UNIVERSITÄT PADERBORN
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FAKULTÄT FÜR
ELEKTROTECHNIK,
INFORMATIK UND
MATHEMATIK

Englische Zusammenfassung der Dissertation:

Ein wellenleiterbasiertes Verfahren zur Bestimmung von Materialdaten für die realitätsnahe Simulation von Schallausbreitungsphänomenen am Beispiel stark absorbierender Kunststoffe

des Herrn Jens Rautenberg

With this dissertation a measurement procedure is stated, which enables to determine all data that are necessary for the simulation of sound propagation phenomena in highly absorbing and weakly anisotropic materials by means of one single transmission measurement through an acoustic waveguide. For that purpose, the consecutive mode conversions at the lateral surfaces of a hollow cylinder are used, whereupon the received signal consists of several signal groups that differ in time-of-flight, delay times and amplitudes, which strongly depend of the material characteristics.

The interrelation between signal characteristics and material parameters will be developed for transverse isotropic materials. Therewith it is possible to find an optimal design of the test specimen as well as to model the transient sound propagation through the waveguide very efficiently, if wave theory is taken into account. Besides, a special requirement is to consider both, frequency dependant damping and sound velocity, which are interrelated to each other following the Kramers-Kronig relations of acoustics. If these relations are abandoned, the simulated signals can become acausal. A common model for damping in computer simulations is the Rayleigh damping model. Here it is anew interpreted under the aspect of causality, wherefrom new consequences for the parameterization of material parameters of the computer models arise. Another main focus of this work is the one-dimensional and wide-band modeling of the surface displacements of a piezoelectric 1-3 composite. On the one hand the models are used to generate very short and non-distorted ultrasonic signals. On the other hand they are part of the holistic simulation of the realized experiment set-up.

The functionality of the measuring method, in particular the signal generation, the extraction of signal characteristics and, finally, the mapping to material and model parameters is demonstrated for two isotropic and one weakly anisotropic synthetic materials. Finally there is a good correspondence between measured and simulated signals.