SHORT COMMUNICATIONS

The Effect of Magnetic Field on the Radiation-induced Polymerization of Formaldehyde in the Solid State at a Low Temperature

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The radiation-induced solid state polymerization of formaldehyde has been reported by several workers.[1,2] In this paper, the effect of magnetic field on this radiation-induced polymerization of formaldehyde in the solid state will be reported.

The experimental apparatus is shown in Fig. 1. The apparatus consists of a pair of electromagnets, a ^{137}Cs γ-irradiation source, and shieldings, as is shown in the figure. The irradiation space is covered by a thick lead wall on the top, while a pair of electromagnets serve as side walls, the maximum magnetic field of which is 6×10^3 gauss. A Dewar vessel is inserted from the upper side into a hole in this lead shield, as is shown in Fig. 1-a. The radiation source is ^{137}Cs of 40 curies, and the structure of the capsule of the source is as shown in Fig. 1-c. The source is located inside the lead container which is installed at the bottom of the electromagnet. The source can be moved from the safe position (inside the container) up to the irradiation space by remote control.

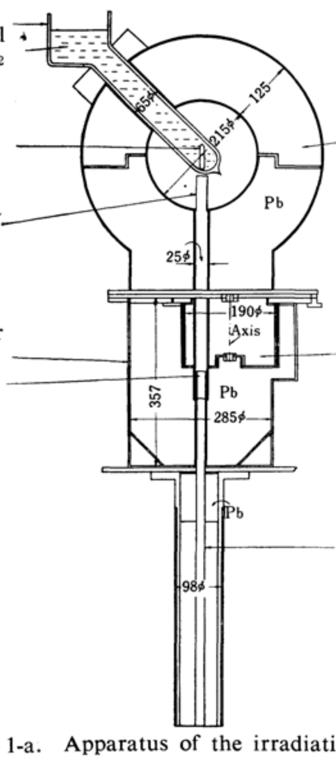

Fig. 1-a. Apparatus of the irradiation.

1) C. Chachaty, M. Magat and L. Terminassan, *J. Polymer Sci.*, **48**, 139 (1960).
2) Y. Tsuda, ibid., **49**, 369 (1960).

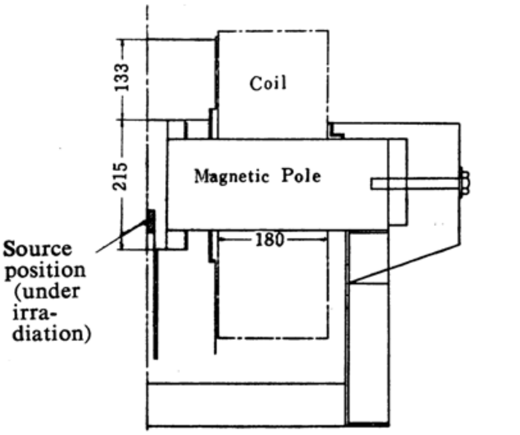

Fig. 1-b. A side view of the electromagnet and shielidings.

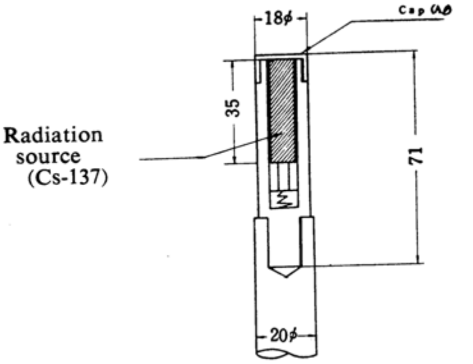

Fig. 1-c. Datails of the ^{137}Cs source.

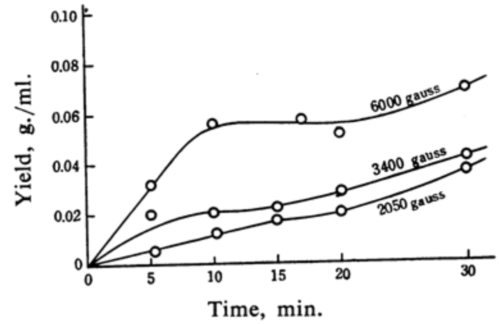

Fig. 2. The relation between the polymerization yield and the irradiation time in various magnitudes of magnetic field. Dose rate was 4.3×10^2 r./hr.

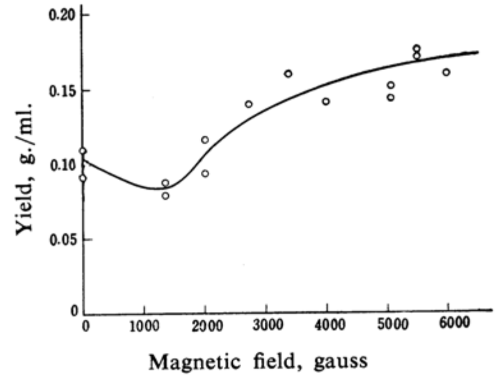

Fig. 3. The relation between the polymerization yield and the magnitudes of magnetic field at -196°C. Dose rate was 1.6×10^3 r./hr.

Formaldehyde was prepared by the heat-decomposition of para-formaldehyde at 160~170°C; it was then refined by distillation in vacuo at -78°C. The monomer was prepared and purified, just prior to use. The monomer in a glass tube was sufficiently degassed and sealed in vacuo. Irradiation was carried out by γ-rays in the solid state of the monomer at -130°C and -196°C, under the influence of the magnetic field. The yield of the polymerization was determined gravimetrically.

The relation between the polymerization yield and the irradiation time for various magnitudes of the magnetic fields at -196°C is shown in Fig. 2. It is obvious from the figure that the rate of polymerization increases with the magnitude of the magnetic field and that the saturation value of the yield also increases.

The relation between the polymerization yield and the magnitude of the magnetic field in the solid state polymerization at -196°C is shown in Fig. 3. The dose rate was 1600 r./hr. and the irradiation time was 10 min.; hence, the total dose was 270 r. To prevent an explosive polymerization, the dosage was appreciably lower than the 400 r. above which Chachaty and Magat[1] have observed that an explosive polymerization takes place.

From the experimental results, it is evident that the polymerization yield increases with the magnitude of the magnetic field in the region of 1500~6000 gauss.

The polymerization was also carried out at -130°C under the same irradiation conditions. It was found from the experiments that the polymerization yield was not affected by the magnetic field at -130°C; on the contrary, however, the polymerization was affected profoundly by the magnetic field at -196°C.

It is difficult to explain this interesting phenomena at the present stage of investigation. However, there are three possible explanation; the first is the interaction of the δ-ray (electrons ejected by an incident γ-ray) with the magnetic field, the second is the effect of the magnetic field on the termination reaction, and the third is the effect of the magnetic field on a collective excited state of the monomer crystal.

The details of the results will be reported in the near future.

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