Effect of Etching on the Relative Intensities of the Components of Double Laue Spots Obtained from a Quartz Crystal

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(Received January 20, 1933)

Laue patterns obtained from a quartz crystal of dimensions 100×6×2 millimeters taken through the 2 millimeter direction are given. One face of the crystal was highly polished and the other face was etched. The pattern obtained when the etched face of the crystal was next to the photographic film exhibited a weaker inner component for spots close to the origin; the pattern obtained when the etched face of the crystal was next to the source of x-rays exhibited a stronger inner component for spots close to the origin. The pattern obtained when the etched face of the crystal was next to the photographic film and the crystal was oscillating piezoelectrically along the direction of the long dimension showed no appreciable difference from the pattern obtained with the crystal in this same position when at rest. An explanation of the recent results obtained by J. M. Cork is offered.

A NUMBER of investigations on quartz plates oscillating piezoelectrically along the direction of thickness of the plates caused by the longitudinal effect[1] have been recently reported.[2, 3, 4, 5, 6] The results obtained showed that the intensities of the Laue spots were greatly increased by the piezoelectric oscillations. J. M. Cork found that the Laue pattern obtained when both sides of the quartz plate were etched with hydrofluoric acid exhibited double spots with the inner components showing more intensity for the spots close to the origin. He found that the spots farther out exhibited components of more nearly equal intensity. One purpose of the present work was to further investigate this phenomenon. As Fox and Cork had failed to observe any effect on the lines obtained by the Bragg method caused by piezoelectric oscillation produced by the longitudinal effect, and as the authors[7] have succeeded in obtaining an effect on the lines obtained by this method caused by piezoelectric oscillations in a long quartz crystal produced by the transverse effect, it was thought that a Laue pattern obtained from this same crystal oscillating in the manner described above would be of interest.

The crystal used was an X-cut crystal of dimensions 100×6×2 millimeters. The long dimension was in the Y direction. A detailed account of how the crystal was cut is given in a previous paper.[7] The Laue patterns were made by passing x-radiation obtained from a Mo target excited by 30 kv through the crystal in the 2 millimeter direction. The photographic films were placed at a distance of approximately two centimeters from the crystal. One face of the crystal was highy polished and the other face was etched with hydrofluoric acid.

The pattern obtained with the etched face of the non-oscillating crystal next to the film is shown in Fig. 1A. It is readily seen that the spots close to the origin are double in nature and that the inner component of most of the spots thus situated is weaker in intensity than the outer component. This result would indicate that the reflecting power of the surface closest to the film was weaker than the reflecting power of the surface closest to the source of x-rays; this result was to be expected. The spots farther out from the origin show considerably less difference in the intensities of their components. This result may be explained by the fact that the radiation reflected from the surface of greater reflecting power has to pass through more of the crystal in

[1] The terminology here used is taken from *Piezo-Electric Terminology*, by W. G. Cady, The Inst. of Radio Eng. **18**, No. 12 (1930).

[2] Y. Sakisaka, Jap. Jour. Phys. **4**, 171 (1927).

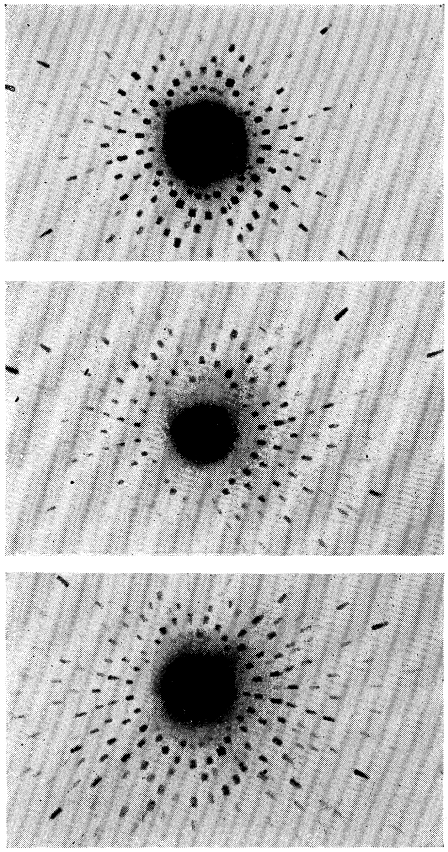
[3] G. W. Fox and P. H. Carr, Phys. Rev. **37**, 1622 (1931).

[4] G. W. Fox and J. M. Cork, Phys. Rev. **38**, 1420 (1931).

[5] C. S. Barrett and C. E. Howe, Phys. Rev. **38**, 2290 (1931); **39**, 889 (1932).

[6] J. M. Cork, Phys. Rev. **42**, 749 (1932).

[7] M. Y. Colby and Sidon Harris, Phys. Rev. **42**, 733 (1932).



A

B

C

FIG. 1. A, pattern with etched face of non-oscillating crystal next to film. B, same with etched face of crystal next to x-ray source. C, pattern with crystal in position of A, but oscillating.

reaching the photographic film than does the radiation which is reflected from the face of weaker reflecting power. It will be observed that the inner ends of the remote spots are stronger than the outer ends. Here, the radiation reflected from the surface of greater reflecting power has to traverse so much more of the crystal in reaching the photographic film than does the radiation reflected from the surface of weaker reflecting power that the radiation reaching the film reflected from the former face is actually weaker in intensity than the radiation reaching the film reflected from the latter face.

The pattern obtained with the etched face of the non-oscillating crystal next to the source of x-rays is shown in Fig. 1B. It is readily seen that the relative intensities of the components of the spots close to the origin are in the reverse order in which they occur in Fig. 1A. This fact shows that the differences in intensities of the components of spots close to the origin is due to differences in the reflecting powers of the two surfaces of the crystal. Thus the result of J. M. Cork might be explained by supposing that, although both sides of his crystal had been etched, the reflecting power of the face nearest the film was stronger than the reflecting power of the face nearest the source of x-rays, and that the reflecting power of both faces was still greater than the reflecting power of the inner layers of the crystal. His result might be explained in this manner without elaboration of the usual Laue theory.

The pattern shown in Fig. 1C was obtained when the crystal was in the same position that it was when the pattern shown in Fig. 1A was taken; however, in the case of Fig. 1C, the crystal was oscillating piezoelectrically in a direction parallel to the long dimension under the influence of the transverse effect. Very little difference, if any, can be observed in the two patterns. When the crystal is oscillating in this fashion, a loop of pressure exists through the crystal in the center of the long dimension. The x-rays were passed through the crystal at this point. It might be supposed, then, that the reflecting power of the etched face should be increased more than the reflecting power of the polished face, and that the difference between the two components of the spots close to the origin should be decreased by oscillations of this fashion. It might be further expected that the reflecting power of the inner layers of the crystal would be uniformly increased and consequently the blackening between the two components of the double spots would be relatively increased by oscillations of this fashion. This point requires further investigation.

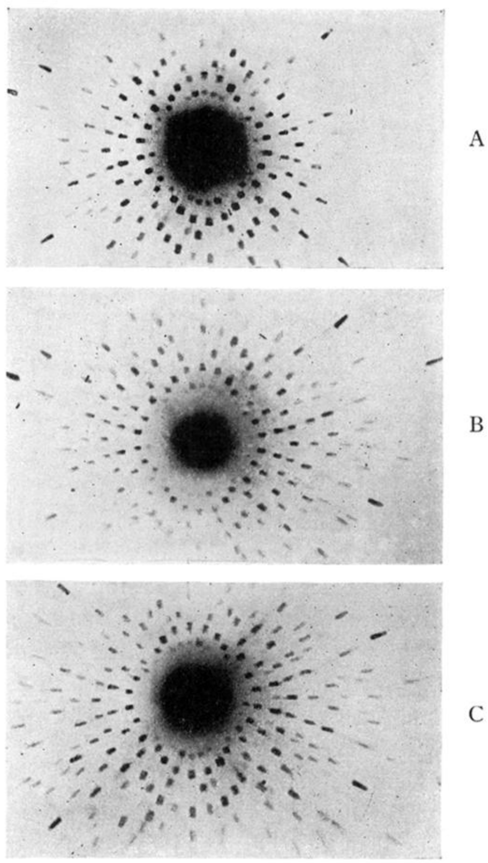


Fig. 1. A, pattern with etched face of non-oscillating crystal next to film. B, same with etched face of crystal next to x-ray source. C, pattern with crystal in position of A, but oscillating.