Functional Oxides Can Be Switched Between Distinct Structures and Properties via Electrochemical Bias

B Yildiz, H. Tuller (IRG III)

Functional oxides with perovskite structure (ABO_3) are an attractive group of materials for energy and information applications. They are the key enabler for several important technologies, including solid oxide fuel cells, thermal-chemical fuel production as well as novel memory devices such as red-ox based memristive systems. Importantly, their physical and chemical properties can be tuned by controlling the oxygen content in them, conventionally done by varying the environment temperature and pressure.

MIT MRSEC researchers have demonstrated that an externally applied electrochemical bias can tremendously alter the oxygen content, structure and properties of a perovskite, $SrCoO_x$ (SCO). $SrCoO_x$ can be flipped reversibly between two related phases by the bias applied – the perovskite $SrCoO_{3-\delta}$ and a more open-structured brownmillerite $SrCoO_{2.5}$. The electrical conductivity, oxide ion conductivity, magnetism and thermal conductivity of these two phases are distinct, and now feasibly controllable via an external bias.

These results pave the way to the use of electrical bias to control the oxygen content and to obtain fast and easily-accessible switching between different phases and distinct properties of functional oxides important for energy and information technologies.

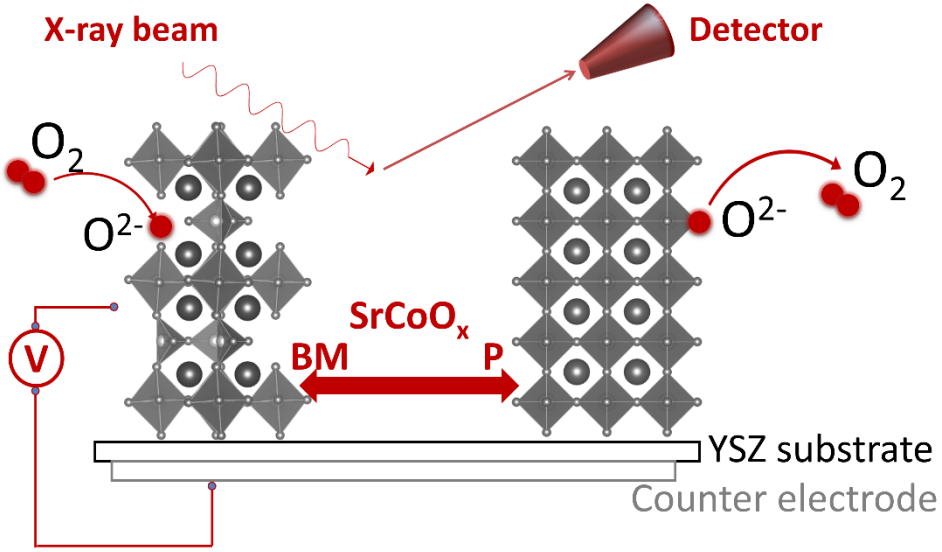

Figure: Schematic of the BM-SCO and P-SCO thin film on YSZ substrate. Light and dark grey spheres represent the O and Sr, respectively, and the Co is located at the centers of the octahedra and tetrahedra. In situ high-resolution X-ray diffraction measurements were performed during the BM→P→BM phase transitions induced by controlling the electrochemical bias.

Lu, Q. & Yildiz, B. Voltage-controlled topotactic phase transition in thin-film $SrCoO_x$ monitored by *in situ* X-ray diffraction. *Nano Letters*. Doi: 10.1021/acs.nanolett.5b04492

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