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Magnetocaloric Mn(Co1-xNix)Ge - Structural and magnetic transitions

The structural and magnetic properties of MnCoGe-based alloys have been studied extensively in recent years due to their potential application as magnetic cooling materials based on the magnetocaloric effect (MCE). The $Mn(Co_{1-x}Ni_x)Ge$ series is of particular interest as magnetic transitions in the range 275 K to 345 K generally coincide with a martensitic structural transition T_M, with such an overlap then allowing scope for the formation of a magneto-structural transition (ferromagnetic orthorhombic to paramagnetic hexagonal) and hence an associated large MCE [e.g. 1].

Neutron diffraction, magnetisation and x-ray experiments on $Mn(Co_{1-x}Ni_x)Ge$ compounds (x = 0.12 to 1.00) have demonstrated magnetic structures ranging from ferromagnetic for $x < 0.50$ to non-collinear spiral antiferromagnetic for $x > 0.55$ at low temperature (e.g. 5 K). T_M is found to decrease initially with increasing Ni content and then increase. First-order magneto-structural transitions are observed in $Mn(Co_{1-x}Ni_x)Ge$ samples for ~$0.20 < x <$ ~0.65 with the presence of ferromagnetic and antiferromagnetic structures in $Mn(Co_{1-x}Ni_x)Ge$ allowing investigation of both direct and inverse magnetocaloric effects. Our results (including the magnetic phase diagram for $Mn(Co_{1-x}Ni_x)Ge$) are discussed in terms of the increase of valence electron concentration on substitution of Ni ($3d^8 4s^2$) for Co ($3d^7 4s^2$) in the orthorhombic phase, leading to expansion of the unit cell and redistribution of the valence electrons [2].

[1] T. Trung, L. Zhang, L. Caron, K. H. J. Buschow, E. Brück, Appl. Phys. Lett. 2010, 96, 172504.
[2] Q. Ren, W. D. Hutchison, J. Wang, A. J. Studer and S. J. Campbell, Chem. Mater. 2018, 30, 1324.

Topic

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