

Charge Ordering and Stripe Phases in Perovskite-Related Compounds

A.R. Moodenbaugh, Y. Zhu, R. Wang, J. Gui, B. Miller, and L.H. Lewis (BNL)

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Beamline(s): X7A

Introduction: Charge ordering in $\text{La}_{1-x}\text{Ca}_x\text{MnO}_3$ has recently attracted attention because these and related oxides have potential practical application based on their magnetoresistance effects. Our objective is to elucidate the charge ordering in these materials. Modulated images have previously been observed in transmission electron microscopy (TEM), which were attributed to stripe phase charge ordering (Mori). A subsequent x-ray diffraction study at NSLS X7A concluded, based on Rietveld refinement of data, that charge order obeyed a Wigner crystal ordering, not consistent with the stripe ordering model (Radaelli). The present work combines comprehensive, quantitative TEM studies with high-resolution x-ray diffraction designed to resolve this conflict. Both techniques are being applied both above and below room temperature.

Methods and Materials: The polycrystalline samples, of varying compositions were prepared from oxides and carbonates. Pressed pellets were reacted at temperatures from 1000°C to 1350°C in air, resulting in well-sintered bulk samples. Conventional x-ray diffraction showed the samples to contain $<1\%$ impurity phases. Low temperature x-ray diffraction at X7A of powder samples was obtained using flat plate geometry, 0.8nm x-rays, configured with a position sensitive detector (PSD). Samples were cooled in a continuously operating refrigerator. The high resolution TEM work is described in detail in (Wang).

Results: Low temperature x-ray diffraction measurements were obtained to confirm the presence of charge order (Figure 1). In fact the diffraction results are very similar to the work of (Radaelli). The TEM work on the same sample confirms features previously observed by (Mori). However, quantitative analysis of the TEM results is entirely consistent with the Wigner crystal model of (Radaelli).

Conclusions: The interpretation of TEM results may be a subjective process, unless accompanied by quantitative analysis, modeling, and simulation used in this work (Wang). X-ray diffraction can be used as a check on the interpretation of TEM, and provides complementary information. In fact, the low temperature x-ray diffraction and TEM results for $\text{La}_{0.33}\text{Ca}_{0.67}\text{MnO}_3$ are consistent with each other. Work is continuing in this system, with additional high temperature x-ray diffraction measurements being gathered, to better understand the entire process of distortion from cubic perovskite at high temperatures.

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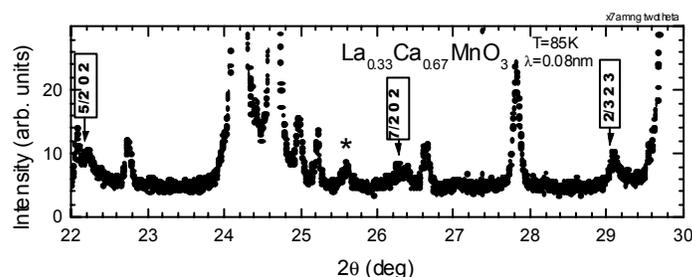


Figure 1. High-resolution x-ray diffraction scan at 85 K of $\text{La}_{0.33}\text{Ca}_{0.67}\text{MnO}_3$ illustrating charge-ordering peaks, identified with arrows, similar to those observed by (Radaelli). Peak marked with asterisk is due to the copper sample plate. Figure from (Wang).