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The magnetic properties and magnetocaloric effect in $(Mn_{1-x}Ni_x)CoGe$

Magnetic refrigeration based on magnetocaloric effect is considered as a potential alternative to the conventional gas-compression based refrigeration [1], because the former can improve energy efficiency and reduce emission of environment-harmful chemicals. Materials with first-order magneto-structural transitions are of great interest for large magnetocaloric effect, e.g. Gd5(Si,Ge)4 and Heusler alloys [3]. Magneto-structural transition and large magnetocaloric effect were also observed in MnCoGe-based alloys. For MnCoGe-based alloys, there are two stable crystallographic structures: nominally low temperature TiNiSi-type orthorhombic structure (Pnma, martensitic phase) and the high temperature Ni2In-type hexagonal structure (P$6_3/mmc$, austenitic phase), with a martensitic transformation around T_M ~650 K [4]. Both phase present as ferromagnetic state at low temperature with Curie temperature of ~345 K and ~275 K, for the martensitic and austenitic phases, respectively. When the martensitic transition temperature T_M is moved into the temperature range of the two Curie temperatures, e.g. Fe doping $(Mn_{1-x}Fe_x)CoGe$ [5], coupling of magnetic and lattice structures is obtained and hence present a magneto-structural transition from the ferromagnetic martensite to the paramagnetic austenite.

In this work, Ni was used as substitute for Mn to drive the martensitic transformation temperature. The crystallographic structures and magnetic properties of annealed (Mn1-xNix)CoGe (x = 0.02, 0.03, 0.04, 0.05, 0.06 and 0.07) were studied via x-ray diffraction (T = 20-310 K) and magnetisation (T = 5-340 K) measurements. Then the magneto-structural transition were confirmed by neutron diffraction experiments (T = 5-320 K), and the influence of magnetic field on the magneto-structural transition were investigated using magnetic-field neutron diffraction (B = 0-9 T). The magnetic entropy changes have been derived in the conventional way from a series of isothermal magnetisation experiments, e.g. $-\Delta S_m$ ~ 8.8 J kg^{-1} K^{-1} for a magnetic field change of ΔB = 0-5 T in $(Mn0.95Ni_{0.05})CoGe$.

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