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Magnetic Twists for Ferroelectricity

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Lattice relaxation in magnetically-ordered states with broken inversion symmetry through exchange-striction can induce non-centrosymmetric lattice distortions, leading to the presence of electric polarization. In these magnetically-driven ferroelectrics, dielectric properties turn out to be highly susceptible to applied magnetic fields. Both symmetric and antisymmetric exchange coupling can be involved in the exchange-striction. Magnetically-driven ferroelectrics with the symmetric coupling are associated with acentric spin density wave (SDW) states, and the antisymmetric coupling, relevant to the Dzyaloshinskii-Moriya-type interaction, becomes active when ferroelectricity is induced by spiral magnetic orders. A few examples of magnetically-driven ferroelectrics, exhibiting high tunability of dielectric properties in magnetic fields, will be discussed.

REFERENCES

[1] Jang, Y. Kim, and R. Kruse, phys. stat. sol. (a), 1, 1 (1999).

[2] Lee, T. Lim, and M. Hong (eds.), Computer Simulation of Materials at Atomic Level (Wiley-VCH, Berlin, 2000), p. 890.

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Ferroelectrics Induced by Spiral Magnetism

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Recently, a new class of magnetoelectric multiferroics such as $TbMnO_3$ and $Ni_3V_2O_8$ has been discovered [1,2]. In these systems, ferroelectric order develops upon a magnetic phase transition into a spiral magnetic ordered phase. Thus, the noncollinear spiral magnetism is the key to understanding the ferroelectric and magnetoelectric properties in these systems. In spiral magnets, inversion symmetry is broken owing to magnetic order, and some spiral-ordered structures such as a cycloidal one make the system polar [3]. This means that a magnetic order can induce ferroelectricity. The ferroelectricity in the new class of magnetoelectric multiferroics can be explained in terms of this scheme. Because spiral order often arises from the competition between nearest-neighbor and further-neighbor magnetic interactions, systems containing competing magnetic interactions (spin frustration) are promising candidates for magnetoelectric multiferroics. Thus, it is no longer so difficult to find new magnetoelectric multiferroics. Indeed, on the basis of this strategy several new magnetoelectric multiferroics related to spiral magnetic orders have been discovered in the past few years. However, most of them operate only at low temperatures ($<\sim 40$ K). This is mainly because competing magnetic interactions that play a role in producing spiral magnetic structures often reduce the magnetic ordering temperature. In my talk, I discuss a trial to develop new magnetoelectric multiferroics, in particular at high temperatures.

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REFERENNCES

[1] T. Kimura, T. Goto, H. Shintani, K. Ishizaka, T. Arima, and Y. Tokura, Nature 426, 55 (2003).

[2] *G. Lawes, A. B. Harris, T. Kimura, N. Rogado, R. J. Cava, A. Aharony, O. Entin-Wohlman, T. Yildirim, M. Kenzelmann, C. Broholm,* and A. P. Ramirez, Phys. Rev. Lett. 95, 087205 (2005).

[3] H. Katsura, N. Nagaosa, and A. V. Balatsky, Phys. Rev. Lett. 95, 057205 (2005).