A high-mobility two-dimensional electron gas at the spinel/perovskite interface of $\gamma$-Al$_2$O$_3$/SrTiO$_3$

Yunzhong Chen$^1$, Felix Trier$^1$, Dennis Christensen$^1$, N. H. Andersen$^2$, T. Kasama$^3$, W. Zhang$^1$, S. Linderoth$^1$, and Nini Pryds$^1$

$^1$Department of Energy Conversion and Storage, Technical University of Denmark, DK-4000 Roskilde, Denmark
$^2$Department of Physics, Technical University of Denmark, 2800 Lyngby, Denmark
$^3$Center for Electron Nanoscopy, Technical University of Denmark, 2800 Lyngby, Denmark

Email: yunc@dtu.dk

Background and motivation

The realization of high-mobility 2DEGs in epitaxially grown heterostructures made of traditional semiconductors is at the heart of present electronics, which has led to a wealth of new physical phenomena as well as new electronic and photonic devices over the past few decades. 2DEGs at the interface between insulating complex oxides not only provide a wealth of opportunities to study mesoscopic physics with strongly correlated electrons confined in nanostructures, but also show promise for multifunctional all-oxide devices with probably even richer behavior than those we experienced in semiconductor devices.

Metallic interface between insulating oxides of Al$_2$O$_3$ and SrTiO$_3$

Exploring 2DEGs at oxide interfaces

1) Oxygen ions redistribution across interface can result in metallic conduction in STO-based heterostructures involving complex oxides with Al, Ti, Zr, and Hf as component elements.
2) Defect engineering of oxygen vacancies, especially interfacial redox reactions with strongly spatial confinement will be a crucial issue for the conductive interface between insulating complex oxides.

High-mobility 2DEGs dominated by interface-stabilized oxygen vacancies

Conclusion

Confined redox reactions in STO-based heterointerfaces: an alternative way to create high-mobility 2D conductivity at oxide interfaces.