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Synthesis, structure and properties of nanostructured manganites[1]

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Manganites form a fascinating class of multifunctional perovskite oxides with competing interactions that couple the charge, spin and the lattice. The presence of competing interactions (that often have a comparable energy scale) leads to presence of variety of phases in the manganites that can be tuned by substitution (hole concentration), pressure and magnetic field. Interesting classes of phenomena arise when the size is taken to nanoscales where the ground state can be tuned by the size. The size also tunes the nature of the phase transition and the nature of the electronic transport. Interestingly, the primary change occurs in the lattice structures on size reduction that weakens the orthorhombic distortion. The physical properties of the nanostructured manganites are very distinct and different from that seen in related nanostructured transition metal ferromagnetic oxides like the cobaltates. In this talk we will first describe the methods of synthesis of nanostructured manganites in the form of nanocrystals, nanowires and nanostructured films using soft chemical routes. Arrays of the nanostructured manganites can also be made using such techniques as dip-pen lithography using an Atomic Force Microscope. This will be followed by presentation of results on structures using synchrotron X-rays and neutrons that establish the nature of structural changes on size reduction. The structural changes (as established through the above studies) on size reduction tend to enhance the ferromagnetic interaction in the system. Next we will report a number of physical phenomena that arise as a consequence of the size reduction. This will include destabilization of the charge ordered state, change in the nature of the ferromagnetic transition and non-linear conduction that arises in the nanostructured films due to presence of a large number of grain boundaries. At very low temperatures the transport in the manganites become dominated by such effects as intergrain tunneling and Coulomb blockade.

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