Structural, Magnetic and Magnetocaloric Properties of $RE_{0.55}(Ca_xSr_{1-x})_{0.45}MnO_3$ (RE= Sm, Pr, La) Perovskite

Speaker: Most. Asma Akter Bally

Abstract

The structural, magnetic and magnetocaloric properties of three series of samples $La_{0.55}Ca_xSr_{0.45-x}MnO_3$, $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$ and $Sm_{0.55}Ca_xSr_{0.45-x}MnO_3$ (x = 0.00, 0.05, 0.1, 0.2 and 0.25) prepared by solid state reaction technique have been investigated. XRD measurements reveal rhombohedral structure for all the samples of $La_{0.55}Ca_xSr_{0.45-x}MnO_3$ and Orthorhombic structure for all the samples of $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$, and $Sm_{0.55}Ca_xSr_{0.45-x}MnO_3$. With increasing Ca content, lattice parameters as well as Mn-O-Mn bond angles are found to decrease. These structural changes control ferromagnetism in the materials via the double-exchange mechanism. Microstructural and compositional analysis have been done by a field emission scanning electron microscope. Arrott plots confirm that all the samples undergo second-order ferromagnetic (FM) to paramagnetic (PM) phase transition for $La_{0.55}Ca_xSr_{0.45-x}MnO_3$ and $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$ series and first-order FM to PM phase transition for $Sm_{0.55}Ca_xSr_{0.45-x}MnO_3$ series. Curie temperature (T_C) decreases with increase in Ca content for all three series but saturation magnetization decreases with increase in Ca content in $La_{0.55}Ca_xSr_{0.45-x}MnO_3$, and $Sm_{0.55}Ca_xSr_{0.45-x}MnO_3$ while increases for $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$. Critical exponent values calculated from modified Arrott plots, Kouvel–Fisher method and critical isotherm analysis disclose the existence of long range ferromagnetic interaction in $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$ and $La_{0.55}Ca_xSr_{0.45-x}MnO_3$ with x=0.00, 0.05, 0.1 and short-range ferromagnetic interactions in samples with x=0.2 and 0.25. The magnetocaloric effect was calculated in terms of entropy change ($-\Delta S_m$) and relative cooling power (RCP). For $La_{0.55}Ca_xSr_{0.45-x}MnO_3$ series maximum values of ($-\Delta S_m$) and RCP are found to decrease with the increase of Ca content while increase in Ca content tunes the T_C near room temperature (RT). These properties make $La_{0.55}Ca_xSr_{0.45-x}MnO_3$ as a potential material for RT magnetic refrigeration. The T_C values of the samples of series $Sm_{0.55}Ca_xSr_{0.45-x}MnO_3$ are found to decrease from 116 K to 75 K and both $(-\Delta S_m)_{max}$ and RCP values also decrease with increase in Ca content. This system may be considered as promising candidate for low temperature magnetic refrigeration. The T_C values of the samples of series $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$ are found to decrease from 290 K to 230 K while both $(-\Delta S_m)_{max}$ and RCP increase with the increase of Ca content. These properties make $Pr_{0.55}Ca_xSr_{0.45-x}MnO_3$ as a potential material for magnetic cooling technology near and below RT.