GIANT MAGNETOCALORIC EFFECT IN MANGANITES

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Recently, there has been a significant increase in research on the magnetocaloric effect. The development of a new magnetic refrigeration technology, based upon this effect, has brought an alternative to the conventional gas compression technique [1]. As a result, many new materials with large magnetocaloric effect have been discovered. The magnetocaloric effect is characterized by an adiabatic change in temperature (or an isothermal change in entropy, ΔS) arising from the application of external magnetic field. The magnetocaloric effect arises due to the presence of two energy reservoirs in magnetic materials: one with phonon and the other with magnon excitations. These two reservoirs are coupled by the spin-lattice interactions. An external magnetic field affects the spin degrees of freedom resulting in heating or cooling of magnetic materials. This simple description of the magnetocaloric effect indicates that the highest change in temperature is expected for strongly magnetostrictive magnetic materials. The magnetocaloric effect increases with increase of the applied magnetic field and with the change of magnetization during application of magnetic field. This means that the effect reaches its maximum in the vicinity of magnetic phase transition points.

In this review we will briefly discuss the magnetocaloric properties of the manganites and the possibility of use these materials in magnetic refrigerators working near room temperature. It will be shown that the maximum entropy change observed in manganites is very high and exceeds that of gadolinium (the prototype material for room temperature refrigerators). In manganites advanced for active magnetic refrigerations paramagnetic-ferromagnetic transition is very narrow but no hysteresis is observed and the transitions are identified as second-order one. For these transitions the critical exponents are determined. Behavior of the adiabatic magnetic entropy change in the critical region is discussed. In particular, the scaling hypothesis for magnetic entropy changes will be checked.

References

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