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Anomalies in Kikuchi Reflection Diagrams
II. Doubling of Kikuchi Lines

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The Kikuchi lines of lattice planes parallel to a crystal surface are doubled if both the surface and the plane of incidence of the electron beam are planes of symmetry (or near them). This was observed in Kikuchi diagrams of copper crystal spheres of high crystal quality.

The following was observed on copper single crystal spheres prepared on carbon-carriers[1]: In a Kikuchi diagram (60 kev-electrons), such as is shown in Fig. 1, each of horizontal Kikuchi lines (004), (006), . . . is accompanied by a parallel companion line (dotted). These lines have approximately the same intensity and width as those of the regular lines. If the angle between the reflecting lattice planes and a regular line is designated by ϑ and the corresponding angle to its companion line ϑ', the position of the companion lines is given by $\vartheta^2-\vartheta'^2=\text{const.}$ In the example cited, the surface of the crystal is almost parallel to the cube face (001). The direction of incidence of the beam is [010]. The value of the constant is 3.6 (ϑ and ϑ' are measured in degrees). The doubling remains unchanged when the crystal is rotated about the normal to the surface

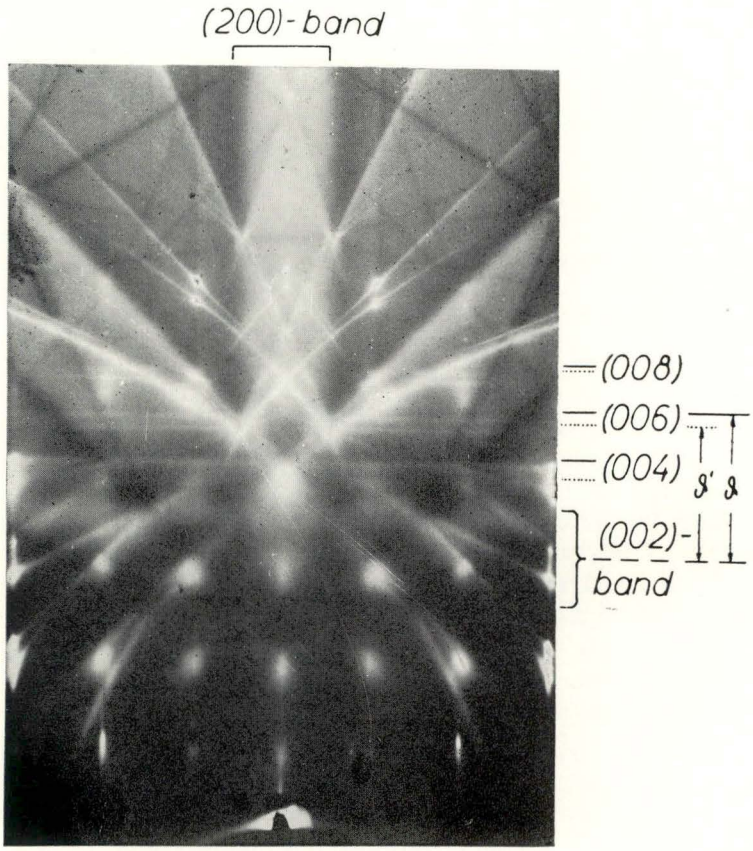

Fig. 1. Kikuchi pattern of a copper crystal sphere with doubled lines of (010).

[001], within an angle to about 2°. If the crystal sphere is rotated up 8° about [100], the companion lines also remain unaltered; during this rotation the locus of the point of incidence of the electron beam on the crystal sphere is the ⟨100⟩ zone circle. For larger rotations the companion lines vanish in both cases. If the point of incidence on the crystal is displaced on the ⟨010⟩ zone circle and [010] is retained as the direction of incidence — here the Kikuchi pattern remains unchanged—then even for an angle of 16° between the surface and the cube face the companion lines are still visible. However, they are no longer parallel to the regular lines.

The companion lines may be observed for cube-face lines even when [110] is the direction of incidence, but the contrast is weaker. They were also observed for higher orders of (220) when [001] was the direction of incidence. They could not be found for Kikuchi lines of the (111) plane. Thus their occurence appears to depend on the requirement that the surface and the plane of incidence are approximately a planes of symmetry. We found doubling only for the Kikuchi lines mentioned and not for neighbouring lines; hence, the phenomenon can be attributed neither to a refraction of the electron beam nor to the existence of two mutually tilted crystallites.

Reference

1 E. Menzel, W. Stößel and M. Otter: Z. Phys. **142** (1955) 241.

DISCUSSION

K. Molière: I should like to mention another kind of anomaly in Kikuchi patterns firstly reported by Pfister and later observed for metal crystals (Cu, Ni, Co) in many cases in our laboratory, namely an extra deficit-line in the middle of a Kikuchi band.

E. Menzel: We have also observed such an anomaly, but only near the primary beam: A dark line in the middle of the white (002)-band (seen on the photographic positive) is seen parallel to the surface.

K. Kohra: In your photographs, the doubling is seen not only at the Kikuchi line, but also for some diffraction spots. Both kinds of doubling seem to be due to the same cause.

E. Menzel: It may be probable.

R. Uyeda: More than ten years ago, Dr. Heidenreich obtained the doubling (and multiplying) of Kikuchi line for aluminum crystal. In his case, the doubling was caused by the existence of small angle boundary. Although I would not go in detail, I'd like to point out that it will be very difficult to prove the crystal has no small angle boundary.

E. Menzel: It seems to me, the following three facts show that a model of two crystals can not explain the doublings mentioned above:

1) A doubling of lines introduced by two crystals should be observed on all the lines which have nearly the same direction and not only on the higher orders of the (002) line.
2) The angular distance of a doubling introduced by two crystals has to be constant for the different doubled lines; but we observed a systematic variation of this distance for (004), (006) and (008).
3) Doubling in the same angular distances was observed on many different crystals and always, if the above mentioned conditions were fulfilled.