EB02

Field directional Dependences of Magnetoelectric Behaviors in Magnetostrictive/pizeoelectric Laminate Composites

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The magnetoelectric (ME) effect of a magnetostrictive/piezoelectric (MP) laminate composite is realized by the "product property", i.e., in a magnetic field, mechanical stresses occurred in the magnetostrictive layer are transferred to the piezoelectric layer where they produce an electric field due to the piezoelectric effect. Previous reported investigations of ME laminates have focused on that the magnetic field (both DC magnetic bias H_{dc} and AC magnetic field H_{ac}) is applied parallel or perpendicular to the oriented direction [1]. However, the magnetostrictive effect has inherent anisotropic behaviors. The magnetostrictive strain occurs while magnetic domains in the material align with the applied magnetic field. It strongly depends upon the direction of the applied magnetic field.

In this study, the induced ME behaviors in various working modes (as shown in Fig.1) are investigated. Rectangular shaped Terfenol-D and piezoelectric $Pb(Zr,Ti)O_3$ (PZT) are used to fabricate the sample. The Terfenol-D and PZT plates are respectively oriented in length direction and poled in thickness direction. The ME voltage coefficients in various working modes are investigated over frequency in various H_{dc} superimposed with H_{ac}=1Oe. The experimental results indicate that the ME voltage coefficients over frequency in the mode (d) and (e) have more peaks than those in mode (b) and (c). In addition, the ME behaviors in different modes show distinct H_{dc} dependence. It is importantly necessary to note the anisotropic ME behaviors, especially for that the ME laminate composites are used for magnetic field sensing.

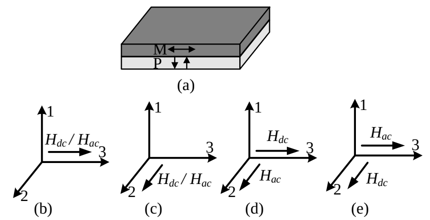

Fig. 1. (a) Illustration of the ME laminate composite; (b) ~ (e) the definition of local coordinate and the applied direction of H_{dc} and H_{ac} for various working modes. (b) both H_{dc} and H_{ac} are parallel to the length direction; (c) both H_{dc} and H_{ac} are perpendicular to the length direction; (d) the H_{dc} is parallel to the length direction while H_{ac} is perpendicular to the length direction; (e) the H_{dc} is perpendicular to the length direction while H_{ac} is parallel to the length direction.

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EB03

Optical Spectroscopic Investigations on Multiferroic $MnWO_4$

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Multiferroic oxide materials with intrinsic magnetoelectric coupling have been drawing considerable amount of interests both scientifically and technologically. Among multiferroic oxides, $MnWO_4$ is known to exhibit ferroelectricity between 7.6 K and 12.7 K, which is induced by its incommensurate elliptical spiral magnetic ordering [1]. In this study, we report optical spectroscopic investigations on $MnWO_4$. We grew single crystals of $MnWO_4$ using floating zone method. To examine the optical anisotropy originating from the monoclinic crystal structure, we measured reflectivity spectra of $MnWO_4$ with light polarizations along three crystallographic axes, and calculated the optical conductivity spectra through the Kramers-Kronig transformation for each axis. We identified the anisotropic phonon structures and electronic structures with temperature and magnetic field dependence. The possible existence of electromagnon, and intriguing feature in the electronic structure correlated with the magnetic structure have been also discussed in relation to its multiferroic properties.

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