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Thickness dependence of ferroelectric stability in $SrRuO_3/BaTiO_3/La_{0.7}Sr_{0.3}MnO_3$ ferroelectric tunnel junctions J. D. BURTON, EVGENY TSYMBAL, University of Nebraska - Lincoln — Ferroelectric tunnel junctions (FTJs) must meet key requirements in order to become viable device structures. One factor which can limit functionality is the thickness of the ferroelectric layer. The ferroelectric must be thin enough that a detectable tunnel current can flow through it, but if it is too thin, screening of the depolarization field by the electrodes will be insufficient for polarization stability. One mechanism to produce a large change in the tunneling resistance, i.e. a large tunneling electro resistance (TER), is to use asymmetric electrodes. This is disadvantageous from the point of view of switchability, however: the electric field due to the mismatch between metal work functions leads to a preference for one polarization state over the other and, in thinner FTJs, may render one of the polarization states unstable. To explore this effect we perform first-principles density functional calculations on $SrRuO_3/BaTiO_3/La_{0.7}Sr_{0.3}MnO_3$ (SRO/BTO/LSMO) FTJs with varying BTO thicknesses. We find an energetic preference for polarization to point away from the LSMO electrode. FTJs with BTO thicknesses at or below 4 unit-cells polarization pointing toward LSMO is unstable, and therefore are unswitchable. Analysis reveals that, in addition to the work function mismatch, the difference in screening lengths and the intrinsic layer-by-layer polar nature of LSMO play a significant role in this instability. We will also present an analysis of these effects on the tunneling barrier profile as well as on the TER effect.

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