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ELASTIC WAVE PROPAGATION IN POLYCRYSTALS UNDER CONDITIONS OF STRONG SCATTERING

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ABSTRACT

It has been shown in recent studies [1,2] that elastic wave propagation and scattering induced attenuation in polycrystals can be accurately described by three-dimensional finite element (FE) modelling, with representation of the materials at grain scale. It has been found that the FE results were in very good agreement with analytical models even for polycrystals with high grain anisotropy, such as Inconel. The extreme computational demands have meant that most of the work so far has addressed cases of relatively low scattering, mostly in the Rayleigh and stochastic regimes. When it comes to the highly scattering frequency range, moving towards the geometric regime, it is suggested [3,4] that the wave behaviour will become more complicated, as the plane-wave condition is no longer satisfied. We are investigating this unvisited regime by pushing the boundary of the FE modelling towards computations that can simulate the extreme scattering conditions by increasing the material inhomogeneity, frequency range and wave propagation distance. In the study, grain-scale spatial representation is used to describe polycrystalline materials and the elastodynamic FE method is adopted to simulate the propagation of longitudinal plane waves. Analytical work is carried out to estimate numerical errors and uncertainties, and thus provides the theoretical basis for achieving large-scale modelling in the highly scattering regime while preserving numerical accuracy. The scattering-induced wave behaviours, namely attenuation and dispersive phase velocity, are numerically measured from the FE simulations. The intention is that the FE results will then be used to evaluate the validity of the assumptions in the analytical models; it is expected that the necessary approximations in the analytical models are most strongly challenged in this regime. The state of progress in this ongoing pursuit will be presented and discussed.

Keywords: elastic wave, propagation, polycrystal, strong scattering, finite element method, analytical model

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