

Acoustic Structural Health Monitoring Using an Array of Embedded Sensors

A.Sutin, P.Johnson, J.TenCate, A.Sarvazyan, G. Park, H.Sohn
Artann Laboratories, NJ and Los Alamos National Laboratory, NM Time Reversal

ABSTRACT

Time Reversal Acoustic (TRA) with an embedded sensor array represents a new approach to in-situ structural health monitoring. The TRA signals can be generated with embedded piezoceramic (PZT) actuators/sensors and focused to any point of the tested part. The ability of TRA to generate a highly focused and short ultrasonic signal from an array of nearby PZT sensors constitutes the basis of sensitive detection of structural faults. Scanning of the focused TRA signal can give information necessary for topographic mapping of damage and degradation. Preliminary experiments on composite structures with embedded sensors were conducted in Los Alamos National Laboratory and in Artann Laboratories, where a multi-channel TRA system was developed.

The following physical phenomena that can be used for damage detection and localization were observed:

1. Influence of damage parameters on the structure of the TRA compressed signals between two and more ultrasonic sensors.
2. Higher harmonic generation in the TRA focused signal due to presence of a crack.

The proposed novel TRA technology may have broad military and civilian applications for the quality control in manufacturing, assessment of structural integrity of materials prior to assembling, immediately following assembling, and during operational life. One of the most promising applications of new technique is -diagnosis of damage in fiber-reinforced composites used in aerospace industries.