Multi-element piezo-composite transducers for structural health monitoring

Author(s):

Erling Ringgaard, Denmark – affiliation(s): 1
Tomasz Zawada, Denmark – affiliation(s): 1
Thomas Porchez, France – affiliation(s): 2
Nabil Bencheikh, France – affiliation(s): 2
Ronan Le Letty, France – affiliation(s): 2

Affiliation(s) Description:

1) Meggitt Sensing Systems, Hejreskovvej 18A, 3490 Kvistgaard, Denmark
2) Cedrat Technologies SA, 15 Chemin de Malacher, Meylan, 38246, France

Abstract:

Structural Health Monitoring (SHM) is a general term for methods of detecting defects in structures before they become fatal. The typical areas of application cover aeronautics, civil engineering (buildings, bridges etc.) and recently also the automotive industry. One of the techniques used for SHM is based on the propagation of ultrasonic waves through a structure in order to assess its structural integrity. The common solution relies on the use of piezoelectric transducers to emit and receive ultrasonic waves. However, because of the high number of echoes and possible propagation modes within the structure, those applications require very extensive signal processing.
In this work we present an approach involving piezo-composite transducers dedicated to SHM in combination with specific electronics that has been developed and successfully tested for reducing the complexity of the detection schemes. This has been achieved by selecting the mode and direction of the Lamb waves. The array transducer comprises a row of eight independently driven PZT elements integrated in a polymer matrix, effectively forming a 2-2 composite. Dielectric and piezoelectric characterisation is presented and the obtained results confirm an excellent uniformity and performance of the tested devices. Moreover, additional results of Finite Element Method modelling are given. Functional characterisation at the system level shows that it has been possible to successfully distinguish waves propagating at different velocities, confirming the concept of mode selectivity using piezoelectric arrays.