Atomic-scale investigation of surfaces/interfaces of energy materials

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Transition-metal oxides show a variety of phenomena at their surfaces and interfaces, which have been induced by structural and electronic modifications. Although recent technical advances in the synthesis of oxide thin films and heterostructures have provided a fertile new ground for creating those novel states at their surfaces and interfaces, the origins of the functionalities, on an atomic scale spatial resolution, remain far from understood.
In order to clarify the origins of such phenomena and to further explore intriguing functionalities, it is important to elucidate their electronic structures at the atomic level.

In this presentation, I discuss following points based on the observations using a scanning tunneling microscopy/spectroscopy (STM/STS) combined with pulsed laser deposition (PLD).[1]
1. Atomic structure of oxide substrate: $SrTiO_3$(100) [2]
2. Preparation of atomically-defined oxide substrate surface:
   $SrTiO_3$(001)-($\sqrt{13}\times\sqrt{13}$)-R33.7° reconstructed surface [3, 4]
3. Growth processes of oxides:
   $SrTiO_3$ [5], SrO [6], $LaAlO_3$, (LaCa)MnO_3, and $SrVO_3$
4. 2D TiO_2-nanomesh formation on $LaAlO_3$.

These STM/STS studies provide us of profound insights into the intriguing phenomena at oxide surfaces. Further, we aim to correlate our microscopic observation with macroscopic properties of oxides. Consequently, these findings on the atomic-scale nature are discussed with electron transport properties and magnetic properties of oxide thin films.

Further, If time allows, I would like to report the surprisingly low electrolyte/electrode ($LiCoO_2$) interface resistance of 8.6 Ω cm^2 observed in lithium thin-film batteries. This value is an order of magnitude smaller than that presented in previous reports on all-solid-state lithium batteries. The value is also smaller than that found in a liquid electrolyte based batteries. The low interface resistance indicates that the negative space-charge layer effects at the $Li_3PO_{4-x}N_x/LiCoO_2$ interface are negligible, and demonstrates that it is possible to fabricate all-solid state batteries with faster charging/discharging properties.

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Solid State Chemistry, Solid State Physics, Surface Science

Publications

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