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Simulations of nonlinear ultrasonic NDT of plate-like structures

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Inclusions in materials generally affect the linear wave propagation characteristics of sound waves, observed through scattering, and reduced reflection or transmission with respect to pure materials. The smaller the inclusions, for a fixed ultrasonic frequency, the harder it is to interpret these observations. Therefore, zones of microdamage initiated from fatigue or thermal loading might not induce any linear scattering at all. Nevertheless, the damage information is definitely carried along within the propagating sound wave. In this case, however, it is necessary to investigate the spectral changes of the propagating sound waves, in the form of harmonics and intermodulation frequencies. This contribution reports on simulations of the nonlinear signatures arising in Lamb, Rayleigh and bulk wave propagation in media with localised microdamaged zones. The simulations are performed with a Finite Difference Time Domain solver accounting for microdamage though the inclusion of hysteretic nonlinear stress-strain relations at the microscale. Depending on the configuration it is possible to obtain one or more harmonic images of the defect, their number and relative position containing information about the location and depth of the defect. The simulations allow simple prediction of the response images in complicated experimental conditions.