Reactive-deposition-based additive manufacturing of Ti-Zr-BN composites

The next generation of high-temperature composites and wear-resistant coatings will require manufacturing techniques that enable engineers to design with application-specific geometry, composition, and functionality – all in one part. Laser-based additive manufacturing (AM), or 3D-Printing, has opened the door to these possibilities by fundamentally changing how parts are crafted – all the way from processing route and composition to desired functionality and final properties. Traditional processing calls for machining large blocks of material, casting complex internal features, and providing multi-step techniques for coatings and other complex functionality. Laser-based AM, however, accomplishes these features in a layer-by-layer fashion while melting and rapidly solidifying feedstock material(s) as outlined from a 3D-CAD file. This processing reduces waste material and the need for secondary procedures as well as extensive post-processing [1–5].

Directed-energy-deposition (DED), a specific type of AM, has the added capability of fabricating functionally-gradient, multi-material, and uniquely reinforced high-temperature composites and alloys by easily changing the feedstock material while printing [6,7]. This aspect of DED leads to unique design possibilities as powders can be premixed or simultaneously printed to form in situ phases and alloys in net-shape from high-temperature reactions between feedstocks during printing, i.e., reactive-deposition [8–10].