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A SIMPLE THERMISTOR BRIDGE FOR ABSORBED RADIATION MEASUREMENT

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GENERAL

An investigation currently under way of the quantum efficiency of photolysis of sodium azide necessitated accurate measurement of absorbed radiation in the ultraviolet region of the spectrum. Since our small grating monochromotor coupled with a carbon arc source delivered less than a hundred microwatts at the output slit, and since only a fraction of this energy may be absorbed by the sample, any radiation detector used must be very sensitive. Simple thermocouples were out of the question, and thermopiles which could double as sample-holders were very inconvenient to manufacture, besides being very fragile.

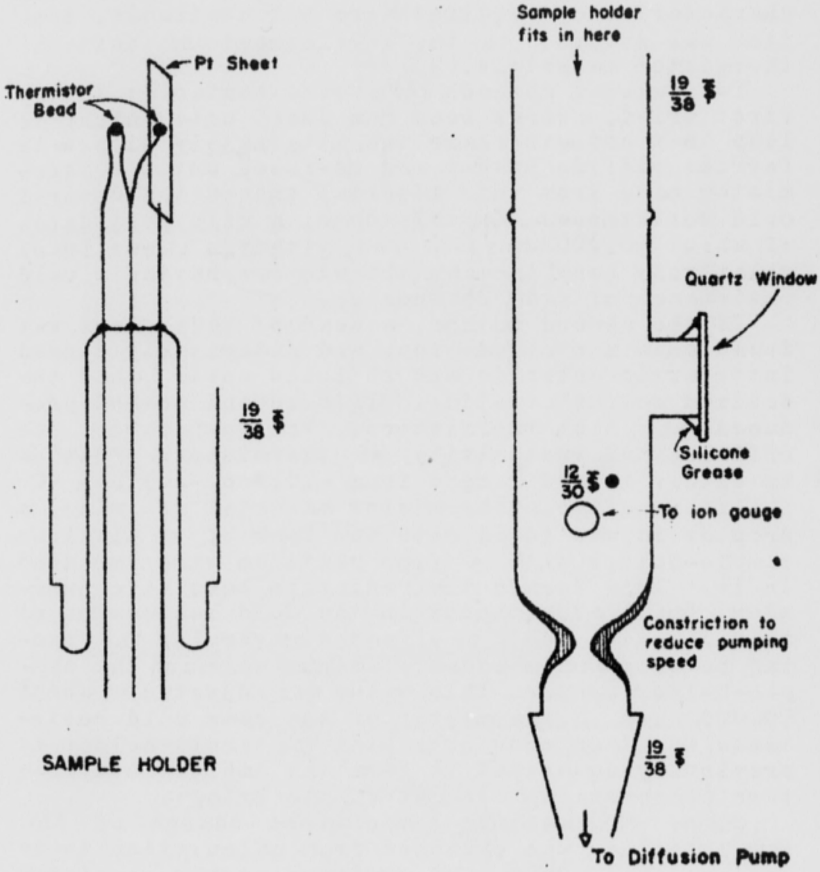
For these reasons some sort of bolometric technique was indicated. The characteristics of thermistors made them admirably suited for this sort of use.(1,2)

DESIGN AND PERFORMANCE OF THE PHOTOLYSIS CELL

Since the measurement of the rate of photolysis of the inorganic azides was to be accomplished by measuring the rate of evolution of nitrogen by means of the change in pressure in a continuously pumped evacuated enclosure, the unit was constructed of glass with a cemented quartz window through which the monochromator beam was to pass. The arrangement is shown in Figure 1.

The sample-holder consisted of a piece of 1-mil platinum foil about 4 x 20 mm spot - welded to a tungsten lead sealed into a 19/38 standard taper. Two other tungsten leads which serve as the other two leads of the thermistor bridge were also sealed into the taper as shown in the drawing.

The platinum sample-holder served as one lead of the sensitive bridge thermistor. The other lead of the sample-holder thermistor was common to the balancing thermistor which was connected between



SAMPLE HOLDER

PHOTOLYSIS CELL

Figure 1.

the other two tungsten leads sealed into the taper. The second thermistor was positioned so that it was shadowed from the incident light by the sample-holder and thus did not change temperature during irradiation (see Figure 2).

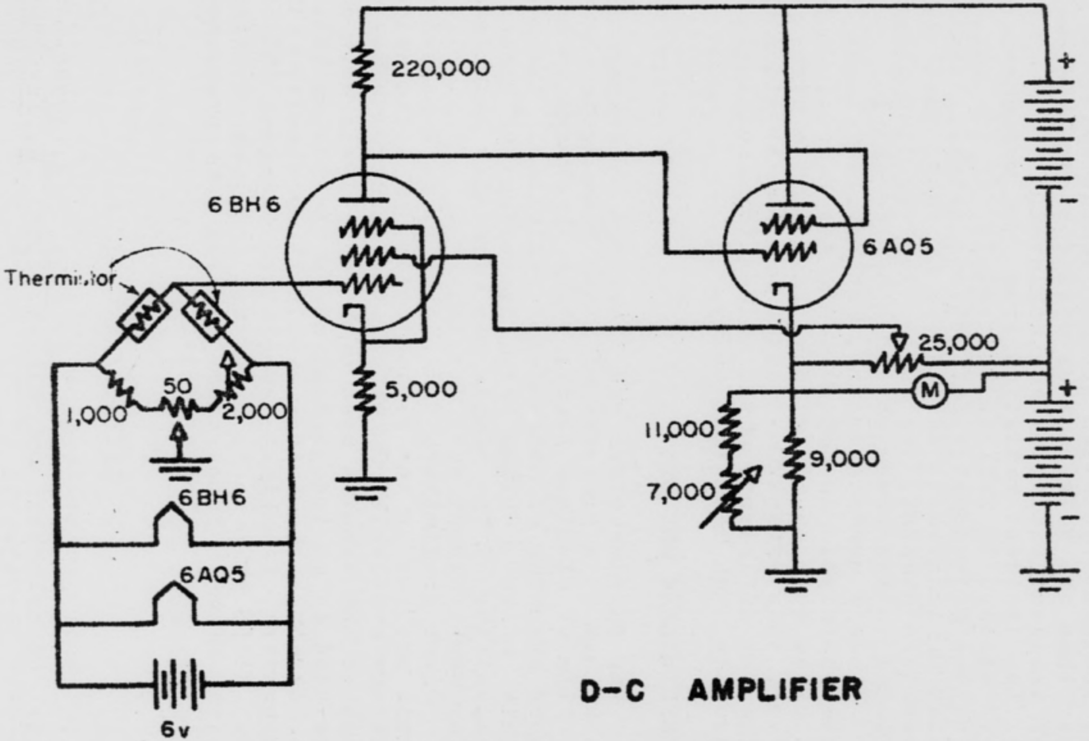
Because thermistors of the special physical characteristics required were not available, some time was devoted to the development of suitable thermistor materials.(3)

Two general methods were found suitable: In the first tried, a borax bead was fused onto a nichrome loop in a hot gas flame and alternately dipped in ferrous sulfide powder and re-fused until a thermistor made from this material showed the desired cold resistance. In this case, a cold resistance of about 50,000 ohms was used, although it was found relatively easy to make thermistors having a cold resistance of from 25 ohms up.

In the second method, a bead of soft glass was fused onto a nichrome loop and alternately dipped into ferric chloride and re-fused until it had the desired characteristics. This second method produced the best thermistors. The temperature coefficient of resistivity of thermistors produced by either method ranged from -.02 to -.03 per °C.

After suitable thermistor material was made, a drop of it was fused onto the back of a platinum sample-holder with a fine platinum wire imbedded in it. This formed the radiation sensitive junction. Small adjustments in the cold resistance of this junction could be effected by varying the spacing between the imbedded platinum wire and the sample-holder proper. This value was adjusted to about 50,000 ohms. A thermistor of the same cold resistance was then mounted behind the sample-holder as previously described to form the ambient temperature compensating element of the bridge.

Since the maximum temperature change of the sample-holder was expected from calculation to be no more than .05°C, and since no highly sensitive galvanometer was available for use as a null instrument, it was anticipated that the bridge output would have to be amplified to be useable. A simple d.c. amplifier was therefore constructed. A schematic diagram of the instrument is shown in Figure 2. It had a voltage gain of about 16, and an output impedance of about 200 ohms.



D-C AMPLIFIER

Figure 2.

Using a helipot as the two external arms of the bridge, this amplifier and a 100 microampere, 100 millivolt D'Arsonval galvanometer, a sensitivity to incident radiation upon the sample-holder of better than one galvanometer division per microwatt of incident radiation was achieved.

The incident radiation from the monochromator was allowed to fall on the sample for one minute, and the galvanometer deflections noted. Assuming that the instrument was linear for these small temperature changes, the deflection was then proportional to the power absorbed by the sample.

Since a certain amount of energy is released by the photolytic decomposition of the sample, the indicated quantum efficiency should be too high; however, this effect is expected to be small since the quantum efficiency of the azides for photolysis is usually much less than unity.

PRELIMINARY RESULTS

The sample-holder was blackened by evaporating aluminum at a pressure of about 5 mm Hg to obtain a film of aluminum black, which is known to be a good absorber of ultraviolet radiation. Assuming this to be a black body, the effective spectral emissivity of the sample may be readily calculated for any incident wave length.

Since preliminary data taken by F. Koperski of this project on the reflectivity of solid azides is now available, the calculated spectral emissivity of the samples used in the photolysis work can be used as an independent check on this method.

Although the bridge should theoretically be independent of ambient temperature changes, this is not found to be so in practice, and lack of effective ambient temperature control has prevented, so far, the taking of data.

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