Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Lamb Waves for Structural Health Monitoring in Carbon Fiber Reinforced Polymers.

ABSTRACT - Masterthesis

Structural Health Monitoring (SHM) is a novel philosophy for an autonomous, built-in non-destructive evaluation of structures, on demand to reduce life-cycle costs, increase safety and reduce structural weight. This Master thesis investigates laser excited ultrasonic waves, particularly Lamb waves, and their propagation properties to perform defect detection of carbon fiber reinforced polymers (CFRP) structures.

One of the objectives of this work lies in the analytical description of laser generated Lamb wave propagation in CFRP. For the prediction of dispersion of guided waves, the calculation of dispersion curves of the anti-symmetric A_0 as well as symmetric S_0 modes were carried out by a software model. The results of the dispersion characteristics were verified experimentally. For experimental verification, an experimental setup was built up in which Lamb waves could be excited by a Nd:YAG pulse laser and their propagation was measured via laser Doppler vibrometry (LDV).

Another important issue in this thesis is the detection of various defects types in different laminate structures by laser ultrasonic and the investigation and analysis of this various detect types. Therefore the interaction of laser generated Lamb waves with specific artificial defects such as cutting edges, delaminations and cracks were considered.

This work provides a quantitative analysis for non-contact and non-destructive excitation and detection of laser generated Lamb wave in CFRP. It was clearly shown that the effectively generation of Lamb waves in CFRP plates is possible by using laser excitation. The results show that with a focused the laser beam in all investigated CFRP specimens a temporal separated antisymmetric A_0 mode with good signal-to-noise ratio (SNR) can be measured via vibrometer. In addition, with this A_0 mode various defects can be detected and analyzed successfully.