The Orientation of Single Crystals of Tin

By

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Abstract

The orientation of many single-crystals of tin, formed by recrystallization in polycrystalline specimens under various conditions, was examined by means of X-rays, to see whether or not it depends upon the previous history of the specimens; and it was found that the dependence of the crystallographic orientation upon the previous treatment was much less than in the case of zinc. The favourable crystallographic direction of growth of the tin crystal was also examined, and it was found to be roughly parallel to the basal plane of the tetragonal crystal.

As a continuation of previous works on aluminium[1] and Zinc[2], in which some regularities in the orientation of the crystals depending upon the conditions under which they were formed was found, the same examination was now made with the single-crystals of white tin. The method of determining the orientation of the crystallographic axes by means of X-rays was the same as before, and it was carried out with the aid of the crystallographic globe devised by Prof. U. Yoshida[3]. The orientation of the axes of the test-pieces of single-crystals of tin, was represented in a stereographic projection by taking three crystallographic axes [001], [100] and [110] of the tetragonal crystal of tin as the reference directions.

The material used as the test-pieces was pure commercial tin. Fig. 1 shows the orientation of the crystals formed in test-pieces consisting of plates 0 3 mm. in thickness, which were prepared from cast plate of 3 mms. thickness by rolling, and then by annealing at 200°C for about one day. The crystals formed by this method were

1 Jap. J. Phys., **4**, 137 (1927)
2 These Memoirs, **11**, 361 (1928)
3 Jap. J. Phys., **4**, 133 (1927)

small in size, and only a few of them allowed of examination with X-rays. In Fig. 1 the direction of the surface normal of the plate and that of the rolling are represented by small circles and dots respectively; and the line joining a small circle and a dot indicates that

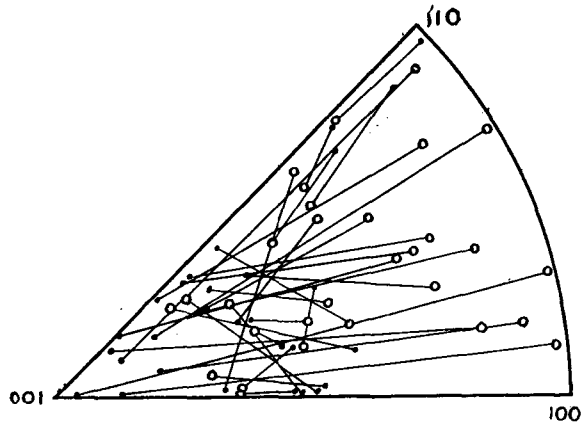

Fig. 1

they belong to same crystal. In this case the scattering of the orientation is very large compared with the corresponding case of the hexagonal crystal of zinc; and though no definite conclusion can be drawn with regard to the regularity in the crystallographic orientation, we can detect a slight tendency for the normal to the basal plane of the tetragonal crystal of tin to approach the direction of rolling.

Fig. 2 shows the results obtained with the crystals formed in thin

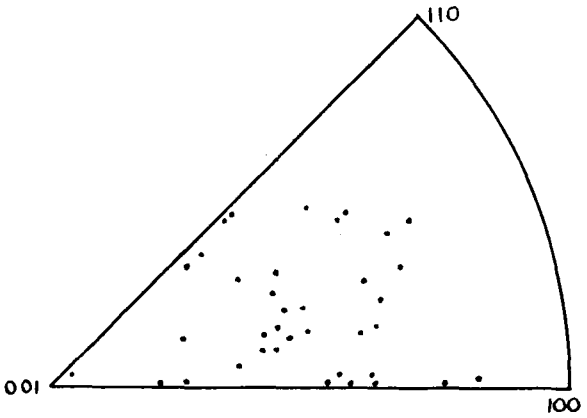

Fig. 2

wires of 1 2 mms. diameter, which were prepared from cast rods of 3 mms. diameter by drawing them through circular dies and then subjecting them to the same heat-treatment as before. In this figure, the distribution of the dots, which represent the direction of the axis of the wire in reference to the crystallographic axes of various tin crystals, shows that it is difficult for a tin crystal to grow in such orientation that the basal plane of it is nearly parallel to the axis of the wire.

Figs. 3 and 4 represent the results of the examination of the crystals

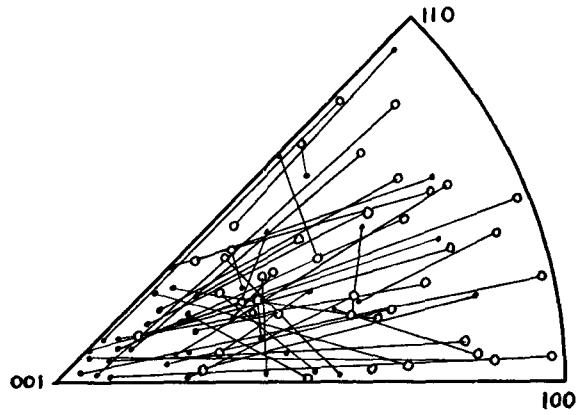

Fig. 3

of tin obtained by the usual stress-annealing method. By this method larger crystals of tin were obtained, as in the case of the other metals. The dimentions of the test-pieces used were the same as before, and

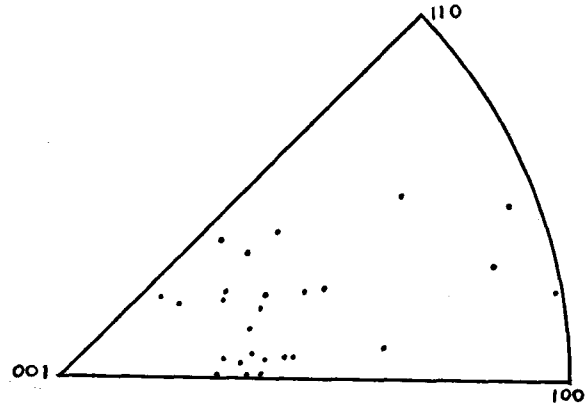

Fig. 4

the stress applied was 1% or 2% extension along the axis of the specimen. In Fig. 3 the small circles and the dots, connected by lines, represent respectively the direction of the surface normal of the plate and that of the stress applied. From this figure, we can see that the dots, the direction of the stress applied, are crowded in the vicinity of the axis [001]. The direction of the stress applied to the wire, that is the axis of the wire, is represented by the dots in Fig. 4. In this case we get a similar result as in the case of aluminium, and the dots are crowded in the vicinity of the [201] axis.

Comparing the results obtained with tin with those of zinc, we can see that the effect of some regular previous treatment of the specimen before recrystallization upon the regularity of the orientation of the crystals is more predominant in zinc than in tin; and in the latter case the scattering of the orientation of the crystals is much greater. This difference in the effect of previous treatment may, at least partially, be attributed to the difference in the recrystallization temperature of these two metals. Tin subjected to cold working recrystallises at room temperature, so that the effect of working will be diminished, at least to some extent, before annealing.

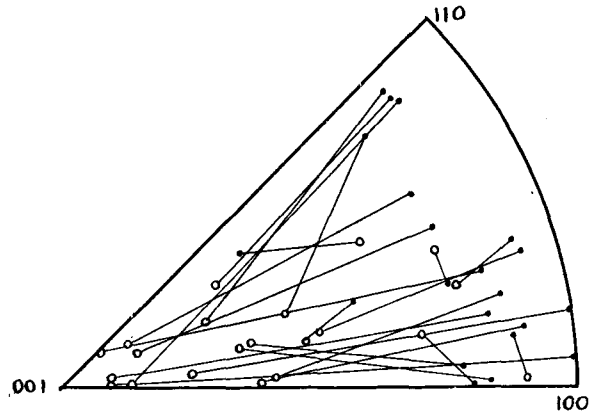

Fig. 5

Next the favourable crystallographic direction of growth of tin was examined. Some tin plates and wires were melted and cooled gradually from one end of the specimen to the other. In Figs. 5 and 6 the dots represent the direction of the advance of the cooling, which may be considered to be the direction of the growth of the crystal formed in the test-pieces of plate and wire respectively; and the small circles in

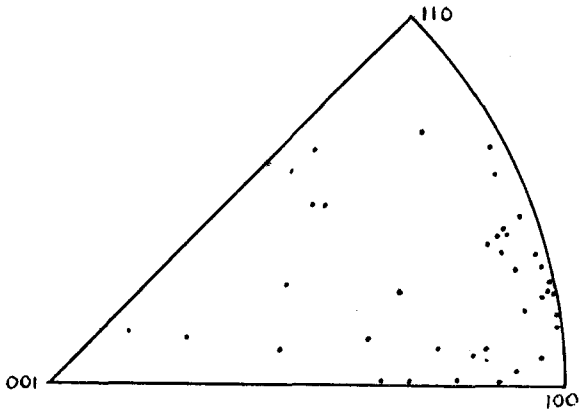

Fig. 6

Fig. 5 indicate the direction of the surface normal of the plate. From these figures, it can be seen roughly that the tin crystal grows somewhat frequently in the direction which is nearly parallel to the basal plane, just as in the case of zinc.

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