A high-mobility two-dimensional electron gas at the spinel/perovskite interface of -Al2O3/SrTiO3 grown by pulsed laser deposition

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A high-mobility two-dimensional electron gas at the spinel/perovskite interface of γ-Al_2O_3/$SrTiO_3$ grown by pulsed laser deposition

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The realization of high-mobility 2DEGs in epitaxially grown heterostructures made of traditional semiconductors is at the heart of present electronics, which has led to a wealth of new physical phenomena as well as new electronic and photonic devices over the past few decades. Recently, high-mobility 2DEGs discovered at the interface between insulating complex oxides provide new opportunities for electronics [1]. Thanks to the strong electronic correlations, oxide 2DEGs not only provide the possibility of multifunctional all-oxide devices with probably even richer behavior than those we experienced in semiconductor devices, but also show the promise to study mesoscopic physics with strongly correlated electrons confined in nanostructures.

So far, complex oxide 2DEGs are nearly exclusively created within the frame of interface polarity, such as the intensively explored $LaAlO_3$/$SrTiO_3$ (LAO/STO) heterointerface [2]. Moreover, the carrier mobilities of such oxide interfaces are still several orders lower than that of bulk materials, such as the reduced STO substrate. The low carrier mobility has been assumed to result from, at least partially, the bombardment of the energetic plasma during the pulsed laser deposition (PLD) process. In this presentation, we will firstly show that the reactivity of PLD plasma rather than its kinetic energy can be used to design metallic and insulating interfaces between two insulating oxides by tunable interface redox reactions [3]. Secondly, we will present a new type of oxide 2DEGs created at a nonpolar spinel/perovskite interface of γ-Al_2O_3/$SrTiO_3$ (GAO/STO). Remarkably, this novel GAO/STO oxide 2DEG grown by PLD exhibits electron mobilities exceeding 100,000 $cm^2V^{-1}s^{-1}$ at 2 K [4], which is 100 times higher than those of LAO/STO heterointerfaces. The dimensionality of the conduction and its spatial confinement at this spinel/perovskite GAO/STO interface will be also discussed. Defect engineering of oxygen vacancies, especially interfacial redox reactions with strongly spatial confinement, turns out to be a crucial issue for the high-mobility 2DEG at the interface between insulating complex oxides.

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