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ELECTRICAL AND MAGNETOTRANSPORT PROPERTIES OF CANTED ANTIFERROMAGNET $Dy_5Si_2Ge_2$

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Since giant magnetocaloric effect is encountered in a ferromagnetic $Gd_5Si_2Ge_2$ alloy near room temperature it is considered as a suitable material for magnetic refrigerator applications. Also a commensurate structural transition occurs at the magnetic transition temperature and there is a good correlation between the crystal structure and magnetic properties. Such observations have triggered numerous experimental studies on similar rare earth alloys and compounds. We have synthesized its Dy- analogue, namely, $Dy_5Si_2Ge_2$ and have characterized it by means of room temperature X- ray diffraction, ac magnetic susceptibility (15 K - 300 K), electrical resistivity (at zero field and at 6 T), thermoelectric power (15 K - 300 K) and neutron diffraction (at 300 K and 9.2 K) experiments. The compound $Dy_5Si_2Ge_2$ has the orthorhombic Sm_5Ge_4-type structure (space group Pnma) as the Gd_5X_4 (X = Si, Ge) end members. The cell parameters are a = 1.4575(2) nm, b = 0.7531(1) nm and c = 0.7632(1) nm. The ac magnetic susceptibility study suggests the presence of paramagnetic to antiferromagnetic-like transition at 57 K (T_N). DC electrical resistivity measurements confirm the magnetic crossover by a strong change of slope. The resistivity drops abruptly below T_N as the spin disorder contribution vanishes. The application of magnetic field suppresses the T_N by about 6 K thereby emphasizing the nature of the magnetic order to be antiferromagnetic. Electrical resistance falls almost monotonically with increasing applied field. Magnetoresistance (MR) is negative till about 50 K. At 77 K, it is 2.5 % in applied fields of 7 T. Just below T_N (at 50 K), MR ratio is observed to be the highest (8.1%), and at lower temperatures, field dependence of resistivity is anomalous. There is a peak feature around 2 T and a bump around 4.4 T followed by a smooth decrease at higher magnetic fields. The neutron diffraction data at 9.2 K reveals a canted spin arrangement giving rise to antiferromagnetism in this compound. The magnetic moment on Dy- ion at 9.2 K is found to be 7.54 μ_B. The thermoelectric power is positive (suggesting that the charge carriers are holes) and has a peak around 36 K.

THE MAGNETOCALORIC EFFECT IN Gd_7Pd_3 AND $Gd_7Pd_{3-x}Ni_x$ COMPOUNDS

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Magnetic refrigeration, based on materials showing high magnetocaloric properties, is at present a valuable alternative to gas compression technology, because of the high thermodynamic efficiency due to the reversibility of the magnetocaloric effect and the high energy densities exhibited in compact devices, coupled with the absence of ozone depleting CFC's as liquid refrigerants. As a part of a current research concerning the physical characterization of Rare Earth intermetallic compounds for magnetic refrigeration devices[1-3], the magnetocaloric properties of the Gd_7Pd_3 phase, which crystallises in the Th_7Fe_3 hexagonal structure type and shows a ferromagnetic transition below 318 K, are presented.
Heat capacity measurements have been performed in the 5-360 K temperature range and for applied magnetic fields up to 5T. Basing on the heat capacity data the isothermal entropy change S_M and the adiabatic temperature raise T_{ad} have been calculated (S_M =6.5 J/Kkg and T_{ad} = 8.5K at 5T and 320K). From the S_M vs T plot the refrigerant capacity $Q \quad {}^{T_f}_{T_i}\; S_M(T)dT$ has been determined. The Q values obtained for the Gd_7Pd_3 phase together with some reference data are reported in table 1. Furthermore, in this work the influence of partial Pd substitution with Ni on the transition temperature and on the magnetocaloric properties is also examined.

Compound	Temperature span [K]	Applied magnetic field [T]	Refrigerant capacity [J/kg]	Reference
Gd_7Pd_3	260-360	5	380	This work
Gd	270-315	5	400	4
$GdAl_2$	130-185	5	350	5
Gd_5Ge_4	10-50	5	780	6

Table 1

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