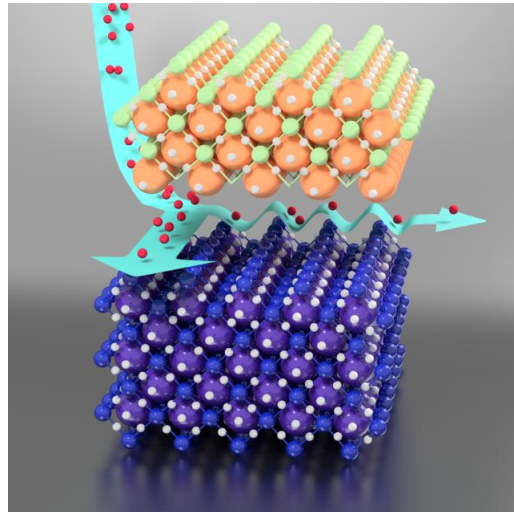


Materials: Unexpected conductivity

Direction dependent electronic transport at the interface of two different oxide insulators

A research collaboration between Asst Prof Ariando and Prof Venky Venkatesan at NanoCore, National University of Singapore, and collaborators from Japan, Sweden, China and The Netherlands have discovered a new revolutionary way to tailor two dimensional sheet of electrons along specific crystallographic orientation at the interface of insulating oxide systems. This has led to a direction dependent conducting behavior with potential for directional superconductivity and magnetism leading to possible new science and applications. This discovery also opens up a new pathway for creating nanoscale one dimensional conducting wires which is of importance for understanding the physics of low dimensional systems and for developing nanoscale devices in this bilayer oxide system.



The team interfaced two dissimilar crystals, SrTiO₃ (STO) and LaAlO₃ and discovered the formation of a highly mobile metallic two-dimensional electron gas (2DEG) between these two insulators. For this particular interface, it is usually formed using the (100) crystallographic orientation of the substrate, STO, and the conductivity is explained through the polarization catastrophe model, in which the discontinuity of the polarization at the interface leads to charge transfer.

Formation of a highly mobile metallic two-dimensional electron gas (2DEG) between two insulators, SrTiO₃ (STO) and LaAlO₃.

[Image source: Asst Prof Ariando]

Asst Prof Ariando and team studied the effects of the (110)-oriented STO when it is used as a substrate. In the usual case, one will expect that the resulting interface would be insulating because there is no polarization discontinuity. However, the researchers found that the transport properties of these interfaces exhibit a phenomena which is similar to those formed on (100) surfaces - creation of a high mobility 2DEG. One major difference is that there is a strong anisotropic conductivity along the two in-plane crystallographic directions. This is attributed to the differing properties of the Ti-O-Ti chains along the two in-plane directions. First-principles calculations suggested that the unexpected conductivity could be explained by the model of an energetically stable buckled interface, which apparently did induce a polarization discontinuity.

This result has been published in **Nature Communication** and highlighted by **Science Magazine** (June 14 issue) as an Editor's choice.

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