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Ultrasonic Tomographic Reconstruction for Unidirectional Fiber Composites: An Experimental and Theoretical Study

N. N. Kishore, P. Munshi , S. K. Rathore and V. Raghuram
Indian Institute of Technology, Kanpur

W. Arnold and V. Schmitz
Fraunhofer-Institute Institute for Non-destructive Testing
Building 37, University, D-66123 Saarbruecken, Germany

Abstract

In this paper a 2-dimensional tomographic reconstruction method suitable for uni-directional composite materials is discussed. The method involves the time-of-flight (TOF) data collection using a laser-based ultrasonic set-up consisting of a Nd:YAG pulse laser for ultrasonic generation and a He-Ne Heterodyne probe for the detection. The data is collected for a number of projection angles on graphite-epoxy composite specimens consisting of embedded inclusions. The data is processed by wavelet technique for the TOF determination.

The theoretical part of the method takes care of the directional dependence of group velocity and the ray bending. The ray tracing and the conventional Algebraic Reconstruction Technique (ART) are alternately undertaken. The vector tomographic reconstruction of transversely isotropic composites involves a total of 7 components which includes 5 elastic constants, the material density and the fiber axis direction for the analysis. However, for certain composite materials such as graphite/epoxy composite, it may be possible that the dominant components may be only a few. In this paper, the analysis was carried out and the results and the images are presented for such a preliminary analysis.