



## Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces

Chen, Yunzhong; Trier, Felix; Christensen, Dennis Valbjørn; Linderoth, Søren; Pryds, Nini

*Publication date:*  
2015

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Chen, Y., Trier, F., Christensen, D. V., Linderoth, S., & Pryds, N. (2015). *Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces*. Abstract from TO-BE Spring Meeting 2015, Aveiro, Portugal.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



## Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces

Y. Z. Chen, F. Trier, D. V. Christensen, S. Linderoth, and N. Pryds

Department of Energy Conversion and Storage, Technical University of Denmark, Risø  
Campus, 4000 Roskilde, Denmark  
yunc@dtu.dk

The discovery of two-dimensional electron gases (2DEGs) at the interface between two insulating complex oxides, such as  $\text{LaAlO}_3$  (LAO) or  $\gamma\text{-Al}_2\text{O}_3$  (GAO) epitaxially grown on  $\text{SrTiO}_3$  (STO)<sup>1,2</sup>, provides an opportunity for developing all-oxide electronic devices<sup>3,4</sup>. However, large enhancement of the interfacial electron mobility remains a major and long-standing challenge for fundamental as well as applied research of complex oxides. Here, we report a 2DEG mobility enhancement of more than two orders of magnitude obtained by inserting a single unit cell (uc) buffer layer at the interface between disordered  $\text{LaAlO}_3$  and crystalline  $\text{SrTiO}_3$  created at room temperature.<sup>5</sup> The spacer layer suppresses strongly the formation of oxygen vacancies on the  $\text{SrTiO}_3$  side and leads to an unexpected modulation-doping scheme of the complex oxide 2DEG via interface charge transfer.<sup>6</sup> This results in a very high 2DEG mobility exceeding  $70\,000\text{ cm}^2\text{V}^{-1}\text{s}^{-1}$  at 2 K and low carrier density in the range of  $10^{12}\text{ cm}^{-2}$ . These findings open new avenues for oxide electronics.

1. A. Ohtomo & H. Y. Hwang, A high-mobility electron gas at the  $\text{LaAlO}_3/\text{SrTiO}_3$  heterointerface. *Nature* **427**, 423-426 (2004).
2. Y. Z. Chen *et al.* A high-mobility two-dimensional electron gas at the spinel/perovskite interface of  $\gamma\text{-Al}_2\text{O}_3/\text{SrTiO}_3$ . *Nat. Commun.* **4**:1371 doi: 10.1038/ncomms2394 (2013).
3. J. Mannhart & D. G. Schlom, Oxide interfaces: An opportunity for electronics. *Science* **327**, 1607-1611 (2010).
4. F. Miletto Granozio, G. Koster & G. Rijnders, Functional oxide interfaces. *MRS Bulletin* **38**, 1017 (2013).
5. Y. Z. Chen *et al.* Metallic and insulating interfaces of amorphous  $\text{SrTiO}_3$ -based oxide heterostructures. *Nano. Lett.* **11**, 3774 (2011).
6. Y. Z. Chen *et al.* Extreme mobility enhancement of two-dimensional electron gases at oxide interfaces via charge transfer induced modulation doping. *Submitted to Nature Mater.*