

Low-voltage control of tunnel magnetoresistance (TMR) in LSMO/BTO/Co/Pt multiferroic junction

J. Pawlak,^{1,2} J. Kanak,² and W. Skowroński²

¹*Academic Centre for Materials and Nanotechnology,
AGH University of Krakow, Krakow, Poland*

²*Institute of Electronics, AGH University of Krakow, Krakow, Poland*

Nanodevices with the magnetoelectric effect are part of a broader research trend aimed at utilizing ferroelectricity for information writing and magnetoelectric and spin effects for information reading [1]. Compared to contemporary electronic memories, such devices promise lower energy consumption and higher operating speeds.

In this work, we present the magnetoelectric effect in nanodevices based on multiferroic tunnel junctions (MFTJs). The investigated MFTJ structure is LSMO/BTO/Co/Pt, with a bottom ferromagnetic oxide electrode $\text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_3$, a ferroelectric BaTiO_3 tunnel barrier, and a top electrode consisting of a ferromagnetic/heavy metal system (Co/Pt) grown by pulsed laser deposition [2].

We report, for the first time, the observation of tunnel magnetoresistance (TMR) at room temperature in LSMO/BTO/Co junctions, similar to previously reported junctions with Fe-based top electrodes [3]. The TMR effect was measurable only for one polarization of the ferroelectric. Furthermore, at $T = 19$ K, a tenfold change in the TMR was observed depending on the bias voltage. Linear changes in the TMR occurred within a small voltage range from -0.1 V to 0.1 V, reaching saturation beyond this range, which is attractive for low-voltage applications [4]. This effect was reproducible under repeated voltage cycles across different devices and samples.

References:

- [1] S. Manapatruni et al., *Nature Physics* 14 (2018) 338
- [2] J. Pawlak et al., *Advanced Electronic Materials* 9 (2023) 2300122
- [3] J. Pawlak et al., *Advanced Electronic Materials* 8 (2022) 2100574
- [4] Y. Jiang et al., *Nature Materials* 21 (2022) 779

The Project is partially supported by the National Science Centre, Poland Project no.2021/40/Q/ST5/00209 (Sheng) and the Excellence initiative-research university (IDUB) programme of the AGH University of Krakow