FFT based numerical study of elastic wave propagation in heterogeneous media: application to polycrystals

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Two Fast Fourier Transform (FFT) based numerical approaches are developed to study acoustic wave propagation in heterogeneous solids. First, a method is proposed to obtain the dispersion relation of acoustic waves in heterogeneous periodic media in which the microstructure is explicitly considered using a voxelized Representative Volume Element (RVE). The dispersion diagram is obtained solving an eigenvalue problem for Bloch waves in Fourier space. The second method is an implicit FFT based algorithm for solving elasto-dynamic problems in which an incident perturbation can be imposed using Green's functions.

Both methods are used then to analyze the propagation of acoustic waves in elastic polycrystals, showing the strong effect of crystal anisotropy and polycrystalline texture on the propagation. The Bloch wave approach aims at obtaining the dispersion diagrams and group wave velocities of the polycrystal and is well suited for wave lengths greater than grain size. The elasto-dynamic algorithm allows to obtain the propagation of a wave through the RVE in the time domain, and study wave attenuation as a function of the incident wave length.