Polymerization by Electric Discharge

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In the course of the study on the paper chromatography of poly ethylene oxide[1], we

found that the surface of the liquid polymer was covered by a membrane with the action of the electric discharge by "Tesla coil", the vacuum tester, when polymer was treated in vacuum. In order to ascertain the accelerating effect of the discharge on polymerization, anticipated from this phenomenon, we preliminarily examined the action of the discharge on some polymers and monomers of different type.

(1) **Polyethylene Oxide.** "Carbowax 4,000" was put in a glass ampule, evacuated continually, melted at 60°C., and exposed to the discharge for 10 minutes. With the action of the discharge the surface of the sample was covered with a colorless membrane, which was insoluble and remained fibrous in hot water. The reacted part amounted to about 1%. A colorless, insoluble and fibrous form of the substance indicates presumably that the polymer molecules were awakened to further polymerization in linear structure by the action of the discharge. For a comparison other samples were kept for 10 minutes at 60°C. and 200°C. in a vacuum, but no change was observed and the samples were dissolved completely in hot water.

(2) **Styrene.** Styrene, distilled in a nitrogen stream, was distilled into a glass ampule in vacuum, sealed, placed in water of 11°C., and exposed to the discharge for 30 minutes. As soon as the discharge began a white cloud was produced in the whole space of the gas phase and settled down slowly. The liquid phase became light yellow. The average molecular weight of 15,000 was obtained from the viscosity measurement of a benzene solution of purified colorless polymer, the value of K_m being taken as 1.1. The amount of reaction was about 1%. The light yellow substance, which was produced under the action of the discharge at dry ice temperature for 1 hour, can not be dissolved in benzene.

(3) **Glycine.** The discharge was showered on the crystalline glycine at 13°C., and on the sublimated stream of glycine at 160°C., and on the cold 10% aqueous solution of glycine at 0°C., inan evacuated ampule in all cases. Only in the last case a dust-like colorless substance appeared. In all cases, however, the small amounts of the insoluble colorless substances were obtained, when the samples were dissolved in water. Glycine was detected by paper chromatography of the insoluble product in the first case, after a washing by hot water and hydrolysis by hydrochloric acid. This would suggest that the product was some sort of polymer of glycine.

These effects would be caused by radicals, or ions, or radicalions, produced by the discharge.

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1) S. Kume, T. Yamamoto, K. Otozai, and S. Fukushima, This Bulletin **26**, 93 (1953).