

Short Communications

The Crystal Structure of RuAl₆

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A phase analytic study on the ruthenium-aluminium system has earlier been reported from this Institute.¹ In this investigation arc-melted alloys and samples annealed at 950°C were analysed on the basis of X-ray powder patterns. The binary compound of the highest aluminium content was found to be Ru₄Al₁₃. In the present investigation, alloys of compositions higher in their aluminium content than RuAl₃ were prepared by arc-melting in an argon atmosphere as described earlier.¹ Lumps of these alloys were then annealed for one day at 660°C in sealed silica tubes. The heat-treatment was discontinued by quenching in water. The powder patterns given by the heat-treated samples in addition to Ru₄Al₁₃ and Al showed the existence of a new intermediary phase. This was obtained in the pure state at the composition RuAl₆. No changes of the pattern of the latter phase were observed at different compositions. The existence of a phase RuAl₁₁,² earlier reported was not

confirmed under the present experimental conditions.

A small irregular crystal (less than 0.02 mm in all dimensions) found in a quenched sample of the composition RuAl₆ was then investigated in a Weissenberg camera using CuK α -radiation. The three-dimensional data obtained showed clearly that they were generated along the [110] direction of a structure very like that of the orthorhombic MnAl₆.³ The powder pattern was indexed and the following unit cell dimensions were obtained after a least squares refinement:

$$a = 7.4882 \pm 4, \quad b = 6.5559 \pm 3, \\ c = 8.9605 \pm 5 \text{ \AA}$$

The Weissenberg data were evaluated visually by comparison with an intensity scale. The atomic parameters given for MnAl₆³ were adopted as starting values in a least squares refinement performed with a program LALS (by A. Zalkin, modified and adopted for the IBM 360/75 computer, Stockholm). The computation was based on 146 reflections and the number of parameters was 13 including 3 scale factors. An *R*-value of 0.08 was obtained. The final structural data are given in Table 1 and the interatomic distances in Table 2.

The structural data for RuAl₆ differ very little from those given for MnAl₆.³ It is remarkable that the very short Al₂-Al₂

Table 1. Final parameters of RuAl₆.
Space group: *Cmcm*

	<i>x</i>	$\sigma(x)$	<i>y</i>	$\sigma(y)$	<i>z</i>	$\sigma(z)$	<i>B</i> Å ²	$\sigma(B)$
Ru in 4 <i>c</i>	0	—	0.4621	0.0005	1/4	—	0.72	0.09
Al ₁ in 8 <i>e</i>	0.3196	0.0010	0	—	0	—	1.43	0.14
Al ₂ in 8 <i>f</i>	0	—	0.1416	0.0014	0.1005	0.0008	2.02	0.16
Al ₃ in 8 <i>g</i>	0.3171	0.0010	0.2939	0.0014	1/4	—	1.66	0.15

Table 2. Interatomic distances in RuAl₆ and their e.s.d.'s in Å.

Ru—4Al ₁ 2.628 0.004	Al ₂ —1Ru 2.492 0.009
2Al ₂ 2.570 0.009	2Al ₁ 2.720 0.007
2Al ₃ 2.618 0.008	2Al ₁ 2.856 0.008
2Al ₃ 2.570 0.009	1Al ₂ 2.587 0.017
	1Al ₂ 2.679 0.015
Al ₁ —2Ru 2.628 0.004	2Al ₃ 2.978 0.011
1Al ₁ 2.702 0.014	2Al ₃ 2.903 0.008
2Al ₂ 2.720 0.007	
2Al ₂ 2.856 0.008	Al ₃ —1Ru 2.618 0.008
2Al ₃ 2.809 0.006	1Ru 2.570 0.009
2Al ₃ 2.955 0.006	2Al ₁ 2.809 0.006
	2Al ₁ 2.955 0.006
	2Al ₂ 2.978 0.011
	2Al ₂ 2.903 0.008
	1Al ₃ 2.739 0.014

distance of 2.57 Å found in MnAl₆ has its counterpart in RuAl₆ (2.59 Å).

In their work on α -FeCuAl, Black *et al.* showed that this phase was very close in structure to MnAl₆, which was originally reported as centrosymmetric.³ However, they indicated a small departure from centrosymmetry in α -FeCuAl. It was also mentioned in this paper that a similar effect though smaller in magnitude had been observed in MnAl₆. Later, an investigation by Walford on FeAl₆,⁵ which is also of the MnAl₆-type, showed that the deviations from centrosymmetry for FeAl₆ are less than those in α -FeCuAl and larger than those in MnAl₆.

A test for non centrosymmetry in RuAl₆ by further least squares calculations did not give evidence of any departure from the *Cmcm* symmetry. The rather high *B*-value of 2.02 Å² for Al₂ in RuAl₆ (*cf.* Table 1) might, however, possibly be associated with a slight deviation from this space group. The *B*-values of aluminium found in similar compounds and calculations in, *e.g.*, Rh₂Al₅,⁶ Ru₆Al₁₃,⁷ and Rh₂Al₉,⁸ are smaller and in the range 0.5–1.8 Å². If, however, a deviation from centrosymmetry is present in RuAl₆, which cannot be judged from the present experimental data, it is small and certainly less than in α -FeCuAl and in FeAl₆.

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Biosynthesis of Putrescine: Characterization of Ornithine Decarboxylase from Regenerating Rat Liver

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The biosynthetic routes of spermidine¹ and putrescine^{2,3} in bacteria are fairly well known. Working with animal tissues, we have shown that putrescine and methionine serve as precursors of spermidine and spermine in animal tissues *in vivo*.⁴⁻⁶ Putrescine is a normal constituent of rat liver and is formed from ornithine *in vivo*.⁷ We reported recently that the synthesis of putrescine is markedly increased in the regenerating rat liver.⁷ In good agreement with this observation *in vivo*, an increase as high as fortyfold in the ornithine decarboxylase (E.C. 4.1.1.17.) activity, catalysing the stoichiometric formation of putrescine and carbon dioxide, was found in the supernatant fraction from the regenerating liver.⁸ In the present work, the latter source has been used for partial characterization of liver ornithine decarboxylase. The crude ornithine decarboxylase obtained by ammonium sulphate fractionation had a pH optimum slightly on the alkaline side and an absolute requirement of pyridoxal phosphate.

Material and methods. The following radioactive compounds, all purchased from the