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STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE.(U)

OCT 68 H TIMAN DA-44-009-AMC-1811(E)

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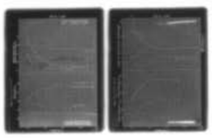

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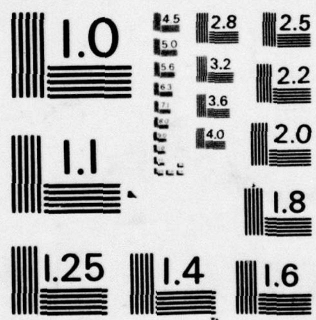

MICROCOPY RESOLUTION TEST CHART

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SEVENTH QUARTERLY REPORT NO. 21

FOR

(6) STUDY AND IMPROVEMENT OF THE S-1 PHOTOEMISSIVE SURFACE. (U)

THIS REPORT COVERS PERIOD 1 FEBRUARY - 30 APRIL 1968

(9) Quarterly (7th) rept. no. 21, 1 Feb - 30 Apr 68,

(10) Hans /Timan (11) 1 Oct 68

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RELEASED BY: Alan Howell, Contract Administrator

DU MONT CONTROL DOCUMENTS: SI-6384, T6-2018, MO-10198

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PART I - PURPOSE

(C) Under this contract, photoelectric emission of the S-1 surface is being studied. Specific aims are:

1. Increase of white light sensitivity to 100 μa/l for 2870°K.

2. Reproducibility of processing schedules for high sensitivity cathodes.

3. Lowering of the thermionic emission to a value of 10^{-13} A/cm^2 or less.

4. Measurement of physical and optical surface properties.

PART I - GENERAL FACTUAL DATA

(U) During April, 14 tubes were assembled, 11 of which attained processing status. Three were lost due to leaks or contact problems.

PART I - DETAILED FACTUAL DATA

A) Tubes processed during the month of April

(C) During this month poor results were achieved in cathode processing. The consistency of poor results suggests a contamination source in our cleaning procedures. A thorough reappraisal of our methods and materials was initiated at the end of this month and is expected to clear up this problem.

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(U) One tube was processed on a special "grooved" glass plate. For results and description see B).

(C) The attempts to process cathodes on TiO_2 substrates or on space reflectors resulted, as in the case of semitransparent cathodes, in poor sensitivities.

B) <u>Summary of work performed during this quarterly period</u>

1. <u>Formation of cathodes on dielectric substrates</u>

(C) The entire line of investigation of S-1 formation on TiO_2 substrates has proven unsuccessful.

(C) Initially, we were able to show that cathode formation in the semitransparent mode on thin TiO_2 substrates was possible. The sensitivity values achieved were reasonably satisfactory. Starting with this assumption, it was logical to continue and to assume that formation on TiO_2 layers of desired thickness and on TiO_2 spacers on metallic refractors would also be possible.

(U) The experiences of the last few months, however, make it clear that this could not be accomplished.

(U) The chosen method of converting Ti into TiO_2 by means of heat treatment - as most sources suggest - is in itself not so suitable for the purpose of forming thick layers of TiO_2. For interference in the desired spectral region (around 10000Å), it is expected that the desired layer thickness would be around $\lambda/4$ values. As subsequent measurements of the TiO_2 thickness have shown,

(U) it would be very difficult to form such heavy controlled TiO_2 layers through conversion from metallic Ti because any TiO_2 thickness above 1000Å requires near opacity of the initial metal coverage. (See Rpt. No. 18, p. 8-9).

(U) In addition to this, it was found that the preparation of heavy TiO_2 layers was in itself difficult. While we were able to form such layers on glass after several weeks of experimentation, it was only in the very last trials that we were able to form a heavy TiO_2 layer on an Ag mirror without "break-up" effects. (See Rpt. No. 19, p. 3).

(C) But none of the formation attempts on heavy TiO_2 layers (above 1000Å), neither on glass nor even less on Ag, resulted in usable cathodes.

(U) Very recent experiments with direct formation of TiO_2 through evaporation of Ti in an oxygen atmosphere always resulted in non-uniform layers.

(U) We have, therefore, begun to prepare SiO films. After several unsatisfactory set-ups, we finally developed a generator type of SiO source which is fitted with a small opening. This source resembles, somewhat, a point source. Through the uniform heating of the surrounding Ta sheath sputtering has been virtually eliminated. Initial measurements show reasonable uniformity over the central region of coverage.

(U) Further experimentation in this direction will continue.

(U) Complete optical data and front-versus-vacuum incidence sensitivities were measured on two semi-transparent TiO_2 substrated cathodes (Nos. O-244T, O-308T).

(U) The Figures 1, 2 for O-244T, and 3, 4 for O-308T show the results of measurements.

(U) The thickness of the TiO_2 layer in No. O-244T was determined from the optical data to be 200Å (See Rpt. No. 12). Because of the similar optical data, the thickness of the TiO_2 in No. 308-T is about the same.

(C) In No. O-244T, the Ag coverage was about 50%; in No. O-308T, the Ag coverage was about 35%. In both cases the cathode was formed with the usual high infrared method. Similar sensitivities were arrived at.

Tube No. O-244T - W.L., 38 μa/l - 2540, 3.8 μa/l
Tube No. O-308T - W.L., 34 μa/l - 2540, 3.5 μa/l
(Measured 2/68).

(C) All optical data were corrected for the outer glass face (See Rpt. No. 12). The vacuum incidence measurements are also corrected accordingly (See this report, p. 8). As the drawings show, an interference effect is clearly displayed in O-244T, while in O-308T, a strong suppression of the front reflection takes place.

(C) While the ratio r of front-to-vacuum incidence is much larger in Tube No. O-244T, the ratio of the two absorptions shows just the opposite. The very large difference of front and vacuum absorption at 3900A does not show up in the corresponding sensitivity figures.

(C) It is not possible to find any clear relationship between absorption and photosensitivity. The results for this type of cathode are even less conducive to interpretation than in the S-1 proper.

2) Formation of heavy cesium oxide layers

(C) Due to the fact that several measurements have not been completed as yet, this series will be reported on in the next quarterly report.

3) Formation of a cathode on a "grooved" substrate

(C) One grooved plate was supplied by Ft. Belvoir in order to establish formation characteristics of the S-1 on it.

(U) Although the properties of this plate are not exactly known, it is quite obvious that the light is incident upon the photocathode at a more glancing angle. Whether actually total internal reflection takes place is, of course, dependent upon the refractive index of the photocathode.

(U) In order to make comparisons between normal glass substrate and the grooved plate, the plate was mounted onto a larger size faceplate.

(C) The initial silver laydown was monitored on the clear glass to about 53%. It was, however, found that this amounted only to about 61% on the grooved plate. It is possible - especially in view of the rather disappointing infrared sensitivity - that this thick-

How does reflectivity behave?

(C) ness is thin for any infrared enhancement. Processing was then performed to peak sensitivity on the grooved plate. Results are given in Table of this report.

(C) The expected enhancement at the "wrong end" of the spectrum is being observed. Apparently a "total internal reflection" condition is at least approached for the two blue lines measured, because the enhancement there is very much larger than could be expected from just a longer light path. This has already been pointed out in the last reports of the previous contract, DA-44-009-AMC-136(T). (See Rpt. No. 37-39). From the comparatively high blue and green transmission of the S-1, any optical enhancement would be expected to show these features.

(C) The sensitivity figures on the grooved plate seem to indicate a strong dependence upon the direction of the incident light beam. These effects, of course, would be expected in a total internal reflection setup.

4) Miscellaneous

(C) In several trials, the oxygen glow discharge voltage was lowered from its normal value of 1000V to lower values (as low as 480V). No obvious effects were detected.

(U) A calculation was made to establish the actual value of vacuum incidence (VI) photoresponse and the ratio r of front-to-vacuum incidence with the correction for the second glass surface.

ratio of what?

sensitivity?

(U) This equation is given below and can easily be arrived at with equations VII-IX and Figure 20 in Report No. 12.

$$FI = (1-r_g+r_g R_F) \times FI_m \text{ (Measured)}$$

$$VI = .922 \times VI_m + r_g T_F \times FI_m$$

$$\text{(X)} \quad FI/_{VI} = \frac{.922 \times \quad 1+r_g \; (1-R_F)}{(VI/_{FI_m}) \; - r_g T_V}$$

Here, all the symbols have the meaning defined in Rpt. No. 12.

PART II - MEETINGS, CONFERENCES

(U) On February 16, and March 22, 1968, Dr. H. A. Stahl visited these laboratories to hold discussions with H. Timan and related personnel about present status and future developments under this effort.

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TABLE I

COMPARISON OF "GROOVED PLATE" (PL) AND 7056 GLASS (GL)

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	Luminous Sensitivity in µA/L		Absolute Sensitivity in mA/W for Different Incidences					Resistivity in Ω/□	
			PL			GL			
	PL	GL	0° Inc.	20° Inc.	40° Inc.	0° Inc.	20° Inc.	PL	GL
								3.0×10^7	2.5×10^5
White Light	44	40							
2540 Filter	32	32							
3900Å			7.3	6.4	5.9	2.25	2.25		
4535Å			7.0	6.6	7.0	1.65	1.65		
5050Å			5.9	5.6	4.5	1.85	1.85		
6015Å			4.6	4.5	3.0	2.0	2.0		
7980Å			1.7	1.6	1.1	1.7	1.7		
9500Å			.65	.52	.36	.70	.70		
11500Å			.024	.025	0	.07	.07		

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TUBE NO. 0-244T

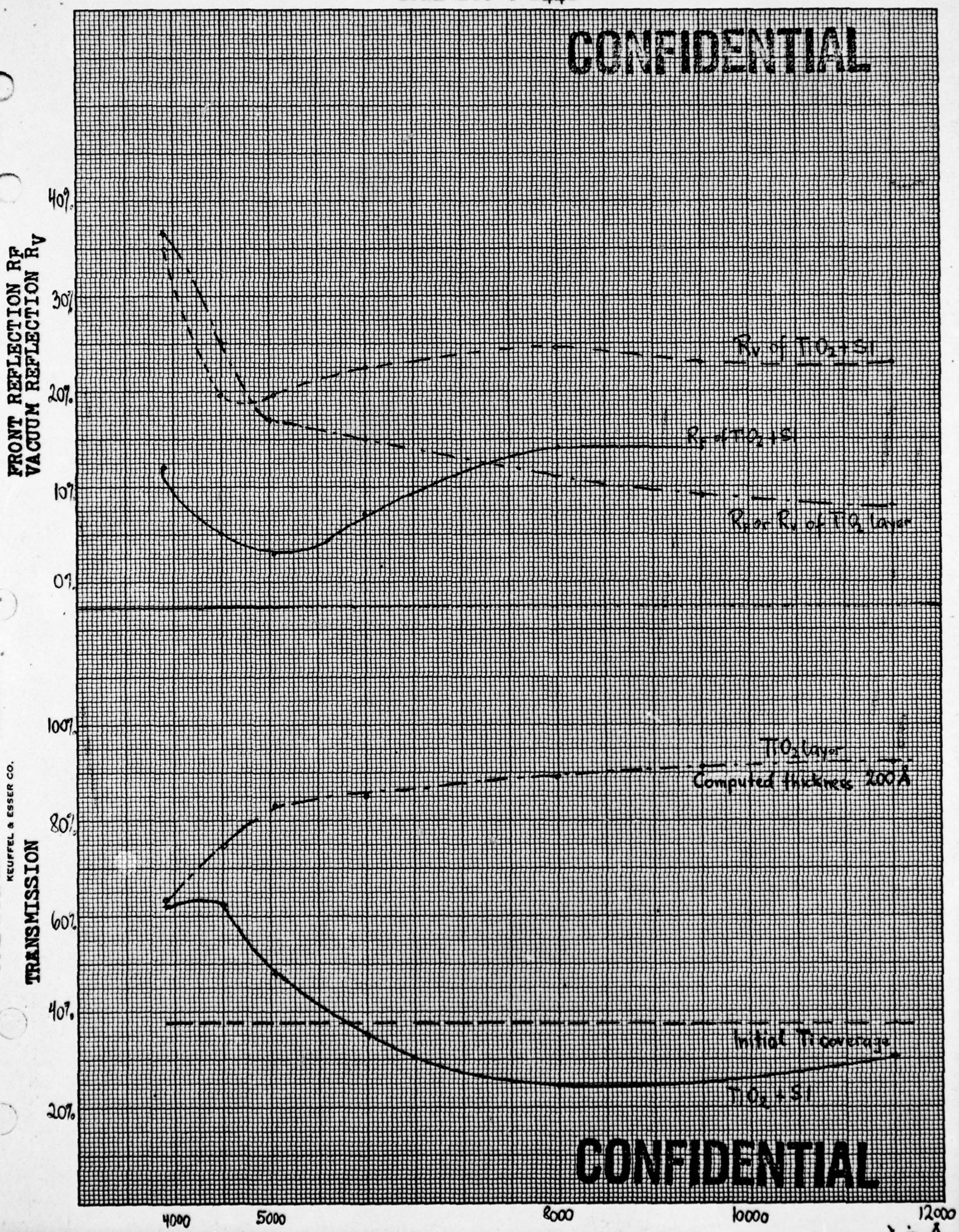

FIGURE NO. 1

× 7.55

TUBE NO. 0-244T

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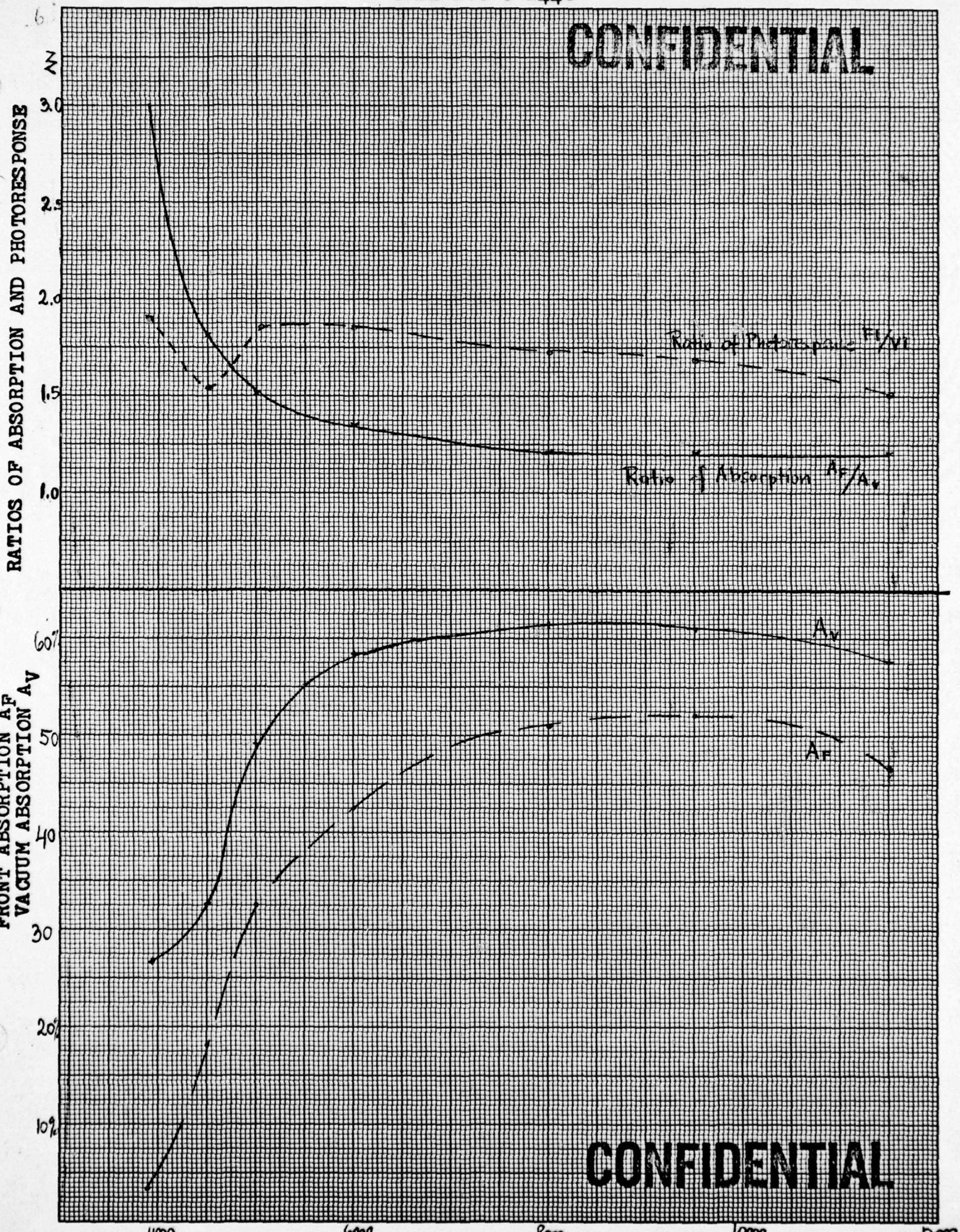

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FIGURE NO. 2

TUBE NO. 0-308T

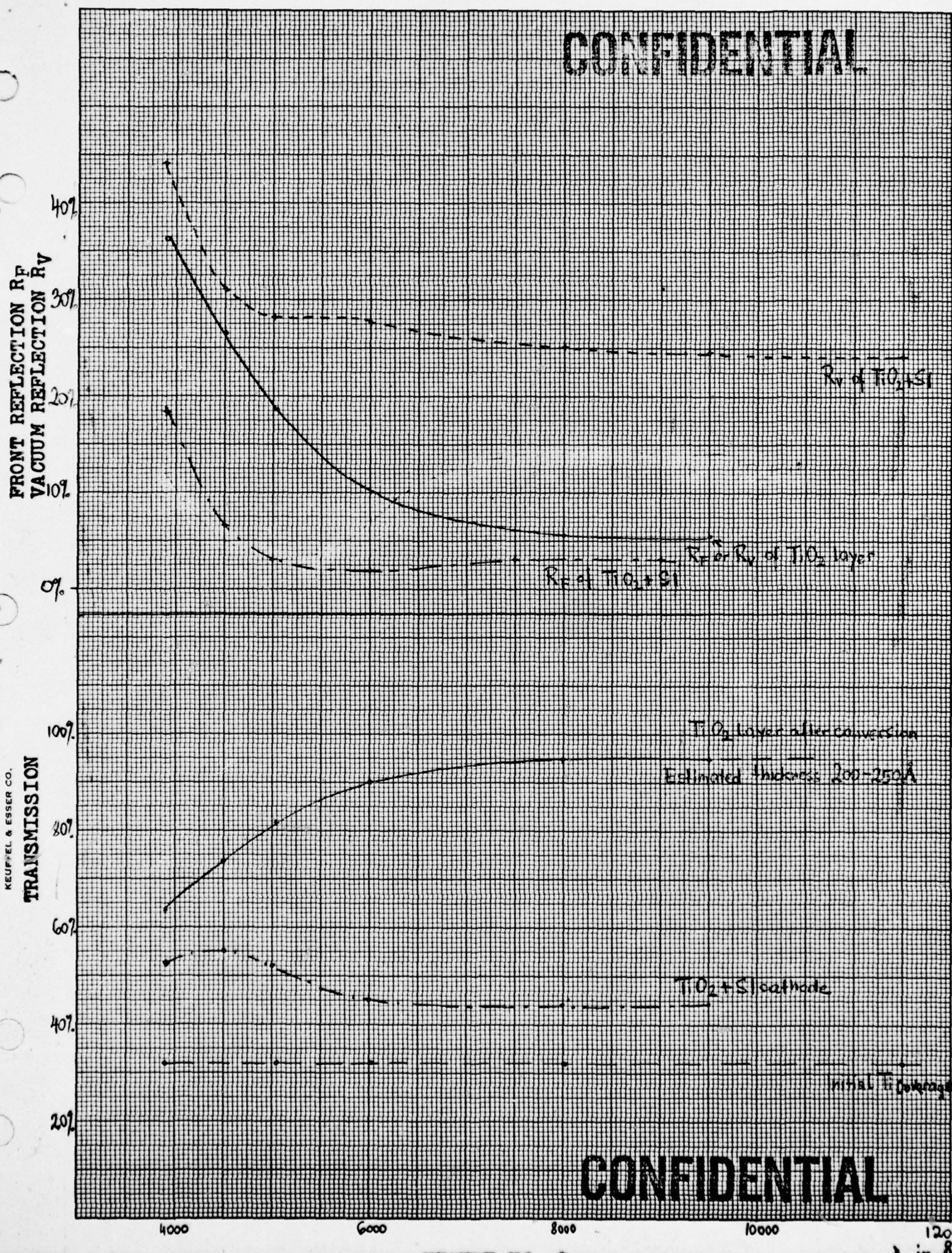

FIGURE NO. 3

TUBE NO. 0-308T

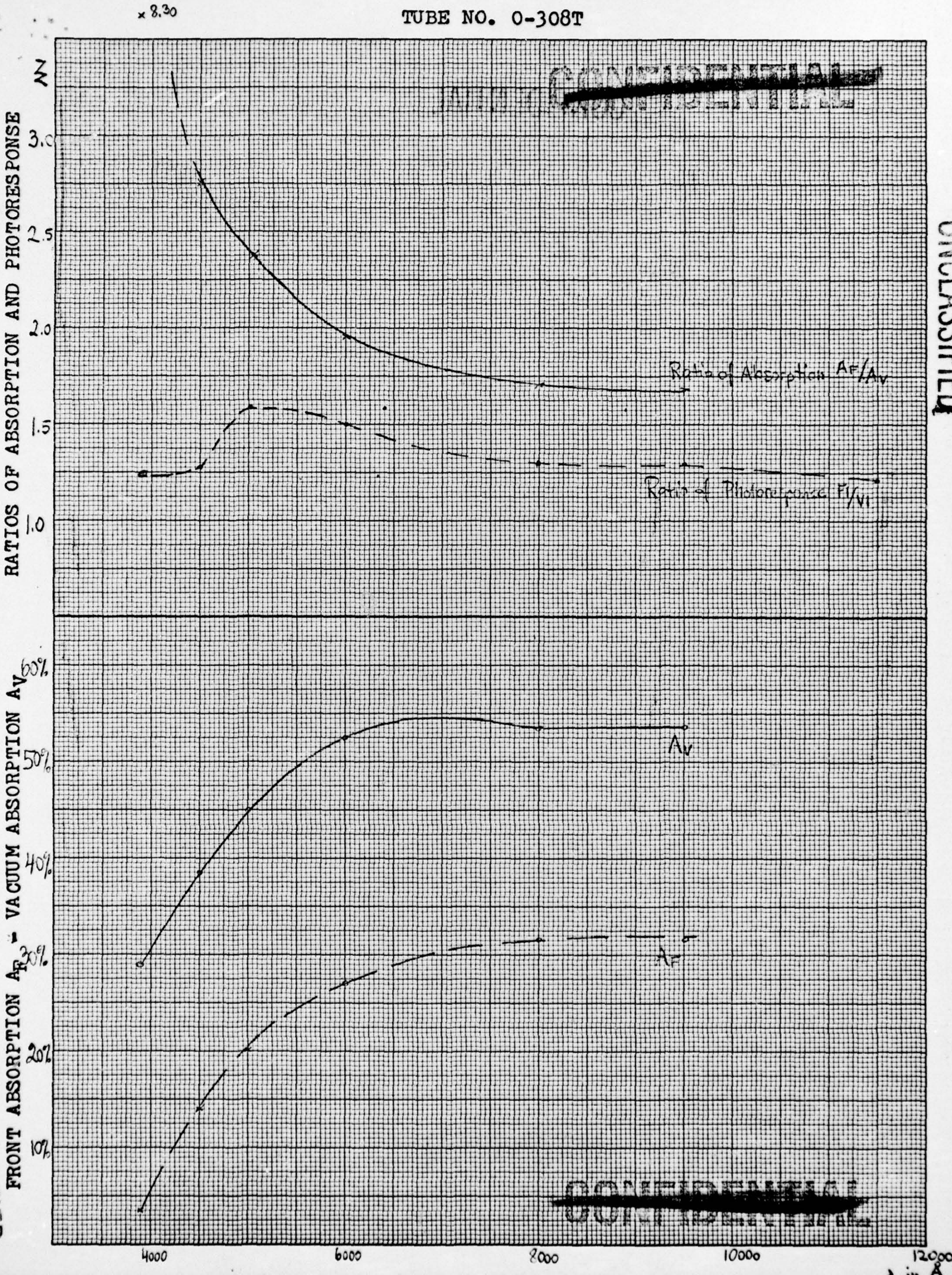

FIGURE NO. 4