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PROCEEDINGS

Quantitative Characterization of Microstructural Inhomogeneity: Integrating Ultrasonic Scattering Mechanisms from Multi-Features in Additive Manufactured Microstructures

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ABSTRACT

The non-destructive characterization of material microstructures presents a significant and enduring challenge in the field. The sensitivity of elastic waves to the nuances of microstructural parameters positions ultrasound as a viable and potent method for non-destructive evaluation. However, enhancing the interaction between elastic waves and the internal microstructure typically involves utilizing wavelengths larger than the microstructural features, thereby rendering ultrasonic scattering as the predominant mechanism. This interaction is complicated by the fact that fundamental microstructural characteristics, such as grain size, morphology, and texture intensity, exert considerable and intertwined effects on ultrasonic scattering, complicating their separate identification. Consequently, the inverse problem of ultrasonic microstructural characterization is inherently ill-posed in additive manufactured components. To address this issue, the present study introduces a novel approach for the quantitative characterization of microstructural inhomogeneity. It translates the microstructural features into the covariance of the elastic tensor along the loading direction, which can be represented as an inhomogeneous surface of the elastic tensor. This representation facilitates a statistical articulation of the microstructure. Simulation studies conducted on a range of models, differentiated by grain size and texture, demonstrate that the proposed parameter encapsulates the combined influence of grains and textures. Importantly, it establishes a monotonic relationship with the attenuation of ultrasonic scattering, suggesting its potential utility in enhancing the precision and accuracy of non-destructive microstructural characterization.

KEYWORDS

Microstructure inhomogeneity; ultrasonic scattering; non-destructive characterization; additive manufacturing

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