Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Probing colossal magnetoresistance in manganites at the nanoscale

GUNEETA SINGH BHALLA, Lawrence Berkeley Nat. Lab and University of California, Berkeley, CA

Although a complete understanding remains elusive, phase separation is often cited as being the underlying cause of colossal magnetoresistance (CMR) in the manganites. In the low T_c manganites, a combination of transport and scanning probe experiments clearly reveal microscale insulating and metallic regions coexisting within a certain temperature range that coincides with CMR. We present results from recent experiments that explore phase separation and CMR in manganite nanostructures. When nanometer wide bridges are patterned from thin films of the prototypical phase separated manganite (La,Pr,Ca)MnO_3, a few alternating insulating and metallic regions can form along the length of the wire. For the purposes of electronic transport across the wire, the phase separated regions can be thought of as microscopic analogs of insulating and metallic multilayers. Transport measurements across the wires reveal that several distinct mechanisms are at play and act simultaneously to give the collective CMR effect observed in bulk. We identify signatures of tunneling magnetoresistance between two ferromagnetic metallic regions separated by an insulating region, exchange bias between the (antiferromagnetic) insulating and ferromagnetic metallic regions, colossal electroresistance jumps and finally, spin dependent tunneling across insulating regions that form at domain walls when the films are predominantly ferromagnetic and conducting at low temperatures. We discuss the implications of our results in understanding CMR in manganites and the potential for practical applications using manganite nanostructures.