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Analysis of electronic spectral weight of two-dimensional electron gases at the surfaces of ferroelectric $KNb_xTa_{(1-x)}O_3$ across T_c

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A two-dimensional electron gas (2DEG) (confined electron which is free to move in two dimensions at the interface/surface) was discovered at the $LaAlO_3/SrTiO_3$ interface; later on 2DEG was also observed at the bare surfaces of $SrTiO_3$ and $KTaO_3$. This system can enhance some physical properties (i.e. superconductivity and ferroelectric polarization) as well as the novel properties such as negative electron compressibility and unusual coexistence of ferromagnetism and superconductivity. In this work, by using angle-resolved photoemission spectroscopy, we have studied the temperature dependence (T=20-130K) of 2DEGs at bare surfaces of ferroelectric $KNb_xTa_{(1-x)}O_3$ (KTN) (x=0.02, 0.03 and 0.05) across their ferroelectric transition temperatures (T_c). We found that the 2DEG spectral weight gradually decreased at temperature below ferroelectric T_c. The possible reason can be described by the transition from paraelectric to the ferroelectric which broadens the quantum well state due to electrical polarization. The number of electrons, which are initially confined at the surfaces, will be delocalized and hence the electronic spectral weight of 2DEG nature is changed. Our finding may help mediate the fundamental study of 2DEGs and phase transition as well as for functional oxide devices.

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