

Investigating the Energy Transfer Mechanisms in Polystyrene based Plastic Scintillators

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Plastic scintillators have become a crucial tool in various fields due to their high fast response time, low cost, and flexibility in design. However, despite their widespread use, the underlying physics governing the scintillation processes in these materials remains not fully understood. It has been known that the polymerization process often leaves behind residual (1% - 5%) monomer [1]. The effects of the residual monomer on scintillator performance of PVT based scintillators have been observed before [2]; however, the exact physics of the energy transfer processes are not well understood.

In this study, we synthesized and characterized polystyrene-based plastic scintillators using bulk free-radical polymerization process with varying concentrations of dopants such as PPO (2,5-diphenyloxazole) and bis-MSB (1,4-bis(5-phenyl-2-oxazolyl)benzene). Steady state fluorescence measurements were used to identify the emission spectra of individual species. These measurements also indicated aspatial dependence in emission spectrum, suggesting a non-uniform distribution within the polymer which may lead to performance variations. Photoluminescence (PL) decay measurements were used to estimate the lifetime of each species. Figure 1 shows the PL decay of the characteristic styrene emission at 307 nm in an undoped polystyrene sample (PS, blue), and in the presence of 1% PPO (green), 0.2% bis-MSB (yellow), and both 1% PPO and 0.2% bis-MSB (red) as dopants. The respective decay lifetimes are presented in the legend and were used to estimate resonant energy transfer efficiencies of 74% (PS→PPO), 47% (PS→bis-MSB), and 63% (PS→PPO→bis-MSB) between styrene and the dopants respectively. This result showcases how time-resolved photoluminescence measurement can probe energy transfer efficiency and guide deliberate design of new materials.

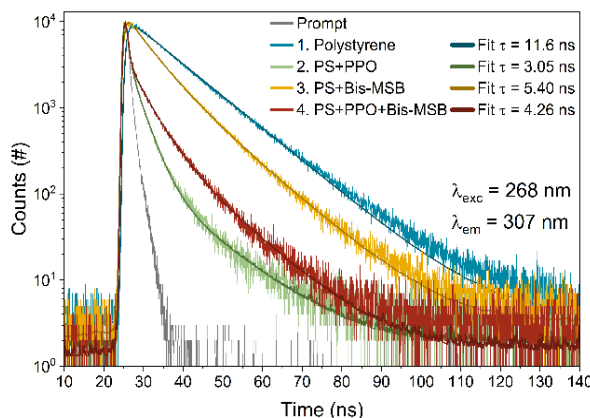


Figure 1. Photoluminescence decay of styrene emission at 307 nm in the presence of 1% PPO and/or 0.2% Bis-MSB.

References

1. L.J. Basile, "Effect of Styrene Monomer on the Fluorescence Properties of Polystyrene," *J. Chem. Phys.* 36, 2204 (1962).
2. L.J. Basile, "Characteristics of Plastic Scintillators" *J. Chem. Phys.* 27, 801 (1957).

Acknowledgments

This work was supported by the Lawrence Berkeley National Laboratory, managed by University of California for the Department of Energy under contract DE-AC05-000R22725. This work was funded by the United States National Nuclear Security Administration's (NNSA) Office of Defense Nuclear Nonproliferation Research & Development.