Extraction of Depth Profiles of Third Order Elastic Constants in Cracked Media

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Elastic constants of components are usually determined by tensile tests in combination with ultrasonic experiments. However, these properties may change due to e.g. mechanical treatments or service conditions during their lifetime. Knowledge of the actual material parameters is key to the determination of quantities like residual stresses present in the medium.

In this work the acoustic nonlinearity parameter (ANP) and the nonlinear coupling parameter for three-wave mixing of acoustic modes guided at surfaces, interfaces and edges of the elastic medium is examined through the derivation of an evolution equation for the amplitude of the second harmonic or the guided wave generated in a three-wave mixing process. Given a certain depth profile of the elastic constants, the dependence of the ANP with respect to the input frequency is determined and on the basis of these results, an appropriate inversion method is developed. This method is intended for the extraction of the depth dependence of the third order elastic constants of the material from guided wave mixing experiments, assuming the change in the constants of second order is small. The latter assumption is supported by a 3D-FEM model of a medium with randomly distributed micro-cracks, conducted in ANSYS as well as theoretical works on this topic in the literature [1].

References: