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CRYSTAL STRUCTURE AND MAGNETIC SUSCEPTIBILITY OF AMERICIUM METAL[1]

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We have obtained interpretable x-ray diffraction patterns of several small polycrystalline samples of americium metal of >99 percent purity, using Cu Kα radiation and a 4.5 cm radius camera. The metal was prepared on a micro scale by reduction of the trifluoride with barium vapor, in a tantalum crucible system and was subsequently annealed by slowly reducing the temperature from 800° to ca. 25° C over a period of ten hours.

The powder patterns have been indexed as double hexagonal close packed, a = 3.642 ± 0.005 A, c = 11.76 ± 0.01 A.

The space group is D_{6h}^4 and the atomic positions are: two Am in (0,0,0), (0,0,1/2); two Am in (1/3,2/3,3/4), (2/3,1/3,1/4). The Am radius is 1.82 A and the calculated density 11.87 ± 0.05 gm cm^{-3}.

Relative line intensities calculated for the proposed structure agreed with visual estimates of the intensities seen in the diffraction patterns, as shown in the accompanying table.

The density calculated for the metal agrees with that observed experimentally[2] (11.7 ± 0.3) within the error of the measurements. The metallic

(2) E. F. Westrum, Jr. and L. Eyring, J. Am. Chem. Soc. 73, 3396 (1951).

radius is 0.02 A smaller than that predicted by Zachariasen[3] for americium

(3) W. H. Zachariasen, Acta. Cryst. 5, 660 (1952).

[1]This work was performed under the auspices of the AEC.

Diffraction Data for Americium Metal[a]

hkℓ	$\sin^2\theta$ calc.	$\sin^2\theta$ obs.	I calc.	I obs.[b]
100	0.0597	0.0592	3	vw
101	0.0640	0.0640	18	m
004	0.0687	0.0692	14	ms
102	0.0769	0.0769	42	s
103	0.0984	0.0985	10	w
104	0.1284	0.1283	2	t
105	0.1670	0.1675	5	vw
110	0.1792	0.1792	11	m
106	0.2142	0.2144	9	m
200	0.2389	--	0.4	-
201	0.2432	--	3	-
114	0.2479	0.2471	13	ms
202	0.2561	0.2567	7	vw
107	0.2700	0.2698	2	t
008	0.2747 }	0.2755	2 }	vvw
203	0.2776 }		2 }	
204	0.3076	--	0.6	-
108	0.3344	--	0.5	-
205	0.3462	0.3462	1	t
206	0.3934	0.3930	4	vvw
109	0.4074	0.4070	1	t
210	0.4181	--	0.4	-
211	0.4224	0.4226	2	t
212	0.4353	0.4353	0.6	t
207	0.4492	--	1	-
118	0.4539 }	0.4531	5 }	m
213	0.4567 }		2 }	
214	0.4867 }	0.4878	0.6 }	vw
1,0,10	0.4889 }		2.6 }	

[a]This list includes all planes up to $\sin^2\theta = 0.5$ for which the intensity was not calculated to be zero, by the symmetry of the special positions.

[b]t, trace; vvw, very, very weak; vw, very weak; w, weak; m, moderate; ms, moderately strong; s, strong.

metal with three valence electrons per atom. This discrepancy may indicate a small error in the predicted value, or may be due to a slight admixture of americium(IV) in the metallic state. Measurements of the magnetic susceptibility of our samples gave $\chi_M = 1000 \pm 250 \times 10^{-6}$ cgs units at 300° K, similar to the value of $\sim 1000 \times 10^{-6}$ cgs units for AmF_3. The number of bonding elettrons per atom appears to be quite close to three.

The decrease in the number of metallic bonds in going from uranium to americium affords a reasonable explanation of the corresponding decrease of some 50 Kcal.[4,5] in the heat of vaporization.

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(4) E. G. Rauh and R. J. Thorn, J. Chem. Phys. 22, 1414 (1954).

(5) S. C. Carniglia and B. B. Cunningham, J. Am. Chem. Soc. 77, 1502 (1955).

It is interesting to note that americium is the first transactinium element which is rare earth-like in the metallic state.

Possible allotropy of the metal is now under investigation, and these studies, as well as a detailed description of the work outlined above will be reported in a future publication.

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