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Synchrotron X-ray studies of superconducting vacancy-ordered monoclinic Titanium monoxide films during synthesis

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Introduction

Light sources provide an indispensable resource for probing with atomic-scale precision, the structural properties of nanoscale materials. In these materials where a strong correlation exists between their crystal structures and their electronic, optical, and magnetic properties, structural and chemical probes using synchrotron X-ray diffraction and spectroscopy are critical for understanding and engineering the functional properties of materials for applications in quantum computing, energy, and catalysis. The ability to directly probe these materials as they are being synthesized and in-operando allows for developing precise quantitative models to predict how materials grow and behave.
In this talk, results will be presented on the evolution of the crystal structure of superconducting monoclinic titanium monoxide thin films during thin film synthesis using the molecular beam epitaxy atomic layer-by-layer growth technique. By monitoring the lattice structure during growth using synchrotron high-energy X-ray diffraction at the 33ID beamline at the Advanced Photon Source, we observe the evolution of strain and the ordering of Oxygen and Titanium vacancies leading to the formation of the monoclinic TiO phase.

Results

Vacancy ordering is correlated to a superconducting-to-metal transition at ˜ 2.8 K. The transition contrasts with the superconducting-to-insulator transition observed in other superconducting TixOy phases where disorder may play a role in the insulation normal phase.
These results are essential for understanding the role disorder plays in modulating transport in superconducting materials and pave the way for designing high-temperature superconductors.

References

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