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Study of the magnetic equation of state as precursor of the area under the isothermal magnetocaloric potential

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Abstract

The isothermal evolution of magnetization under different magnetic fields, described by an equation of state, not only defines de entropy change $\Delta S(T)$ (magnetocaloric effect) but also the cooling power (area enclosed by the $\Delta S(T)$ curve). In fact, the area under the $M_{T_0}(H)$ curve limited by the initial (H_i) and final (H_f) fields equals the area under the $\Delta S(T)$ curve above $T > T_0$ for the same field range. This "sum rule" has been used to compare magnetocaloric curves for a number of materials. We based this study in the prediction that $M_{T_0}(H)$ contains all the information to the establishment of the cooling power above T_0 over the whole range of considered magnetic fields. To perform a check, we studied here some magnetic systems described by different equations of state including that around the transition region (power law). We show results of theoretical calculations in $GdAl_2$-like ferromagnetic material with equation of state in the framework of Brillouin and Oguchi models. An intricate phenomenological equation of state for polycrystalline $NdAl_2$ under hydrostatic pressure is also used to validate the sum-rule.

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Magnetically ordered materials; Magnetocaloric; Phase transitions; Thermodynamic properties