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Multiferroic tunnel junctions: Prediction of four resistance states from first-principles J.P. VELEV, University of Puerto Rico, C.-G. DUAN, East China Normal University, J.D. BURTON, University of Nebraska, A. SMOGUNOV, Intl. Centre for Theoretical Physics, Trieste, Italy, M.K. NIRANJAN, University of Nebraska, E. TOSATTI, Intl. Centre for Theoretical Physics, Trieste, Italy , S.S. JASWAL, E.Y. TSYMBAL, University of Nebraska — Electron tunneling and ferroelectricity have had long but separate histories. In the past decade both attracted significant interest due to application in electronic devices such as magnetic tunnel junctions (tunneling) and ferroelectric capacitors (ferroelectricity) relevant to non-volatile random-access memories. Recently, driven by demonstrations of ferroelectricity in ultrathin films, it was proposed to combine these two phenomena in a multiferroic tunnel junction (MFTJ) utilizing a ferroelectric barrier between two magnetic electrodes. Due to sensitivity of the conductance to both the magnetization alignment of the electrodes (magnetoresistance) and orientation of the polarization in the ferroelectric barrier (electroresistance), this junction can serve as a four-state resistance device. Here based on first-principles calculations we demonstrate the existence of the four resistance states in $SrRuO_3/BaTiO_3/SrRuO_3$ MFTJs with asymmetric interfaces. We find that the resistance of such a MFTJ is significantly changed when the electric polarization of the barrier is reversed and/or when the magnetizations of the electrodes are switched from parallel to antiparallel. These results reveal exciting prospects of MFTJs for application in multifunctional electronic devices.

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