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**Direct Imaging of Nanoscale Phase Separation in $La_{1-x}Ca_xMnO_3$ and Its Relation with Colossal Magnetoresistance**

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Colossal magnetoresistance (CMR) that occurs at intermediate temperatures in doped manganites has been widely believed to arise from inhomogeneous phases. However, convincing evidence is missing to link the structural inhomogeneity, especially at nanoscale, to the CMR effect without direct observation. Here we employed a newly developed technique, scanning electron nanodiffraction, to map in real space the distribution of the charge-ordered (CO) phase, ∼3-4 nm in size, with its characteristic structure as a function of temperature in $La_{1-x}Ca_xMnO_3$. The direct observation enables us to establish that the nanoclusters are not due to chemical inhomogeneities and quantify the volume fraction of the nanoscale CO phase. Our results show that the volume fraction of the nanoscale CO phase is significant enough to contribute to the transport property through the phase transition. Correlated with the property measurements from the bulk materials, the magnetic and transport properties of the nanoscale CO phase will also be discussed to establish the possible role of the nanoscale phase in the CMR effect.[1,2] [1]. J. Tao, et al., *Phys. Rev. Lett.*, **103**, 097202 (2009). [2]. Research was sponsored by the U.S. DOE/BES, Division of Materials Sciences and Engineering.