Solid Non-Crystalline Scintillation Phosphors

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THE recent announcements of Kallman[1] and the Princeton group[2,3] of their success with liquid phosphors, and particularly with terphenylated metaxylene, immediately raises the possibility of obtaining counting solid solutions of terphenyl, anthracene, naphthacene, stilbene, and other scintillating materials in organic plastic materials. For low energy beta-counting the advantages of the solid is obvious, as are they also in ease of preparation as compared to crystal growing.

We have found that 0.5 percent terphenyl in *m*-xylene, when rapidly frozen so that the terphenyl does not leave the solution, will count Co^{60} gamma-rays. The counting efficiency when frozen was about one-half that of the liquid, but the solid was very cloudy so that presumably much of the scintillation light was lost in the phosphor. Frozen *m*-xylene itself counts, but at a much lower efficiency.

More successful have been solid solutions of terphenyl in polystyrene. These were prepared by: (1) mixing the terphenyl in molten polystyrene; (2) polymerizing a solution of styrene with a one percent benzoil peroxide catalyst; and (3) without the catalyst. All counted well, but the best phosphor resulted from the use of the catalyst. However, the other methods involved protracted heating of the solutions, which may well have affected their characteristics. Large clear masses are obtainable with terphenyl percentages at least up to two percent. The effects of terphenyl concentration on counting rates are given in Fig. 1.

The scintillation pulses have been investigated with both 1P21 photo-multipliers in a two-channel coincidence circuit and a single 5819 tube cooled with dry ice. The counting efficiency for gammas and betas is comparable to that obtained with clear stilbene crystals. Viewing of the pulses on a synchroscope shows them to have a rise and decay time of less than 0.05 μsec. with pulse heights somewhat smaller than those obtained from stilbene. Typical plots of counting rate for Cs^{137} gamma-rays as a function of photo-multiplier voltage for a five percent terphenyl polymer and a polymer containing 10 percent dissolved *trans*-stilbene are shown in Fig. 2. A curve for a clear, single stilbene crystal is included as reference. The reason for the smaller plateau slopes of the plastics is not completely understood, but may be due to less aftercounting in the phosphor. The synchroscope shows a much smaller occurrence of secondary pulses following the scintillation than is observed with crystalline phosphors. As the tube voltage is raised, these secondaries can start giving multiple counts. A detailed investigation of the concentration and purity of the materials, effects of catalysts, and response to different types of radiation is underway. Other materials will also be studied.

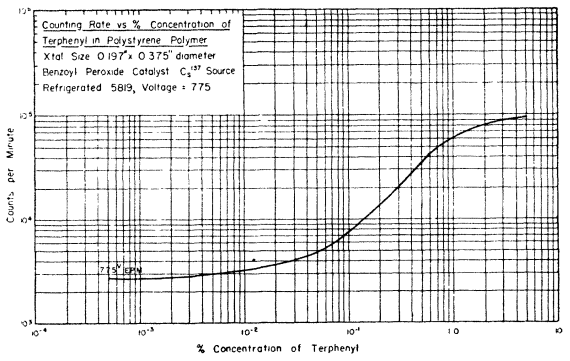

FIG. 1. Effect of terphenyl concentration on counting efficiency of plastic.

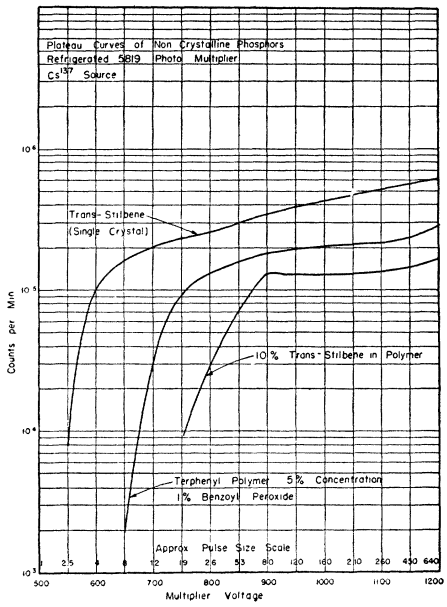

FIG. 2. Counting plateaus for plastics and a clear single crystal of stilbene.

The mechanism here seems distinct from that involved in the work of Robinson, *et al.*[4] in which crystalline zinc sulfide was imbedded in plastic.

It would seem quite reasonable to suppose that much of the observed counting in commercial polystyrene, Lucite, and quartz may be due to small terphenyl-like impurities.

The phosphor samples were prepared by Dr. J. Bornstein of these laboratories; the possibilities of solid solution phosphors were first pointed out to us by Dr. Walter Juda of Ionics, Inc.

[1] H. Kallman, Phys. Rev. **78**, 621 (1950).
[2] G. T. Reynolds, Nucleonics **6**, 68, (May, 1950).
[3] Reynolds, Harrison, and Salvini, Phys. Rev. **78**, 488 (1950).
[4] Robinson, Cook, and Jefferson, J. Chem. Phys. **18**, 148 (1950).

On the μ-Meson Decay*

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AN experiment is being performed to investigate the energy of the gamma-rays resulting from the capture of negative μ-mesons in lead. This experiment is an extension of work initiated by Chang,[1] and differs from the previous work in that the cloud chamber is in a magnetic field of 2200 gauss. The chamber expansion is controlled by a Geiger counter telescope that selects events in which a particle stops in the chamber foil system.

During the course of the experiment several pictures have been obtained showing positive and negative mesons stopping in the gas of the chamber. One of these events is considered of interest because of the low energy of the decay particle. Observation of momentum and ionization serve to identify the decay product as a positron. The momentum of the decay particle is 6.2 ± 1.7 Mev/c, corresponding to a positron energy of 5.7 ± 1.8 Mev. Interest in the event arises from the fact that the observations of Leighton *et al.*[2] indicate that the probability of a decay product of such a low energy is very small.

* Assisted by the ONR.
[1] W. Y. Chang, Rev. Mod. Phys. **21**, 166 (1949).
[2] Leighton, Anderson, and Seriff, Phys. Rev. **75**, 1432 (1949).