METALLURGY

An Anti-ferromagnetic Heusler Alloy, Cu_2MnSb

In the course of a comprehensive examination of the Heusler alloys it has been found that the alloy Cu_2MnSb, previously reported as ferromagnetic[1], shows some of the properties of an antiferromagnet. The alloy was prepared by melting at 1,000° C., homogenizing at 650° C. for 50 hr., and quenching in water. The composition of the specimen was $Cu_{2\cdot000}Mn_{0\cdot998}Sb_{1\cdot026} \pm 0\cdot001$. *X*-ray diffraction analysis showed the presence of Heusler structure similar to that of the alloy Cu_2MnAl, with a lattice parameter 6·097 ± 0·004 Å., which is intermediate between the values of 5·95 Å., and 6·20 Å. for Cu_2MnAl and Cu_2MnIn respectively, both of which are ferromagnetic.

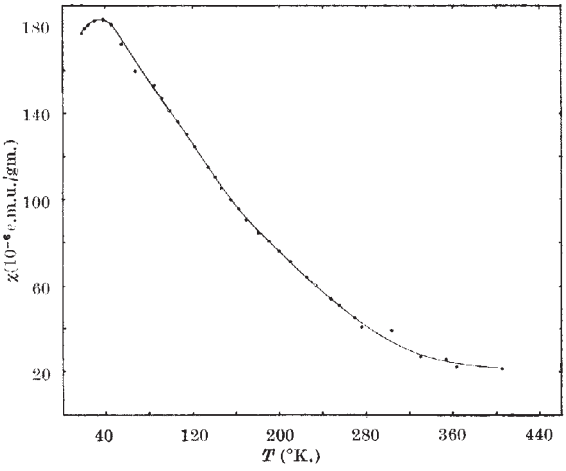

Fig. 1. Variation in magnetic susceptibility (χ) with temperature of Cu_2MnSb

No lines other than those attributable to the ordered Heusler phase were observed. The variation in magnetic susceptibility with temperature is shown in Fig. 1. Below 38° K., the susceptibility χ decreases with decreasing temperature, indicating the presence of antiferromagnetic order; above this (Néel) temperature the alloy is paramagnetic in that χ decreases with increasing temperature, but there is no indication that a Curie–Weiss law is followed within the range of temperature investigated. A specimen with slightly different composition showed the same characteristics.

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Crystal Structures of $ThRh_2$, ThRu and ThIr

An investigation of the constitution of alloys of thorium and the platinum metals is in progress, and the structures of five intermetallic compounds of the type Th_7X_3 have been reported previously[1]: the structure of Th_7Rh_3 has since been confirmed by Ferro and Rambaldi[2]. Dwight, Downey and Conner[3] have established that the compound $ThRh_3$ has the Cu_3Au structure ($L1_2$). This communication presents the structure of three new compounds $ThRh_2$, ThRu and ThIr.

Alloys were prepared by arc-melting 1-gm. samples of the component metals in a zirconium-gettered argon atmosphere. The alloys were brittle and powders for X-ray studies were prepared by crushing in air; powder patterns were obtained with a Guinier-type focusing camera using mono-chromatized copper radiation.

Phase relationships in thorium–rhodium alloys of 60–75 at. per cent rhodium are complex, compounds having been identified by metallographic and X-ray methods at approximately 63, 65, 66·6 and 75 at. per cent rhodium. The structure of $ThRh_3$ is given in par. 1 and X-ray patterns of the compounds at 63 and 66·6 at. per cent rhodium were complex and have not been indexed, but the film of the compound at 65 at. per cent rhodium was indexed on the basis of a hexagonal lattice $a = 4\cdot629 \pm 0\cdot002$, $c = 5\cdot849 \pm 0\cdot003$ Å. $c/a = 1\cdot264$. Systematic extinction of the $000\,l$ and $hh2\bar{h}\,l$ reflexions were noted when l was odd and of $hkil$ lines when $h-k = 3n$ and l was odd. The observed intensities showed excellent agreement with those for the Ni_2In structure ($B8_2$) space-group D^4_{6h} $P\,6_3/mmc$.

The $B8_2$ structure proposed for $ThRh_2$ is related to the $B8_1$ NiAs lattice by filling up the trigonal positions in the latter structure, the completely filled-up version having the composition A_2B. If the trigonal positions are incompletely filled it is possible for this structure to occur over a range of compositions or at the non-stoichiometric composition. The effect of temperature on the relationship between the complex structure in alloys of 66·6 at. per cent rhodium and the comparatively simple Ni_2In structure of 65 at. per cent rhodium has not yet been established.

ThRu and ThIr are formed directly from the melt: their *X*-ray patterns were indexed as orthorhombic with the following lattice parameters:

	'a' (Å.)	'b' (Å.)	'c' (Å.)
ThRu	3·878 ± 0·002	11·29 ± 0·01	4·071 ± 0·002
ThIr	3·894 ± 0·003	11·13 ± 0·01	4·266 ± 0·003

No hkl reflexions were observed unless $h+k$ was even and $h0l$ lines were present only when l was even. The lattice parameters and systematic extinctions suggested that ThRu and ThIr might be isostructural with ThCo (ref. 4) space group D^{17}_{2h} Cmcm. Line intensities calculated on the basis of this structure with $y_{Th} = 0\cdot14$ and $y_X = 0\cdot41$ where X is Ru or Ir gave good agreement with the observed intensities; other compounds reported to have this structure include ThAl (ref. 5), CeNi (ref. 6), PuNi (ref. 7) and DyGa (ref. 8).

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