Screen Printed Piezoelectric Transducers for Structural Health Monitoring of Curved Thick Composite Panels

Marc Rebillat*[1], Shweta Paunikar†[1], George Galanopoulos‡[2], Pierre Margerit[1], Ingo Wirth[3], Eric Monteiro[1], Dimitrios Zarouchas[2,4], and Nazih Mechbal[1]

[1]Arts et Métiers Institute of Technology, CNRS, CNAM, PIMM, HESAM Université, Paris, France – CNRS-PIMM, Arts et Métiers ParisTech, Paris – France

[2]Structural Integrity and Composites Group, Aerospace Engineering Faculty, Delft University of Technology, Delft, The Netherlands – Netherlands

[3]Fraunhofer Institute for Manufacturing Technology and Advanced Materials – Germany

[4]Center of Excellence in Artificial Intelligence for Structures, Prognostics and Health Management, Aerospace Engineering Faculty, Delft University of Technology, Delft, The Netherlands – Netherlands

Abstract

This research focuses on the development and experimental validation of a novel printed piezoelectric transducers network employed on a foreign object damage panel substructure of an aircraft engine fan blade. The main goal of the work is to leverage the screen printing technology to fabricate arrays of piezoelectric transducers and ultimately employ these transducers for operations, enabling the development of structural health monitoring methods for the panel. The printed transducer is made up of a piezoelectric layer sandwiched between two silver electrodes, each printed in a controlled manner. Upon printing and drying of the layers, the transducers undergo polarization. The electromechanical behaviour of the printed transducers, characterized using impedance measurements, exhibits high repeatability, thus indicating its potential for large scale industrial deployment. Following this, it is demonstrated that the transducers are capable of accurately sensing impact, which is one the most common yet critical sources of damage to an engine fan blade. It is also shown that the printed transducers are able to detect acoustic emission events. The ability of the printed transducers to actuate and sense guided wave signals over a range of ultrasonic frequencies is also demonstrated. Furthermore, apart from the noticeable advantages of the non-intrusive nature, and negligible weight as compared to their traditional ceramic counterparts, the printed piezoelectric transducers can potentially be integrated into the manufacturing process in the future, and the presence of transducer arrays ensures the availability of other transducers in case of an individual failure during service. This innovative printing technology for PZT transducer networks thus holds significant promise in bridging the gap between research advancements and the industrial implementation of SHM technology.

*Speaker

†Corresponding author: shweta.paunikar@ensam.eu

‡Corresponding author: G.Galanopoulos@tudelft.nl