The Arrangement of the Micro-Crystals in Compressed Single-Crystal-Plates of Aluminium

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By

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Abstract

The scattering of the orientations of the micro-crystals of aluminium in compressed single-crystal-plates of aluminium was investigated in the present research. The orientations of the cubic micro-crystals of aluminium were found to be scattered by compression, to some extent around the [110] axis which made the smallest inclination against the surface of the aluminium plate. It was also found that the amount of such scattering around the axis [110] increased with the reduction in thickness of the plate by compression, so that the arrangement of the micro-crystals tended to a fibrous one. The maximum angle of rotation of the micro-crystals of scattered orientations was seen to increase proportionally with the thickness of the plates by compression.

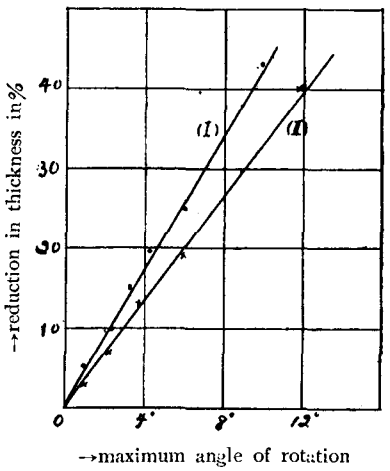
The size of the test pieces of the single-crystal-plates of aluminium examined in the present experiment was about 10mm. × 6mm. × 0,8mm. First, ordinary Laue-photographs were taken with these single crystal plates, by sending a narrow and circular beam of X-rays perpendicularly to the flat surface of the test piece. The orientation of the crystallographic axes of the cubic aluminium-crystal in the form of the plate was determined by treating the Laue-spots thus taken with the spherical scale and the globe devised by Prof. U. Yoshida.[1] Next the writer held the crystal plate between two steel plates, and compressd it in a stepwise manner by a vice, the Laue-photograph and the measurement of the thickness of the plate being taken at each step of the compression.

When the thickness of the plate was a little reduced—by about 5% of the original thickness by compression—the Laue-photograph became a little different from the ordinary Laue-spots: the ordinary sharp and

1 Japanese J. Phys., **4**, 133 (1927)

well-defined Laue-spots became somewhat diffused and elongated to some extent in some direction, the direction of this elongation and its amount being different for different spots. Such elongation of the Laue-spots must, of course, be due to some regular scattering of the orientations of the micro-crystals formed by compression. Assuming that the orientations of the micro-crystals are so scattered that they occupy the orientations rotated by various angles around a certain common crystallographic axis, the writer tried to find such common axis of rotation of the micro-crystals, by using the spherical scale and the globe, quite similarly as was done by K. Tanaka[1] and T. Sakao ;[2] and he was able to ascertain that such axis of rotation of the micro-crystals was the [110] axis of the cublic crystal of aluminium, which made the smallest inclination against the flat surface of the single-crystal-plate.

Fig. 1



The relation between the maximum angle of such rotation of the micro-crystals around the common [110] axis and the reduction in thickness of the plate by compression is shown in Fig. 1 ; and the proportionality between these two quantities is observed clearly in that figure. The proportional factor seems, however, to depend to some extent upon the orientation of the crystallographic axes of the initial single crystal. In the case of curve (I) in Fig. 1, the angle between the flat surface of the plate and the [110] axis which makes the smallest inclination against the flat surface of the plate is $7°50'$, and in the case of curve (II), it is $4°30'$, showing that the maximum angle of rotation is greater when the inclination of the [110] axis against the flat surface of the plate with the same amount of compression is smaller.

Furthermore, the writer assumed that the [110] axis which makes the smallest inclination against the flat surface of the plate is the common axis of the rotation of the micro-crystals, and that the micro-

1 These Memoirs, **11**, 199 (1928)
2 These Memoirs, **11**, 179 (1928)

crystals rotated with various angles, less than the maximum angle stated above, and then he calculated the diagram of the arrangement that might be expected to appear on the photograph. The agreement between the diagram thus calculated and the photograph was confirmed in each case. Figs. 2 and 3 are the calculated diagrams which corre-

Fig. 2

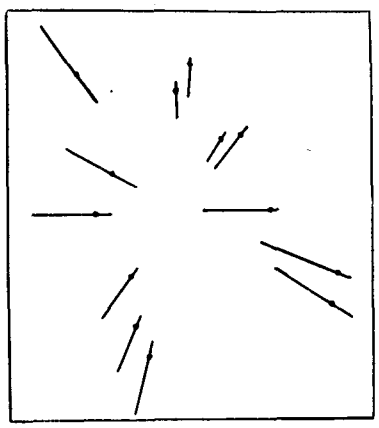
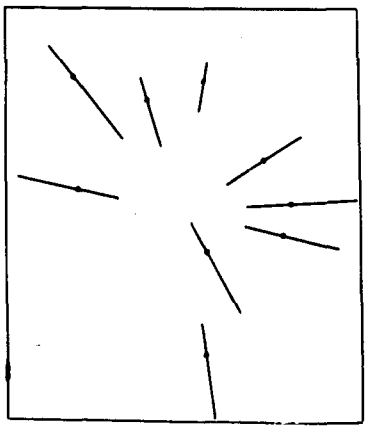
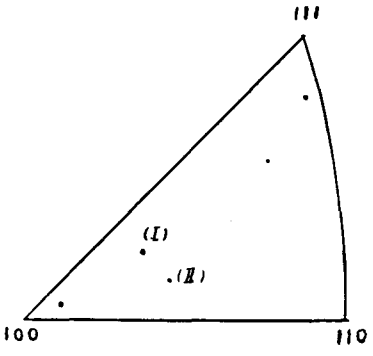


Fig. 3



spond respectively to Figs. 1 and 2 in Plate I. Fig. 2 is drawn by taking 10° as the angle of maximum rotation of the micro-crystals around the [110] axis, and this figure corresponds to curve (I) in Fig. 1; and Fig. 3 is drawn by taking 12° as the maximum angle of rotation, and corresponds to curve (II) in Fig. 1. In these figures the dots indicate the positions of the initial Laue-spots.

Fig. 4



As was stated before, the angle of rotation of the micro-crystals around the [110] axis becomes larger with increased compression, and the arrangement of the micro-crystals approaches gradually to a fibrous one. Figs. 3 and 4 in Plate I are the photographs taken respectively with the same plates as in Figs. 1 and 2 in Plate I, and it was confirmed that the micro-crystals were arranged fibrously with the [110] axis as the fibrous axis. The dots in Fig. 4 show, in stereographic projection, the initial orientation of the direction of the normal to the

flat surface of the plates which were examined in the present research, in reference to the crystallographic axes. The dots (I) and (II) in that figure correspond respectively to the above stated specimens I and II. The same results as with specimens I and II were also obtained with the other specimens examined.

The investigation described above is rather a preliminary one, and the results of a further investigation are expected to be published in the near future.

In conclusion, the writer wishes to express his sincere thanks to Prof. U. Yoshida of Kyoto Imperial University for his kind guidance during this research.

Plate I

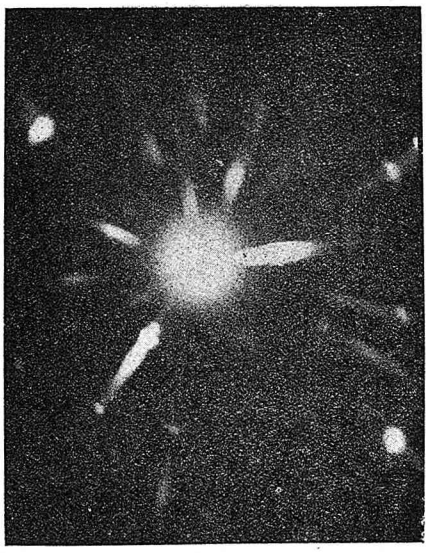


Fig. 1

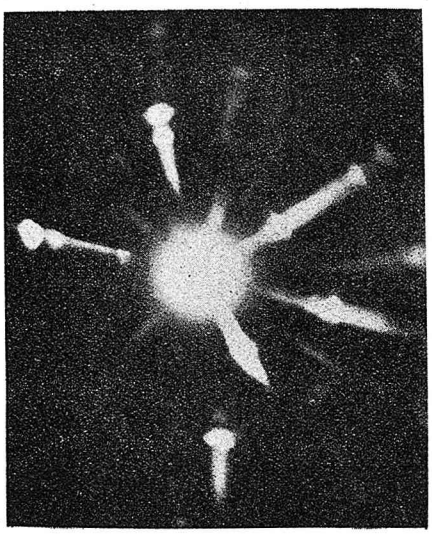


Fig. 2

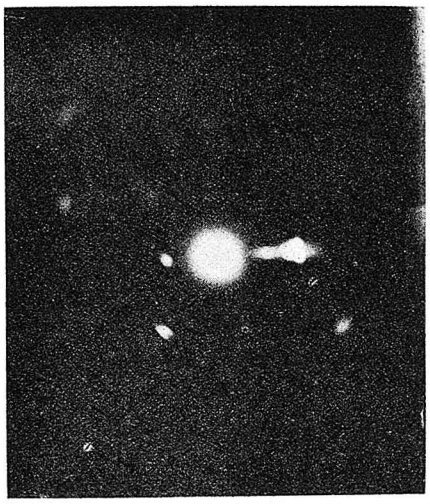


Fig. 3

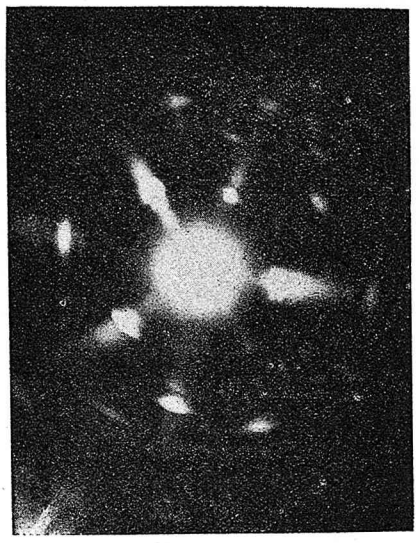


Fig. 4