

P-Terphenyl as Novel Organic Scintillator for Alpha Spectroscopy, X-ray, Beta, and Neutron Detection as well as other Advanced Applications

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To the best of our knowledge, we are the first group in the US to successfully grow pentacene doped p-terphenyl and undoped p-terphenyl fast organic crystal scintillators using the cost effective and commercially scalable vertical Bridgman technique. We have grown and investigated both of these single crystal scintillators. These new, advanced organic crystal scintillators exhibited superior alpha particle energy resolution (measured using SiPM) compared to all known scintillators ever reported in the literature to date. The material has also been shown recently by some European groups [1, 2] to have wide energy range neutron detection from 1.1 to 1.9 MeV with clear gamma-neutron pulse shape discrimination capability. This novel material has also found application in maser gain [3], as well as quantum sensing applications, as recently demonstrated by our R&D group [4]. In this work, initial alpha and gamma spectral response will be reported, along with optical absorption and emission spectra. Both undoped and pentacene-doped crystals with different concentrations have been studied and the corresponding detector performance presented. Gamma-neutron pulse shape discrimination and alternative dopants will be investigated in the near future for further optimization.

1. A. Jancar et al., *Instruments* **2024**, 8, 46.
2. A. Sardet et al., *NIM A*, 792 (2015) 74-80.
3. M. Oxborrow et al., *Nature* **2012**, 488, 353-356.
4. Brimrose 2025 DoD Contract #W911SR-25-C-0014, "Quantum NMR RF sensing of Phosphorus-31 (31P) and Fluorine-19 (19F) using Pentacene-Doped Organic Crystals for Precision Threat Identification.