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Ti substitution for Mn in MnCoGe – The magnetism of $Mn_{0.9}Ti_{0.1}CoGe$

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ABSTRACT

Bulk magnetization measurements (5–320 K; 0–8 T) reveal that below room temperature $Mn_{0.9}Ti_{0.1}CoGe$ exhibits two magnetic phase transitions at ~178 K and ~280 K. Neutron diffraction measurements (3–350 K) confirm that the transition at ~178 K is due to the structural change from the low-temperature orthorhombic TiNiSi-type structure (space group *Pnma*) to the higher temperature hexagonal Ni_2In-type structure (space group P63/*mmc*), while the transition at ~280 K originates from the transition from ferromagnetism to paramagnetism. The magnetocaloric behaviour of $Mn_{0.9}Ti_{0.1}CoGe$ around $T_{str} \sim 178$ K and $T_C \sim 280$ K as determined *via* the magnetic field and temperature dependences of DC magnetisation are given by the maximum values of the magnetic entropy changes $-\Delta S_M^{max} = 6.6\ J\ kg^{-1}\ K^{-1}$ around $T_{str} \sim 178$ K, and $-\Delta S_M^{max} = 4.2\ J\ kg^{-1}\ K^{-1}$ around $T_C \sim 280$ K for a magnetic field change of $\Delta B = 0$–8 T. Both structural entropy – due to the unit cell expansion of ~4.04% – and magnetic entropy – due to an increase in the magnetic moment of ~31% – are found to contribute significantly to the total entropy change around T_{str}. Critical analysis of the transition around $T_C \sim 280$ K leads to exponents similar to values derived from a mean field theory, consistent with long-range ferromagnetic interactions. It was found that the field dependence of $-\Delta S_M^{max}$ can be expressed as $-\Delta S_M^{max} \propto B^n$ with $n = 1$ for the structural transition around T_{str} and $n = 2/3$ for the ferromagnetic transition around T_C, thereby confirming the second order nature of this latter transition.