

MULTISCALE NUMERICAL STUDY ON ORIGIN OF MAGNETOELECTRIC EFFECT

Y. Uetsuji¹ and T. Wada²

¹ Department of Mechanical Engineering, Osaka Institute of Technology,
5-16-1 Omiya, Asahi-ku, Osaka 535-8585, Japan,
yasutomo.uetsuji@oit.ac.jp and <http://www.oit.ac.jp/med/~uetsuji/index.html>

² Graduate School, Osaka Institute of Technology,
5-16-1 Omiya, Asahi-ku, Osaka 535-8585, Japan,
m1m15430@yahoo.co.jp

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A multiscale numerical investigation into the origin of the magnetoelectric effect in multiferroic composite materials was performed. An asymptotic homogenization theory was employed for scale bridging to analyze macroscopic homogenized physical properties and microscopic response against external loads. Focusing first on a polycrystalline multiferroic composite, the relation between the physical properties and the ferroelectric-phase content was investigated. A uniform magnetic field was then applied to the macrostructure and the mechanical strain in the microstructure was investigated. The specific strain component exhibited an off-centered distribution when divided into ferroelectric and ferromagnetic phases. The simulation revealed that the macroscopic magnetoelectric effect is determined by two factors, the shift of the average strain from zero and the homogenized piezoelectric constant. The macroscopic magnetoelectric effect increases as the product of these two factors increases. This conclusion is applicable to other inhomogeneous structures and it can explain the trend in the magnitude of the magnetoelectric effect for a random polycrystalline structure, a layered polycrystalline structure, and a layered single-crystal structure. The findings are helpful for the functional design of multiferroic composite materials.

REFERENCES

- [1] Y. Uetsuji, T. Wada, Y. Uekita, J. Terada and K. Tsuchiya, Computational and experimental investigation of the crystal orientation control effect on the electric permittivity and magnetic permeability of multiferroic composite materials. *Acta Mechanica*, Vol. **228**, pp.2879-2893, 2017, DOI: 10.1007/s00707-015-1526-9.
- [2] Y. Uetsuji, T. Wada and K. Tsuchiya, Statistical investigation of homogenized physical properties of polycrystalline multiferroic composites materials. *Acta Mechanica*, DOI: 10.1007/s00707-017-2018-x.