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Carrier Density at LaAlO3/SrTiO3 Interfaces: Evidence of Electronic Reconstruction.[1]

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The origin of the 2D electron gas at the LaAlO3/SrTiO3 interface has been a controversial subject ever since its discovery. A serious inconsistency with the most accepted mechanism, an electronic reconstruction in response to a polar discontinuity at the interface, is that the carrier densities reported experimentally are invariably lower than the expected value except under conditions where reduction of SrTiO3 substrate is suspected. We have grown LaAlO3 films of different stoichiometry on TiO2-terminated SrTiO3 substrates using atomic layer-by-layer laser molecular beam epitaxy (ALL-Laser MBE), in which La2O3 and Al2O3 targets were sequentially ablated in 37 mTorr oxygen. The high oxygen pressure during growth prevents the possible oxygen reduction in SrTiO3, ensures that the LaAlO3 films are sufficiently oxygenated, and suppresses the La-Sr intermixing due to the bombardment effect. X-ray linear dichroism (XLD) and x-ray magnetic circular dichroism (XMCD) measurements show characteristics of oxygenated samples. In the electronic reconstruction picture, instead of the charge transfer of half of an electron in the case of a sufficiently thick stoichiometric LaAlO3, a LaAlO3 film thickness dependence is expected as well as a linear dependence on stoichiometry. Our experimental results on carrier densities in 10 nm-thick LaAl1+yO3(1+0.5y) films agree quantitatively with the theoretical expectations, lending a strong support for the electronic reconstruction mechanism.

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