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An electron microscopic study on the crystal growth of silver evaporated on molybdenite.

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By electron microscopy Hashimoto & Uyeda (1957) observed moiré patterns of overlapping crystals and found that a single dislocation in one of the crystals could be detected as a so-called moiré dislocation. Independently, Pashley and others (Pashley, Menter & Bassett, 1957; Bassett, Menter & Pashley, 1958) carried out a more extensive experiment on moiré dislocations and studied imperfections in metal crystals. They used overlapped metal films such as palladium/gold which were prepared by taking advantage of epitaxy (Pashley, 1956). We carried out a similar experiment with silver/molybdenite. The present communication gives a preliminary account of the result.

The sample of molybdenite (MoS_2) used in the present experiment was a very good crystal of Korean origin. Dislocations were rarely found in this crystal (Kamiya & Uyeda, 1960) and no monatomic step was detected on good cleavage surfaces of macroscopic dimensions (Kainuma, 1951; Uyeda & Miyake, 1957). Films of molybdenite about 600 Å in thickness were made by cleaving and silver was deposited on them by vacuum evaporation.

According to a previous experiment (Uyeda, 1942), (111) of silver lies parallel to the cleavage surface (0001) of molybdenite, taking the azimuthal setting as illustrated in Fig. 1. Thus a moiré pattern with spacing $d_1d_2/(d_1-d_2)$ $=17$ Å should be observed, where d_1 and d_2 are given in Fig. 1.

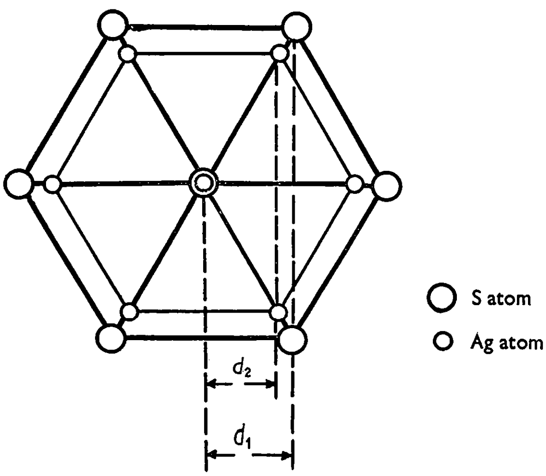

Fig. 1. Azimuthal setting of silver crystal on molybdenite
$d_1=1{\cdot}57$ Å: $(11\bar{2}0)$-spacing of molybdenite,
$d_2=1{\cdot}44$ Å: $(2\bar{2}0)$-spacing of silver.

An example of electron micrographs of silver/molybdenite is reproduced in Fig. 2. Moiré fringes of spacing 17 Å are observed as predicted. Important features of the photograph are summarized below with some speculative interpretations:

(*a*) There are areas of dimensions 500–1,000 Å over which fringes are straight and equally spaced. Each area may correspond to a crystal grain grown from a nucleus. Inside the grain the crystal is remarkably perfect.

(*b*) Many of the boundaries are straight and make angles 30°, 60° and 90° with the boundaries.

(*c*) Near the boundaries the fringes are usually distorted and look darker than the inside. Fringes are often shifted across the straight boundaries. This implies that phases of $(2\bar{2}0)$ plane of silver, which is parallel to the fringes and normal to the specimen film, are shifted across the boundaries. It may be highly probable that the phases do not coincide when two grains grown from different nuclei meet together.

(*d*) Moiré dislocations are often found on the boundaries. They may be attributed to dislocations in silver crystals because the molybdenite used in the present experiment rarely has dislocations. No twin was recognized in Fig. 2.

(*e*) Blank areas in Fig. 2 are not covered by silver. Buerger's circuit around a blank area often proves that a moiré dislocation should exist in the area. This means that a dislocation should be produced in silver when the blank area is completely covered by depositing more silver. This mechanism of introducing dislocations into the evaporated metal has been suggested by Bassett & Pashley (1959), but it has not yet been verified. Fig. 2 gives an experimental proof of this mechanism. The dislocation density in Fig. 2 is the order of 1×10^{10} per $cm.^2$. According to Bassett, Menter & Pashley (1958), the dislocations with Buerger's vectors parallel to $(2\bar{2}0)$ of silver are not included in the above density.

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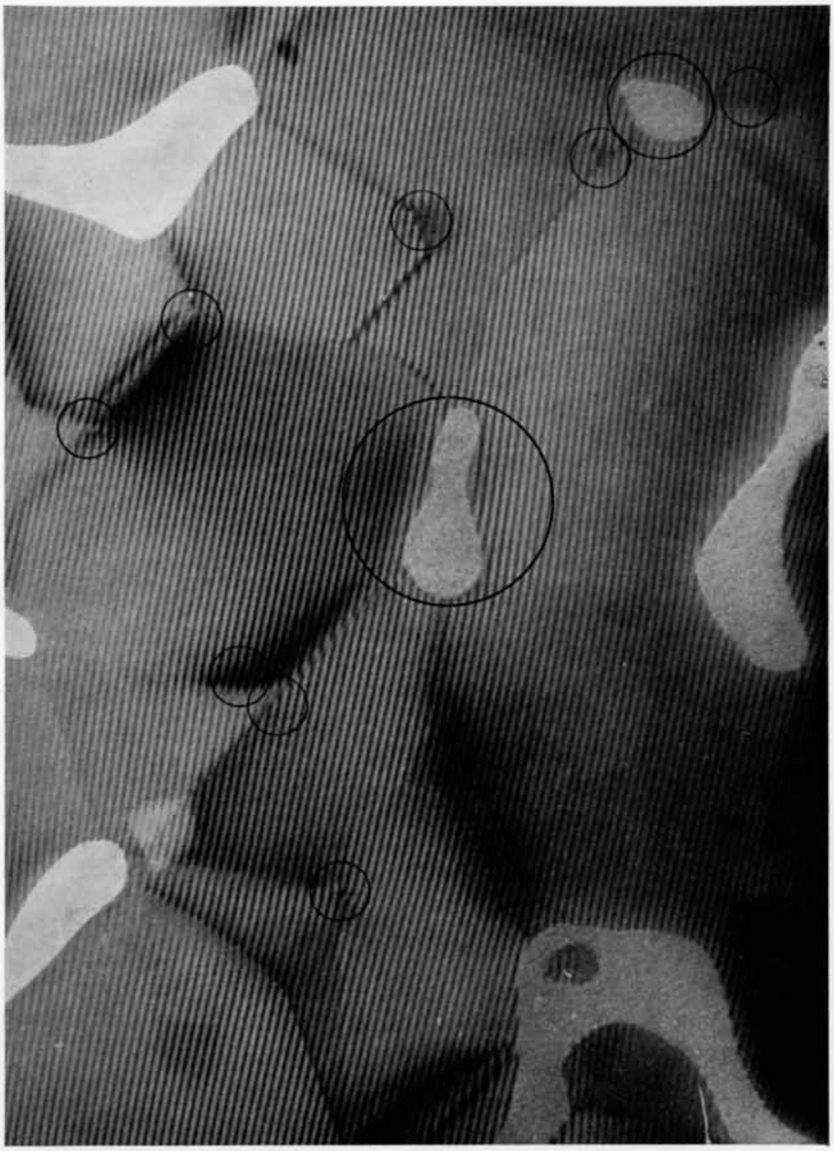

Fig. 2. Electron micrograph of silver/molybdenite, Mag. × 630,000. Silver deposited at 350 °C. with mean thickness 150 Å.

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