# The Orientation of Single-Crystals of Zinc

By

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ABSTRACT

The orientations of many single-crystals of zinc, formed under various conditions, are examined to see whether they depend upon the conditions under which the crystals are formed or not; and some peculiarities in their orientation are found in some cases.

Whether the orientations of the single-crystals of metals, formed under various conditions, have some relations with these conditions or not has not yet been satisfactorily investigated. In a previous paper[1], the writer reported some regularities in the distribution of the orientations of the single-crystals of aluminium, which are due to the conditions under which they were formed. In the present paper are reported the results of a further investigation carried out on 119 different pieces of the single-crystals of zinc. The method of determining the orientation of the crystal by means of X-rays was essentially the same as before, and it was very much facilitated by the use of the globe and the spherical scale devised by Prof. U. Yoshida[2]. The orientations of the axes of the test-piece of a single-crystal of zinc, in reference to the crystallographic axes of the hexagonal crystal of zinc, were represented in a stereographic projection, by taking the three crystallographic axes [0001], $[11\bar{2}0]$ and $[10\bar{1}0]$ as the reference directions.

Fig. 1 shows the orientations of large crystals formed in the test-pieces of plates; which were prepared from commercial zinc plates of 1.5 mms. thickness, by first rolling the plates to about a 20—70% reduction

1 Jap. J. Phys., **4**, 137 (1927).
2 Jap. J. Phys., **4**, 133 (1927).

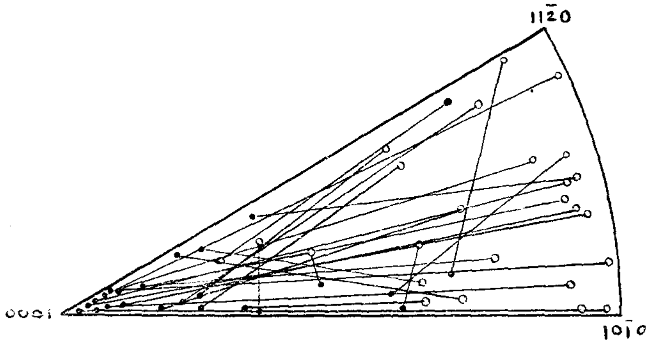


Fig. 1.

in thickness and then by annealing at 400° C for one day. In Fig. 1 the direction of the surface normal of the plate and that of the rolling are represented respectively by a dot and a small circle, and the line joining a dot and a small circle indicates that they belong to the same specimen of one single-crystal. It can be seen from the figure that the rolled plane or the plane of the plate of most of the crystals is nearly parallel to the base of the hexagonal crystal of zinc. Fig. 2 shows the results obtained with similar test-pieces of plates as in the case of Fig. 1 ; the test-pieces in this case were prepared by being extended, instead of being rolled, before annealing. The dot and the small circle in this figure represent respectively the direction of the surface normal of the plate and the direction of pulling of the plate. The single-crystals thus obtained show almost the same distribution of their orientations as in Fig. 1.

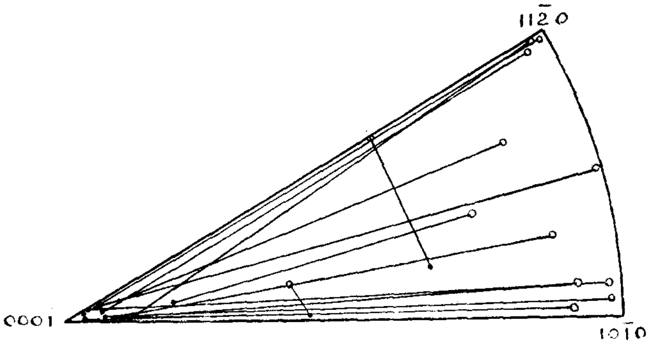


Fig. 2.

In Fig. 3, commercial zinc-wires of 1.5 mm. diameter were drawn to about 0.5mm. through dies, and then they were subjected to the same heat-treatment as the plate. In this figure, the axis of the wire is represented by a dot; and it will be seen from the figure that the [11$\bar{2}$0] axes of most of the *Zn*-crystals take a direction nearly parallel to the axis of the wire. A rather random distribution of the orientations of the crystals shown in Fig. 4 is of the crystals formed in the test-pieces of 1.5 mm. wires, which were subjected to pulling for an elongation of a very small percentage before annealing.

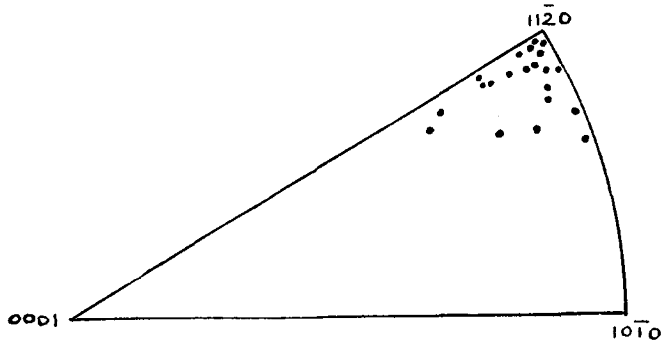


Fig. 3.

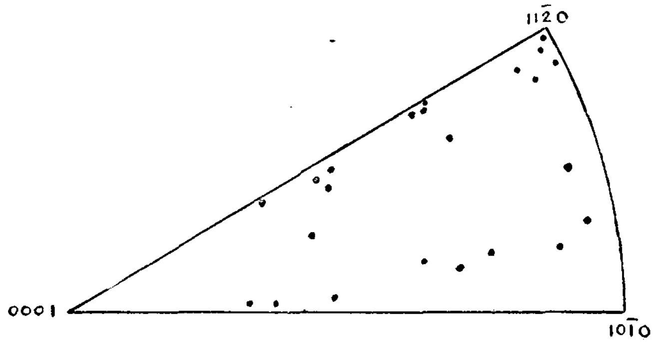


Fig. 4.

When a circular zinc plate is melted and cooled gradually from the peripheral part toward the center of the plate, there grow some large crystals from the periphery as the process of cooling proceeds toward the central part. By etching the surface thus obtained with some proper

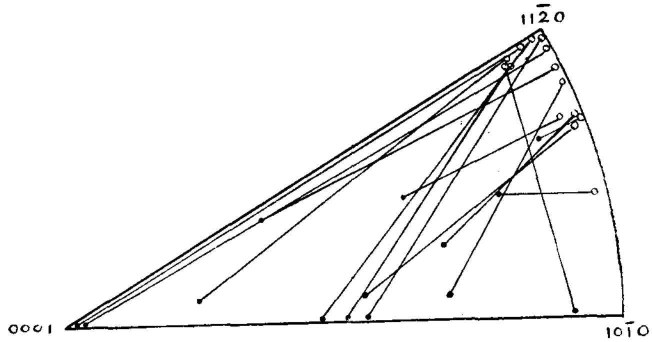


Fig. 5.

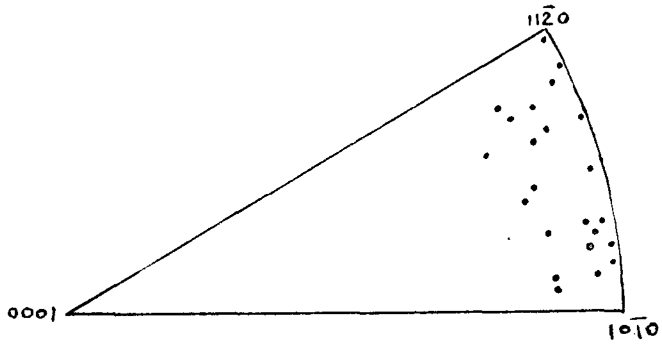


Fig. 6.

reagent, we can detect clearly that many large crystals have grown toward the center of the specimen, and that the plate is divided into many sectors with these crystals of different orientations. The orientations of these crystals are shown in Fig. 5, where the dot and the small circle represent roughly the direction of the surface normal and the radial direction or the direction of the process of cooling in the specimen respectively. Fig. 5 shows that most of the crystals grow in a direction nearly parallel to the plane of the base of the hexagonal crystal. This result is confirmed by the results shown in Fig. 6. In this case, metallic zinc was melted in a thin and long glass tube, and then it was cooled gradually and slowly from one end of the tube to the other end. Comparatively large crystals of zinc in the wire were obtained by this process. The direction of the growth of the crystals must be the same, in this case, as that of the progrèss of cooling along the axis of the specimen. Thus the axis of the wire of the zinc-crystal was taken as the direction of the growth of the crystal and it was represented by the dot in Fig. 6. The fact stated in connection with Fig. 5, that the crystals of zinc grow in a direction nearly parallel to the base of the hexagonal crystal of zinc, is also seen in Fig. 6.

These results stated above show that the ortentations of zinc-single-crystals formed by various treatments, depend to some extent upon the manner of the heat-treatment and also upon the history before the heat-treatment.

In conclusion, the writer wishes to express his sincere thanks to Prof. U. Yoshida for his kind guidance in the research.