction. Pressureless sintering results for individual constituents, as well as co-sintering of the graded structures, will be presented along with preliminary thermal and mechanical behavior of the densified components.

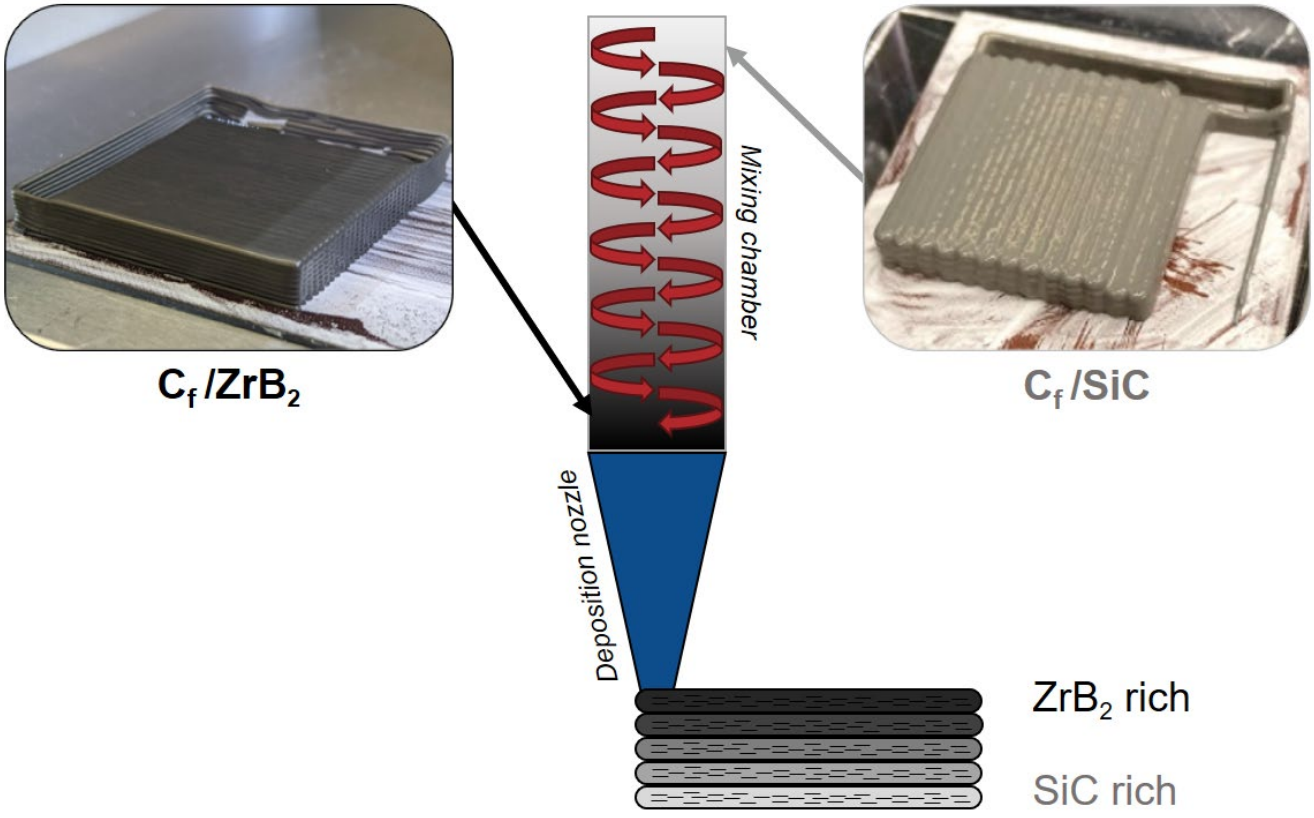

Figure 1 – Simplified diagram mixing head and functionally graded structure with chopped carbon fiber reinforcements