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Laboratoire d'OPTIque et de MAGnétisme (OPTIMAG), Brest

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Mechanical, electrical and optical control of magnetization reversal and spin dynamics in extrinsic multiferroics

A way to achieve energy-efficient information processing, computation, communication or signal generation is using magnetostrictive nanostructures, and manipulating their magnetic anisotropy through strain [1]. Many studies on magnetic Straintronics for energy savings involve a family of materials named extrinsic multiferroics (ExMF), combining a piezoelectric material and a magnetostrictive one The research concerning this family has attracted a lot of interest in the last few decades [2]. Therefore, it is of interest to understand the fundamental mechanisms driving the strain and magnetic coupling in ExMF thin films. Also, the magnetostriction (MStr) properties are key properties used in different applications and devices, such as actuators and energy-harvester spintronic devices. Among the different MStr alloys, Fe1-xGax, discovered in 2000 by Clark [3], has received particular attention as it exhibits remarkable properties, such as low magnetic hysteresis, large magnetostriction, good tensile strength, machinability and recent advances in commercially viable methods of processing. (pas utile) In this regard, the present study focuses on the strain-mediated control of the FeGa magnetization reversals (MR), with different stimuli (mechanical, electrical and optical), for FeGa thin film grown onto different substrates by RF sputtering [4] .

Firstly, Fe81Ga19 films were grown on flexible aluminum kitchen foil, and the strain-mediated mechanical control of MR was achieved and studied through the deposition onto spherical optical lenses [5] to impose different bending radius of curvature. Secondly, Fe81Ga19 films were grown on piezoelectric PMN-PZT and the strain-mediated electric field control of the magnetization reversal was probed and studied on the samples[6]. Finally photostrictive manipulations of static and dynamic magnetic properties are demonstrated in this (PMN-PZT/Fe81Ga19) extrinsic multiferroic composite. The converse magneto-photostrictive effect (CMPE) strength is analyzed with a novel physical coefficient named the converse magneto-photostrictive coupling coefficient [7].

[1] Bukharaev,el al, Y. K. Straintronics: a new trend in micro- and nanoelectronics and materials science. Physics-Uspekhi 2018, 61, 1175–1212.[2] Spaldin, N. A.; Fiebig, M. The Renaissance of Magnetoelectric Multiferroics. Science 2005, 309, 391–392.[3] A. E. Clark, el al IEEE Trans. onMagn., Vol. 36, p.3238 (2000)[4] Walaa et al (2019). Physical Review Applied. 12.10.1103/PhysRevApplied.12.024020 [5] F. Legall, el al (2021). Phys. Rev. Applied 15, 044028 10.1103/PhysRevApplied.15.044028[6] W. Jahjah el al, (2020). Phys. Rev. Applied 13, 034015 10.1103/PhysRevApplied.13.034015[7] M. Liparo et al cond-mat > arXiv:2206.12703

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