Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces

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Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces
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The discovery of two-dimensional electron gases (2DEGs) at the interface between two insulating complex oxides, such as LaAlO₃ (LAO) or gamma-Al₂O₃ (GAO) epitaxially grown on SrTiO₃ (STO)¹,², provides an opportunity for developing all-oxide electronic devices³,⁴. However, large enhancement of the interfacial electron mobility remains a major and long-standing challenge for fundamental as well as applied research of complex oxides. Here, we report a 2DEG mobility enhancement of more than two orders of magnitude obtained by inserting a single unit cell (uc) buffer layer at the interface between disordered LaAlO₃ and crystalline SrTiO₃ created at room temperature.⁵ The spacer layer suppresses strongly the formation of oxygen vacancies on the SrTiO₃ side and leads to an unexpected modulation-doping scheme of the complex oxide 2DEG via interface charge transfer.⁶ This results in a very high 2DEG mobility exceeding 70 000 cm²V⁻¹s⁻¹ at 2 K and low carrier density in the range of 10¹² cm⁻². These findings open new avenues for oxide electronics.