where "d" is the interplanar spacing and "λ" the electronic wave-length. For the diagonal (220) plane of MgO, $d=1.48$A and $\lambda=0.05$A for 60-kv electrons. The average spacing of intensity maxima obtained from Fig. 2 is about 200A. For the crystal orientation of Fig. 2, the crystal thickness at a given maximum is just twice the distance from the maximum to the cube edge and so the maxima are located by simply dividing Eq. (2) by 2. The value of "j" is not known, but in order to obtain the correct spacing, a value of "j"$=2.17$ (± 20 percent) was determined from (2), which is of the correct order of magnitude for penetration of electrons in diffraction from surfaces. It is possible to make some calculations regarding "j," but these must wait on more urgent problems.

It follows from what has been said that with a limiting aperture in the microscope, the plate density of images of crystals oriented with a facet in the plane of the image should vary periodically with the thickness of the crystal. An attempt was made to substantiate this, but the plate densities ranged so widely due to slight variations in orientation of crystal and electron beam[3] that no correlation could be made.

It was learned in a recent conversation with Dr. Hillier that he had observed this phenomenon in MgO crystals and the maxima spacings roughly check those of Fig. 1.

[1] J. Hillier and R. F. Baker, Phys. Rev. **61**, 722 (1942).
[2] M. von Ardenne, Zeits. f. Physik **116**, 736 (1940).
[3] Cf. B. von Borries and E. Ruska, Naturwiss. **28**, 366 (1940).

Electron Microscope Study of Surface Structure

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THE application of the electron microscope to the study of fine surface structure of opaque bodies depends either upon the ability of an electron optical system to view[1] directly the surface through emission or reflection or a technique of reproducing the surface structure into a thin film suitable for study in the transmission electron microscope. Several methods of producing such replicas have appeared in the literature, chief among which are the natural oxide films of Mahl,[2] the direct Formvar films of Schaefer and Harker,[3] and the silver-collodion process of Zworykin and Ramberg.[4]

It is the purpose of this communication to report yet another technique of reproduction developed in these laboratories which depends upon first forming an impression of the surface to be studied in a thermoplastic by the normal molding technique. Several plastics have been tried and polystyrene was concluded to be the best suited, because of the combination of moldability, dimensional stability, and chemical inertness. The plastic molding is removed from the specimen, either by mechanical shock or dissolution of the metal in an appropriate acid. A thin film replica is then made from the molding by evaporating onto it a film of silica and subsequently removing the silica by means of ethyl bromide solvent.

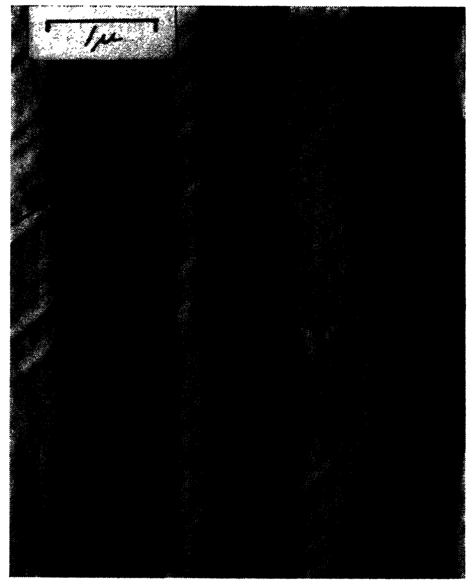

FIG. 1. Deformation striae in calcite crystal.

It has been found that silica condensing from a molecular beam onto a polystyrene surface possesses great mobility upon both the styrene and its own condensing surface. A beam only a few thousandths of an inch in cross section incident upon a styrene block will result in a film completely surrounding the block. If the surface of the styrene is "electron microscopically" smooth a film structureless to the electron microscope is so obtained which will serve as a temperature-stable support for microscope specimens and is capable of being heated to 1000°C without notice-

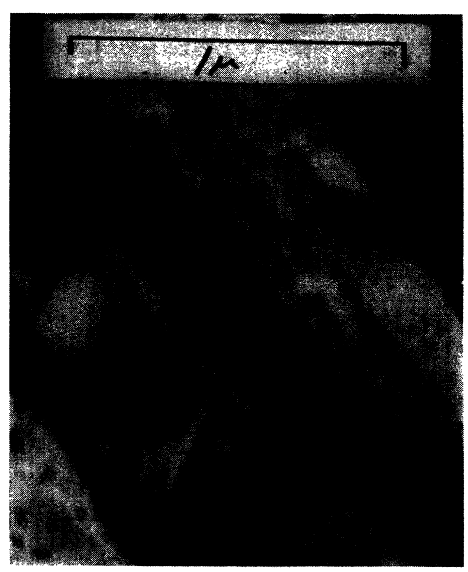

FIG. 2. Illustrating resolution in silica replica.

able effect. Electron diffraction shows these films to be vitreous silica. Aluminum oxide also tends to be quite mobile on polystyrene during condensation.

If the styrene surface is a molded replica, it is observed that the evaporated silica film tends to fill in the irregularities to a certain degree and yield a positive replica film of the original surface suitable for use in the transmission electron microscope. The extent to which these irregularities are filled in is now under investigation.

Figure 1 is an electron micrograph[5] of a silica replica prepared as just described from a freshly cleaved surface of a calcite crystal. During molding, the crystal was deformed and gave rise to the striae observed in Fig. 1. The light regions in this micrograph are "valleys" in the original surface. The slip lines within the bands are quite visible, making an angle of 60° with the axis of the band, and are particularly interesting because of their curvature. Families of bands were observed, similar to those of Fig. 1, which had the appearance of a sine wave with an amplitude of 0.2–0.3μ and a period of 2–3μ. In a single group, the individual bands exhibited a phase difference of 60° from band to band and this phase difference seemed to be generally in the same direction throughout the group. The curvature of slip lines illustrated in Fig. 1 may well be a demonstration of the local curvature[6] giving rise to shear hardening.

Excellent contrast and resolution can be obtained with these replicas as evidenced in Fig. 2, which was taken from the same replica as Fig. 1, but a different part of the field showing slip on a larger scale. A resolution of 40A is estimated in this replica.

Full details of the technique and applications will appear elsewhere.

[1] V. K. Zworykin, J. Hillier, and R. L. Snyder, A.S.T.M. Bull. No. 117, pp. 15–23 (1942).
[2] H. Mahl, Zeits. f. tech. Physik **22**, 93 (1941).
[3] V. J. Schaefer and D. Harker, J. App. Phys. **13**, 427 (1942).
[4] V. K. Zworykin and E. G. Ramberg, J. App. Phys. **12**, 692 (1941).
[5] Taken with an RCA electron microscope, Type B.
[6] Cf. R. Houwink, *Elasticity, Plasticity, and Structure of Matter* (Cambridge University Press, 1937), pp. 96–97.

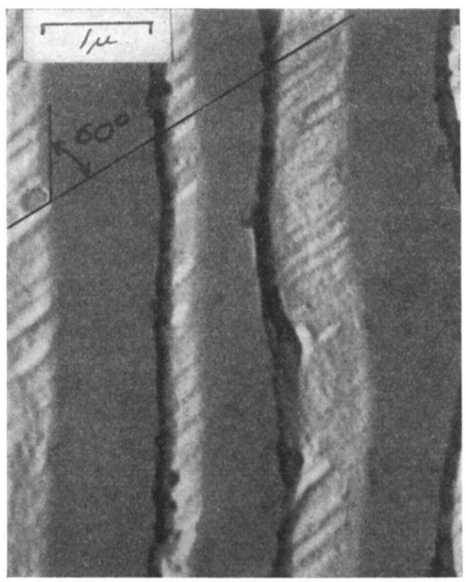

FIG. 1. Deformation striae in calcite crystal.

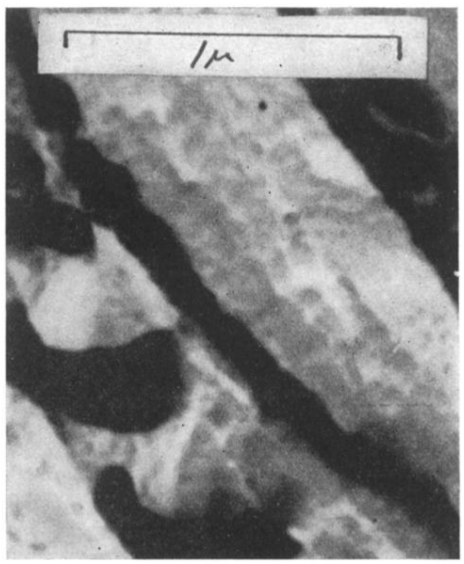

FIG. 2. Illustrating resolution in silica replica.