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DEVELOPMENT OF TAILOR MADE PROPERTIES VIA ADDITIVE MANUFACTURING OF FUNCTIONALLY GRADED INCONEL 718

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Additive manufacturing (AM) technologies are known to allow the production of parts with an extreme degree of complexity, enabling design and functional part optimization. This study demonstrates novel way in development of programmed location dependant properties through the control of microstructure in 3D-printed metallic components. It is shown that AM thermal profiles can be used to manipulate preferred orientation of growing crystals as well as produce grains with different sizes, which affects the Young's modulus, strength and overall mechanical properties. The transitions in microstructure, texture, and properties in functionally graded components can be obtained at relatively small or large length scales, depending upon the functional gradient desired in a particular application. As a proof-of-concept, graded Inconel 718 was designed exhibiting core with coarse elongated and outside shell with fine grained microstructure which allowed the best trade-off between creep and fatigue performance and showed improved thermomechanical fatigue lifetime as compared to conventional Inconel 718 material. The developed herein graded component is represented as a composite material where elongated grains in preferentially textured core enable fatigue cracks deviation into positions perpendicular to the loading direction, hence providing no driving force to cause any crack extension. Application of such materials featuring tailor-made microstructural design and site-specific properties will allow for a more efficient use of resources and can be exploited in AM fabrication of complex components requiring challenging high-temperature mechanical performance.

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