Atomic-level Phenomena in Complex Oxide Interfaces Uncovered by Aberration-corrected Scanning Transmission Electron Microscopy

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Novel functionalities in oxide heterointerfaces are significantly manifested by coupling effects between structural order parameter fields, which can be corroborated with the evidence of subtle atomic distortions occurring on the unit-cell scale (1, 2). To understand fundamental science of order parameter-structure couplings and optimize physical properties of the materials, therefore, the ability to control and measure these structural parameters with atomic precision is required. In this presentation, I will discuss recent results on structural and chemical imaging of oxide heterostructures by aberration-corrected Scanning Transmission Electron Microscopy (STEM) combined with Electron Energy Loss Spectroscopy (EELS). In the real-space local crystallography approach, STEM measures position shifts of atomic columns with sub-5 pm precision (3). This technique allows minute displacements of atoms within the unit-cell level to be measured and the structural order parameter fields to be directly visualized. This approach was demonstrated for deciphering functional properties of some oxide heterostructures, which show exciting coupling phenomena between structural order parameters (4, 5). The application further extends to uncover polarization charge compensation mechanisms at the $BiFeO_3$(BFO)/$La_xSr_{1-x}MnO_3$(LSMO) interface driven by oxygen vacancy dynamics (Fig. 1), which underlines the highly non-trivial effect of electrochemical phenomena on the functional properties of oxide interfaces (6).

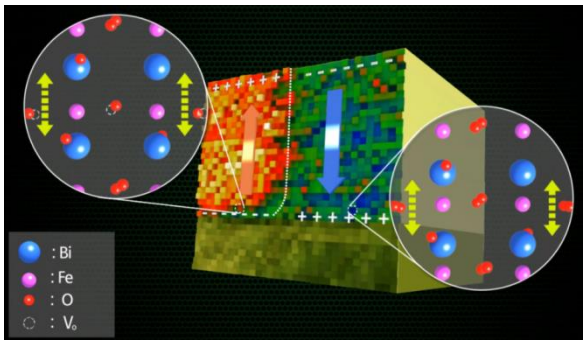

Figure 1 Graphical representation of interface charge distribution depending on the sign of the polarization charge and the nontrivial role of interface oxygen vacancy for charge screening mechanism, which is revealed by STEM-EELS technique.

References

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