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Surface charges & adsorbates tune the electron gas at the $LaAlO_3/SrTiO_3$interface YANWU XIE, CHRISTOPHER BELL, YASUYUKI HIKITA, HAROLD Y. HWANG, Department of Applied Physics and Stanford Institute for Materials and Energy Science, Stanford University,Stanford, California 94305, USA — The physical properties of the $LaAlO_3/SrTiO_3$ heterointerface are substantially determined by the density and mobility of the electron gas at the buried interface. Here, we present two ways to tune the electron gas from the $LaAlO_3$ surface. First, the electron gas can be locally tuned by using biased atomic force microscope probe [1]. Our studies show that this is caused by the accumulation of charge on the $LaAlO_3$ surface [2], and can change the density by up to 3×10^{13} cm^{-2}[3], comparable to the maximum modulation achieved in normal field effect devices. Second, we found that the electron gas can be dramatically tuned by the surface adsorption of common polar solvents such as acetone, ethanol and water [4]. This strong surface-interface coupling provides a new technique for manipulating the interface-confined electrons. Most significantly, adsorbates induce an insulator to metal transition when the thickness of the $LaAlO_3$ is 3 unit cells, suggesting sensor applications with extremely large sensitivity.

[1] C. Cen *et al.*, *Nature Mater.* **7**, 298 (2008).
[2] Y. Xie *et al.*, *Nano Lett.* **10**, 2588 (2010).
[3] Y. Xie *et al.*, *Adv. Mater.* **23**, 1744(2011).
[4] Y. Xie *et al.*, *Nature Commun.* **2**, 494 (2011).

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