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Ultrasonic Attenuation and Backscattering in Polycrystalline Materials With Nonspherical Grains

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Abstract

An ultrasonic wave propagating through a microscopically inhomogeneous medium, such as polycrystalline materials, is subject to scattering at the grain boundaries. The fraction of energy removed from the incident wave is responsible for important phenomenon like attenuation, dispersion, and background “noise" associated with a given ultrasonic inspection system. Quantitative knowledge of attenuation, phase velocity, and scattered wave field are extremely important for a reliable nondestructive evaluation of such materials. Expected propagation characteristics of ultrasonic waves in randomly oriented equiaxed grains are fairly well understood. But when the grains are elongated and/or preferentially oriented, the wave propagation constants exhibit anisotropic behavior. The present paper sheds more light on the effect of grain shape on the attenuation and dispersion of ultrasonic waves in polycrystals. Specifically, theoretical results are presented showing the effects of different grain aspect ratios. It is observed that for the same effective grain volume, grain elongation has smaller effect on attenuation. Although considerable attention has been given to the understanding of mean propagation characteristics of an ultrasonic beam, until recently, there have been relatively little efforts devoted towards rigorous treatments of backscattered signals. In this paper, we also attempt to include some degree of multiple scattering in the calculation of the backscattered signals by developing a formalism that relates mean wave propagation characteristics to the noise.