Magneto caloric Materials for Magnetic Refrigeration

Abdelilah Benyoussef

Académie Hassan II des Sciences et Techniques, Rabat, Maroc

LaMCScI, Faculté des Sciences, Université Mohammed V, Rabat, Maroc

Centre Matériaux et Nanomatériaux, MAScIR, Rabat, Maroc

The possibility of using magnetic refrigeration has become more reliable during the last twenty years, which will enable it to replace conventional refrigeration systems. Such a change is desirable due to the advantages of using the magnetocaloric effect (MCE) for magnetic refrigeration application, thus leading to high refrigeration efficiency, small volume requirement, low cost, environmental friendliness, no noise pollution and better performance. An excellent magnetic refrigerant should have large magnetic entropy change induced by low magnetic field change.

MCE has mainly been investigated for bulk crystal and polycrystal materials. However, nanostructured Gd has a different magnetocaloric behavior when compared with the bulk counterparts. The ordering temperature and magnetic entropy changes of alloy thin films could be tuned by changing the alloy's composition. [Gd/Tb] multilayers with the same thickness and concentration of the studied Gd1-xTbx alloy films enables to strongly increase the relative cooling power, and reach values twice as big as from the corresponding alloys. The origin of this change appears to be a combination of interface defects and lower size effects. Thanks to this approach, the variation of entropy can be controlled continuously from the individual properties of its constituting elements. This study opens up new possibilities in the control and optimization of the magnetocaloric effect in magnetic thin films.

Recently, ferrite spinels, such as CoFe2O4, MnZnFe2O4, and Zn–NiFe2O4, were studied by numerous research groups in the objective to investigate the magnetic and magnetocaloric properties. Zn1−xNixFe2O4 present an important relative cooling power “RCP” higher than 500 J/kg which was considered as a recommended parameter for a wide temperature range in magnetic refrigeration application.

Perovskite ABO3-type manganites with the general formula $(R^{3+}_{1-x}A^{2+}_{x})\ (Mn^{3+}_{1-x}Mn^{4+}_{x})O^{2-}_{3}$ (R: Rare-earth = La, Pr, Nd…, A: Alkali and Alkali-earth metal = Sr, Ca, Ba…) have attracted a great attention due to their colossal magnetoresistance (CMR) and strong MCE. These properties are explained in the framework of the double exchange interaction between the trivalent (Mn3+) and tetravalent (Mn4+) manganese. The mixture of (La0.7-xNdx)Sr0.3MnO3 (LNSMO) with a small amount of CuO (typically 5 % weight ratio) enables to markedly enhance the magnetocaloric effect.

Density Functional theory is a Powerful Quantum mechanics method for the design of new magnetocaloric materials. Indeed, colossal magnetoresistance (CMR) and strong MCE have been predicted for several materials including MnAs and DyNi4Si.

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