Probing Temperature-Induced Phase Transitions in $SmBaMn_2O_6$

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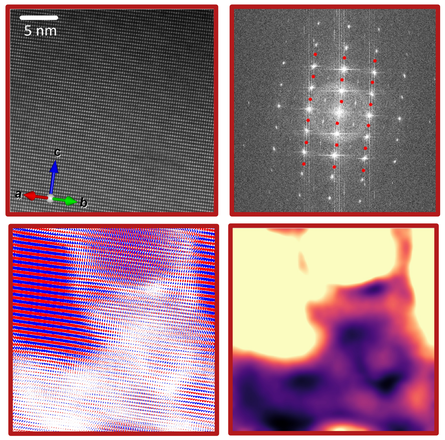
Introduction

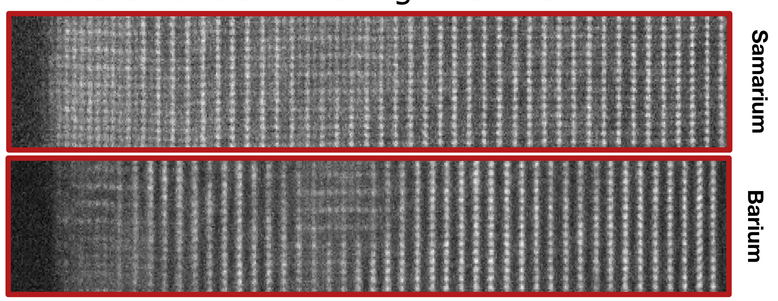
- $SmBaMn_2O_6$ (SBMO) thin films grown by molecular vapor decomposition upon a substrate of $LaGaO_3$ exhibit metal-insulator and ferromagnetic-antiferromagnetic transitions as a function of temperature
- Electrical transport measurements and theoretical calculations via DFT suggest a structural phase transition may be responsible
- Using convergent beam electron diffraction (CBED), we show evidence for this structural change in situ through the manifestation of additional higher order Laue zone lines at cryogenic temperature

SBMO's A-Site Ordering

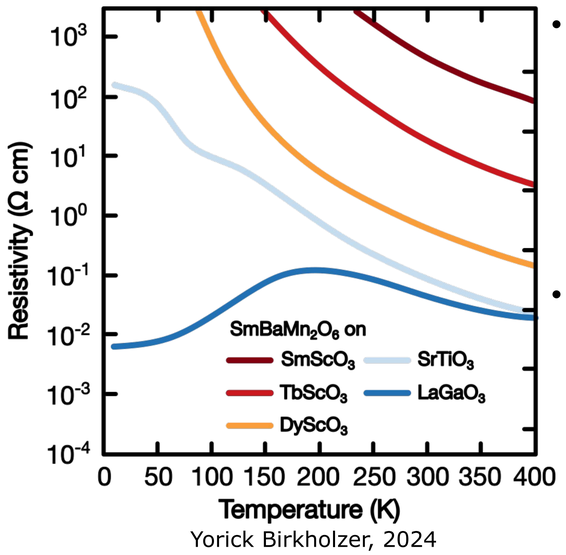
- A-site ordered SBMO has alternating rows of Sm and Ba occupying its A-sites
- In samples, we see domains where the desired order is present



- Reciprocal space difference mapping and electron energy loss spectroscopy confirm the extent of ordering in SBMO

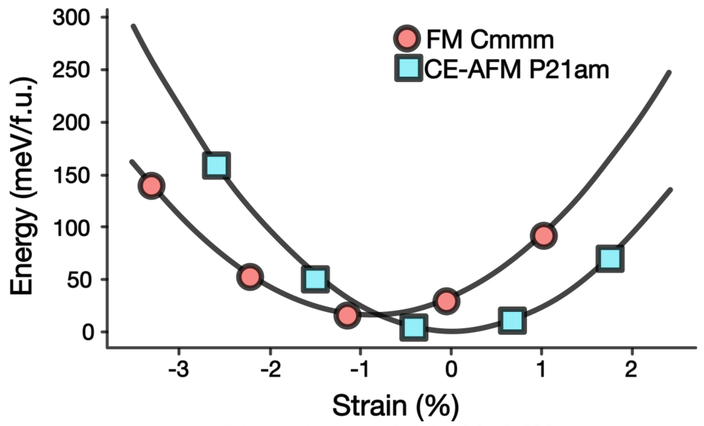


SBMO's Metal-Insulator Transition



Yorick Birkholzer, 2024

- SBMO on LGO exhibits a metal-insulator transition at ~200 K
- Host to other transitions as well, though not well studied
- A potential mechanism for the transition is a change in space group, as suggested by density functional theory



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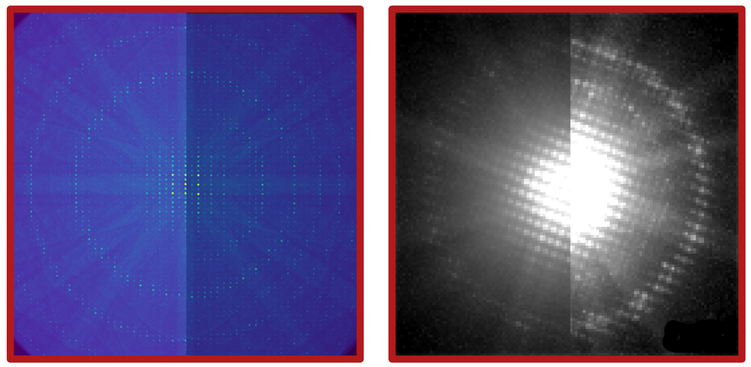
- LGO induces a compressive epitaxial strain of 0.7%, enough for the Cmmm space group to be stable at low temperature
- As temperature rises, a transition from the conductive, ferromagnetic Cmmm space group to the insulating, antiferromagnetic P21am space group that takes precedence for less compressive strains is suggested

Results

- A search for detectable changes associated with the change in space group was conducted using simulation
- The number of higher order Laue zone lines obtained using electron diffraction exhibited a change across space groups
- Experimental CBED measurements showed the same change



- Using an EMPAD detector, spatial data regarding the number of HOLZ lines was detected
- Mappings of where the additional HOLZ line appeared are indicative of a partial phase transition, with phase coexistence between space groups
- Future work will involve more temperature resolution to probe size of these domains

References

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[2] E. A. Nowadnick, J. He, C. J. Fennie, Physical Review B **100**, 195129 (2019)
[3] J. P. Ruf, H. Paik, N. J. Schreiber, H. P. Nair, L. Miao, J. K. Kawasaki, J.N. Nelson, Y. Lee, B.H. Goodge, Nature Communications **12**, 59 (2021)