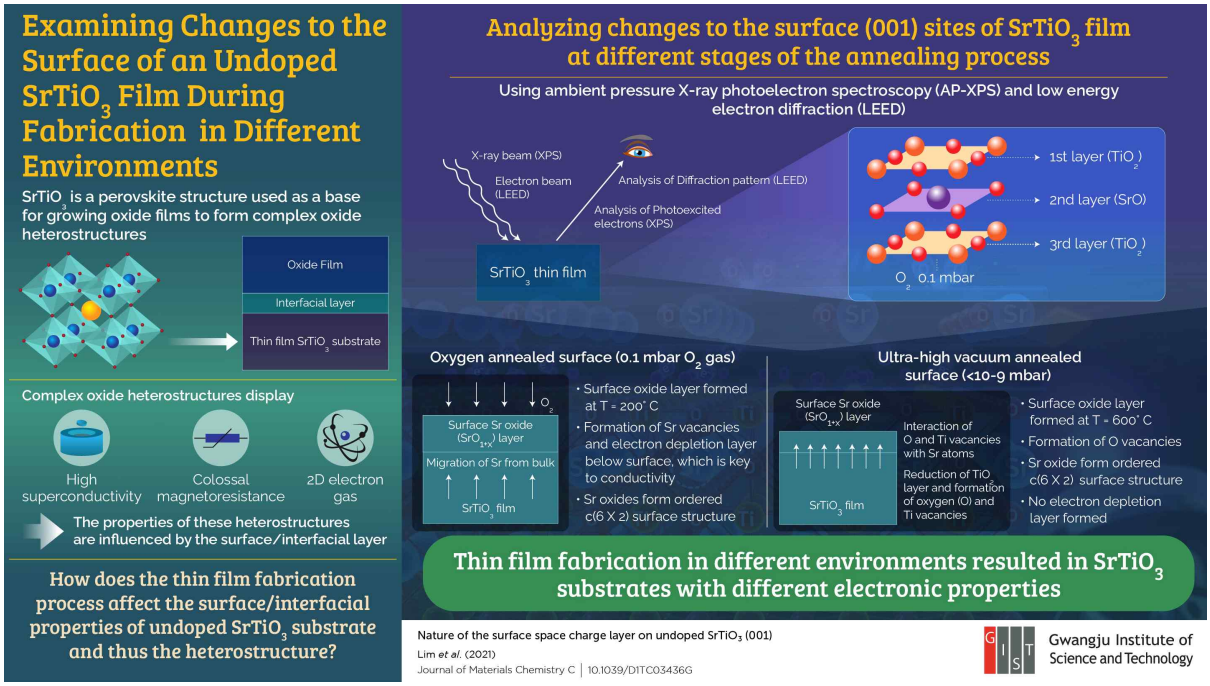
PRESS RELEASE

Gwangju Institute of Science and Technology Makes Breakthrough on New Electronic Material

New research reveals the easy tunability of a perovskite material, opening doors to its widespread use in next generation electronics

Perovskites are semiconducting materials that are a promising alternative to silicon for use in electronics. In a new study, researchers highlight how fabrication of thin films of a particular perovskite in different environments leads to altered electronic properties. This flexibility allows for the development of films with tunable electronic properties, opening doors to a wide variety of next generation electronic devices.



As our lifestyles become ingrained in flexible electronics, smart devices, artificial intelligence, the internet of things, etc., high performance, electronic components that can perform high speed data collection, processing, and execution become a necessity. Certain perovskites are crystal structures that can be promising alternatives to silicon-based components for these next generation electronic applications. Their cubic-like lattice makes them ideal for use as a base for growing oxide films to form heterostructures with unique electrical properties. The properties of these heterostructures depend on the charge transfer in the interfacial layer between the perovskite substrate and oxide overlayer. This charge transfer can be manipulated via either doping or through the fabrication process.

Now, researchers from Korea, led by Prof. Bongjin Simon Mun from Gwangju Institute of Science and Technology, use ambient pressure X-ray photoelectron spectroscopy (AP-XPS) and low energy electron diffraction (LEED) to investigate how fabrication conditions (annealing in an oxygen-rich environment and an oxygen deficit, low-pressure environment)

for a particular perovskite material, $SrTiO_3$—one of the most popular substrates for growing oxide films—affects its undoped surface and the resulting interfacial layer of the heterostructure. By using an undoped surface, the researchers wanted to examine the changes that occur on the surface of the substrate without interference from the dopants. "The presence of doping can interfere with correct interpretation of the surface defect states, which can be critical to apprehend the electrical properties of heterostructures. Our study on undoped $SrTiO_3$ provides unbiased characteristics of $SrTiO_3$ substrate," says Prof. Mun. Their findings were made available online on 16 September 2021 and published in Volume 9 Issue 38 of the Journal of Materials Chemistry C.

In the oxygen environment, an electron depletion layer formed as the Sr atoms in the substrate migrated to the surface of the film to react with oxygen and form a stable oxide layer. In the low-pressure oxygen deficit environment, the formation of such a depletion layer was limited as the oxide layer was formed due to the reduction of the TiO_2 layer that generated electrons.

In both environments, a similar oxide layer was formed, but the electronic properties of the structure differed as the electron depletion layer is key to the conductivity of the structure. "Our work shows clearly how the electrical properties of devices can be tuned by adjusting the population of electrons near the surface region, which is a very fundamental and important result indicating that future electronic devices can be realized with material characterization at the atomic level," says Prof. Mun. "In the long run, our study on $SrTiO_3$ will lay out a solid foundation for advanced electronic devices that will enable a better lifestyle for us."

Reference

Authors:	Hojoon Lim[1], Chanyang Song[1], Minsik Seo[1], Dongwoo Kim[1], Moonjung Jung[1], Habin Kang[1], Seunghwan Kim[1], Kyung-Jae Lee[1], Youngseok Yu[2], Geonhwa Kim[3], Ki-Jeong Kim[*3] and Bongjin Simon Mun[*1]
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About the Gwangju Institute of Science and Technology (GIST)

The Gwangju Institute of Science and Technology (GIST) is a research-oriented university

situated in Gwangju, South Korea. As one of the most prestigious schools in South Korea, it was founded in 1993. The university aims to create a strong research environment to spur advancements in science and technology and to promote collaboration between foreign and domestic research programs. With its motto, "A Proud Creator of Future Science and Technology," GIST has consistently received one of the highest university rankings in Korea.

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About the author

Bongjin Simon Mun is a Professor of Physics and Photon Science at the Gwangju Institute of Science and Technology in Korea. His main research interest is to understand the correlation between surface chemical reactions and electronic structures under various reaction conditions. Mun has been actively involved with the development and application of ambient pressure X-ray photoelectron spectroscopy. Before moving to Korea, Mun worked at Advanced Light Source as a staff scientist. After receiving a Ph.D. in physics from the University of California Davis under the supervision of Prof. Chuck S. Fadley, Mun completed his postdoctoral training at the Phil Ross Group at the Lawrence Berkeley National Laboratory.