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Transport properties observed at hetero-interfaces of $LaAlO_3$ on $SrTiO_3$; intrinsic or extrinsic interface effect?

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We have made very thin films of $LaAlO_3$ on TiO_2 terminated $SrTiO_3$ and have measured the properties of the resulting interface in various ways. Transport measurements show a sheet carrier density of 10^{16} cm^{-2} and a mobility around 10^4 cm^2 V^{-1} s^{-1}. *In situ* UPS results indicate that oxygen vacancies play an important role in the creation of the charge carriers and that these vacancies are introduced by the pulsed laser deposition process used to make the hetero-interfaces [1]. Our results explain for the first time the origin of the large sheet carrier densities and high mobility observed previously [2]. XAS and spectroscopic ellipsometry [3] measurements confirm the existence of (oxygen) defects in the $SrTiO_3$. Simple model calculations confirm the plausibility of having defects at the origin of charge carriers while still maintaining a high mobility. By means of annealing experiments in atomic oxygen we try to answer the question whether an intrinsically doped interface does indeed exist at lower carrier concentrations [2]. Due to its reactive nature (i.e., binding energy in an oxygen molecule is about 5 eV), atomic oxygen will have much more power to eliminate any oxygen vacancies compared to conventional annealing methods.

[1] W. Siemons et al, Phys. Rev. B 76, 155111 (2007)
[2] W. Siemons et al., Phys. Rev. Lett. **98**, 196802 (2007)
[3] G. Lucovsky, H. Seo and J. Luning, unpublished

[1]Work presented was done at Stanford University.