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Complex Phenomena in Nanostructured Transition Metal Oxides

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When the spatial dimension of a material becomes comparable or even smaller than the characteristic length scale of the relevant cooperative (collective) phenomena, it is expected that all related physical properties including phase transitions of this material will be dramatically changed. In this work, we focus on the discovery, understanding, and design of low-dimensional 3d transition metal oxides (TMO). We use both physical and chemical methods including laser MBE growth and hydrothermal synthesis to grow TMO thin films and nanostructures. The electronic and magnetic properties of the TMO films have been investigated by in-situ scanning tunneling microscopy/spectroscopy and ex-situ SQUID magnetometer. We have observed both large-scale (large than a few tens nanometers) and nano-scale electronic phase separation (PS) in epitaxially grown thin films of $(La_{5/8-0.3}Pr_{0.3})Ca_{3/8}MnO_3$. While the large PS domains are present only below the Curie temperature (T_c), the nano-scale PS clusters exist at temperatures both below and above T_c, which implies that the small clusters may originate from doping-related disorder.