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Studies on Magnetoelectric Effect for Magneto-Electro-Elastic Cylinder Using Finite Element Method

Atul Daga[1], N. Ganesan[2] and K. Shankar[3]

Summary

Composites made with piezoelectric and piezomagnetic phase not only have the original piezoelectric and piezomagnetic properties but also exhibit magneto electric coupling effect which is not present in its constituents, and are termed as magneto-electro- elastic (MEE) materials. This materials show a significant coupling between the mechanical, electrical and magnetic fields. One example of such material is a composite made of a piezoelectric phase i.e. Barium Titanate ($BaTiO_3$) as the embedded material and piezomagnetic phase i.e. Cobalt Ferrite ($CoFe_2O_4$) as the matrix material. The magnetoelectric coupling is a new property of this composite which is not present in its individual phase. The study for ME effect in structures made of such materials is widely useful for the design of devices for the modulation of amplitudes, polarization and phases for optical waves, ME data storage and switching, optical diodes, spin wave generator etc.

In this paper semianalytical finite element formulation is presented to study the magnetoelectric effect for a multilayered and multiphase magneto-electro-elastic cylinder under various boundary conditions. An external magnetic field is applied and the maximum output voltage within the structure is evaluated. Numerical studies have been done to evaluate the magnetoelectric coefficient for different thickness ratio of piezoelectric phase in the multilayered composite. Studies have also been done for the evaluation of magnetoelectric coefficient for different volume fractions of piezoelectric phase in the multiphase composite. The effect of magnetic field applied along and perpendicular to the polarization direction of the structure is also studied. Ansys 8.1 is used to validate the present formulation using thermal analogy concept for a multilayered magneto-electro-elastic cylinder.

[1]Research Scholar, IIT Madras, Chennai, INDIA
[2]Professor, IIT Madras, Chennai, INDIA
[3]Assistant Professor, IIT Madras, Chennai, INDIA. skris@iitm.ac.in