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Tuning the ground state of polar $LaAlO_3/SrTiO_3$ interface by an electron sink

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Abstract

Most of the intriguing properties of two-dimensional electron gases (2DEGs) at the $LaAlO_3/SrTiO_3$ (LAO/STO) interface are sensitive to the electrons located in 3d-orbit of Ti. However, tuning the electronic structure of the system remains challenging due to the intrinsic high carrier density. Herein, instead of using $LaMnO_3$ (LMO) as buffer layers [1], we show that Mn doping in $LaAlO_3$ (LAMO) creates an electron sink that alters the ground state of 2DEG by suppressing the carrier density at the interface, without changing the polarity of the system. By precise control of the Mn-doping level, we found that 2DEGs in our system experience a change from two-band to one-band transport with decreasing carrier density, which is accompanied by a Lifshitz transition at a critical carrier density of 2.76×10^{13} cm^{-2} at 2K. Significantly, the peak value (255.7mK) of superconducting transition temperature is observed at Lifshitz point. In addition, our experiments realize the coexistence of ferromagnetism (FM) and superconductivity (SC) by Mn doping.

References:

1. Y. Z. Chen et al. Extreme mobility enhancement of two dimensional electron gases at oxide interfaces by charge-transfer-induced modulation doping, Nature Mater. (2015) 14, 801-806. DOI: 10.1038/NMAT4303