Tuning the magnetocaloric response of $Gd_{7-x}Y_xPd_3$ ($2 \leq x \leq 6$) alloys by microstructural modifications

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We investigated the influence of microstructural changes on the magnetic and magnetocaloric properties of $Gd_{7-x}Y_xPd_3$ ($2 \leq x \leq 6$) alloys rapidly quenched by vacuum suction casting and melt-spinning techniques. Structural investigations were carried out using X-ray diffraction, while the microstructure was studied utilizing scanning electron microscopy. Quenched-in structural disorder determines magnetic and magnetocaloric properties in both series of alloys. For rc-cast samples two distinct magnetic transitions are visible. The peak at higher temperatures is related to the ferromagnetic/paramagnetic transition of the crystalline phase. In contrast, the peak observed at low temperatures is believed to be related to the ferro-para transition of the amorphous phase and/or a spin reorientation. In the samples obtained by vacuum suction casting (rc-cast), the grain size was estimated to be equal 30-70 nm, while for the $Gd_2Y_5Pd_3$ composition the grains were slightly larger (up to 80 nm). The $Gd_{7-x}Y_xPd_3$ alloys in the form of rapidly cooled cast exhibit the magnetic transition temperatures at 262 K, 242 K, 202 K, 153 K and 9 K, for ($2 \leq x \leq 6$) respectively. The Curie temperatures of melt-spun $Gd_{7-x}Y_xPd_3$ alloys are much lower compared to rc-cast samples. The melt-spun $Gd_5Y_2Pd_3$ orders ferromagnetically below 90 K, while $Gd_4Y_3Pd_3$, $Gd_3Y_4Pd_3$, $Gd_2Y_5Pd_3$ and GdY_6Pd_3 ribbons undergo the magnetic transformation at 65 K, 40 K, 25 K, and 9 K, respectively. For the rc-cast samples, a table-like magnetocaloric effect in a wide temperature range is observed. This table-like temperature dependence of magnetic entropy change (ΔS_m) is caused by the successive magnetic transitions of crystalline and amorphous phases. Ribbons exhibit almost doubled magnetic entropy change in comparison to rc-cast samples. For instance, the (ΔS_m) value for melt-spun and rc-cast $Gd_5Y_2Pd_3$ is equal to 6.31 $Jkg^{-1}K^{-1}$ and 3.64 $Jkg^{-1}K^{-1}$, respectively. Moreover, due to the large FWHM of the magnetic entropy change peak, both the melt-spun and rc-cast samples exhibit large refrigerant cooling power (*RCP*), reaching 466 Jkg^{-1} ($\Delta\mu_0 H$=5 T) for the rc-cast $Gd_5Y_2Pd_3$. *RCP* values are comparable to those of some potential magnetic refrigerants.

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