Quantifying the Microstructure Uniformity of Hybrid Additively Manufactured Ti6Al4V with Ultrasound

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Hybrid AM processes propose to combine additive manufacturing (AM) with additional processes or energy sources following a synergistic approach instead of a pre or post-processing scheme. In this manner, hybrid AM is able to address challenges such as control of porosity and microstructure, prevention of cracks, and improvement of mechanical properties. Similarly, hybrid AM processes are able to create functionally graded components through controlled microstructural changes. Nonetheless, the need for methods to characterize these components and ensure they meet design requirements is still present and exacerbated by the added complexity. In particular, nondestructive evaluation (NDE) methods are preferred due to the high value of hybrid AM components. In this work, a hybrid AM process (directed energy deposition + milling) was used to impart spatial property variations onto Ti6Al4V samples. Statistics-based ultrasonic NDE methods grounded in diffuse backscatter modeling were then used to detect and quantify these variations. This method was successfully implemented in the evaluation of a single sample and across an ensemble of samples. Limitations and potential developments of these methods are also discussed, and the results are expected to inform the NDE decisions of both research and practitioner audiences. [Research support by the United States National Science Foundation].