Journal of Alloys and Compounds, 194 (1993) 179–180
JALCOM 571

Ternary aluminides $LnPd_2Al$ with YPd_2Si-type structure

F. Hulliger and B. Xue
Laboratorium für Festkörperphysik ETH, CH-8093 Zürich (Switzerland)

(Received November 4, 1992)

Abstract

Attempts to synthesize YPd_2Si-type representatives $LnPd_2Al$ were successful only with Ln ≡ Ce, Pr, Nd. This orthorhombic structure (*oP*16; space group *Pnma*) is an ordered variant of the Fe_3C type. Only $NdPd_2Al$ undergoes magnetic ordering above 2 K.

Recently, we reported on rare-earth palladium gallides $LnPd_2Ga$ which crystallize in the YPd_2Si type of structure [1]. The orthorhombic YPd_2Si structure is an ordered derivative of the Fe_3C type, which occurs frequently among Ln_3T alloys (where Ln is a rare-earth element (La–Lu, Y) and T is a transition element (Fe, Ru, Os,.., Ni,...). The YPd_2Si structure, which differs somewhat from its parent structure in the axial ratios, is predominant in the silicides $LnPd_2Si$ [2] and germanides $LnPd_2Ge$ [3] and also occurs in the corresponding Pt compounds [4]. Therefore we expected to meet this structure among the aluminides $LnPd_2Al$ and $LnPt_2Al$. However, in a first attempt none of the Pt compounds and only three of the Pd compounds could be synthesized with this structure. Neither $GdPt_2Sn$-type nor Heusler-type phases were detected.

Polycrystalline samples of these compounds were prepared by reacting the constituent elements (minimum 3N grade) in an argon arc furnace in the same way as for the gallium compounds [1]. Only with Ln ≡ Ce, Pr and Nd (with increasing difficulty in this sequence) did we obtain the YPd_2Si-type phase. The aluminides are similar to the gallides: brittle, with a silvery metallic lustre. The reason for our failure in the case of Ln ≡ Sm, Gd, etc. could be a low peritectic temperature.

The room-temperature lattice parameters were derived from Guinier patterns with silicon as internal standard (assuming $a_{Si(22°)}/\lambda_{Cu\ K\alpha_1} = 3.52511$). The resulting data are listed in Table 1. Intensity calculations with LAZY PULVERIX [5] and the site parameters of YPd_2Si [2] gave a fair agreement with the observed intensities. The influence of the B metal on the unit cell is clearly visible. The larger size of the Al atom than the Ga atom leads to larger *c* axes and larger unit cell volumes, but to slightly smaller *a* and *b* axes, compared with $LnPd_2Ga$. The lattice parameters indicate a perfect trivalency of Ce in $CePd_2Al$, as is also the case in $CePd_2Ga$. Magnetic data show that this trivalency persists down to lower temperatures.

TABLE 1. Room-temperature (295 K) lattice parameters, unit cell volumes and X-ray densities of the YPd_2Si-type $LnPd_2Al$ compounds; space group *Pnma* (No. 62); Pearson symbol *oP*16. Estimated standard deviations of the last digit (excluding systematic errors due to calibration) are added in parentheses

Ln	*a* (Å)	*b* (Å)	*c* (Å)	*V* (Å^3)	d_X (g cm^{-3})
Ce	7.4670(7)	7.0007(8)	5.9433(6)	310.7(1)	8.12
Pr	7.4473(7)	6.9967(7)	5.8960(6)	307.2(1)	8.23
Nd	7.4250(7)	6.9935(7)	5.8634(7)	304.5(1)	8.38

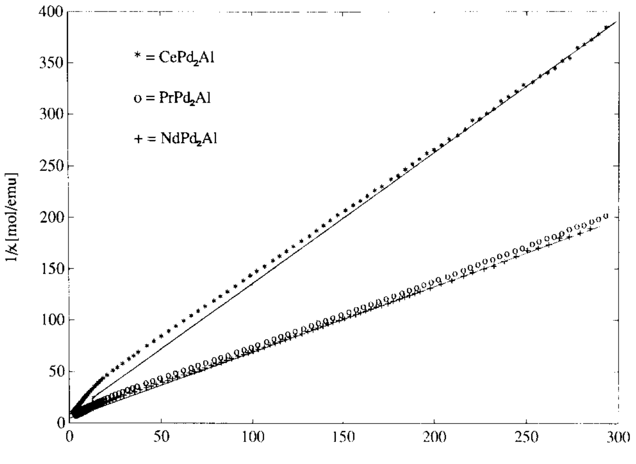

Fig. 1. Temperature dependence of the reciprocal magnetic susceptibilities of $CePd_2Al$, $PrPd_2Al$ and $NdPd_2Al$. The straight lines indicate the asymptotic Curie–Weiss law.

Magnetic measurements were carried out between 1.6 K and room temperature. Below about 200 K in the case of the Ce compound and 150 K in the case of $PrPd_2Al$ and $NdPd_2Al$ the magnetic susceptibility

0925-8388/93/$6.00

of all three compounds shows distinct deviations from the Curie–Weiss law due to crystal–electric-field effects (Fig. 1). Asymptotically, the following values are approximated for the effective magneton number n_p and the paramagnetic Curie temperature Θ_p: 2.49 μ_B and −4 K for $CePd_2Al$, 3.49 μ_B and −8 K for $PrPd_2Al$ and 3.52 μ_B and −4 K for $NdPd_2Al$. A maximum in the susceptibility curve $\chi(T)$ of $NdPd_2Al$ points to an antiferromagnetic ordering below a Néel temperature $T_N = 2.5$ K. No sign of magnetic ordering was detectable in the $\chi(T)$ curves of $CePd_2Al$ and $PrPd_2Al$.

Acknowledgment

We thank Stefan Siegrist for sample preparation and X-ray measurements and Kurt Mattenberger for magnetic measurements on Dr. Oscar Vogt's moving-sample magnetometer. Moreover, we are obliged to Professor H. C. Siegmann and the Swiss National Science Foundation for continuous support.

References

1 F. Hulliger, K. Mattenberger and S. Siegrist, *J. Alloys Comp., 190* (1992) 125.
2 J. M. Moreau, J. Le Roy and D. Paccard, *Acta Crystallogr. Sect. B, 38* (1982) 2446.
3 J. L. Jorda, M. Ishikawa and E. Hovestreydt, *J. Less-Common Met., 92* (1983) 155.
4 P. Villars and L. D. Calvert, *Pearson's Handbook of Crystallographic Data for Intermetallic Phases,* American Society for Materials, Materials Park, OH, 2nd edn., 1991.
5 K. Yvon, W. Jeitschko and E. Parthé, *J. Appl. Crystallogr., 10* (1977) 73.