ELSEVIER

Journal of Alloys and Compounds 235 (1996) 188–191

Journal of ALLOYS AND COMPOUNDS

Magnetic properties of the equiatomic ternary rare earth platinum gallides

P.A. Kotsanidis[a], J.K. Yakinthos[a,*], W. Schafer[b], Hel. Gamari-Seale[c]

[a]*Democritos University of Thrace, Electrical and Computer Engineering Department, Physics Laboratory, 67100 Xanthi, Greece*
[b]*Mineralogisches Institut, Universitat Bonn, Poppelsdorfer Schloß, Bonn D-53115, Germany*
[c]*Institute of Material Science, NSRC Democritos, 15310 Aghia Paraskevi, Greece*

Received 29 September 1995

Abstract

Susceptibility and magnetization measurements were realized on the equiatomic ternary orthorhombic RPtGa compounds. LaPtGa is non-magnetic.The compounds with R = Ce, Pr, Nd, Ho and Er do not present any ordering temperature down to 5 K. The ordering temperatures of the compounds with R = Gd, Tb, Dy and Tm are 25 K, 20 K, 15 K and 8 K respectively. The paramagnetic Curie temperatures do not have the same sign across the RPtGa series.

Keywords: Ternary rare earth platinum gallides; Magnetic properties; RPtGa compounds

1. Introduction

The very large number of equiatomic ternary rare earth–transition metal compounds RTM (R = rare earth; T = Co, Ni, Rh, Pd, Ir, Pt; M = Si, Ga, Ge, Sn) have been the subject of investigations of several researchers [1–3]. These compounds crystallize in the orthorhombic *Pnma* space group. Each element occupies the same crystallographic 4c site with atomic position (x,1/4,z). The compounds present complicated magnetic structures: i.e. TbNiSn [4] and HoNiSn [5] present, at relatively low temperatures, sine-modulated magnetic structures. As a continuation of our studies of ternary rare earth–transition metal compounds, we report on the magnetic properties of the equiatomic rare earth–platinum–gallides. The lattice parameters and the crystal structure of RPtGa have already been determined by Hovestreydt et al. [3].

2. Experimental

The samples were prepared with the composition 1:1:1 by arc melting under helium atmosphere from high purity elements (rare earth 99.9%, platinum and gallium 99.99% pure) as starting materials. The compounds were remelted several times to ensure homogeneity. They were investigated by X-ray diffraction and found to be free of a second phase. They crystallize in the *Pnma* space group with TiNiSi-type structure. Their a, b, c lattice parameters and atomic positions were found to be the same as those given in Ref. [3]. Susceptibility and magnetization measurements on powdered samples were performed on a SQUID magnetometer between 5 and 300 K at field strengths up to 30 kOe.

* Corresponding author.

3. Results

3.1. Light rare earths

The susceptibility values of the compound LaPtGa are four orders of magnitude lower than those of the other RPtGa compounds and due to its non-magnetic behaviour.

For the compounds with R = Ce, Pr and Nd, the reciprocal susceptibility vs. temperature curves, under 50 Oe, show a linear behaviour above 50 K. Below this temperature a rapid decrease in the inverse susceptibility of CePtGa takes place, probably caused by relatively high anisotropic paramagnetic behaviour. The deviation of the reciprocal susceptibility from the

SSDI 0925-8388(95)02132-9

straight line, for PrPtGa and NdPtGa, is smooth (Fig.1). The extrapolation of the linear part of the reciprocal susceptibility of these compounds leads to negative values of the paramagnetic Curie temperatures (PCTs) with the largest absolute value for CePtGa. Only NdPtGa has a remanent magnetization equal to 0.19 μ_B mol^{-1} (insert of Fig. 1). These compounds do not show any susceptibility maximum down to 5 K.

3.2. Heavy rare earths

The reciprocal susceptibility vs. temperature, derived from measurements in 50 Oe for GdPtGa and 1 KOe for the compounds with R = Tb, Dy and Tm, follows the Curie–Weiss law above 60 K for TmPtGa with a negative PCT, and above 90 K for Tb and Dy with positive PCTs (Fig. 2). Below these temperatures, the susceptibility increases rapidly or smoothly for the compounds with Dy,Tm and Gd,Tb respectively. It reaches a maximum value and then decreases down to 5 K (insert (a) of Fig. 2). The 5 K isotherms do not show any remanence (insert (b) of Fig. 2). DyPtGa shows a metamagnetic behaviour with a critical field equal to 12 kOe. The reciprocal susceptibility of HoPtGa and ErPtGa compounds follows the Curie–Weiss law above 10 K and 30 K respectively. Both compounds have a positive PCT. There is a deviation from the straight line below these temperatures (Fig. 3). Their susceptibilities do not exhibit any maximum value down to 5 K. The 5 K isotherm of ErPtGa is not a straight line, while for HoPtGa, it clearly shows the occurrence of low-temperature antiferromagnetism due to the metamagnetic transition at 14 kOe (insert of Fig. 3). PCT values, effective moments μ_{eff}, 3^+ free ion moments (μ^{3+}), magnetizations σ, $g_J J$ and ordering temperatures for the RPtGa compounds are given in Table 1.

4. Discussion

The equiatomic ternary gallides RPtGa crystallize in the orthorhombic space group *Pnma* with a single rare earth site in the unit cell. LaPtGa is non-magnetic. The effective magnetic moments μ_{eff} are found to be slightly different from the theoretical values $\mu_{th} = g_J[J(J+1)]^{1/2}$ for the tripositive rare earth ions in the RPtGa compounds. The magnetization of these compounds at 5 K and 30 kOe is far from saturation. This may be due to a strong rare earth anisotropy or to a probable non-collinearity of the rare earth moment. Further magnetization measurements on monocrystals or neutron diffraction experiments are needed to find

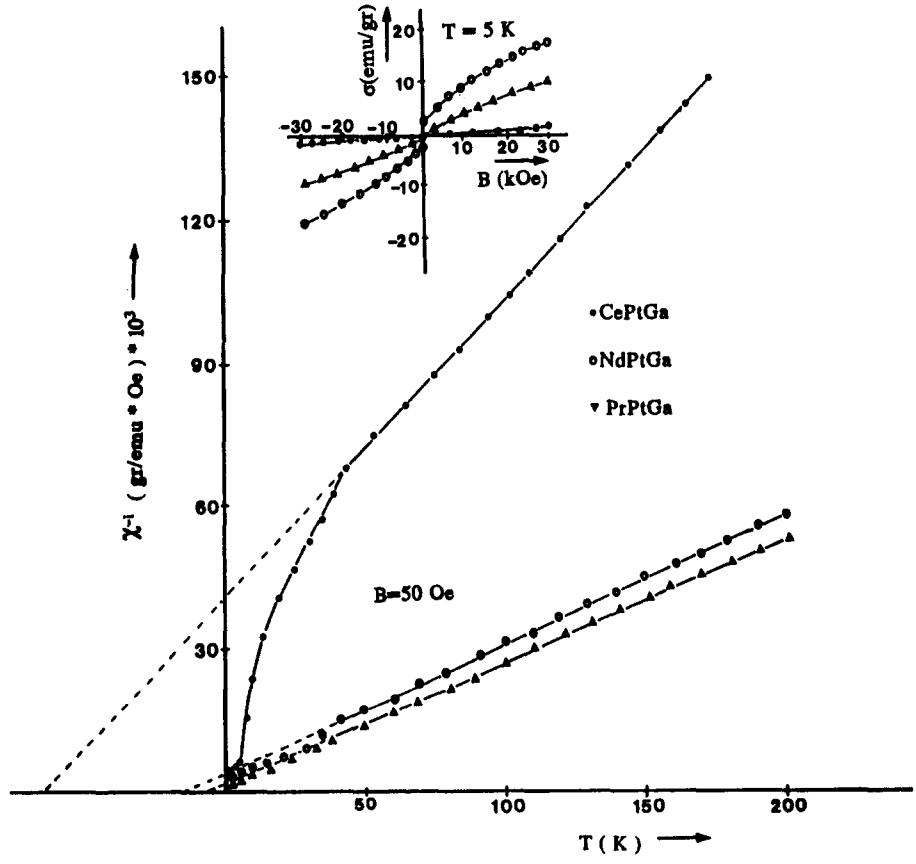

Fig. 1. Reciprocal susceptibility of CePtGa, PrPtGa and NdPtGa. Insert: magnetization at 5 K and field strengths up to 30 kOe.

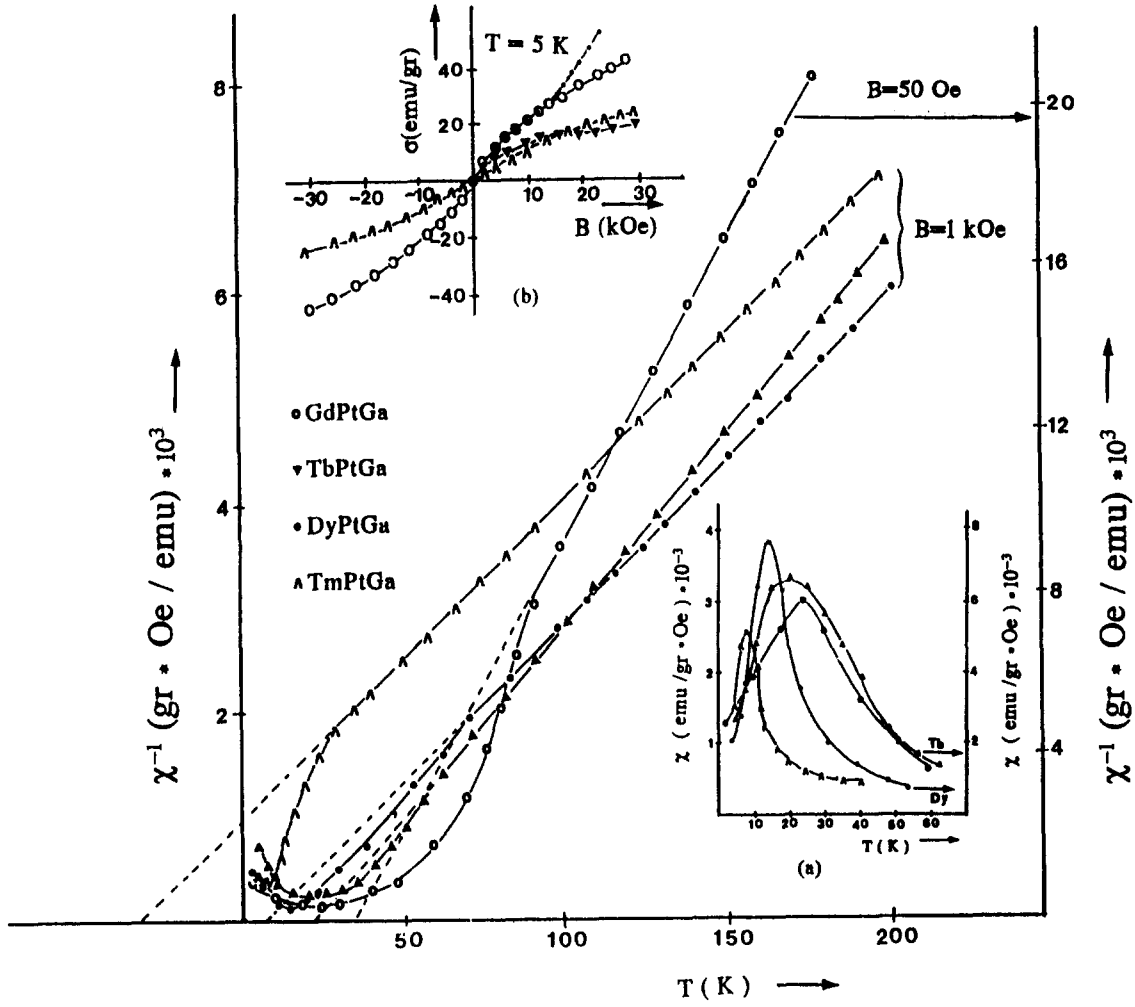

Fig. 2. Reciprocal susceptibility of GdPtGa, TbPtGa, DyPtGa and TmPtGa. Insert (a): susceptibility; insert (b): magnetization at 5 K and field strengths up to 30 kOe.

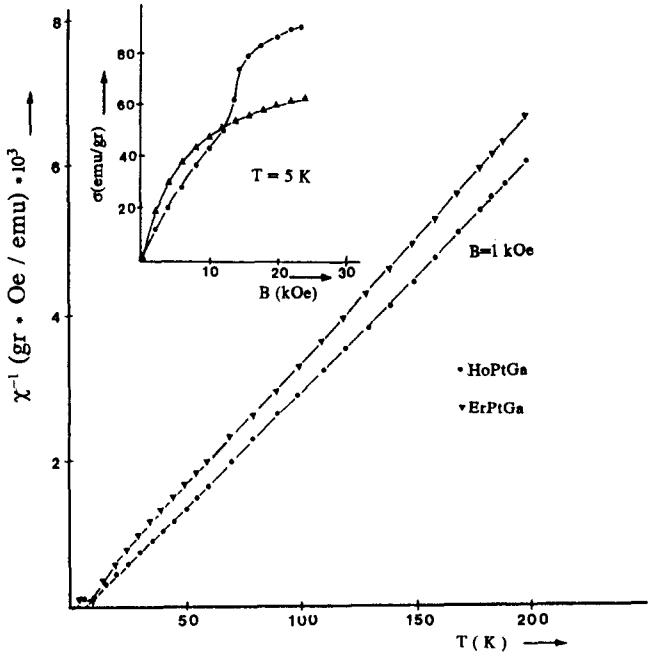

Fig. 3. Reciprocal susceptibility of HoPtGa and ErPtGa. Insert: magnetization at 5 K and magnetic field up to 30 kOe.

Table 1
PCTs, effective moments μ_{eff}, μ^{3+}, magnetizations σ at 5 K and 30 kOe, $g_J J$ and ordering temperatures of RPtGa compounds

RPtGa	PCT(K)	μ^{eff}	μ^{3+}	σ	$g_J J$	T_0 (K)
Ce	−68	2.36	2.54	0.12	2.1	–
Pr	−18	3.50	3.58	0.7	3.2	–
Nd	−15	3.55	3.62	1.2	3.3	–
Gd	34	7.90	7.94	3.2	7.0	25
Tb	20	9.70	9.72	1.5	9.0	20
Dy	10	10.68	10.65	3.9	10.0	15
Ho	6	10.55	10.61	7.2	10.0	–
Er	5	9.55	9.58	5.0	9.0	–
Tm	−5	7.40	7.56	1.8	7.0	8

anisotropy strengths and moment directions as well as the magnetic structures of the RPtGa compounds.

Acknowledgement

This work has been supported by the Stride 8–Hellas program.

References

[1] R.V. Skolozda, O.E. Koretskaya and Yu.K. Gorelenk, *Ukr. Fiz. Zh., 27* (1982) 213.
[2] D. Rossi, R. Marazza and R. Ferro, *J. Less-Common Met., 107* (1985) 99.
[3] E. Hovestreydt, N. Engel, K. Klepp, B. Chabot and E. Parthé, *J. Less-Common Met., 85* (1982) 247.
[4] P.A. Kotsanidis, J.K. Yakinthos and E. Roudaut, *J. Magn. Magn. Mater., 124* (1993) 51.
[5] J.K. Yakinthos, Ch. Routsi and E. Roudaut, *J. Magn. Magn. Mater., 136* (1962) 65.