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Characterization of Electrical Transport across Ultra-Thin $SrTiO_3$ and $BaTiO_3$ Barriers in Tunnel Junctions

Authors : Henry Navarro, Martin Sirena, Nestor Haberkorn

Abstract : We report the electrical transport through voltage-current curves (I-V) in tunnels junction $GdBa_2Cu_3O_7$-d/ insulator/ $GdBa_2Cu_3O_7$-d, and Nb/insulator/ $GdBa_2Cu_3O_7$-d is analyzed using a conducting atomic force microscope (CAFM) at room temperature. The measurements were obtained on tunnel junctions with different areas (900 μm², 400 μm² and 100 μm²). Trilayers with $GdBa_2Cu_3O_7$-d (GBCO) as the bottom electrode, $SrTiO_3$ (STO) or $BaTiO_3$ (BTO) as the insulator barrier (thicknesses between 1.6 nm and 4 nm), and GBCO or Nb as the top electrode were grown by DC sputtering on (100) $SrTiO_3$ substrates. For STO and BTO barriers, asymmetric IV curves at positive and negative polarization can be obtained using electrodes with different work function. The main difference is that the BTO is a ferroelectric material, while in the STO the ferroelectricity can be produced by stress or deformation at the interfaces. In addition, hysteretic IV curves are obtained for BTO barriers, which can be ascribed to a combined effect of the FE reversal switching polarization and an oxygen vacancy migration. For GBCO/ BTO/ GBCO heterostructures, the IV curves correspond to that expected for asymmetric interfaces, which indicates that the disorder affects differently the properties at the bottom and top interfaces. Our results show the role of the interface disorder on the electrical transport of conducting/ insulator/ conduction heterostructures, which is relevant for different applications, going from resistive switching memories (at room temperature) to Josephson junctions (at low temperatures). The superconducting transition of the GBCO electrode was characterized by electrical transport using the 4-prong configuration with low density of topological defects and with Tc over liquid N_2 can be obtained for thicknesses of 16 nm, our results demonstrate that GBCO films with an average root-mean-square (RMS) smaller than 1 nm and areas (up 100 um²) free of 3-D topological defects can be obtained.

Keywords : thin film, sputtering, conductive atomic force microscopy, tunnel junctions
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