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Nonlinear Insulator in Complex Oxides ZHIQI LIU, T. VENKATESAN, A. ARIANDO, NANOCORE, NUS TEAM, NTU COLLABORATION — For complex oxides, the very concept of an insulator must be re-examined as they behave differently from conventional insulators such as SiO_2 due to the presence of multiple defect levels within bandgap. As the semiconductor industry is moving to such oxides for high-k materials, we need to truly understand the insulating properties of them under various electrical excitations. We report a class of material which we coin as nonlinear insulators that exhibit reversible electric-field-induced metal-insulator transitions (MIT). We show this behaviour for an insulating $LaAlO_3$thin film with a large bandgap of $\sim$5.6 eV in a metal/$LaAlO_3$/Nb-$SrTiO_3$ heterostructure. The reversible MIT is attributed to the formation of a quasi-conduction band (QCB) in the defect states of $LaAlO_3$ that forms a continuum state with the conduction band of the Nb-$SrTiO_3$. An opposing voltage is required to deplete the charges from the QCB. The implications of these nonlinear insulators are far-reaching. For example, the use of multi-component oxides as insulators in devices (e.g., high-k dielectrics in silicon CMOS devices) must be exercised with caution.

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