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Electronic structure and two-dimensional electron gas at the surface of $SrTiO_3$[1]

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Similar to silicon that is the basis of conventional electronics, strontium titanate ($SrTiO_3$) is the bedrock of the emerging field of oxide electronics. $SrTiO_3$ is the preferred template to create exotic two-dimensional (2D) phases of electron matter at oxide interfaces, exhibiting metal-insulator transitions, superconductivity, large magnetoresistance, or coexistence of superconductivity and ferromagnetism. However, the physical nature of the electronic structure underlying these 2D electron gases (2DEGs) remains elusive, although its determination is crucial to understand their remarkable properties. In this talk, we present our angle-resolved photoemission spectroscopy (ARPES) results showing that there is a highly metallic universal 2DEG at the vacuum-cleaved surface of $SrTiO_3$, independent of bulk carrier densities over more than seven decades, including the undoped insulating material [A. F. Santander-Syro *et al.* Nature **469**, 189-193 (2011)]. Our data unveil a remarkable electronic structure consisting on multiple subbands of heavy and light electrons. We find that the 2DEG is confined within a region of ~5 unit cells and has a sheet carrier density of ~0.33 electrons per a^2 (a is the cubic lattice parameter). The similarity of this 2DEG with those reported in $SrTiO_3$-based heterostructures and field-effect transistors suggests that different forms of electron confinement at the surface of $SrTiO_3$ lead to essentially the same 2DEG. Our discovery provides thus a model system for the study of the electronic structure of 2DEGs in $SrTiO_3$-based devices and a novel route to generate 2DEGs at surfaces of other functional oxides.

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