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Theoretical consideration on magnetic entropy changes in CMR materials

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In past years, theoretical controversy involving a realistic and physical mechanism that leads to large magnetic entropy change as a large magneto-caloric effect in colossal magneto-resistance (CMR) materials had been left as an open question. Thus it is desirable to clarify this problem.

In present advances, we have the magnetic entropy change considered by utilizing the tools of molecular field approximation, which provides with a desirable manner of magnetic field- and transition temperature (T_C) dependences of the magnetic entropy in CMR materials. As an example, $La_{2/3}Ca_{1/3}MnO_3$ with the magnetic entropy change (ΔS_M) as a function of field (B = 0-5 T) and temperature (T = 150-300 K), has been taken into account. Calculated results show that ΔS_M reaches a peak at T_C and develops as the magnetic field is increasingly applied. It is remarkable that, in $La_{2/3}Ca_{1/3}MnO_3$, the maximum ΔS_M values are found to be a decreasing function of T_C temperature, indicating a reduction of spin-lattice coupling or an increase in the lattice entropy, as T_C is increased under assumption. Our calculated results are in agreement with the experimental data, and thus allow a selection of magnetic refrigerants appropriate for magnetic refrigeration technology.

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