Nondestructive Evaluation of Composites using Model Based Design

Edouard Nesvijski
ACOUSTICS@MBD CONSULTANTS, LLC, Westborough, Massachusetts, 01581
E-mail: enesvijski@mbd-acoustics.com

Introduction: There is a practical interest among composite materials manufacturers to high-speed accurate non-destructive evaluation (NDE) technology for voids inspection.

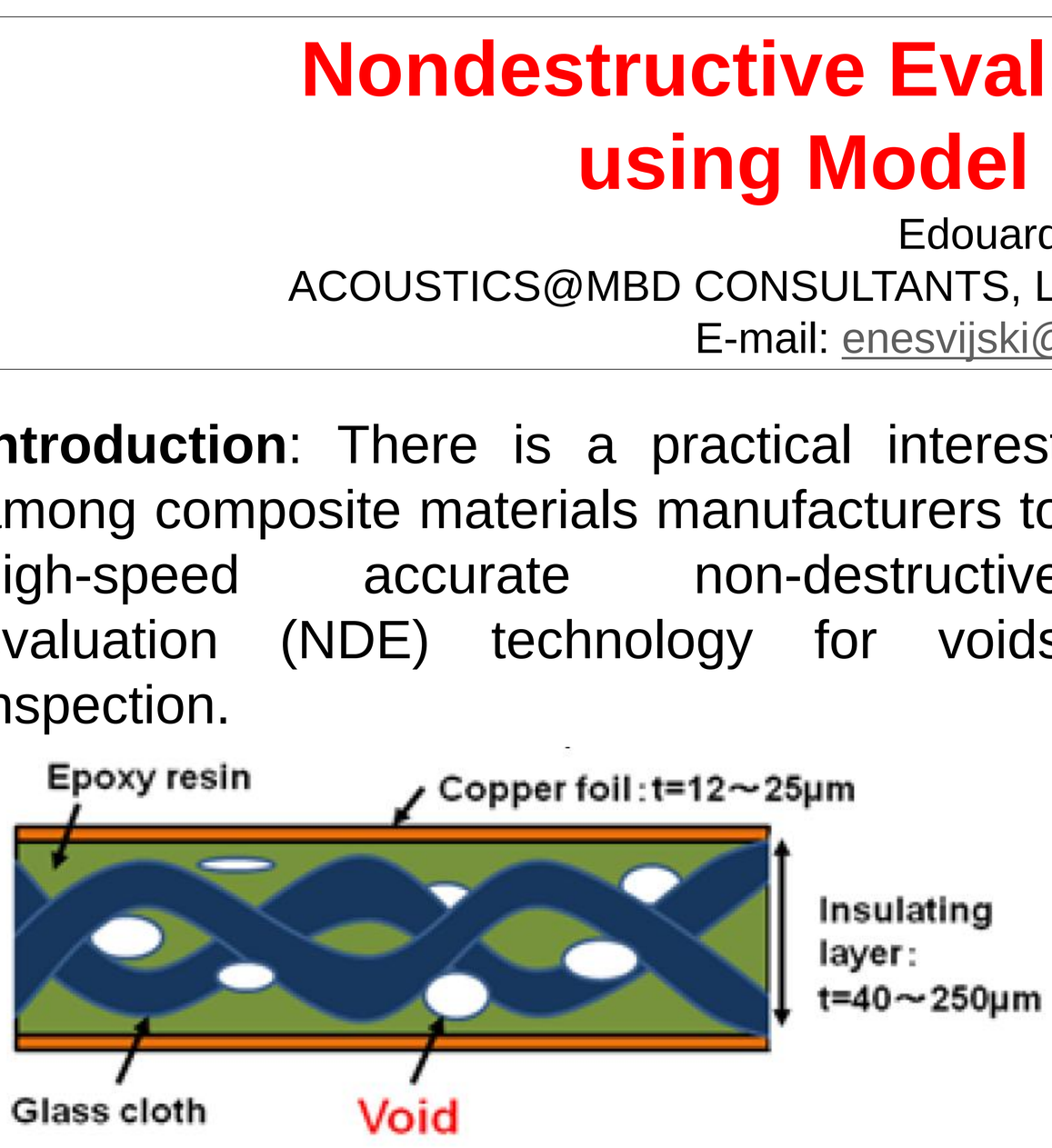

Figure 1. Complexity of testing composite material.

Computational Methods: The detection method is based on application of surface and bulk high frequency ultrasonic waves using MBD for design of transducers with dry compiling elements (DPC) and modern digital signal processing (DSP) and artificial intelligence (AI) techniques implemented to voids detection, recognition and classification using COMSOL, MATLAB and SOLID WORKS together:

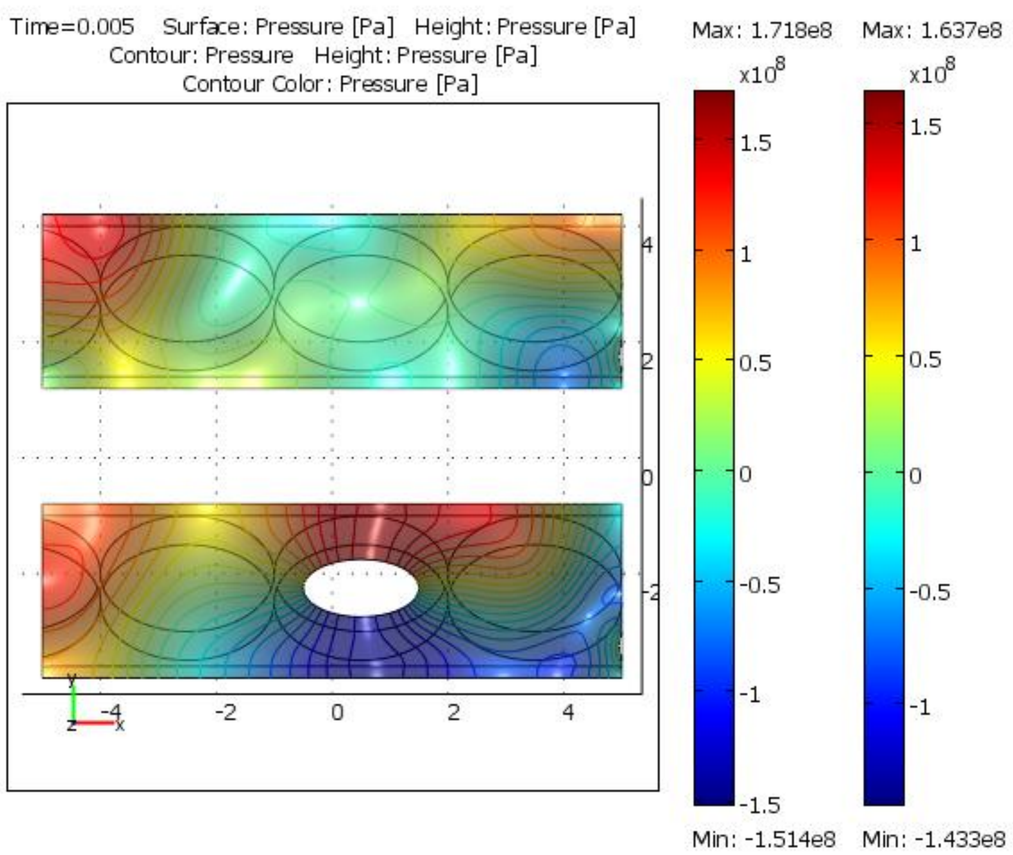

Figure 2. COMSOL model of acoustic waves propagation.

Gaussian acoustic pulse were applied for NDE of composites.

Results: Miniature DPC transducers were involved to physical testing:

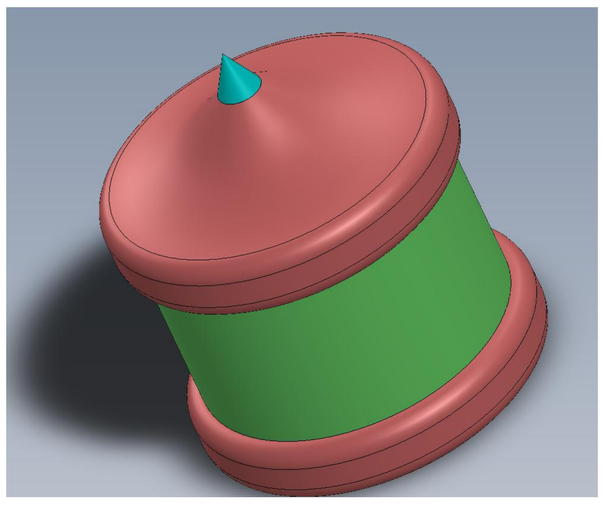

Figure 3. Miniature DPC transducers.

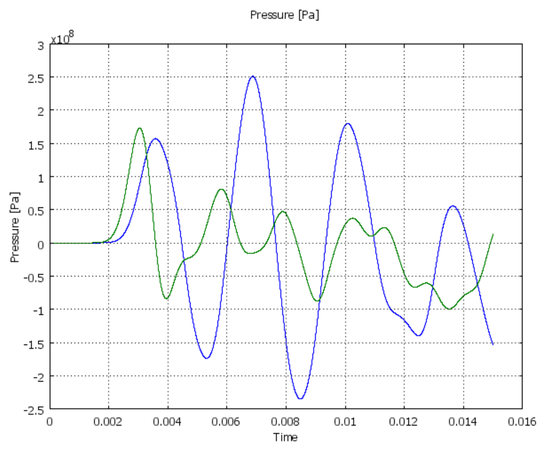

Figure 4. Patterns of bulk waves propagating through specimen without void (blue) and with void (green).

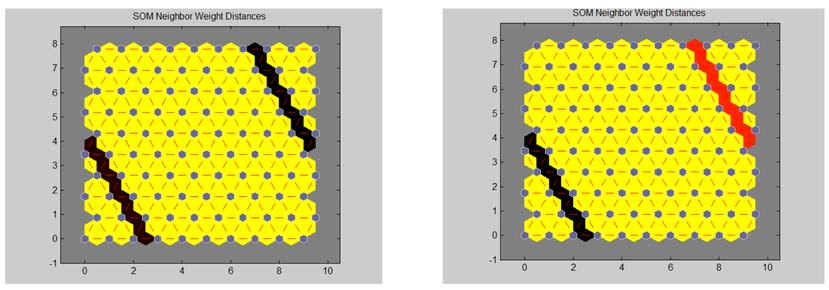

Figure 5. Patterns of AI neural network for bulk waves propagating through specimen without void (left) and with void (right) indicated in red.

Conclusions: analysis of the approach shows ability to detect voids with size 50 μm. MBD may allow finding solutions and optimization of design of NDE for smaller voids detection.

References:

1. Nesvijski, E., Dry Point Contact Transducers for Transfer Technology Applications. Proceedings: 1998 International Advanced Studies Institute (Science and Technology Series), Monterey, CA, February 10-13, 1998).
2. Nesvijski E., Model Based Design and Acoustic NDE of Surface Cracks, NDT.NET Journal: The e-Journal of Nondestructive Testing & Ultrasonics, No.9, 2011, (ISSN 1435-4934).

Excerpt from the Proceedings of the 2012 COMSOL Conference in Boston