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Direct Mapping of Magnetic and Structural Profiles of Electric Field Moderated Oxygen Migration DUSTIN A. GILBERT, ALEXANDER J. GRUTTER, BRIAN J. KIRBY, JULIE A. BORCHERS, BRIAN B. MARANVILLE, National Institute of Standards and Technology, ELKE ARENHOLZ, Lawrence Berkeley National Laboratory, KAI LIU, University of California, Davis — Recent studies on metal/oxide heterostructures have demonstrated control of interfacial magnetic anisotropy and saturation magnetization in ultrathin (5 ML) Co films through electric-field controlled oxygen migration. This approach presents a promising route to realizing next-generation, ultralow power sensor and data-storage technologies. Here we demonstrate magnetoelectric coupling moderated by electrically-driven oxygen migration in much thicker AlOx(1 um)/GdOx(2 nm)/Co (15 nm) heterostructures. Using polarized neutron reflectometry, we present direct, quantitative depth profiling of the magnetization and oxygen concentration in these systems. Electro-thermal conditioning moves oxygen from AlOx and GdOx baselayers throughout the entire thickness of the 15 nm Co layer, resulting in a suppressed magnetization. Switching the electric field polarity semi-reversibly ejects oxygen preferentially from the GdOX/Co interface, partially recovering the magnetization and establishing a practical limit to this approach. First order reversal curve diagrams show that the conditioned samples exhibit two distinct magnetic phases, while the as-grown samples are single phase, suggesting that the treatments alters the Co film microstructure. X-ray spectroscopy confirms the oxidation states of the Co and Gd, and suggest that the GdOX acts to transmit oxygen but does not source or sink it.

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