University College of Southeast Norway

Master Thesis

Characterization of Acoustic Material Properties Using Broadband Through-Transmission Technique

Author:
Hoa T. K. Tran

Supervisor:
Professor Lars Hoff

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Abstract

Faculty of Technology and Maritime
Department of Micro and Nano Systems Technology

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by Hoa T. K. Tran

Acoustic properties of materials such as velocity and attenuation are important properties in many ultrasonic applications, i.e. non-destructive evaluation and ultrasound tissue characterization. When designing acoustic devices, e.g. ultrasound transducers, accurate knowledge of the acoustic properties of the materials is essential. Reliable characterization of these acoustic properties is necessary to give experimental data for the design and modeling of transducers. In addition, for complex materials such as composites, the dispersions of velocity and attenuation may deform the acoustic pulse and cause inappropriate interpretation of the acoustic pulse signal. Thus, it is more important to understand the characteristics and structure of these materials. The material properties are not unique values, but may vary with frequency and temperature. Consequently, the effects of temperature and frequency variation in acoustic parameters should be taken into account when characterizing materials.

In this thesis, an experimental setup of the broadband through-transmission technique was implemented and calibrated in our laboratory. A LabVIEW program to acquire pulses was available, while MATLAB code were written to process the measured data according state of the art methods found in the literature. Using this implemented system, the acoustic properties such as the acoustic impedance, the group velocity, the phase velocity, and attenuation of compressional and shear waves in both homogeneous and composite materials can be measured over an investigated frequency range from 2.5 MHz to 10.5 MHz. In addition, temperature

effects on ultrasonic phase velocity and attenuation in both PMMA and Eccosorb MF-117 materials are studied and compared.

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Abbreviations

FFT	Fast Fourier Transform
NDT	Non-destructive testing
PMMA	Polymethyl methacrylate
SNR	Signal-to-noise ratio