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.

Selective X-Ray Diffraction from Artificially Stratified Metal Films Deposited by Evaporation

In a search for a new method of determining absolute x-ray wave-lengths we have produced stratified metal films on glass consisting of one hundred layers of gold alternating with one hundred layers of copper by evaporation and have obtained selective x-ray diffraction of molybdenum K radiation in the first order from them.

We chose gold and copper because these metals are isomorphs almost indistinguishable from each other as to their external fields which determine mutual cohesive and adhesive forces. We hoped thus to avoid coherence of the layers into islands. We intend soon, however, to try pairing nonisomorphic atoms to form stratified films.

The copper, evaporated in vacuum from a molybdenum trough of "V" cross section heated by electrical conduction was deposited without interruption on the under surface of a 5-cm square of plate glass distant about 12.5 cm. Simultaneously the gold was deposited in intermittent spurts on the same glass plate from a similar molybdenum trough near the first one by periodically raising and lowering the heating current on the second trough just enough alternately to produce and inhibit boiling of the gold. This intermittent heating was timed by a pendulum clock mechanism. Thermojunctions placed near the troughs permitted us to check and control the uniformity of the temperature regime of the copper and gold boilers during the deposition.

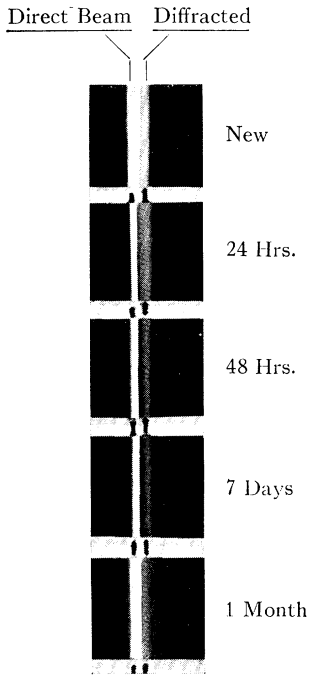

FIG. 1. X-ray spectra of molybdenum K radiation made with artificially stratified metal films deposited by evaporation.

At the end of every twenty-five layers of gold a light aluminum vane shielding one corner of the glass plate was shifted a little by means of magnets so as to form a "staircase" with steps 25 layers high in the deposit in this region, to check the uniformity of deposition by interferometry with visible light and also to determine to what extent the change of phase of the light at reflection on each step might be influenced by the varying proximity of the glass backing. Rough estimates of thickness of the entire deposit made by placing an optical flat against the film and observing the fringe shift across the steps of the staircase give a total thickness of roughly 10,000A, and hence a "grating constant" of 100A. The total stratified deposits transmit light appreciably.

The films were examined for selective x-ray reflection with K radiation from a molybdenum target tube and an improvised Bragg type rocking crystal spectrograph having an especially designed shielding mechanism preventing fogging of the diffracted spectrum at such small angles by direct radiation. Control exposures showing no diffraction maxima like those obtained with the stratified films were made with (1) clean glass, (2) a pure evaporated copper deposit on glass, (3) a copper plate, (4) nothing whatever, (5) a calcite crystal (cleavage surface), etc. *The reality of the diffraction maxima is clinched by the interesting fact shown in Fig. 1, that the intensity of these diffracted images falls off approximately exponentially with time, with "half-life" of roughly two or three days.* Ten minutes suffices to give a good photographic exposure hence this instability is no bar to their use. The *sharpness* of the diffracted image does not change materially; only the intensity diminishes, as if the amplitude of the strata were obliterated by diffusion. *It would seem likely that we have here an excellent way of studying intimately the diffusion of atoms in the solid state.*

The photographs indicate a grating constant in accord with the 100A computed above from the total thickness of the deposit. The fuzziness of the layers probably explains the absence of higher orders.

We are indebted to Dr. Leon L. Watters of New York City for the funds which have supported this work.

JESSE W. M. DUMOND
J. PAUL YOUTZ
California Institute of Technology,
September 2, 1935.

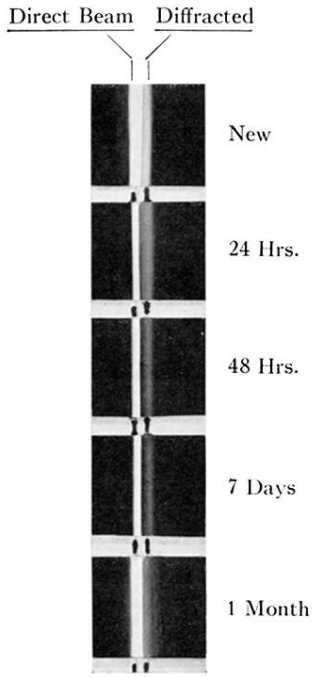

FIG. 1. X-ray spectra of molybdenum K radiation made with artificially stratified metal films deposited by evaporation.