Chemiluminescence-Oxidation of Pyrogallic Acid

Lyle K. Ward and C. W. Bennett

Western Illinois State Teachers College, Macomb, Illinois

The subject of chemiluminescence has attracted much attention during the last few years. Our interest in this matter was started by the paper given by Dr. Audrieth[1] a year ago on the oxidation of 3-amino phthalyl hydrazide.[2] This material yields a brilliant bluish green light upon oxidation with H_2O_2 and $K_3Fe(CN)_6$, but no appreciable heat. In a photochemical process such as photosynthesis light is used to cause a certain chemical reaction, or the process may be said to absorb light. If there are processes in which light is absorbed there should be those where light is evolved. Many of these yield both light and heat as in ordinary combustion. Those yielding light without heat are not so common. This process of yielding cold light is called chemiluminescence. This phenomenon is related to, but different from, fluorescence or phosphorescence. In fluorescence light of a certain wave length, usually ultra-violet, is absorbed by the activated material and emits light, usually visible, of a different wave length. Phosphorescence seems to differ only in that it persists after the source of light is removed. Chemiluminescence is the emission of light directly from a chemical reaction without any outside source of radiation.

A review of the literature in Taylor's Physical Chemistry[3] and a recent number of the Journal of Chemical Education[4] shows that several substances when oxidized give varying degrees of light of different wave lengths. These include the oxidation of siloxene, an unsaturated silicon hydroxide, the oxidation of safranin by means of ozone, oxidation of phosphorus (the best known example), and the one we are going to attempt to show, the oxidation of pyrogallic acid[5], or 1, 2, 3, benzene-triol, $(C_6H_3(OH)_3)$.

A mixture of 50 cc. of a 10% aqueous solution of pyrogallic acid, 35 cc. of 40% formaldehyde and 50 cc. of 40% KOH is placed in a separatory funnel and concentrated hydrogen peroxide in another funnel. These are allowed to drip very slowly into a spiral condenser. In a darkened room the brilliant red glow is very striking. We have found that by using equal parts of saturated $K_3Fe(CN)_6$ with the peroxide the action seems to be increased.

It is noteworthy that this oxidation must be carried out in alkaline solution. This seems to be the general rule. The mechanism of chemiluminescence is not understood nor is it known, so far as we can determine, what products are formed in most cases.

BIBLIOGRAPHY

1. Sveda and Audrieth, Trans. Ill. St. Acad. Sci. *29*, 106 (1936).
2. Huntress, Stanley, and Parker, J., Chem. Education *11*, 142 (1934).
3. Taylor, Treatise on Physical Chemistry, D. Van Nostrand Co., Inc., New York, 2nd Ed. (1932), p. 1511.
4. Abstract, J. Chem. Education *13*, 497 (1936).
   Ayres, Sch. Sci. Rev. *17*, 615 (1936).
5. Loc. cit.