LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Multiple Laue-Spots from Aluminum Crystals

In an investigation upon thick (6 mm) deformed aluminum crystals we have found that the distribution of the intensity along the Laue-spots depends strongly upon the degree of plastic deformation. The spots from a thick

FIG. 1. The deformed Al-crystal.

undeformed crystal are radially elongated and uniformly black. (Fig. 1.) Each portion of the spot is formed by rays reflected from a corresponding region of the crystal along the x-ray beam. The spots from the same crystal which has been plastically deformed to the extent of only $\frac{1}{2}$

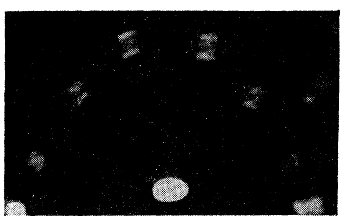

FIG. 2. The undeformed Al-crystal.

percent are no longer uniformly black on photographic film. (Fig. 2.) The blackening increases on the ends of all the spots and on the inner edges of several of the spots. All of the spots become double or triple and similar to the multiple spots which have been described in previous investigations.[1] This result indicates that the exterior layers and several layers situated below the surface scatter more energy and, therefore, are more imperfect than other layers. This condition varies with the degree of plastic deformation and, therefore, with the non-uniform distribution of residual stresses along the path of the x-ray beam. The dependency of the doubling of the spots on the distance from the crystal to the photographic plate evidently depends on focussing properties of the differently oriented crystal blocks as they are situated along the path of the very nearly parallel beam. Thus it would appear that the multiple Laue-spots which have been described in previous investigations may be due to the reversible or irreversible changes in the perfection of the crystals and also to the focussing in the case of deformed crystals.

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March 9, 1934.

[1] Y. Sakisaka and I. Sumoto, Proc. Phys.-Math. Soc. of Japan III, **15**, 211 (1931); C. S. Barret, Phys. Rev. **38**, 832 (1931); J. M. Cork, Phys. Rev. **42**, 749 (1932); C. C. Murdock, Phys. Rev. **45**, 117 (1934).

On the Possibility of a Secondary Structure in Calcite

From the results of experiments performed by Professor M. Y. Colby and the writer of this letter, it has been found that the change per unit dimension of the spacing between the (1 1 0) set of planes of quartz is far from a one-to-one correspondence with the change per unit dimension of the crystal as a whole in this direction when the crystal is oscillating under the transverse piezoelectric effect. As a matter of fact, no evidence of any change in the grating constant was observed, and the spectrograph was capable of indicating a change as small as 1.45×10^{-5}. The change in the outside dimension of the crystal was of the order of 6×10^{-4} per unit dimension. This fact can be explained by the secondary structure theory of F. Zwicky, if it is assumed that the homogeneous strain produced in the crystal takes place in the so-called π planes of Zwicky, the spacing of the p planes remaining unaltered to a degree smaller than could be detected by the spectrograph. Thus, the increased intensity of Laue spots made from quartz plates oscillating piezoelectrically can be explained by a reduction of secondary extinction as first suggested by Langer.[1] This theory can also account for the increased intensity of a Bragg line reflected from the face of a long

[1] R. M. Langer, Phys. Rev. **38**, 573 (1931).

quartz crystal when oscillating under the transverse piezoelectric effect which was found by Professor Colby and the writer.[2] The increase in width of the line reflected from the crystal when oscillating, which was reported in the abovementioned article, has been found to be due to instrumental causes. A detailed account of the recent experiments will be mailed to the *Physical Review* at an early date.

The fact that this evidence of a secondary structure in quartz has been obtained, and that quartz is a very nearly perfect crystal as far as the reflection of x-rays is concerned, has led the writer to think that possibly a secondary structure might well exist in calcite, despite the evidence obtained by Tu,[3] which shows that the shape and intensity of lines reflected from calcite correspond to those expected by reflection from a perfect lattice. The statement that quartz is a very nearly perfect crystal as far as the reflection of x-rays is concerned, is based on the experimental fact that the intensity of a line reflected from a polished face of quartz can be greatly reduced by etching the face with some appropriate acid as has been shown by Professor Colby and the writer.[4]

Before a definite statement with regard to the existence or non-existence of a secondary structure in calcite can be made, it seems that it should be shown that the grating constant between some set of planes in calcite either does, or does not change in a one-to-one ratio with the change in the outside dimension of the crystal in this direction, when the crystal is subjected to a homogeneous strain. Until such an experiment is performed it seems reasonable to picture calcite as composed of Zwicky's secondary structure blocks lined up to such a degree of perfection that the lattice will act like one continuation of a perfect lattice, the π planes threading through the crystal in some regular manner. It is possible that the existence of these π planes might effect the size and shape of x-ray lines reflected from this type of crystal, but Professor Colby and the writer have evidence that changing the spacing between these blocks of Zwicky by many times their original spacing does not effect the reflected line. Hence, in Tu's experiments it may be that the effect of the π planes threading through the crystal in a very nearly perfect pattern did not produce a sufficient effect on the shape and size of the reflected line to be detected. Therefore, it is the writer's reaction that Tu's experiment does not conclusively disprove the existence of a secondary structure in calcite.

Now, these π planes may have a slightly higher population of atoms than the p planes as has been proposed by Zwicky,[5] and thus cause the value of the grating constant determined for calcite from Avagadro's number and the density to be somewhat less than the actual spacing of the atomic planes within the perfect blocks. If this notion is correct, it would explain the low value of x-ray wavelengths obtained by reflection from calcite, as compared with those from ruled grating experiments.

Of course the foregoing statements are presented as merely an interesting possibility, and require additional experimental evidence to substantiate them.

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University of Texas,
March 15, 1934.

[2] M. Y. Colby and Sidon Harris, Phys. Rev. **42**, 733 (1932).
[3] Tu, Phys. Rev. **40**, 662 (1932).
[4] M. Y. Colby and Sidon Harris, Phys. Rev. **43**, 562 (1933).
[5] F. Zwicky, Proc. Nat. Acad. Sci. **16**, 211 (1930).

Segregation of Polonium in Bismuth Crystal

Using a Geiger counter, Focke[1] has detected groups of ranges in alpha-particles emerging from a cleavage face of a Po infected Bi crystal. It was thought worth while to obtain evidence of these groups by direct measurements of tracks formed in a Wilson expansion chamber. Accordingly, one of Focke's crystals was mounted outside an expansion chamber[2] and photographs of the tracks were taken with a Leica camera, the particles entering through a mica covered slit of dimensions 0.5×3 mm. The camera was mounted vertically about a foot and a half above the chamber, and corrections due to non-parallelism of film and track were reduced by confining the alpha-rays by a collimating slit to angles within about 7.5° of the horizontal. The chamber was filled with hydrogen, and expansion ratios of the order of 1.34–1.38 were used. A shutter mounted on top of the piston allowed the particles to pass into the chamber only at the moment of complete expansion, so that the stopping power of the gas must have been the same for all.

About 500 photographs were taken, averaging three tracks each. Images ($1.24\times$natural size) formed by a Leica projector on drawing paper were adjusted so that origin and other fiducial marks coincided and the end of each track was then marked by a dot. About one-third of the tracks were rejected due to collisions near the end of the path, uncertain end points, etc. The ends of 1150 tracks were thus marked on three sheets of paper, 527 on one and the rest on two others. On each chart the dots nearest the origin showed a tendency to grouping. Circles at 4 mm intervals in radius were then drawn, with the midpoint of the slit as center, and counts were made of the number of dots in each interval. These numbers were then plotted against the serial number of the interval from the slit. The sequence of numbers confirmed the visual impression that groups were present in two cases, and after reducing the distances between the range groups to standard temperature and pressure in air, it was found that the value, about 0.5μ, checked that obtained by Focke for the mean group separation very satisfactorily. No consistent evidence of grouping was observed farther from the source than about 3 or 4 groups, due probably

[1] Focke, Phys. Rev. **45**, 219–220 (1934).
[2] Kurie, Rev. Sci. Inst. **3**, 655 (1932).