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Submicronic Spatial Mapping of Magnetoelectric Coupling in an Electronically Inhomogeneous System GERVASI HERRANZ, ONDREJ VLASIN, NICO DIX, FLORENCIO SANCHEZ, Institute of Materials Science of Barcelona, ICMAB-CSIC — Electric-field control of data stored in magnetic units prefigures a promising alternative to nowadays conventional electronics. A development of such technology demands a complete understanding of the dynamics and magnetoelectric response at small scales. Yet, present experimental approaches are hampered by the extreme difficulty of having simultaneous access to magnetism and ferroelectricity. Here we present an innovative approach that exploits optics to achieve a magnetoelectric coupling mapping with unprecedented resolution. More specifically, we used the effects that ferroelectricity and magnetism exert on light polarization, by electro-optic and magneto-optic effects, respectively. The analysis was performed at room temperature in a Pt(10 nm)/$BaTiO_3$ (120 nm)/$La_{2/3}Sr_{1/3}MnO_3$ (15 nm) trilayer. We uncovered a stunningly large coupling by which the magnetization was modulated by up to above 50%. The magnetoelectric coupling was, however, distributed non uniformly with micron-scale inhomogeneities. The origin of such a large effect is discussed in terms of electric-field modulation of competing electronic phases in $La_{2/3}Sr_{1/3}MnO_3$. Additionally, our work emphasizes the potential of intrinsically electronically inhomogeneous systems for large magnetoelectric responses.

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