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THE BEHAVIOR OF THE PHOTOELECTRIC THRESHOLD OF CADMIUM FILMS

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The purpose of the present work was to investigate the photoelectric properties of thin films of cadmium formed by evaporation in a high vacuum. The preliminary experiments necessary to verify previously reported values of the threshold wave-length of cadmium in bulk and to develop the technique of slowly depositing thin films of this metal by evaporation were described in a previous paper*

The photoelectric cell was about 25 cm in height and the body was made from 37 mm pyrex tubing. The quartz window, through which the ultra-violet light entered, was sealed to the top of the cell by means of a graded quartz-pyrex seal. The anode consisted of a network of 0.2-mm tungsten wire fashioned in such a manner as to expose a large surface for capturing the emitted photoelectrons. The cathode, upon which the cadmium film was deposited, consisted of a plate of oxidized Swedish iron. The cathode was maintained at a potential of 30 volts negative to ground through a 0.6-mm tungsten wire which was sealed into a pyrex tube extending out from the cell at right angles near the bottom. This arrangement made it possible to remove the cathode without demolishing the cell. The cathode plate rested upon a flat circular pyrex plate which formed the bottom of the cell. It could be cooled by passing a stream of liquid air vapor over the bottom of the cell.

The cell was connected to the evacuating system through a liquid air trap by means of a 20-mm tube which was sealed to the cell near the bottom and which made an angle of 45 degrees with the walls of the cell. To this tube was connected two small pyrex bulbs in series. These bulbs were to contain the cadmium. The cell and bulbs were contained in separate electric ovens which were used for outgassing the pyrex and for distilling the cadmium. The whole high-vacuum system was constructed from

*Roller, Zenor and Schmidt, Okla. Acad. Sci. Proc. Vol. 12 (1931)

pyrex and the only stop-cocks used were located between the mercury diffusion pumps and the Cenco Megavac pump. All work was done at a pressure of 10^{-6} mm of mercury as registered by a McLeod gauge.

The source of ultra-violet radiation was a 110-volt d.c. horizontal, Cooper-Hewitt quartz mercury arc. The radiation was rendered monochromatic by passing it through a Bausch and Lomb single quartz monochronomator of high resolving power, and was focused upon the cathode by means of a quartz lens. The photoelectric current was measured with a Dolezalek electrometer having a sensitivity of 1300 mm per volt at 1 m scale distance.

The system was baked for thirty hours at a temperature of 400°C during which time the vacuum pumps were operated continually. Spectroscopically pure cadmium was then placed in the bulb farthest from the cell, and after the cell was rebaked for four hours more, the metal was distilled into the second bulb and then into the cell where the thin film was formed on the cathode.

While the film was being deposited, the cathode was irradiated continuously with ultraviolet light and, as soon as any indication of a photoelectric effect was noted, the distillation was halted and the photoelectric current measured for the five mercury arc lines, 2536A, 2653A, 2804A, 2894A, and 2967A. The threshold wave-length was then found by plotting spectral distribution curves.

The thickness of the film was then increased by adding some more metal to the first film. In this way determinations were made of the threshold wave-lengths of fourteen different films, some of which were thin enough to be invisible while others were slightly visible. In the cases of those films which were thin enough to be invisible, the threshold was found to be 3025 ±25A, whereas for the visible films it was 3030±30A. Thus the thin films of cadmium failed to exhibit the excursion of the threshold wave-length toward the red end of the spectrum that is exhibited in the case of thin films of the alkali metals.

The foregoing values for the threshold wave-length are in rather close agreement with the value found by Bomke** for evaporated films of cadmium deposited on silver in outgassed cells, namely, 3040A. The slightly lower values found in the present work can probably be attributed to the fact that our cell was more highly outgassed than was the cell used by Bomke. It was found during the course of this investigation that the presence of air tended to increase the threshold wave-length.

Films were formed both at room temperature and at the temperature of liquid air vapor, but no difference could be detected in the photoelectric properties of the films formed under these two conditions.

**Bomke, Ann. d. Phys. 5, 579 (1931).