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Correlation of elastic wave attenuation and scattering with three-dimensional grain size distribution for polycrystals of statistically equiaxed grains

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Abstract: This study establishes an explicit relation between spatial two-point correlation function (TPCF) and 3D grain size distribution for aggregates of statistically equiaxed grains. This relation is further validated by applying it to available TPCF and 3D grain size distribution in the literature. Based on this relation, analytical attenuation coefficients for longitudinal and transverse waves, accounting for grain size distribution, are derived from Born approximation for macroscopically isotropic polycrystals of equiaxed triclinic grains. These attenuation models are applicable for whole frequency range except geometric region. Moreover, scattering coefficients for a polycrystal of equiaxed triclinic grains with a 3D grain size distribution are obtained. Finally, the analytical attenuation model for the longitudinal wave is verified by comparison with existing 3D finite element simulation results in the literature. This theoretic study has practical applications to the inverse determination of 3D grain size distribution from ultrasonic measurements.

Keywords: Grain size distribution, two-point correlation function, scattering, equiaxed grains

1.Introduction

Modeling of elastic wave attenuation and scattering in polycrystalline materials has practical applications in nondestructive evaluation and seismology, thus extensive studies have been reported for wave attenuation and scattering in various polycrystalline media[1]–[20]. A series of