Finite Element Analysis of Inhomogeneous Electric Potential and Mechanical Stress Distribution in Cymbal Piezocomposites.

P.Ochoa*, J.L.Pons^, M.Villegas* and J.F. Fernandez*
* Electroceramic department, Instituto de Cerámica y Vidrio, CSIC, 28049 Madrid, Spain.
^ Instituto de Automatica Industrial, CSIC, 28500 Arganda del Rey, Madrid, Spain.

Piezoelectric ceramics are widely used in many actuator and sensor applications. The piezoelectric ceramics present some limitation in their performance and were introduced in practical application as composite materials. Piezoelectric transducers with hollows allow to obtain low acoustic impedance, mass reduction, high sensitivity to weak hydrostatic waves and enlarged displacements through flextensional and rotational motions. Hollow piezocomposites clearly demonstrate the advantages of functional composites in the field of smart systems. The cymbal piezocomposite consists of a piezoelectric disk (poled in the thickness direction) sandwiched between two “cymbal-shaped” metal endcaps.

The objective of this work is the modelling of the electric potential and mechanical stress distributions to understand the performance of the cymbal piezocomposite. Finite Element Analysis of the cymbal was attempted using the ATILA® software package for both the resonant and the no-resonant modes.

The stress concentration have been proved reduce the performance of the cymbals and are on the origin of the further degradation issues. In order to minimise this effects a new geometry was developed that reduce this stress concentration. It is possible to eliminate part of the stress concentration by removing a portion of the ceramic where the maximum stress concentration is observed. Several ATILA® models were generated to analyse the stress distribution behaviour of cymbals with different grooves. The developed take into account the groove’s geometrical parameters to estimate their impact on the device’s behaviour. Unexpected high electric field concentration are observed associated to the mechanical stress of the resonant modes.

Beside the mechanical stress concentration, the electrical potential concentration may cause failures of the device under operation. Because of this, the electric potential distribution in the cymbal device was compared to the electric potential distribution in a single disk.