Temperature Characteristics of Naphthalene-Anthracene Mixtures

S. H. Liebson and R. T. Farrar
Electricity Division, Naval Research Laboratory, Washington, D. C.
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VARIATION of the light output of organic scintillators under gamma-excitation as a function of temperature have recently been reported.[1,2] In order to clarify the energy transfer mechanism, a series of phosphors was prepared containing known amounts of anthracene in naphthalene. It is believed that, for these mixtures, energy is absorbed by the naphthalene and transferred by a process akin to sensitized fluorescence[3] to the anthracene molecules which, in turn, emit. Accordingly, measurements were made to a higher degree of accuracy than previously reported,[2] and are shown in Fig. 1. A Wratten Type IIA filter was used to obtain readings of the light output corresponding to the anthracene emission spectra, designated as anthracene light in Fig. 1, and no filter was used when measuring the total emitted light output. The percentage of anthracene light output for the mixtures was in agreement with Bowen,[4] the relative placement of curves in the figure being arbitrary, to provide a ready comparison. For all measurements with the filter, the naphthalene light through the filter was negligible compared with the anthracene light. The melting point of the mixtures was approximately the same, about 353°C. It may be seen that as the percentage of anthracene is reduced, the temperature characteristics assume a greater slope, similar to the characteristics of pure naphthalene. On the other hand, as the percentage of anthracene is increased the characteristics become less temperature dependent and, as can be seen, have a smaller slope at the lower temperatures than does anthracene itself. This was further verified with mixtures containing greater percentages of anthracene. The measurements suggest that the temperature characteristics for these materials are determined by the matrix (naphthalene) crystal, the larger percentages of anthracene corresponding to shorter paths for energy transfer and less thermal quenching.

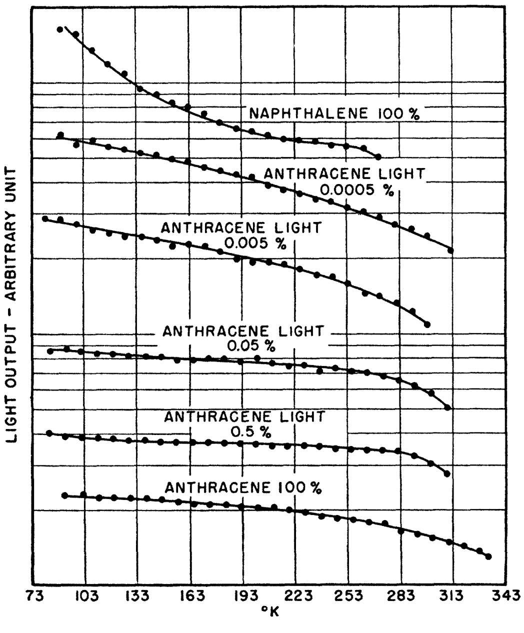

FIG. 1. Temperature characteristics of naphthalene-anthracene mixtures.

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[2] S. H. Liebson and J. W. Keller, Phys. Rev. **78**, 385 (1950).
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Ambipolar Diffusion in Neon

Manfred A. Biondi
Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania
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THE results of measurements of the removal of electrons from ionized gases have been presented in two previous papers.[1,2] In particular, studies of ambipolar diffusion in helium and of electron-ion recombination in helium, neon, and several other gases were described. In neon the recombination loss of electrons exceeded the diffusion loss over the range of gas pressures and electron densities which the apparatus was capable of studying. Thus, no reliable measurements of ambipolar diffusion in neon were obtained. In the present experiment an improved, more sensitive, version of the apparatus has been used to study ambipolar diffusion in neon in a region where recombination losses are small.

The method involves the use of microwave techniques to observe the decay of electron density from an initially ionized gas. Free electrons in a microwave cavity will, under the proper conditions, perturb the cavity's resonant frequency in proportion to their concentration. By measuring the change of resonant frequency of a cavity containing a discharge as a function of the time after the maintaining field is removed, the decay of electron density is determined. For the case in which electrons are removed by diffusion to the walls and, to a lesser extent, by recombination with positive ions, the electron density decreases according to the following equation

$$n/(1+\alpha\tau n)=[n_0/(1+\alpha\tau n_0)]\exp(-t/\tau)$$

[see Eqs. (16) and (17) of reference 1], where n is the average electron density, α is the recombination coefficient, and τ is the mean decay time due to diffusion. The recombination correction is minimized by making $(\alpha\tau n)\ll 1$, which requires measurements at low electron densities and at low pressures, since τ decreases with decreasing pressure. The present apparatus achieves an increased frequency stability and higher breakdown fields which permit measurements to be made at electron densities ten times smaller and gas pressures three times lower than those attained by the previous apparatus.

To assure the purity of the gas samples under study, a vacuum system which could be pumped to 4×10^{-9} mm Hg was used. After bake-out at 450°C, the system had a rate of rise of gas pressure of less than 10^{-8} mm/min., when isolated from both the pumps and the pumping action of the ion gauge. The gas samples used were Air Reduction Company's spectroscopically pure neon.

Figure 1 shows a typical experimental curve. The upper curve shows the decay of electron density while the lower curve is ob-

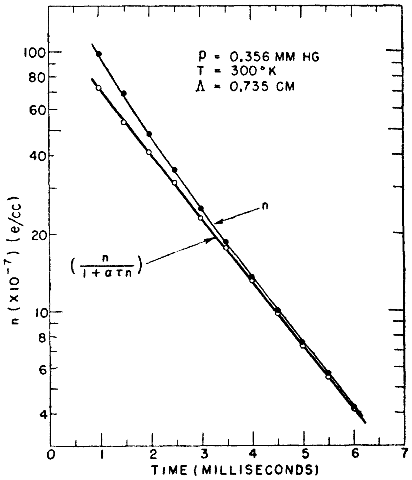

FIG. 1. Loss of electrons in neon by ambipolar diffusion and recombination.

tained using the value $\alpha=2.0\times10^{-7}$ cc/ion-sec. for neon given in reference 2. The slope of the curve yields a value, $\tau=1.75$ milliseconds for the diffusion decay time. The diffusion of the electrons takes place in a quartz cylinder with an inside radius, $R=2.22$ cm and inside height, $H=3.82$ cm. For this geometry, the characteristic diffusion length, Λ, as determined by the equation in Fig. 6 of reference 1 is equal to 0.735 cm.

The ambipolar diffusion coefficient, D_a, is given by Eq. (9) of reference 1.

$$D_a=\Lambda^2/\tau=309\ \text{cm}^2/\text{sec.}\ (p=0.356\ \text{mm Hg}).$$

Data of the type shown in Fig. 1 were taken over the pressure range 0.27 to 1.10 mm Hg. According to kinetic theory, the product D_ap, where p is the gas pressure, should be constant at constant temperature. The experimental results are shown in Fig. 2. The value $D_ap=115\pm10$ (cm²/sec.) – (mm Hg) is obtained at $T=300°$K, which agrees with unpublished estimates obtained with the previous apparatus. With the knowledge of D_ap, one may calculate the positive ion mobility from Eqs. (18) and (19) of reference 1. The extrapolated value for 760 mm Hg and 20°C is 2.9 cm/sec. per volt/cm as compared to Munson and Tyndall's value[3] of 6.23. As in the analogous case of helium,[4] a possible explanation of the discrepancy is that the ions observed by Munson and Tyndall were molecular; i.e., Ne_2^+. Rough estimates of the rate of conversion of atomic to molecular ions by three-body collisions with normal atoms indicate that, at the pressures used in our experiment, the ions are predominantly atomic. Unfortunately, the lack of pressure data in reference 4 prevents the drawing of conclusions as to the nature of the ions observed.

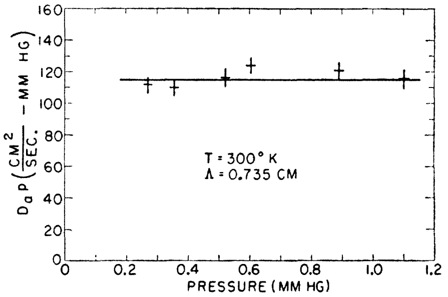

FIG. 2. Pressure dependence of the ambipolar diffusion coefficient for neon.

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A New Method for Measuring Film Transport in Liquid He II*

H. A. Boorse† and J. G. Dash**
Columbia University, New York, New York

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FILM transport rates of liquid He II have heretofore been measured mainly by a visual method; i.e., by observation of the changes in height of liquid helium columns in glass vessels.[1,2] The optical technique requires the incidence of external radiation upon the helium film, and is limited to studies of transport rates over transparent dielectric surfaces.

In the present method the dielectric property of liquid helium is employed to indicate the total amount of liquid helium between the walls of a cylindrical capacitor. Variations in height of the liquid helium contained within the annular space are observed as changes in capacitance. The capacitor, serving in this way as a depth gauge, is placed within a container of the material over whose surface the transport rate is to be measured. The container and capacitor assembly is enclosed within a copper radiation shield provided with small holes to allow the passage of liquid and vapor. Electrical connections are brought down through the liquid helium bath to minimize thermal conduction to the container.

The capacitor is connected in parallel with the tuned circuit of a radiofrequency oscillator, and changes in capacitance are observed by means of frequency changes of the oscillator. The oscillator frequency has been measured by beating the signal against the output of a heterodyne frequency meter, and reading the frequency of the meter in the condition of zero beat note. An automatic frequency recording circuit has also been used. In this case, the frequency meter is not tuned during the course of a transport rate measurement. The audio beat signal is amplified and fed to a voltage divider consisting of a large resistance in series with an air core inductance. The voltage across the inductance, proportional to frequency, is rectified and fed to a recording potentiometer.

The depth gauge has been calibrated with a cathetometer in the He II region, and shows a satisfactorily linear frequency *vs.* height dependence.

As a check on the method, transport rates in glass containers have been measured in this way, and found to compare very closely with the results of Daunt and Mendelssohn.

Preliminary measurements of creep over copper indicate rates significantly higher than those over glass. Further studies over various materials are now in progress.

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† Barnard College, Columbia University.
** AEC Predoctoral Fellow.
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A Precision Determination of the Half-Life of Radium C′

Guy von Dardel
Research Institute for Defense, Stockholm, Sweden

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THE widespread use of RaC′ to check the proper functioning of delayed coincidence and variable resolution coincidence equipment made a redetermination of the half-life with high accuracy desirable.

The apparatus used was a 20-channel time analyzer, originally intended for neutron time-of-flight measurements, and similar in principle to other time-of-flight spectrometers already described.[1,2] For the measurement, a gated amplifier was inserted between the time analyzer proper and the crystal oscillator which produced pulses to switch the analyzer. A β-ray pulse from a set of 6 G-M tubes in parallel will open the amplifier, which stays open for a sequence of 20 pulses. In this way each β-pulse renders all the channels in turn operative once. The six β-ray tubes surround a thin-walled proportional counter, in whose sensitive volume a small thin-walled glass capillary containing radon is mounted. A β-pulse from RaC will be registered by the G-M tubes and is followed by an α-particle from RaC′, which is registered by the proportional counter. The time-distribution of the α-pulses relative to the β-pulses is analyzed by the time analyzer. The α-pulses are first fed to a special prearranging circuit where they are replaced by standard pulses derived from the oscillator. The position of these pulses has been chosen such that they always fall definitely in one channel and not on the border between two channels. These standard pulses are then fed to the time analyzer proper. With this arrangement the channels will be entirely equivalent and will not depend on varying tube characteristics