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Quasi-two-dimensional electron system at the interface between antiferromagnet $LaMnO_3$ and ferroelectric $Ba_{0.8}Sr_{0.2}TiO_3$

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It has been shown that analogous to the ionic polar discontinuity, the quasi two dimensional electron gas (q2DEG [1]) may be created at an interface due to electric polarization discontinuity [2,3]. A two dimensional electronic gas (2DEG) is formed in the STO layers next to the interface which becomes superconducting below a temperature of 300 mK [1,4]. Remarkably, the superconducting state coexists with a magnetic state being stable up to the room temperature. Ferroelectrics are attractive materials for such purpose. They have a wide range of different distinctive properties, among them: spontaneous polarization switching, high dielectric permeability, dielectric nonlinearity, piezo- and pyro- activity, linear and quadratic electro-optical effects. That can expand the scope of application in nanoelectronics. The direction of such polarization in the ferroelectric film might be switched by an external electric field.

Antiferromagnetic $LaMnO_3$ might be transferred to ferromagnetic state by increasing the concentration of free carriers by injection. This means that increasing the free change carriers might lead to the local ferromagnetic state and magneto-resistivity in a system with 2DEG. Therefore, there is an opportunity to switch both conductivity by an electric field (trigger effect), and the magnetic order (magnetoelectric effect) in the heterostructures similar to BTO/LMO.

In the present work the thin film of epitaxial $Ba_{0.8}Sr_{0.2}TiO_3$ (BSTO) was sputtered on the top of single crystalline $LaMnO_3$ samples using the magnetron sputtering technique. Conductivity measurements were performed by a four-point probe method. Measurements were performed for three types of samples: (1) sample N_1 is a heterostructure based on single crystalline LMO with a BSTO film on top of it (*c* axis of LMO is parallel to the deposition plane); (2) sample N_2 is a heterostructure based on single crystalline LMO with a BSTO film on top of it (*c* axis is perpendicular to the deposition plane); (3) samples N_{01} and N_{02} are single crystals LMO without films with polarization axis as in the cases of N_1 and N_2, respectively.

Our measurements demonstrated that the resistivity of samples with deposited film of BSTO decreases strongly, and below the temperature of 160 K passes to a metallic-like behavior. The results of optical investigations of BSTO/LMO heterostructure are presented. In the case of the *c* axis perpendicular to the film surface the substrate has a compressive effect on the film.

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