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Static and Dynamic Magnetoelectric Effects in Multiferroic Hexaferrites

SAE HWAN CHUN[1], Department of Physics and Astronomy, Seoul National University, South Korea

Multiferroics, wherein magnetism and ferroelectricity coexist, are of great interest for the prospect of new multifunctional devices by utilizing cross-coupling between the electric and magnetic properties. In most multiferroics currently known, however, the magnetoelectric (ME) coupling does not reach the level enough for the practical applications and the cross control of electric polarization by magnetic field or magnetization by electric field has been realized only at low temperature. Hence, for use in the ME devices, it is essential to increase both the ME sensitivity and the operating temperature. From investigation of multiferroic hexaferrites, we discover a chemical route to effectively tailor the critical magnetic field inducing electric polarization in $(Ba,Sr)_2Zn_2Fe_{12}O_{22}$ (Zn_2Y-type) by Al-substitution, yielding a giant magnetoelectric susceptibility [1]. In $(Ba,Sr)_3Co_2Fe_{24}O_{41}$ (Co_2Z-type) hexaferrite single crystals, we realize the control of magnetization by electric field at room temperature [2]. In addition to those static ME properties, a dynamic ME effect, electric-dipole-active magnon resonance in THz frequency range, is also found in the Co_2Z-type hexaferrite, exhibiting the spectral weight even at room temperature [3]. The unprecedented supreme static and dynamic ME phenomena in the hexaferrites may provide a pathway to overcome the challenge in application of multiferroics for the real devices.

[1] S. H. Chun et al., Phys. Rev. Lett. 104, 037204 (2010).
[2] S. H. Chun et al., Phys. Rev. Lett. 108, 177201 (2012).
[3] S. H. Chun et al., in preparation.

[1]Currently at Materials Science Division, Argonne National Laboratory, Argonne, IL 60439