

Origin of the Magnetodielectric Effect and the Magnetostriction in Terbium Iron Garnets

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Multiferroics induced by unusual magnetic structures lead to extensive theoretical and experimental studies. The driving force for these magnetic multiferroics has been known to lie in the inverse Dzyaloshinskii-Moriya (DM) interaction in magnets with long wavelength “non-collinear” spin structures. Here, we report experimental observations supporting the induction of antiferroelectricity in terbium iron garnet with a non-collinear spin structure in a single unit cell, through the similar DM interaction. The effects of magnetism on the lattice are demonstrated by the magnetodielectric effect in magnetically induced antiferroelectrics and the huge magnetostriction. We attribute the observed magnetodielectric effects and the magnetostriction to the magnetic field induced spin structure change from non-collinear to collinear, which weakens the antiferroelectric distortion. Our results suggest a new class of multiferroics, “ferromagnetic-antiferroelectric multiferroics” and are expected to enrich the theoretical understanding of phenomena related with unusual magnetic structures.