Characterization and modelling of 3D piezoelectric ceramic structures with ATILA software.

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Abstract

In this paper, correspondence between ATILA simulated and measured values of two piezoelectric ceramic structures; bulk and RAINBOW actuators were determined. Modelling began by creating a 2D wire-model of the structures, after that the 3D model was created and simulation parameters were introduced (electric potentials, polarizations, and boundary conditions). Harmonic type analyse was used in the simulations. Results obtained from the simulations contained information about displacements in the z-axis direction.

Displacements of the structures showed nonlinearity as a function of electric field in measured values. Accordingly, effective piezoelectric coefficients (ie. d_{31}, d_{33}) calculated from electric field and displacement changed nonlinearly. However, displacement results acquired from simulations are linear, since ATILA program uses a linear approach for calculation. This causes the modelling results to differ from the measurement results, especially when large voltages were used.

The problem was solved by modifying the constant parameters used in the simulations. In this paper, relative permittivity K_{33}, piezoelectric coefficient d_{33} and approximated piezoelectric coefficient d_{31} were used to obtain more accurate modelling results corresponding to the measurement results.

The differences of the z-axis displacements between modelling (using original material parameters) and measurement results with bulk and RAINBOW actuators were 6.5-17.7 % and 6.0-27.9 % respectively. With modified material parameters the differences were 1.1-1.6 % and 3.1-8.5 % respectively.

Keywords: ATILA; actuators; PZT; piezoelectric properties