

Nanophase Separation at the Surfaces of Layered TMOs.

E. W. Plummer^{1,2}, Ismail^{1,2}, J. Zhang³, R. Jin², D. Mandrus^{1,2}, S. Gai², J. Shen², L. Petersen², T. Kimura^{4,5}, Y. Tokura^{4,5}, Z. Fang⁴ and K. Terakura⁴

- 1) *Department of Physics and Astronomy, The University of Tennessee, Knoxville, TN 37996-1200*
- 2) *Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37831-6057, U.S.A.*
- 3) *Department of Physics, Florida International University, Miami, FL 33199, U.S.A*
- 4) *Joint Research Center for Atom Technology, Tsukuba, Japan 305-0046*
- 5) *Department of Applied Physics, University of Tokyo, Tokyo, Japan 113-0033*

Transition metal oxides (TMOs) exhibit complex behavior because the structural, electronic, and magnetic properties are strongly coupled. The diversity of spectacular properties of these highly correlated materials has caused a paradigm shift in our basic understanding of solids in general. The uniqueness and diversity of these materials are undoubtedly associated with the temporal and spatial inhomogeneities in charge, dopant concentration, and spin densities, which couple to lattice distortions, breaking the translational symmetry. This static and dynamic nanophase separation is on the nanometer-length scale. A recent neutron scattering paper has challenged the basic concept of dynamic nanophase separation in the CMR perovskites manganites [1].

We have conducted a systematic investigation of both the structural and electronic nanophase separation at the surface of the layered Ruthenate series $\text{Ca}_{2-x}\text{Sr}_x\text{RuO}_4$ using samples grown at ORNL by R. Jin and D. Mandrus. The motivation is to document the dependence of the static nanophase separation on the dopant concentration in a system that is simpler than the doped manganites. In this case, substituting Ca for Sr in the (214) Sr Ruthenate does not change the valence, only the size. Also the material does not change its phase until x is greater than 1.5. Our findings will be discussed, but they can be summarised. There is a monotonic increase in both the rms roughness of the surface and the length scale of the corrugation as the Ca concentration increases ($2-x$). The corrugation length scale increases from atomic dimensions for the pure undoped compounds to $\sim 50\text{nm}$ for SrCaRuO_4 . Quite surprisingly, an AFM measurement shows that the electronic roughness is accompanied by a topological roughness. The results for $\text{Ca}_{2-x}\text{Sr}_x\text{RuO}_4$ will be compared to previously reported nanophase separation at the surfaces of $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$ and $\text{La}_{1.8}\text{Sr}_{1.8}\text{Mn}_2\text{O}_7$.

References:

1. "Non-percolative Behavior in the Field-induced Insulator-to-metal transition of $\text{Pr}_{0.70}\text{Ca}_{0.30}\text{MnO}_3$," J. A. Fernandes-Baca, P. Dai, H. Kawano, H. Yoshizawa, S. Katano, Y. Tomioka, and Y. Tokura, to be published.

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