Study on magnetoelectric response due to flexoelectricity and flexomagnetism coupling in multiferric composites

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Abstract

This paper presents the constitutive modeling of the magnetoelectric (ME) response in multiferric composites involving in an electric field generated in the presence of inhomogeneous strain induced by applied magnetic field. The governing equations and associated mechanical, magnetic and electric boundary conditions are derived using variational principle. The coupling response arising only from the interaction between flexoelectricity and flexomagnetism of laminated multiferric composites, called flexo-magnetoelectric (FME) effect, may be evaluated using these constitutive relations and solving the obtained governing equations with a specific boundary conditions. Following this, the FME effect over bending response of a laminated nanobeam is analyzed by solving these differential equations. The numerical results show that the FME effect will be of significance in the nano-thick composite structures, which wanes as the geometric dimensions are increased to macroscale. In addition, The FME effect is influenced by mechanical boundary conditions, material constant and geometric parameters at different levels via the change in strain gradient. The theory for FME effect proposed here may be utilized in the development of smart ME nano-structures without using piezomagnetic and piezoelectric materials, since flexomagnetism and flexoelectricity is also exhibited by the centrosymmetric ferroics where piezomagnetic and piezoelectric tensors would be zero.

Keywords: Flexoelectricity, Flexomagnetism, Strain gradient