Reprinted from JOURNAL OF THE OPTICAL SOCIETY OF AMERICA, Vol. 51, No. 5, 583, May, 1961
Printed in U. S. A.

Quantum Yield of Gold-Cathode Photomultipliers

CHARLES B. CHILDS
National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland
(Received November 22, 1960)

TWO gold-cathode EMI 6255G tubes have been investigated for their quantum yield between 3100 and 1900 A. The tubes had cathodes of different appearances. One of these, numbered 3012, had a slight bluish tinge and was very transparent to visible light; the other, numbered 3021, had a definite gold coloration.

The relative quantum yield of each tube was determined with the aid of a Cary model 14 recording spectrophotometer used as a monochromator. The monochromator relative-energy output was determined from the current output of a sodium-salicylate-coated RCA 1P21 photomultiplier. Each gold-cathode tube was then operated at 3000 v, and the central 1.8 cm² of the cathode was exposed to the monochromator output.

Quantum yield at 2537 A was acquired by using the central 0.40 cm² of cathode which was placed seven centimeters from a low-pressure mercury arc[1] whose irradiance at that distance was 630 μw of 2537 A per cm². Each photomultiplier was operated as a diode with a cathode-first dynode potential of 180 v. Under these conditions the output current for No. 3012 was approximately 6×10^{-11} amp and for No. 3021 9.6×10^{-10} amp, giving respective quantum yields of 1.2×10^{-6} and 1.9×10^{-5}. Applying the latter yield to the relative yield curve of the tube, one finds that for No. 3021 the 1900-A yield would be approximately 1.5×10^{-3}.

The quantum-yield curves of Fig. 1, when considered with the cathode appearance, lead one to the conclusion that in No. 3012 sufficient gold had not been evaporated, with the lack of gold resulting in a "tail" extending into the near ultraviolet. This "tail" is possibly caused by a combination of photoelectrons from both the slight gold cathode and Ag-Mg-O dynodes. However, tube No. 3021 had a "heavy" gold cathode and a relatively high 2537-A quantum yield combined with a sharp quantum yield cutoff at 2600 A.

Because the No. 3012 cathode was not sufficiently thick for "low" near-ultraviolet response and "high" 2537-A yield, an attempt was made to evaporate more gold, but this attempt failed when a large current surge melted the evaporator wire before gold was evaporated. In the case of No. 3021, more gold was successfully evaporated but the 2537-A response of the tube had decreased, indicating that the optimum gold thickness, which is correlated with the sharp cutoff in quantum yield at longer wavelengths, had been exceeded.

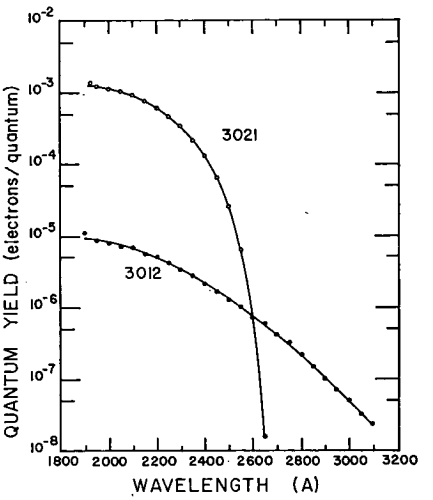

FIG. 1. Quantum yield of two gold cathode EMI 6255G photomultipliers.

It is our belief that this limited study of the two gold cathodes lshows that maximum yield, for both near-ultraviolet cutoff and relatively high quantum yield at short wavelengths, can be obtained by evaporating while monitoring the tube as a diode exposed to a high 2537-A flux, with evaporation being terminated when the diode current reaches a plateau or begins to decrease.

[1] Pen-Ray lamp model 11 SC-1, Black Light Eastern Company, New York.