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# Tuning the ground state of polar LaAlO<sub>3</sub>/SrTiO<sub>3</sub> interface by an electron sink

Yulin Gan<sup>1\*</sup>, Merlin von Soosten<sup>1</sup>, Yu Zhang<sup>1</sup>, Wei Niu<sup>1</sup>, Dennis Valbjørn Christensen<sup>1</sup>,  
Thomas Sand Jespersen<sup>2</sup>, Nini Pryds<sup>1</sup> and Yunzhong Chen<sup>1\*</sup>

<sup>1</sup>Department of Energy Conversion and Storage, Technical University of Denmark, Risø  
Campus, 4000 Roskilde, Denmark

<sup>2</sup>Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen,  
Universitetsparken 5, 2100 Copenhagen, Denmark

\*E-mail: [yuga@dtu.dk](mailto:yuga@dtu.dk); [yunc@dtu.dk](mailto:yunc@dtu.dk);

## Abstract

Most of the intriguing properties of two-dimensional electron gases (2DEGs) at the LaAlO<sub>3</sub>/SrTiO<sub>3</sub> (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<sub>3</sub> (LMO) as buffer layers<sup>[1]</sup>, we show that Mn doping in LaAlO<sub>3</sub> (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  $2.76 \times 10^{13} \text{ cm}^{-2}$  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