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Magnetoelectric coupling in Ni/$BiFeO_3$ bilayers

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We report a reversible and non-volatile magnetoelectric (ME) effect in Ni/ $BiFeO_3$ bilayers. A very large modulation of the magnetic coercive field of the Ni layer is obtained by electrical poling of the ferroelectric $BiFeO_3$ (BFO) layer. The ME effect is nonvolatile, reversible and cyclable. The repeatability of the effect is demonstrated up to 250 polarization switching cycles at room temperature which is promising for applications in the field of spintronics.

Interleaving a thin dielectric $SrTiO_3$ (STO) film between Ni and BFO reveals a strain-mediated origin of the ME coupling in this system by disregarding direct interface effects. A controlled transition of the ME curve from a rectangular shape hysteresis loop with two non-volatile remanent states to a conventional butterfly-like hysteresis loop is obtained by tuning the thickness of the dielectric spacer. The non-volatility of the ME effect in the Ni/BFO bilayer is explained by an asymmetric piezoelectric strain response of the ferroelectric film with respect to the applied electric field, yielding two different states at remanence.

[1]) C. Daumont, J. Wolfman, C. Autret-Lambert, P. Andreazza, B. Negulescu, Appl. Phys. Lett. 112, 112401 (2018).
[2] B. Negulescu, , J. Wolfman, A. Ruyter, C. Autret-Lambert**,** Salia Cherifi-Hertel, JMMM 526, 167689 (2021).

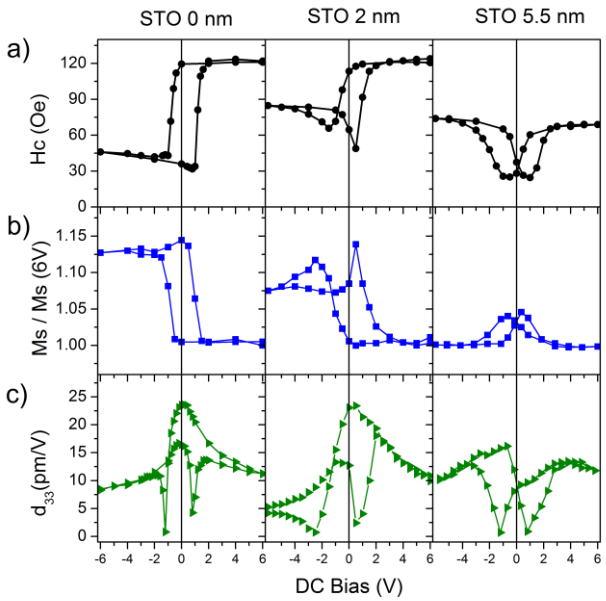

Figure 1 : a) Magnetic coercivity Hc (black circles), b) Saturation magnetization Ms, normalized to the Ms value at +6 V (blue squares) and c) piezoelectric d_{33} (green triangles) variations with the DC voltage for three different STO spacer thicknesses: 0 nm, 2 nm, and 5.5 nm.