The phenomenon is not due to the oxidation of the antimony since it takes place in hydrogen and in vacuum.

One sample of bismuth showed the same phenomenon occurring at the same temperature. This was due to contamination of the bismuth. Roughly one part of antimony in 2,000 of bismuth is sufficient to show luminescence.

Details will appear in Journal Am. Opt. Soc.

NELA RESEARCH LABORATORIES,
CLEVELAND, OHIO,
December, 1921.

THE THERMIONIC WORK FUNCTION OF TUNGSTEN.

BY C. DAVISSON AND L. H. GERMER..

IN the derivation of Richardson's equation, $i = AT^{1/2}\epsilon^{-b/T}$, the constant b is related to the energy, Φe, required to liberate a single electron through the equation, $\Phi e = bk$, where k is Boltzmann's gas constant and e the electronic charge. Φ is referred to as the equivalent voltage of the work function.

The authors have made a direct calorimetric determination of Φ upon a filament of pure tungsten by the measurement of changes arising from the cooling effect of the emission. At the same time the b of Richardson's equation has been determined, and the calorimetric Φ has been compared with bk/e. With the exception of some work done on oxide-coated platinum filaments by W. Wilson[1] this is the first measurement of these two constants ever made upon the same filament.

The value of Φ has been computed from the relation,

$$\Phi = \frac{2EI}{E - I\dfrac{dE}{dI}} \cdot \frac{\Delta E}{i},$$

where ΔE is the change in voltage across the filament caused by the emission, i, while the heating current, I, is maintained constant. All essential measurements were made upon a Leeds and Northup potentiometer. After correcting for several spurious effects our final value is

$$\Phi = 4.91 \pm .05 \text{ volt.}$$

For the determination of b the temperatures of the filament must be accurately known. The calculation of these temperatures has been based on the temperature characteristics of tungsten published by Langmuir and by Worthing and Forsythe. Langmuir's data lead to a value of b equal to 5.646×10^4 degrees, while those of Worthing and Forsythe lead to the value 5.541×10^4 degrees. The relation between resistivity and power radiated per unit area for the filament used in the present experiment was found to be accurately consistent with Worthing and Forsythe's data. Furthermore, the temperature scale of Worthing and Forsythe is probably more accurate than the scale of

---

[1] Nat. Acad. of Sci. Proc., 3, p. 426 (1917).

Langmuir. From both of these considerations it is believed that the latter value of b is the more reliable.

The derivation of Richardson's equation, with the assumptions involved, requires that the values of Φ and of bk/e for a given material be identical. The values of b given above correspond to values of bk/e that are, respectively, 0.8 per cent. and 2.7 per cent. lower than the calorimetrically determined Φ. Since the value of b, corresponding to the greater of these discrepancies is regarded as the more reliable, a real, though small, difference between the constants is indicated. There is some question, however, as to what probable error should be assigned to the values of b. For this reason we do not feel that a difference between Φ and bk/e can be regarded as definitely established.

Research Laboratories of the
American Telephone and Telegraph Company
and the Western Electric Company, Inc.

A Spectroscopic Method for Determining the Effective Temperature of Absorbing and Emitting Molecules.

By Raymond T. Birge.

In a preliminary investigation[1] of the distribution of intensity in typical band series, as affected by temperature, it was found that Kemble's formula for the statistical distribution of angular velocities did not exactly represent the intensity distribution. This is to be expected, since the intensity, on the quantum theory of band spectra,[2] should be given by $I = (E - E')B_m{}'^m(a_m)$. If this expression refers to absorption spectra, then, labeling the missing line $m = 0$, the value of m for any line refers to the number of quanta of angular momentum in the initial state.[3] The third factor, $a_m{}'$ then gives the distribution of angular momentum, and if "J" is a constant, the distribution of angular velocities as well. On this assumption Kemble's formula is the theoretical expression for a_m.

Now $E - E' (= h\nu)$ varies only slightly throughout a band. $B_m{}'^m$, from the author's curves of intensity distribution, varies slowly with m, if m is not too small. The moment of inertia of the molecule in its initial condition (J) can be obtained from the coefficient of the first power term of the Deslandres' formula for the series considered.[4] The deviations of the CN series from a parabolic law show that J is not constant, but that it is approximately so.

The value of m corresponding to maximum intensity, in Kemble's formula, is

$$m_m = \frac{2\pi}{h}\sqrt{kJT},$$

where k is the gas constant per molecule. This connects m with the absolute

---

[1] Phys. Rev., 18, 319, 1921.

[2] Heurlinger, Zeit. f. Physik, 1, 82, 1920.

[3] Kratzer, Zeit. f. Physik, 3, 289, 1920.

[4] See Sommerfeld's Atombau, 2d edition, p. 555.