

December 1967

Brief 67-10596



AEC-NASA TECH BRIEF



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Epoxy Resins Produce Improved Plastic Scintillators

The problem:

To produce a plastic scintillator which would be easy to cast, stable at room temperature, and have the desirable properties of a thermoset or cross-linked system. Existing scintillators require expensive apparatus to produce, are subject to crazing, and lack resistance to heat and solvents.

The solution:

An improved plastic scintillator produced by the substitution of epoxy resins for the commonly used polystyrene. The epoxy system has definite advantages over existing systems. Epoxy systems typically shrink only one percent on polymerization, while styrene shrinks approximately 15 percent. This decrease in shrinkage, combined with low vapor pressure and a small exotherm, facilitates casting into complex and readily reproducible shapes without danger of cracks or burn-up. Since the epoxies are cross-linked systems, the scintillator would have greater dimensional stability, greater resistance to high temperature and to chemical and solvent attack, and essentially no tendency to stress crack or surface craze. Such scintillators can possibly be immersed directly in strong solvents, an advantage in many chemical and biological experiments. These epoxy resin systems can also be readily tailored for special applications by adding modifying agents such as flexibilizers.

How it's done:

To produce the scintillator, an epoxy resin was selected. Epi-Rez 50810 is a commercially available clear, colorless aromatic epoxy resin, produced by the purification of the diglycidylether of bisphenol A. It is a crystalline solid at room temperature (25°C), melts completely at 52°C, and upon cooling at 25°C, remains a supercooled liquid of 4,000-5,000 cps viscosity for several days. If 25% p-tert butyl phenyl

glycidyl ether is added, the resin remains liquid indefinitely at 25°C.

Curing agents for this material can be selected from various anhydrides, amines, sulfides, organic acids or Lewis acids. However, only two materials have so far produced efficient colorless scintillators, the Lewis acids Epi-Cure 877 and Epi-Cure 8771. Some anhydrides, when used with long slow cures which are undesirable, produce colorless castings, but they usually yellow if cured quickly at elevated temperatures.

The scintillator p-terphenyl (TP) which has been selected must be heated with the resin in order to achieve solution and then cooled before adding the acid. The solubility of the scintillator in the resin is too low for a room temperature cure with the Lewis acid. This solubility is also too low to produce a stable two-part system, so mixing is necessary just prior to use.

After selection of the epoxy resin and curing agent, a variety of primary solvents, wave length shifters, diluents, and flexibilizers were investigated and the results recorded. No work has yet been done on an antifoam agent, although one is desirable for increasing efficiency in the manufacturing process.

Successes were measured on the basis of the relative pulse heights (RPH) of the various samples. A scintillator, Pilot B, was used as a standard and all RPH's were reported in percent of this sample. The best sample made so far was the following system: resin, Epi-Rez 50810; curing agent, 12 pht (parts per hundred parts of total system) Epi-Cure 877; diluent, 20 pht (parts per hundred parts of resin) xylene; scintillator, 1 pht p-terphenyl (TP); shifter, 0.08 pht biso-propylstyrylbenzene (BPSB). This combination gave a RPH of 54%, which is superior to several commercial plastic scintillators. This pulse height was achieved

(continued overleaf)

without special purification, careful deoxygenation, or other costly material preparation. Some pulse height improvement could be expected with more care.

Notes:

1. Both the epoxy resin and the Lewis acid curing agent will yellow with time reducing the efficiency in samples made from them.
2. The viscosity of the system needs further reduction and a good defoamer is required.
3. This innovation may be of interest to instrument manufacturers who deal in scintillation detectors, and to those people who use these detectors analytically.
4. Available information includes further discussion, tabular and graphic test data. For additional details see: *International Symposium On Organic Scintillators*, Argonne National Laboratory, 1966, Molecular Crystals, Vol. 4 (In press).

5. Inquiries concerning this innovation may be directed to:

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Patent status:

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