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# DOMAIN DYNAMICS IN MULTIFERROICS

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Spin-spiral multiferroics exhibit a strong coupling between the electric and magnetic subsystems which is of potential interest for technological applications. Although these systems have been investigated for more than a decade, the magnetoelectric domain evolution under external fields is still largely unknown. Using optical second harmonic generation (SHG) microscopy we resolve how electric, magnetic, and optical fields affect the multiferroic domains in the archetypal spin-spiral multiferroic $TbMnO_3$. In consecutive electric switching cycles, varying multi-domain patterns emerge before a single-domain state is obtained. This observation reflects that the domain walls can easily move without being pinned by, e.g., structural defects. In striking contrast to the electric-field response, multi-domain patterns persist when the polarization direction is flopped by applied magnetic fields. Here, a uniform polarization rotation is observed within all domains, which incorporates a transformation of neutral into nominally charged domain walls. Landau-Lifshitz-Gilbert simulations reveal that this behavior is intrinsic and provide first evidence for the scalability of macroscopic magnetoelectric properties onto the level of domains. Furthermore, in a proof-of-principle experiment we demonstrate that reversible optical switching of multiferroic order parameter is possible by using light pulses of two different colors, which leads to sequential laser-controlled writing and erasure of multiferroic (antiferromagnetic spin-spiral) domains. Opto-magnetism is thus complemented by an important degree of freedom, namely local control of antiferromagnetism by means of light.

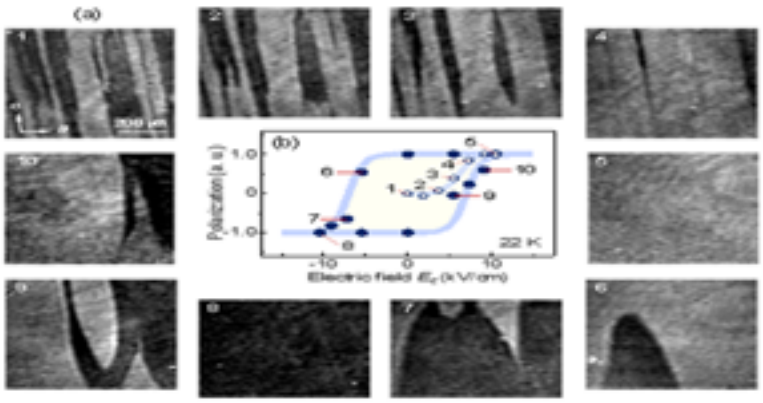


Fig.1: Electric-field control of multiferroic domains in $TbMnO_3$. (a) Progression of multiferroic domain structure in a cycled electric field Ec along the c axis. Bright and dark regions correspond to +Pc and –Pc domains, respectively. (b) Ferroelectric hysteresis loop derived from the areal ratio of +Pc to –Pc domains in SHG images.

## BIOGRAPHY

Masakazu Matsubara has completed his PhD from University of Tokyo, Japan. He is the Associate Professor of Tohoku University, Japan.

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