PhD Dissertation Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Introduce Ultrasound Fabry-Pérot Resonator for Attenuation Characterization and

Sensitization Detection of Aluminum-Magnesium Alloys

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Abstract

The Ultrasound Fabry-Pérot Resonator (UFPR) is introduced as a novel technique for non-destructive evaluation and material characterization. By adapting Fabry-Pérot Resonator principles to ultrasonic systems, UFPR inherits advantages such as enhanced sensitivity, reduced uncertainty, and the capabilities of frequency-dependent analysis and fringe spectral analysis. This study focuses on UFPR's application to ultrasonic attenuation characterization and sensitization detection in aluminum-magnesium (Al-Mg) alloys, which are critical for understanding microstructural changes and improving material performance.

The research was conducted in three systematic steps. First, time-frequency analysis was utilized to examine frequency-dependent attenuation behavior, establishing a foundation for ultrasonic attenuation characterization. Second, longitudinal UFPR was developed and validated to characterize ultrasonic attenuation through fringe spectral analysis, offering a novel approach to measuring attenuation parameters. Third, the UFPR method was extended to flexural modes to address dispersive wave challenges, enabling characterization in a lower frequency inspection range and directly correlating attenuation parameters with the Degree of Sensitization (DoS). The DoS was determined using Nitric Acid Mass Loss Tests (NAMLT), providing a benchmark for comparison.

The study demonstrated that UFPR-based fringe frequency domain analysis enhances sensitivity and reduces uncertainty compared to conventional ultrasonic methods. Strong correlations between attenuation parameters and DoS were established, validating UFPR's potential for advanced material characterization. By leveraging fringe frequency domain analysis and extending the principles of FPR to ultrasonic systems, UFPR offers a robust and reliable method for material characterization and microstructural change detection.