

University College of Southeast Norway

Master Thesis

Characterization of Acoustic Material Properties Using Broadband Through-Transmission Technique

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Abstract

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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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Contents

Abstract	i
Acknowledgements	iii
List of Figures	viii
List of Tables	xiii
Abbreviations	xv
1 Introduction	1
1.1 Introduction.....	1
1.1.1 Pulse-echo technique	2
1.1.2 Through-transmission technique	4
1.2 Objectives of this thesis	7
1.3 Outline of this thesis	8
2 Theory and fundamentals of ultrasound	9
2.1 Introduction of ultrasound.....	9
2.2 Characteristic acoustic impedance, reflection and transmission	10
2.3 Phase velocity and group velocity	11
2.4 Wave propagation.....	13
2.4.1 Wave propagation in homogeneous elastic media	13
2.4.2 Wave propagation in anisotropic elastic media.....	13

2.5 Attenuation of ultrasonic waves	14
3 Determination of velocity and attenuation of ultrasonic waves	16
3.1 Speed of sound in water	16
3.2 Cross-correlation algorithm for estimating the transit time difference between two signals	19
3.3 Mode conversion at oblique incidence angle	20
3.4 Group velocity of ultrasonic waves	23
3.4.1 Group velocity of compressional waves	23
3.4.2 Group velocity of shear waves	24
3.5 Phase velocity and attenuation of ultrasonic waves.....	26
3.5.1 Phase velocity and attenuation coefficient of compressional waves	26
3.5.2 Phase velocity and attenuation coefficient of shear waves	30
3.6 Transmission coefficients of compressional and shear wave at oblique incidence angle.....	31
3.6.1 Transmission coefficients at fluid-solid interface	31
3.6.2 Transmission coefficients at solid-fluid interface	32
3.6.3 Total transmission coefficients.....	32
3.7 Diffraction loss in attenuation measurements	33
4 Setup for acoustic material characterization	35
4.1 Broadband through-transmission technique.....	35
4.2 Measuring sample dimensions and densities	39
5 Results and Discussions	42
5.1 Thickness and density of samples	42
5.2 Speed of sound in water	42
5.3 Acoustic properties of the aluminum sample.....	45
5.3.1 Group velocity of ultrasonic waves.....	45

5.3.2 Phase velocity and attenuation of ultrasonic waves	48
5.4 Acoustic properties of the PMMA sample.....	51
5.4.1 Group velocity of ultrasonic waves	51
5.4.2 Phase velocity and attenuation of ultrasonic waves	54
5.5 Acoustic properties of the Eccosorb MF-117 samples	57
5.5.1 Group velocity of ultrasonic waves	57
5.5.2 Phase velocity and attenuation of ultrasonic waves	59
5.6 Acoustic properties of the unknown material samples from Kongsberg Maritime ...	64
5.6.1 Group velocity of ultrasonic waves	64
5.6.2 Phase velocity and attenuation of ultrasonic waves	65
5.7 Temperature effects on acoustic properties of PMMA and Eccosorb MF-117 samples.....	68
5.8 Correction for diffraction effects in attenuation measurements	72
5.9 Errors in measuring velocity and attenuation.....	73
5.9.1 Path length estimations	73
5.9.2 Determination of arrival time.....	74
5.9.3 Speed of sound in water.....	74
5.9.4 Measurement of the incident angle.....	75
5.9.5 Determination of the transmission coefficient	75
5.9.6 Temperature effects	76
6 Conclusion	77
6.1 The contributions in this thesis.....	77
6.2 Future works	79
Appendix	80
A1 MATLAB code for calculating the phase velocity of the compressional wave	80

A2 MATLAB code for calculating the attenuation coefficient of the compressional wave	81
A3 MATLAB code for calculating the phase velocity of the shear wave	82
A4 MATLAB code for calculating the attenuation coefficient of the shear wave	83
A5 MATLAB code for calculating the total transmission coefficient of the compressional and shear waves	83
Publications	85
Bibliography	94

List of Figures

1.1	Schematic reverberation path between transducer and sample	3
1.2	Measured pulse-echo signal for flat solid sample perpendicular to ultrasonic beam	3
1.3	Schematic of pulse-echo contact configuration.....	4
1.4	Experimental setup of through-transmission immersion technique	5
1.5	Principle of the broadband through-transmission technique.....	5
1.6	Signal paths in the immersion experiment for measuring attenuation, dispersion and thickness using the broadband-pulse technique	6
2.1	Different types of ultrasonic waves	10
2.2	Normal incident wave at the boundary between two media	11
2.3	Group velocity and phase velocity	12
3.1	Schematic diagram of the experiment setup for measuring the speed of sound in water: (a) the first approach, and (b) the second approach	16
3.2	Different criteria for measuring transmission time of ultrasonic waves	17
3.3	(a) Received signals with and without an aluminum (Al) sample inserted, and (b) the correlation function of the two signals	20
3.4	Mode conversion of an acoustic wave in a fluid-immersed sample at an oblique incidence angle. The solid-lines represent the compressional waves and the dashed-line represent the shear waves	21
3.5	Signal paths in measuring the velocity of compressional wave in a sample.....	24

3.6	Geometry diagram for determining shear wave velocity.....	25
3.7	(a) Original received pulse without sample inserted, and (b) its phase spectrum	27
3.8	(a) Original pulse with sampling window, and (b) the pulse after using sampling window and adding with zero	28
3.9	(a) The circularly shifted pulse, and (b) phase spectrum of the circularly shifted pulse.....	29
3.10	Reflection and refraction of (a) a compressional wave, and (b) a shear wave at a solid-fluid interface	32
4.1	Experiment setup for the broadband through-transmission technique for characterizing acoustic properties of materials	36
4.2	Three different types of sample mounts. The holder to the left is obtained by making threads in the sample, and screwed the post into the sample. The holders to the right are based on optical mounts from Standa ltd. (Vilnius, Lithuania)	36
4.3	Received signal measured with the 5 MHz transducer pair in with Eccosorb MF-117 inserted at a normal incidence angle (blue line), and at an oblique incidence angle (red line).....	38
4.4	Geometry of the measured Al sample and thickness measurement procedure	38
4.5	Geometry of PMMA sample.....	40
4.6	Geometry of two Eccosorb MF-117 samples: (a) sample 1, and (b) sample 2	41
4.7	Geometry of six unknown material samples from Kongsberg Maritime.....	41
5.1	(a) Received signal measured with the 5 MHz transducer pair without a sample inserted, and (b) its power spectrum.....	43
5.2	(a) Received signal measured with the 5 MHz transducer pair without a sample inserted, and (b) its auto-correlation function	44

5.3	(a) Received signal measured with the 10 MHz transducer pair without a sample inserted, and (b) its power spectrum.....	44
5.4	(a) Received signals measured with the 5 MHz transducer pair with and without the Al sample inserted, and (b) their cross-correlation function.....	46
5.5	(a) Received signal measured with the 5 MHz transducer pair with Al sample inserted, and (b) its auto-correlation function.....	46
5.6	Calculated total transmission coefficients of the compressional and shear waves in the Al sample based on velocity measured with (a) the 5 MHz transducer pair, and (b) the 10 MHz transducer pair at $19.5^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$	48
5.7	(a) Received signals measured with the 5 MHz transducer pair at the normal incidence angle, with and without the Al sample inserted, and (b) their power spectra.....	49
5.8	Phase velocity of compressional and shear waves in the Al sample versus frequency measured with (a) the 5 MHz transducer pair, and (b) the 10 MHz transducer pair at $19.5^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$	50
5.9	Attenuation coefficients of compressional and shear waves in the Al sample measured with the 5 MHz transducer pair at $19.5^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$	51
5.10	(a) Received signals measured with the 5 MHz transducer pair without and with PMMA sample at the normal incidence angle, and (b) their power spectra	52
5.11	(a) Received signals measured with the 5 MHz transducer pair without and with PMMA sample at an oblique angle of 38° , and (b) their power spectra.....	52
5.12	(a) Received signals measured with the 10 MHz transducer pair without and with PMMA sample at the normal incidence angle, and (b) their power spectra	53
5.13	Phase velocity and attenuation of (a) compressional and (b) shear waves in the PMMA sample measured at $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ using the 5 MHz transducer pair	55
5.14	Phase velocity and attenuation of (a) compressional and (b) shear waves in the PMMA sample measured at $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ using the 10 MHz transducer pair	55

5.15	Total transmission coefficients of compressional and shear waves in the PMMA sample measured with (a) the 5 MHz transducer pair, and (b) the 10 MHz transducer pair at $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$	57
5.16	(a) Received signals measured with the 5 MHz transducer pair at the normal incidence angle with and without the Eccosorb sample 1 inserted ($d = 5.16$ mm), and (b) their power spectra	58
5.17	(a) Received signals measured with the 5 MHz transducer pair at the normal incidence angle with and without the Eccosorb sample 2 inserted ($d = 1.94$ mm), and (b) their power spectra	59
5.18	Phase velocity and attenuation of (a) compressional wave and (b) shear wave in the Eccosorb sample 1 ($d = 5.16$ mm) measured with the 5 MHz transducer pair	60
5.19	Phase velocity and attenuation of (a) compressional wave and (b) shear wave in the Eccosorb sample 1 ($d = 5.16$ mm) measured with the 10 MHz transducer pair	60
5.20	(a) Cross-section SEM image of the Eccosorb MF-117 sample, and (b) the element analysis of one particle	61
5.21	Total transmission coefficients of compressional and shear waves in the Eccosorb sample 1 measured with (a) the 5 MHz transducer pair and (b) the 10 MHz transducer pair.....	62
5.22	(a) Phase velocity and (b) attenuation of shear wave in the Eccosorb sample 1 at different incident angles.....	62
5.23	Phase velocity and attenuation of shear wave in the Eccosorb sample 2 ($d = 1.94$ mm) measured with (a) the 5 MHz transducer pair and (b) the 10 MHz transducer pair.....	63
5.24	(a) Received signals measured with the 5 MHz transducer pair at the normal incidence angle, with and without sample A3 inserted, and (b) their power spectra	64
5.25	(a) Received signals measured with the 5 MHz transducer pair at the normal incidence angle, with and without sample B1 inserted, and (b) their power spectra.....	65

5.26	(a) Phase velocity and (b) attenuation of compressional wave in the samples A with different thicknesses measured with the 5 MHz transducer pair.....	66
5.27	(a) Phase velocity and (b) attenuation of compressional wave in the samples B with different thicknesses measured with the 5 MHz transducer pair.....	66
5.28	Speed of sound in water as a function of temperature.....	69
5.29	Phase velocity and attenuation of (a) compressional wave and (b) shear wave in the Eccosorb MF-117 samples versus temperature.....	70
5.30	Phase velocity and attenuation of (a) compressional wave and (b) shear wave in the PMMA sample versus temperature	71

List of Tables

4.1	Thickness measurement of the Al sample.....	40
5.1	Thickness and density of Al, PMMA, and Ecosorb MF-117 samples	42
5.2	Thickness and density of six unknown material samples from Kongsberg Maritime ...	42
5.3	Travelling distance and transmit time of the signal between two transducers	43
5.4	Comparison of the speed of sound in water measured with two different approaches and literature	45
5.5	Group velocity of compressional wave in the Al sample	46
5.6	Group velocity of shear wave in the Al sample	47
5.7	Acoustic properties of the Al sample.....	50
5.8	Comparison of the acoustic properties of PMMA between measurement results and published values in literature	54
5.9	Acoustic properties of the PMMA sample.....	56
5.10	Acoustic impedance and group velocity of ultrasonic waves in Ecosorb MF-117 samples	58
5.11	Acoustic properties of the Ecosorb MF-117 samples	63
5.12	Acoustic impedance and group velocity of compressional wave in the samples A, and B.....	65
5.13	Phase velocity and attenuation of compressional wave in samples A, and B	68
5.14	Polynomial coefficients	68
5.15	Correction for diffraction effects in attenuation measurements using the 5 MHz transducer pair.....	73

5.16 Correction for diffraction effects in attenuation measurements using the 10 MHz transducer pair.....	73
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Abbreviations

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