MAGNETIC SUSCEPTIBILITIES OF SOME TERNARY AND PSEUDOTERNARY PHASES OF URANIUM

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Magnetic susceptibilities of a group of intermetallic compounds of the general composition $UNi_{5-X}M_X$ (M=Al, Sn) and UNi_4Y (Y=In+Sb, In+As) were determined by means of Faraday method in the temperature interval 87 - 293 K.

Previous results[1,2] of x-ray investigations in the systems $UNi_{5-X}Al_X$ and $UNi_{5-X}Sn_X$ indicated the existence of single phase regions up to the composition UNi_4Al and UNi_4Sn, respectively. The substitution of nickel atoms in UNi_5 is also possible with combinations of some elements of the IIIa-Va group (In+Sb, In+As) in atomic ratio 1:1, i.e. pseudoternary compounds are formed.

The crystal structure of these isostructural compounds belongs to the UNi_5-type (S.G. $F\bar{4}3m$) (Fig. 1.).

Samples were prepared by arc melting appropriate quantities of elements in an argon atmosphere, annealed at 800 °C for 700 h in evacuated quartz glass vials and slowly cooled (50 °C/day).

Susceptibilities were determined in a selfconstructed Faraday aparatus. $Hg[Co(CNS)_4]$ was used as a calibrating agent. The results of magnetic susceptibility measurments, for some samples, are presented in Fig. 2. The best fit

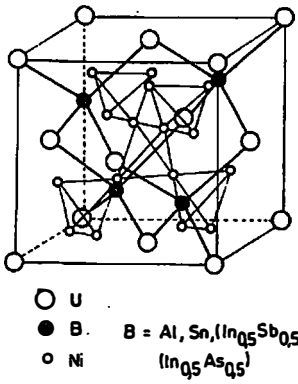

Fig. 1. The crystal structure of UNi_4M and UNi_4Y.

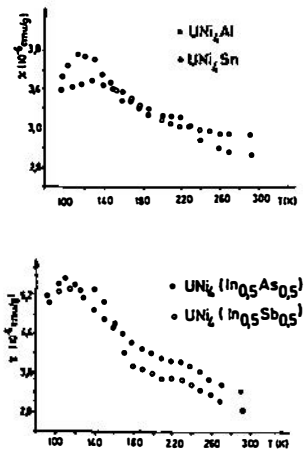

Fig. 2. The plot χ v.s. T for UNi_4M and UNi_4Y.

functions were constructed by a computer program using the equation:

$$\chi = \frac{A}{T + kB}$$

where A = Curie constant

B = Curie temperature

χ = measured magnetic susceptibility

T = temperature

k = -1 or +1 for ferromagnets and antiferromagnets, respectively

Type of magnetic behaviour, numerical values of Curie or

Néel temperatures and effective magnetic moments per uranium atom were determined by this procedure. The results for all samples are presented in Table 1. The corresponding unit cell parameters are also given. In all compounds antiferromagnetic ordering which does not exist in binary prototype UNi_5 was confirmed.

Table 1. Magnetic data for the systems $UNi_{5-x}Al_x$, $UNi_{5-x}Sn_x$, $UNi_4(In_{0,5}Sb_{0,5})$ and $UNi_4(In_{0,5}As_{0,5})$.

composition	lattice constant a (Å)	magnetic order	θ_n (K)	μ_{eff} (μ_B)
$UNi_{4,8}Al_{0,2}$	6.787	anti	-619	3.70
$UNi_{4,6}Al_{0,4}$	6.793	anti	-468	3.38
$UNi_{4,4}Al_{0,6}$	6.797	anti	-329	1.96
$UNi_{4,2}Al_{0,8}$	6.805	anti	-604	4.21
UNi_4Al	6.810	anti	-472	2.92
$UNi_{4,8}Sn_{0,2}$	6.823	anti	-536	2.70
$UNi_{4,6}Sn_{0,4}$	6.854	anti	-725	3.20
$UNi_{4,4}Sn_{0,6}$	6,903	anti	-756	3.10
$UNi_{4,2}Sn_{0,8}$	6.941	anti	-833	3.81
UNi_4Sn	6.984	anti	-440	3.10
$UNi_4(In_{0,5}Sb_{0,5})$	6.884	anti	-208	2.64
$UNi_4(In_{0,5}As_{0,5})$	6.810	anti	-153	2.56

It may be interesting to point out that isostructural compounds UNi_5 and UCu_5 do not have the same magnetic properties[3]. Whereas UCu_5 is antiferromagnetic, UNi_5 has a nearly

temperature independent susceptibility. This is probably due to the different unit cell parameters. The occurence of long-range magnetic order in UCu_5 (a=7.021 Å) is caused by the large U-U distance which prevents 5f-level broadening due to the direct f-f overlap. The lack of magnetic order in UNi_5 (a=6.780 Å) may result from d-f hibridization which causes sufficient 5f-level broadening and no magnetic order. Some later investigations[4] confirmed this assumption, because strong localization of $5f^3$ electronic shell of uranium atoms was observed in UCu_5.

Since addition of the third (or pseudothird) component leads to an increase of the unit cell parameter of UNi_5, the magnetic cell resembling the one found for UCu_5[5] was postulated. This lattice can be described as consisting of parallel sheets ((111) planes) within which all the uranium magnetic moments are coupled ferromagnetically, but with antiferromagnetic coupling between neighbouring sheets (Fig. 3.). The magnetic moments are perpendicular to the ferromagnetic sheets.

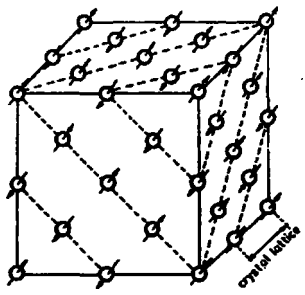

Fig. 3. The magnetic lattice of UCu_5.

We believe that further study on magnetic behaviour will enable us to clarify the magnetic structure of these compounds.

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