WESTINGHOUSE
ELECTRIC CORPORATION

LAMP DIVISION

BLOOMFIELD, N. J.
Research Department

USA

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October 24, 1952

Sir K. S. Krishnan
National Physical Laboratory of India
New Delhi, India

Dear Sir:

Since writing to you on September 4 concerning your interesting article in the June issue of Proceedings of the Royal Society, I have obtained a copy of the article A. S. Bhatnagar wrote in 1944 on the same topic. It appears that Bhatnagar using the effusion method found that the work function for graphite increased with the heat treatment given and approached 4.8 ev. asymptotically. He said this effect seemed to be due to the progressive elimination of the impurities contaminating the emitting surface. H.F.Ivey reported the same effect in 1949 measuring the emission of a carbon filament by conventional means.

On page 155 of the paper written by S. C. Jain and yourself it is suggested that the adsorbed gases do not affect the saturation vapour pressure inside your chamber, and hence do not affect the work function. This observation seems to be contrary to that of Bhatnagar. It is wondered what difference existed in the two experimental arrangements to account for the difference in results.

A group of us in the Research Department intends to discuss your article in a laboratory meeting soon. For this reason I would like to request again that we be sent one or several reprints of your article, if available.

Thank you.

Respectfully,

R. G. Young

R. G. Young

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November 11, 1952

Dear Mr.Young,

Allow me to thank you for your letters of September 4 and October 24 and for the kind interest you have taken in the method of determining the thermionic constants from the rate of effusion of the electrons from a chamber of the substance. Regarding the various points raised by you I give below the relevant information that may help in the elucidation of these points.

(1) In the early measurements made on graphite by Dr.A.S.Bhatnagar by this method it appears now that most of the electrons collected by his Faraday cylinder were electrons emitted by the graphite surface adjoining the effusion hole, which surface was naturally at practically the same high temperature as the chamber. Hence the earlier measurements may be taken to refer practically to emission from the surface rather than to effusion through an aperture from a chamber. On the other hand in the present measurements by Mr.S.C.Jain and myself, the effusion hole is a small hole in a mica sheet, which comes in front of a slightly bigger hole in the graphite wall, so that ~~all~~ the electrons emitted by the graphite surface adjoining the hole are prevented from reaching the Faraday cylinder, and only the electrons effusing through the hole in the mica sheet can reach the Faraday cylinder

We have also studied thermionic emission from the surface of graphite with the present arrangement by removing the mica sheet and blocking the hole in the graphite wall with a suitable thin plug of the same material. The effective area of emission and the solid angle of electrons from the various parts of this area that could each the Faraday cylinder could not now be determined precisely. Even so it was found that the A coefficient was quite low, of the order of 10^{-2} to 10^{-3} amp $^{-2}$ deg $^{-2}$ as compared with 60 determined by the effusion method. Similarly the work function φ was about 3.7 e.v. as against 4.62 determined by the effusion method.

Any heating that is normally involved in making the thermionic measurements up to about 1600° K, did not increase much the value of either A or φ.

From these results it appears that the thermionic constants for a normal surface, i.e. one that has not been specially degassed, are much smaller than obtained from the effusion measurements, and that heating casually and for short periods to 1600° K, as is done in the course of the experiments, is quite insufficient for purposes of degassing of the surface. Prolonged heating at still higher temperatures will be necessary for proper degassing, and that was done in Dr.Bhatnagar's measurements.

2. Coming back to our measurements I may mention that the heating of the graphite tube is done by direct current from a low voltage generators. We had already studied in some detail the effect of changing the polarity of the heating current. We found that the saturation current extrapolated to zero applied voltage, corresponding to the effusion of electrons from the hole at any given temperature, remains practically unaltered by the reversal of polarity.

The total voltage drop over the whole length of the graphite tube would have been about 5 to 6 volts, and the drop between the ends of the electron gas chamber would be less than half of this. But we have not considered the question whether this voltage drop in any manner affects the rate of effusion. We shall take up this question for detailed study soon.

3. The question of a possible effect of the surface charges on the mica sheet in which effusion hole is punctured and also on the cylinder of mica sheet covering the inner walls of the extension of the graphite tube, has been giving us some concern, and we could not think of a suitable crucial test for deciding this point. But the following observation suggests that their effect if any on the determination of the thermionic constants is small. The observation is this. Without using the mica sheet a small hole in the graphite wall was made to serve as the effusion hole. The surface was an undegassed one,

and hence the surface emission was relatively small, even though its area was several times larger than that of the effusion hole so that practically all the electrons that reached the Faraday cylinder were those effusing from the hole. In the actual experiment connection was made for the small contribution from the electrons emitted by the graphite surface. The measurements were then repeated using the mica sheet, a hole punctured in the sheet, and backed by a slightly bigger hole in the graphite wall, serving now as the effective effusion hole. Both the methods gave the same values for A and φ

4. We have studied the effect of introducing bits of various metals into the chamber. As long as these bits are not too close to the effusion hole, there is no appreciable effect on thermionic emission. On the other hand with a thin foil of nickel placed just behind the effusion aperture, inside the chamber, there was a definite change in the thermionic emission. When a platinum foil was introduced between mica sheet and graphite aperture, the hole in the platinum foil being of intermediate size, the effusion current was again found to be affected.

5. We have not tried the effect of introducing preliminarily oxygen or other gases as suggested by you, to contaminate the surface.

6. We have recently extended the measurements to other metals by coating the inner surface of the graphite chamber completely with these metals, either by thermal deposition or by electrolytic deposition. The measurements for the first transition group of elements, from titanium to nickel, are in course of publication in the Proceedings of the Royal Society as Part II of the Paper and a preliminary note is in the course of publication in NATURE. I am enclosing a copy of the NATURE note herewith.

We have also recently tried coated graphite tubes of very mich larger cross section which permits using a correspondingly larger effusion hole, for studying the constants of copper, silver and other metals which have a low melting point; and some preliminary measurements

have been made. We shall send you the results in due course.

With kind regards,

Yours sincerely,

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xxxxx have been made. We shall send you the results in due course.

With kind regards,

Yours sincerely,