The Photoelectric Effect of Thin Bi Films

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Thin Bi films on glass were obtained by sputtering in A. The photoelectric currents were measured when ultraviolet light was focused on a film, and at the same time direct current passed through the film in one direction and also in the reversed direction, as well as alternating current. It was found that only relatively large alternating currents affected the photocurrent—thus heating alone did not affect the photocurrent much. The direction and magnitude of the direct currents, however, affected the photocurrent appreciably.

IN 1921, Shenstone[1] noticed a change in the photoelectric current of a Bi strip when direct currents passed through it. He suggested that the effect might be due to (1) orientation of metal crystals and/or (2) temperature changes. Cardwell[2] showed that crystal changes did alter the photoelectric current—the crystal changes were affected by the heating effect of a direct current through the specimen. Weber,[3] using Mo strips, attributed the findings of Shenstone to occluded gases that escaped by the heating of the current.

The aim of the present investigation was to determine the variation of the photoelectric current in the case of thin Bi films on glass when direct or alternating current (50 cps) passed through the film. The first series of films were prepared by sputtering in an atmosphere of pure A.

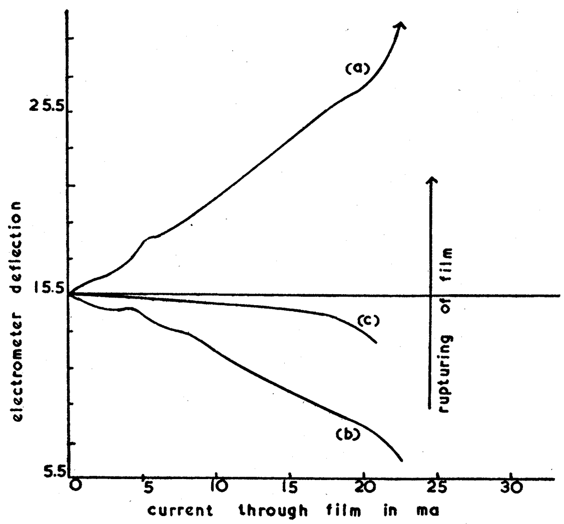

FIG. 1. Photoemission of Bi film as a function of electric currents through film. Deflection of electrometer was 15.5 units with zero current through film. Curve (a) positive of external battery connected to negative side of film (as cathode of photocell); curve (b) negative of external battery connected to negative side of film; curve (c) alternating current (rms). Thickness of film ~350A.

[1] A. G. Shenstone, Phil. Mag. **41**, 916 (1921).
[2] A. B. Cardwell, Proc. Natl. Acad. Sci. U. S. **15**, 544 (1929).
[3] A. H. Weber, J. Franklin Inst. **223**, 215 (1937).

(If the A is not pure, Bi reacts with the slightest traces of O_2 or N_2 present, and no sputtering takes place, or a nonconducting film is obtained.) The A is then pumped off by an oil diffusion pump and the glass plate with film moved (in vacuum) into a thick-walled brass compartment fitted with quartz windows and a tungsten anode. Ultraviolet light from a mercury vapor lamp (unfiltered) is focused through a slit on the middle portion of the film and the photoelectric current measured by means of a Lindemann electrometer. The film thickness is afterwards determined by an interference method.

Films of thicknesses varying from 200 to 700A were used, and typical curves of one film are shown in Fig. 1. These curves were the final results after many runs of increasing and decreasing currents through the film and when the deflections obtained for the same current values did not alter. Before readings were made, the tube was evacuated to less than 2×10^{-5} torr for at least 6 hours, and the film was frequently heated by the filament of the ionization gauge used for controlling the pressure. During observation, the vacuum pumps were kept on and the pressure was measured at regular intervals. At a maximum value of the current through the film it is ruptured. Just before rupturing, the photocurrent increases steeply; this might be due to the same phenomenon observed by Kramer.[4]

From Fig. 1 it is clear that the variation in photocurrent depends on the direction of the current through the film [curves (a) and (b)] and that it is not a pure heating effect since the passage of the alternating current does not cause the same variation (curve (c)]. At certain relatively small currents the photocurrent remains constant over a limited range, probably because of crystal transformation.

The work is being continued by using other metals and different methods of making the films.

I hereby wish to express my sincere thanks to Professor H. Verleger, who suggested the problem and who took a keen interest in the progress of the present work.

[4] J. Kramer, Z. Physik **133**, 5 (1952).