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Anisotropic and excellent magnetocaloric properties of $La_{0.7}Ca_{0.3}MnO_3$ single crystal with anomalous magnetization

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ABSTRACT

Magnetic properties and the magnetocaloric effect (MCE) have been investigated in $La_{0.7}Ca_{0.3}MnO_3$ single crystal with applied field along both the *ab*-plane and the *c*-direction. Due to the magnetocrystalline anisotropy, the crystal exhibits anisotropy in the MCE. Upon application of a 5 T field, the magnetic entropy changes (ΔS_M), reaching values of 7.668 J/(kg K) and 6.412 J/(kg K) for both the *ab*-plane and the *c*-direction, respectively. A magnetic entropy change of 3.3 J/(kg K) was achieved for a magnetic field change of 1.5 T at the Curie temperature, T_C = 245 K. Due to the absence of grains in the single crystal, the ΔS_M distribution here is much more uniform than for gadolinium (Gd) and other polycrystalline manganites, which is desirable for an Ericsson-cycle magnetic refrigerator. For a field change of 5 T, the relative cooling power, RCP, reached 358.17 J/kg, while the maximum adiabatic temperature change of 5.33 K and a magnetoresistance (MR) ratio of 507.88% at T_C were observed. We analysed the magnetization of $La_{0.7}Ca_{0.3}MnO_3$ single crystal at T_C and estimated several parameters of spin fluctuation on the basis of a self-consistent renormalization theory of spin fluctuations, with reciprocal susceptibility above T_C. We found that the magnetic property of $La_{0.7}Ca_{0.3}MnO_3$ is weakly itinerant ferromagnetic. A large reversible MCE and no hysteresis loss with a considerable value of refrigerant capacity indicate that $La_{0.7}Ca_{0.3}MnO_3$ single crystal is a potential candidate as a magnetic refrigerant.