High temperature superconductivity at the interface $Ba_{0.8}Sr_{0.2}TiO_3/La_2CuO_4$

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A high-mobility electron gas was observed in 2004 [1] at the interface of heterostructure $LaAlO_3$ (LAO) and $SrTiO_3$ (STO). Such heterointerfaces involving two insulating nonmagnetic oxides were comprehensively studied. In particular, it was found that the metallic phase (quasi-two-dimensional electron gas, 2DEG) is formed in the STO layers at the LAO/STO interface when the number of LAO layers is larger than three [2]. Such a system undergoes a transition to a superconducting state at temperatures below 300 mK [3].

Here we report the tailoring quasi-two-dimensional electron gas (q2DEG) state as well as a high-T_C quasi-two-dimensional superconductivity (HTq2DSC) in heterostructure $Ba_{0.8}Sr_{0.2}TiO_3/La_2CuO_4$ consisting of an insulating ferroelectric film deposited by magnetron sputtering on a *non*-atomically-flat surface of an insulator single crystal. We have shown, that the temperature dependence of the electrical resistance for heterostructure formed by antiferromagnetic La_2CuO_4 (LCO) single crystals with epitaxial films of ferroelectric $Ba_{0.8}Sr_{0.2}TiO_3$ (BSTO) deposited onto them has been studied. The measured electrical resistance is compared to that exhibited by LCO single crystals without the films. The interface of that heterostructure shows superconducting behavior with transition temperature T_c is about 30 K, which 100 time larger than T_c in $LaAlO_3/SrTiO_3$.The beginning of a transition to superconducting state occurs around 40 K, similar to what is observed in bulk $La_{2-x}Sr_xCuO_4$ single crystals at optimal doping. Important that, when we applied electrodes for resistance measurements on the back side of the heterostructure (from single crystal side, without contact with interface), superconducting state is not observed. Therefore, we conclude that this is not a case of surface superconductivity, and that the oxygen does not penetrate the surface layer during the sputtering of the film. The heterostructure in that case is created by a relatively simple method at the *non*-atomically-flat boundary of the two insulating oxides with different elementary cell structures. It opens up new physics, when a polarization catastrophe is associated not with the polar oxides, but with the ferroelectric oxides. If a weak magnetic field is applied perpendicularly to the interface of the heterostructure, a resistance appears. This confirms a quasi-two-dimensional nature of the superconductive state. The existence of superconducting phase at the interface was confirmed by observation of the diamagnetic susceptibility. The proposed concept promises ferroelectrically controlled interface superconductivity which offers the possibility of novel design of electronic devices.

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