ratus can be made small and compact for mounting on individual flasks in an incubator or on a shaker for adding acid, alkali, or other reagents during incubation of bacterial cultures. Only light leads are needed to service the units and, if several units are to be used, as for replicate flasks, addition will be identical in all flasks if the electrodes are wired in series. (vii) There are no moving parts which need lubrication.

ROBERT J. HECKLY

Naval Biological Laboratory,
School of Public Health,
University of California, Berkeley

Reference

1. This work was supported by a contract between the University of California and the Office of Naval Research. The opinions contained in this report are not to be construed as reflecting the views of the Navy Department or the Naval Service at large.

23 September 1957

Radiation-Induced Reactions of Potassium Bromide with Air

Pressed discs of potassium bromide (*1*) showed selective absorption in the 4000 to 650-K (*2*) infrared region after irradiation with 1.5-Mev electrons in the presence of air, oxygen, nitrogen, helium, or carbon dioxide. The samples received about 10^{21} ev/g at a dose-rate of about 10^{19} ev/min. In all experiments the potassium bromide "windows" became less transparent as devitrification, with consequent scattering, proceeded. In addition, there was decreased absorbance of the only bands initially present—those centered at 3430 and 1630 K, which were due to adsorbed water or to occluded water retained by the potassium bromide despite careful desiccation, or to both. These results were produced also by heating the discs several hundred degrees. The rate of devitrification decreased as the rate of heating was decreased. The "windows" were restored to the glass-clear condition by repressing. While loss of water and devitrification were the only effects noted for experiments conducted in the three gases last named, in oxygen and in air, radiation-induced chemical reactions occurred.

When a potassium bromide "window" was irradiated in ordinary laboratory air, new bands appeared in the infrared absorption spectrum, with maxima at 1360, 1260, 830, 1440, 1765, and 2340 K, in order of decreasing magnitude. Part of the pattern was unstable and shifted rapidly: peaks at 1385 and 825 K appeared and grew at the expense of the original 1360 and 830 maxima. The rate of shift was greater in humid air. Since the new peaks were characteristic of potassium nitrate dispersed in potassium bromide and in Nujol (*3*), it was interesting to speculate on the precursor. The immediate possibilities were: (i) that scattered "isolated" nitrate ions on the surface of the disc migrated to form potassium nitrate crystals; (ii) that a metastable crystalline phase of potassium nitrate was initially formed on the surface under the influence of the crystalline surface forces of the potassium bromide lattice and subsequently recrystallized. The latter possibility appeared to be the more likely since it was found (*4*) that isotropic, triangular microcrystals of high melting point, which spontaneously changed to the normal anisotropic form of potassium nitrate, were produced on the surface of potassium bromide crystals irradiated in air with polonium alpha rays.

Although nitrogen dioxide alone (the other nitrogen oxides were inert) reacted with potassium bromide in a manner similar to that of irradiated air, the 100-fold greater rate of reaction at room temperature (20-fold greater at 70°C) in the latter case indicated that energy-rich surface dislocations or excited gaseous intermediates were involved in the reaction. At constant dose-rate, it was found that the production of infrared-absorbing species decreased as the contact time of the irradiated air with the salt diminished. Coupled with the fact that discs irradiated in helium at room temperature did not undergo appreciable postirradiation reaction with air, the view that excited gaseous intermediates were involved gained plausibility.

Of the absorption bands listed above, those centered at 1385, 825, and 1765 K could be identified as belonging to potassium nitrate; that centered at 2340 K, which appeared only in windows prepared from chemically pure potassium bromide and not in windows made from Harshaw optical grade potassium bromide, was undoubtedly produced by carbon dioxide arising from the radiolysis of organic impurities; that centered at 1260 K, on the basis of other work (*5*) could be tentatively identified as belonging to potassium nitrite produced by radiolysis of potassium nitrate. Although potassium carbonate has been reported (*3*) to have a very strong absorption band at 1450 K, the 1440 peak here noted did not appear when potassium bromide was irradiated in an atmosphere of carbon dioxide; it did appear when the irradiations were conducted in atmospheres of oxygen or air. Possibly KNO, which has been reported (*6*) to absorb at 1445 K, or KOBr was the absorbing species.

The irradiation of a disc in an atmosphere of dry oxygen produced, in addition to the aforementioned peak at 1440 K, an infrared absorption band with a maximum at 790 K, which was found to be the principal absorption region of potassium bromate when it was dispersed in potassium bromide or Nujol (*3*). This absorption did not appear when the irradiations were conducted in dry or moist air.

A. RUSSELL JONES

Chemistry Division,
Oak Ridge National Laboratory,
Oak Ridge, Tennessee

References and Notes

1. M. M. Stimson and M. I. O'Donell, *J. Am. Chem. Soc.* 74, 1805 (1952); U. Schiedt and H. Reinwein, *Z. Naturforsch.* 7b, 270 (1952).
2. The convention "kayser" (symbol K) as a name for the reciprocal centimeter unit of wave number has been used: Report of the Joint Commission for Spectroscopy, Rome, Sept. 1952, *J. Opt. Soc. Am.* 43, 410 (1953).
3. F. A. Miller and C. H. Wilkins, *Anal. Chem.* 24, 1253 (1952).
4. R. Blöch, *Österr. Akad. Wiss. Math.-naturw. Kl. Sitzber. Abt. IIa,* 162, 99 (1953); L. Wieninger and N. Adler, *Acta Phys. Austriaca* 4, 81 (1950).
5. A description of this work is in preparation.
6. D. J. Millen, C. Polydoropoulos, D. Watson, *Proc. Chem. Soc.* 1957, 18 (1957).

30 September 1957

Mechanism of Immune Hemolysis: Recognition of Two Steps in the Conversion of $EAC'_{1,4,2}$ to E*

In recent publications from this laboratory (*1*) it has been established that the lysis of sheep erythrocytes (E) by Forssman antibody (A) and guinea pig complement (C′) is the result of a series of successive reaction steps, as follows:

$$E + A \longrightarrow EA \quad (1)$$

$$EA + C'_{1,4} \xrightarrow{Ca^{++}} EAC'_{1,4} \quad (2)$$

$$EAC'_{1,4} + C'_{2} \xrightarrow{Mg^{++}} EAC'_{1,4,2} \quad (3)$$

$$EAC'_{1,4,2} + C'_{3} \longrightarrow E^{*} \quad (4)$$

$$\hookrightarrow \text{inactive product} \quad (4a)$$

$$E^{*} \longrightarrow \text{ghost} + \text{hemoglobin} \quad (5)$$

In this scheme C'_1, C'_2, C'_3, and C'_4 represent the four recognized components of complement (*2*). Ca^{++} and Mg^{++} have been found to function in steps 2 and 3, respectively. E* refers to an activated or damaged cell which eventually hemolyzes without further interaction with complement from the fluid phase. The conversion of $EAC'_{1,4,2}$ to E* by C'_3 has been found to proceed without requirement of a divalent cation such as Ca^{++} or Mg^{++}, and hence can take place in the presence of $0.01M$ ethylenediamine tetraacetate (EDTA). As a source of C'_3, either C'_y (guinea pig serum lacking C'_1 and C'_4) or whole guinea pig serum in the presence of $0.01M$ EDTA has been used. The identification of C'_3 as the component which interacts with $EAC'_{1,4,2}$ to form E* (*3*) is based on the observation that $EAC'_{1,4,2}$ can be hemolyzed by R_1, R_2, or R_4, but not by R_3 (*4*).