Characterization of Multilayer Structures by Acoustic Microscopy

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▶ **To cite this version:**

Youness Ezziani, Pooyan Manoochehrnia, Mounsif Ech-Cherif El-Kettani, Damien Leduc, Pierre Marechal, et al.. Characterization of Multilayer Structures by Acoustic Microscopy. 5th International Conference on Materials Science and Engineering Technology, Feb 2024, Singapore, Singapore. hal-04472277

HAL Id: hal-04472277
https://hal.science/hal-04472277

Submitted on 22 Feb 2024

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Characterization of Multilayer Structures by Acoustic Microscopy

MATERIALS International Conference

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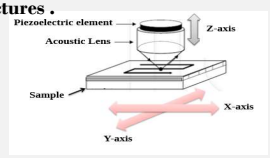
Introduction

-Ultrasonic acoustic methods have the advantage of being non-intrusive with respect to the materials tested, rapid and inexpensive implementation.

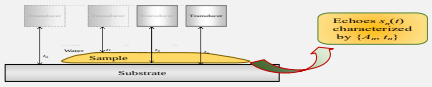
-Acoustic microscopy: characterization and imaging with high resolution (10ns-100ds MHz) for a wide range of materials and structures .



Trilayer Titanium/Epoxy/Composite

Material	Sample 1 Thickness (mm)	Sample 2 Thickness (mm)
TA6V	0.994	0.981
Epoxy	estimated at 0.135	Estimated at 0.086
Composite	13.5	13.5

Bilayer Thin film on substrate



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METHODS AND MATERIALS

Trilayer structure: epoxy film thickness and adhesion quality??

-A-scan signal from two trilayer samples (Titanium/Epoxy/Composite), 50 MHz plane transducer

-Quantification with X-scan imaging

Bilayer structure: Estimation of local material geometric & elastic parameters??

-85µm thick Resin-Epoxy

-50 MHz plane transducer

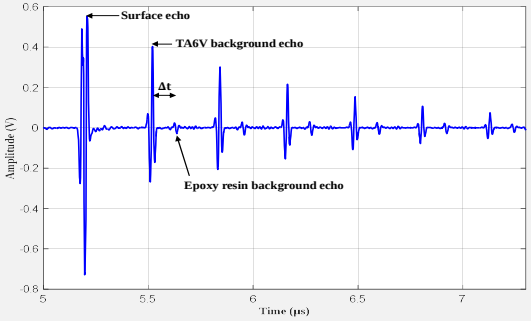
-Model: Debye Series Model (DSM) formalism:

$$R_g = R_{12} + \frac{T_{12}\rho_{23}T_{21}}{1 - R_{21}\rho_{23}}$$

$$s(t) = \left\{ A_{ref} e^{-\frac{1}{2}\left(\frac{t-t_0}{\sigma_t}\right)^2} \cos\left(2\pi f_0 (t - t_0)\right) \right\} * FT^{-1}\left\{R_g\right\}$$

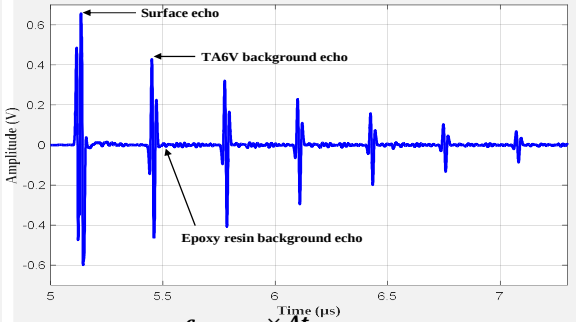
RESULTS for the Trilayer

-A-scan Sample 1



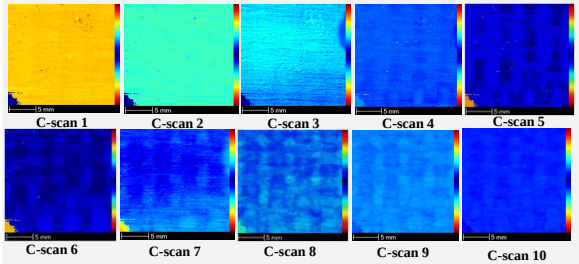
$$e_{Epoxy} = \frac{c_{L-Epoxy} \times \Delta t_{corr}}{2} \cong 0.1357\ mm$$

-A-scan Sample 2



$$e_{Epoxy} = \frac{c_{L-Epoxy} \times \Delta t_{corr}}{2} \cong 0.069\ mm$$

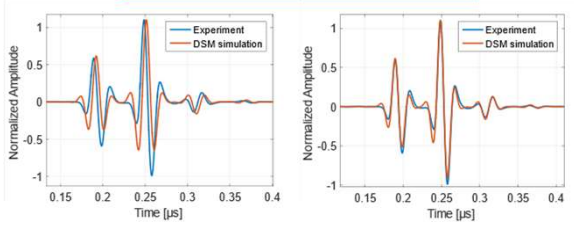
-X-scan of sample 2



Size of the X-scan gate = 20 ns ➔ d(Epoxy)=23 µm , d(Composite) = 29.2 µm

Epoxy medium : 3 Gates (C-scan 1 => C-scan 3) ➔ epoxy = 3*23 = 69 µm

RESULTS for the Bilayer

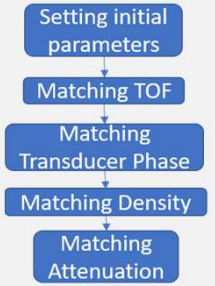


Initial model parameters:

- C_L=2500 [m/s]
- ρ=1300 [kg/m³]
- Th=85 [µm]
- δ=1.5e⁻⁵
- α=3.5e⁻⁸ [Np/(m.Hz)]

Matched model parameters:

- C_L=2500*1.07 [m/s]
- ρ=1300*0.75 [kg/m³]
- Th=85*0.85*0.93 [µm]
- δ=1.5e⁻²
- α=3.5e⁻⁵ [Np/(m.Hz)]



DISCUSSION / CONCLUSION

Trilayer samples :

-Precise determination of the thickness of the adhesive for two samples with A-scan and X-scan Imaging (135 µm for Sample 1, 69 µm for sample 2)

-Sample 1 (135 µm epoxy): High background Epoxy amplitude, and composite is less visible and on few windows of the X-scan.

-Sample 2 (69 µm epoxy): low background Epoxy amplitude, and composite clearly visible on several windows of the X-scan.

the background echo amplitude of the epoxy film depends on the epoxy-composite interface and, consequently, on the adhesion quality. We can conclude that the adhesion quality of sample 2 is better than that of sample 1.

Bilayer:

-Estimation of elastic and geometric parameters of thin layer by analysis of specular insonation of thin layer using SAM

-Inverse problem algorithm used for estimation of best match between parameters