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Magnetocaloric cooling: the phenomenon and materials[1]

VITALIJ PECHARSKY, Ames Laboratory and Department of Materials Science and Engineering, Iowa State University

The discovery of the giant magnetocaloric effect in $Gd_5Si_2Ge_2$ and other R_5T_4 compounds (R = rare earth metal and T is a Group 14 element) generated a broad interest in the magnetocaloric effect and magnetic refrigeration near room temperature in particular, and in magnetostructural transitions in general. Reports on the giant magnetocaloric effect in other systems soon followed. These include $MnFeP_xAs_{1-x}$ and related compounds, $La(Fe_{1-x}Si_x)_{13}$ and their hydrides, $Mn(As_xSb_{1-x})$, $CoMnSi_xGe_{1-x}$ and related compounds, Ni_2MnGa and some closely related Heusler phases, and a few non-metallic systems. A common feature observed in all giant magnetocaloric effect materials is the enhancement of the magnetic entropy change by the overlapping contribution from the lattice. In addition to the interplay between magnetic and lattice entropies, both of which are intrinsic materials' parameters that in principle can be modeled theoretically from first principles, extrinsic parameters such as microstructure and nanostructure, have been found to play a role in controlling both the magnetostructural transition(s) and magnetocaloric effect. Both the intrinsic and extrinsic parameters are, therefore, important in order to maximize magnetocaloric effect. The role of different control parameters and the potential pathways towards materials exhibiting advanced magnetocaloric effect will be discussed.

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