On the Arrangements of the Micro-crystals in Zinc and Cadmium obtained by Sublimation.

By

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ABSTRACT

The arrangements of the micro-crystals in sublimed zinc and cadmium were investigated with X-rays. From the diffraction patterns obtained, it became clear that the portion of the metals which is commonly supposed to be a single crystal is not necessarily composed as such a crystal.

Introduction.

In the present X-ray investigation of crystal-structures, it seemed to be of vital importance to use specimens which can be prepared without any complicated and ambiguous procedure, such as sublimed metals, as was proposed by several workers.[1] Up to now, however, very few results[2] were published in connection with sublimed metals. So the writer was induced to set about this experiment to determine the crystal structures in the samples of sublimed zinc and cadmium, which were obtained in the following way :—

In an evacuated hard glass tube of some 15 cm. in length, pieces of pure zinc or cadmium were heated up to 900° or 750° respectively for about an hour. The metallic vapours formed were then condensed on the wall of the glass tube, where those which adhered to the glass

1 H. Hirata and H. Komatsubara, Z. f. Anorg. u. Allgem. Chem., **158**, 137 (1926).

2 A. W. Hull, Phys. Rev., **10**, 688 (1917); H. Kahler, Phys.Rev., **18**, 210 (1921).

in the region of comparatively high temperature were perfect crystals (named specimen A for convenience sake), while those which appeared in the region of low temperature were of the so-called amorphous powder (named specimen B) variety.

The micro-figures of these two specimens are shown in Figs. 1 and 2.

Experimental results.

In the present experiment, the writer adopted the ordinary "transmission method" with the heterogeneous X-rays emitted from the molybdenum anticathode of a Coolidge tube. To obtain the diffraction figures with specimen A, a crystal of zinc or cadmium was so placed that the surface, adhering to the glass wall, was perpendicular to the incident X-ray beam. The diffraction patterns reproduced in Figs. 3 and 4 were obtained on the photographic plates at 3·2 cms. behind the specimens.

It was believed at first that the crystals, microscopically so perfect in form as we see in specimen A, were undoubtedly single crystals and would give rise to the Laue spots by the X-ray transmission. Contrary to our expectation, however, the diffraction patterns obtained were in both cases not of Laue's spots, but of patterns consisting of a number of concentric circular rings and several radiating bands with many intense spots on them. The radii of these concentric rings agree fairly well with the results of calculation, carried out from the crystallographical data of zinc and cadmium given by Hull and Davey,[1] and from the wave length of the molybdenum K_α radiation. As the consequence of this calculation, it was seen that the concentric rings I, II, III, IV, V and VI in the figures were produced by the prominent atomic planes of the indices (0, 0, 0, 1), (1, 0, $\bar{1}$, 1), [(1, 0, $\bar{1}$, 2) and (1, 0, $\bar{1}$, 3)], (1, 1, $\bar{2}$ 2) and (2, 0, $\bar{2}$, 1) respectively.

The absence of Laue's spots thus confirmed in the two figures shows us without doubt that specimen A is not composed of a single crystal, but that it is mostly made up of the irregular aggregations of the micro-crystals containing several fragments of the fibrous structure.

So far, we must legitimately conclude that that portion of the sublimed metals which is commonly supposed to be a single crystal, is not sufficiently of the regular lattice configuration to be called a single

1 Phys. Rev., **17**, 571 (1921).

crystal.

As a furtherance of our foregoing investigation, the specimen B were also examined. To obtain the interference figures with these powder metals, each of them was pasted on a sheet of paper and then illuminated by the incident X-ray beam. The interference-figures thus obtained, as reproduced in Figs. 5 and 6, consist of a number of concentric rings. From the results of calculation, the rings I, II, III, IV, V, VI, VII, VIII and IX in the figures were also found to be produced by the reflection of the prominent atomic planes of the indices $(0, 0, 0, 1)$, $(1, 0, \bar{1}, 1)$, $(1, 0, \bar{1}, 2)$, $[(1, 1, \bar{2}, 0)$ and $(1, 0, \bar{1}, 3)]$, $(1, 1, \bar{2}, 2)$, $(2, 0, \bar{2}, 1)$, $(2, 0, \bar{2}, 2)$, $(2, 0, \bar{2}, 3)$ and $(2, 1, \bar{3}, 1)$ respectively.

This fact shows that the so-called amorphous metals under consideration, some parts of them at least, are not amorphous, but are composed of the irregular aggregation of the micro-crystals of the metals.

Now, on the closer inspection of Figs. 5 and 6, one may notice some difference between them: the former seems to be an assemblage of a large number of intense spots, while the latter is the same as those obtained with very fine powder.

This indicates that the crystalline fragments are generally larger in zinc than in cadmium.

In conclusion, the writer wishes to express his best thanks to Professor M. Chikashige, Professor U. Yoshida and Dr. H. Hirata for their much appreciated advice and help.

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Fig. 1 Zinc specimen (×19)

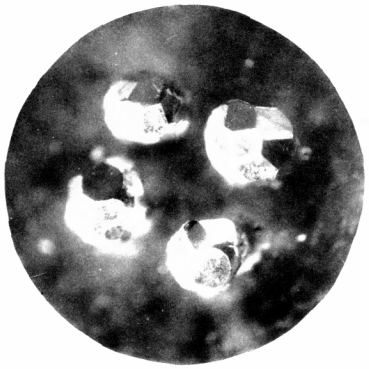

Fig 2 Cadmium specimen (×50)

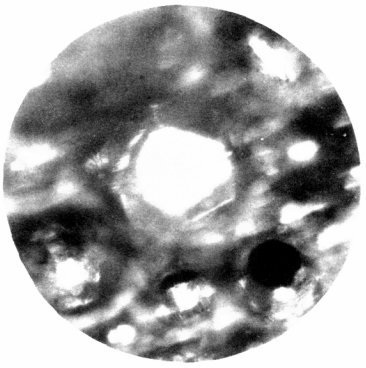

Fig. 3 Zinc

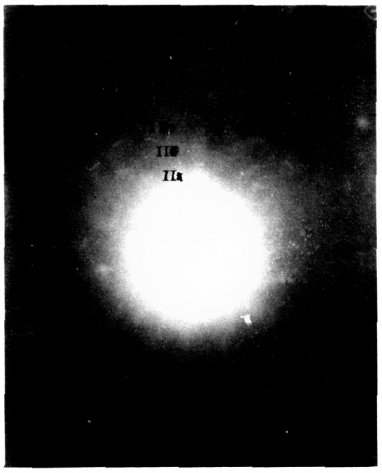

Fig. 4 Cadmium

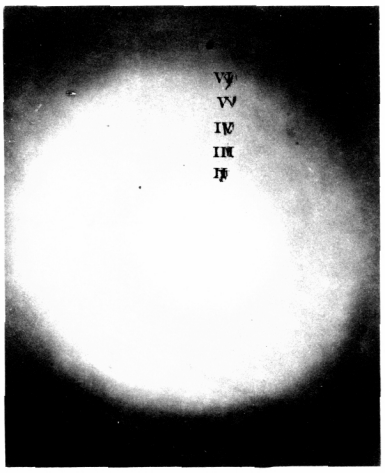

Fig. 5 Zinc

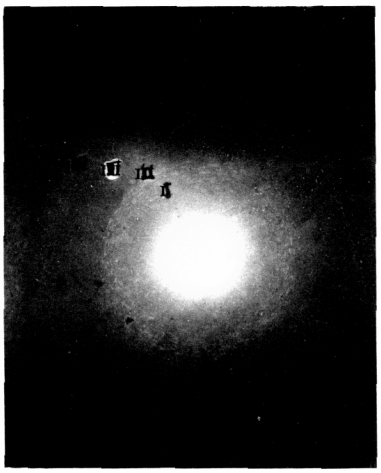

Fig. 6 Cadmium