Magnetocaloric materials for room temperature refrigeration: the case of rare earth doped La-Ba manganites

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Magnetic refrigeration is an emerging technology, environmentally friendly and energetically more efficient than the widespread gas compression one. It exploits the magnetocaloric effect, which is a manifestation of the exchange between magnetic and lattice entropy when a material is subject to changing magnetic field in adiabatic conditions, resulting in a decrease or increase of temperature [1]. Commercial refrigeration systems are expected in the next years, but the development of a suitable magnetocaloric material is still a materials engineering challenge. Although the intermetallic iron alloys $La(Fe_{1-x}Si_x)_{13}$ are the choice of current prototypes, other compounds, such as $(Mn,Fe)_2(P,Si)$ and manganites of the type $RE_{1-x}AE_xMnO_3$, are proposed as room temperature refrigerants [2]. Especially the manganites present advantages over intermetallic alloys, such as low production cost, chemical stability, minimum eddy current loss and low thermal and magnetic hysteresis, as the magnetocaloric effect is associated to a second order magnetic transition [3].

We have been studying structural and magnetic properties of substituted La-Ba manganites and their potential as magnetocaloric materials [4,5]. In this presentation we report on Nd or Gd doped $(La_{1-x}RE_x)_{0.7}Ba_{0.3}MnO_3$ (x=0.05, 0.10, 0.15) and summarize our findings in rare earth (Y, Dy, Nd, Gd) doped La-Ba manganites. Samples are prepared by standard ceramic process and they all present a sharp ferromagnetic-paramagnetic transition of second order type. Due to change in A site average cation size, the transition temperature and the crystal structure type vary with composition. Calculation from isothermal magnetization curves and analysis of magnetic entropy change vs temperature or field curves provide insight of the effect of substitution on the materials properties. With Nd substitution we obtain at 305 K the performance of $La_{0.7}Ba_{0.3}MnO_4$ (330 K).

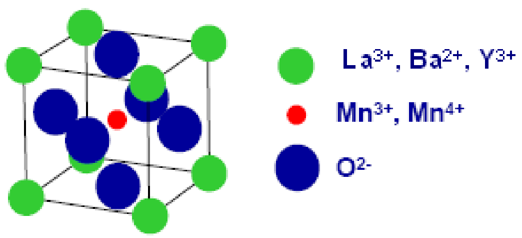

Fig. 1: The perovskite structure

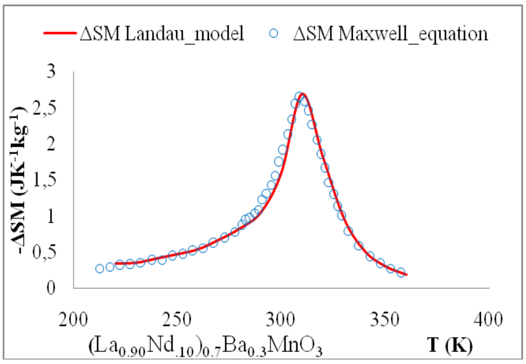

Fig. 2: Magnetic entropy change for 2T field change

References

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