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Superconductor to Non-Superconductor Transitions at Oxide Interface Tuned by Electrostatic Dual Gates ZHUOYU CHEN, HISASHI INOUE, HYEOK YOON, TYLER MERZ, DI LU, YANWU XIE, ADRIAN SWARTZ, Stanford Univ., HONGTAO YUAN, YASUYUKI HIKITA, SLAC Nat. Acc. Lab., HAROLD HWANG, Stanford Univ. SLAC Nat. Acc. Lab., HWANG TEAM —
The quantum phase transitions from superconductor to non-superconductor in two dimensions (2D) are determined by various factors including carrier density, disorder, and dissipation coupling. By applying a dual gate technique on the $LaAlO_3/SrTiO_3$ interface superconductor, we obtained the degrees of freedom to tune these factors and induce different phase transitions electrostatically. Our device is formed by simultaneous gating from the top of the epitaxially grown $LaAlO_3$ and the back of the $SrTiO_3$ (100) substrate. The structural asymmetry of the dual gate device and the large and nonlinear dielectric constant of $SrTiO_3$ enable independent and wide-range parameter tuning. We found, by top gating, a superconductor-metal transition can be achieved within the highly conducting limit ($k_F l >> 1$, where k_F is the Fermi wave vector and l is the electron mean free path). By back gating, a superconductor-insulator transition can be observed with the collapse of $k_F l$. Our results provide a comprehensive perspective for the quantum phase transitions for the oxide interface systems.

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