A field-induced IM-type transition observed in low-energy H_2^+ ion implanted epitaxial $La_{2/3}Ca_{1/3}MnO_3$ thin films

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Epitaxial $La_{2/3}Ca_{1/3}MnO_3$ thin films on $LaAlO_3$ substrates were implanted with 120 keV H_2^+ ions over a range of does from 10^{12} to 10^{17} ions/cm^2. An implantation-induced metal-insulator transition is observed at a dose around 8.0×10^{15} ions/cm^2, which is accompanied by a structural change. The specified sample at this critical implantation dose is semiconductor-like, but can be driven to a metal at intermediate temperatures in an applied field of 4 T or higher. As a consequence, an unusual insulator-metal-insulator transition and thus an enormous magnetoresistance are observed. At 5 K, the field-cooled sample in 5 T shows a drastic resistance upsurge with the decreasing field and presents a very sharp peak as the field is reversed. The results are interpreted in terms of changes in magnetoresistive properties with the displacement of oxygen atoms or lattice distortions, most probably associated with a spin glass ground state, which can be provoked by ion implantations and suppressed by magnetic fields.