Multiphase Segregation and Metal-Insulator Transition in Single Crystal $La_{5/8-y}Pr_yCa_{3/8}MnO_3$

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We report synchrotron x-ray diffraction measurements performed on single crystal samples of $La_{5/8-y}Pr_yCa_{3/8}MnO_3$. This material belongs to the family of the so-called Colossal Magnetoresistance (CMR) compounds. At temperatures below T=50 K, application of magnetic field changes the electric resistivity of this compound by more than 6 orders of magnitude. This property is potentially applicable in magnetic recording. In our work, we study the zero-field insulator-metal transition which occurs in this compound at T_{MI}=70 K (on cooling). Previously, it was proposed that this transition occurs through the percolation of conducting ferromagnetic metallic (FM) phase through insulating charge-ordered (CO) matrix. We find that despite the dramatic drop in the resistivity at T_{MI}, the CO diffraction peaks exhibit no anomaly at this temperature and continue to grow below T_{MI}. Our data suggest that in addition to the CO phase, another insulating phase is present at low temperatures in this compound. In this picture, the insulator-metal transition is due to the changes that occur within this latter phase. The CO phase does not appear to play a major role in the insulator-metal transition. We propose that a percolation-like insulator-metal transition occurs via the growth of FM domains within the parts of the sample that do not exhibit charge ordering. Our results reveal a previously unknown mechanism of the insulator-metal transition in charge-ordered manganites and can provide important clues for understanding of the Colossal Magnetoresistance phenomenon.