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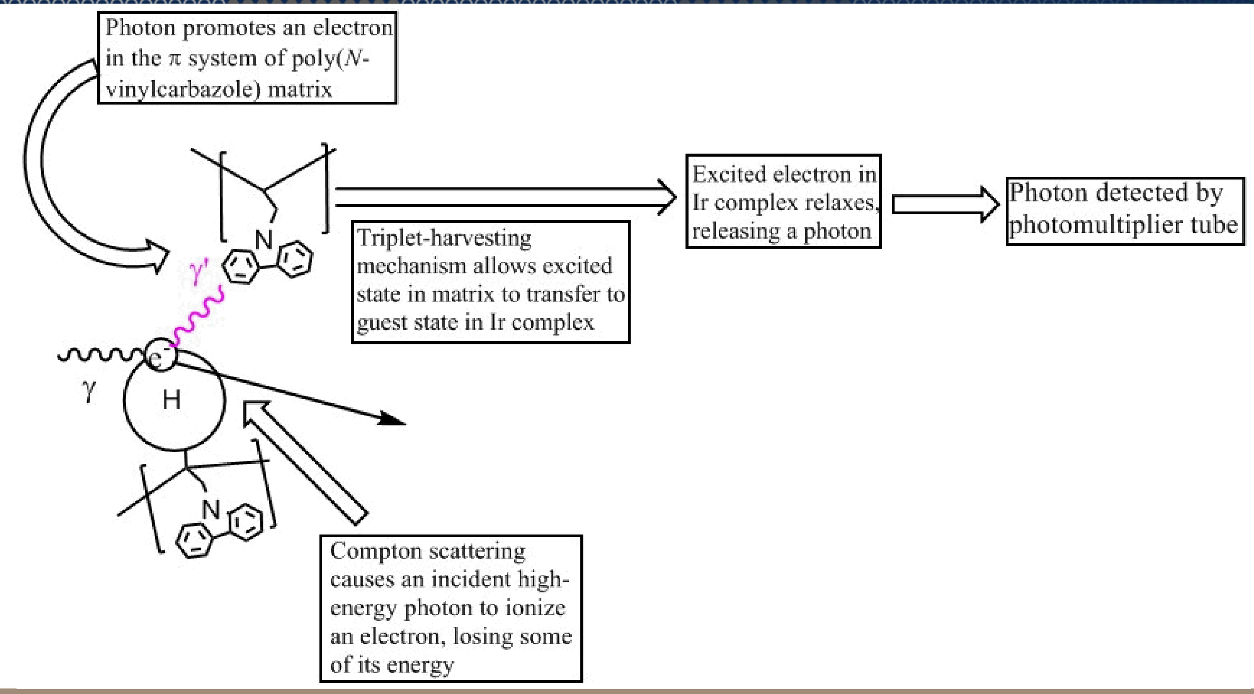
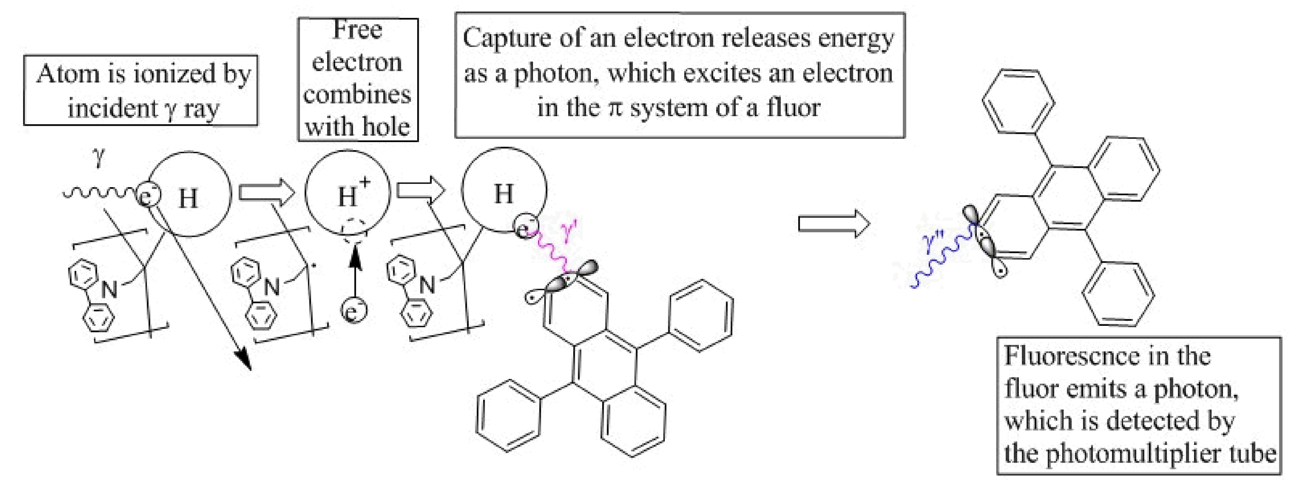
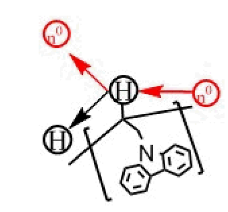
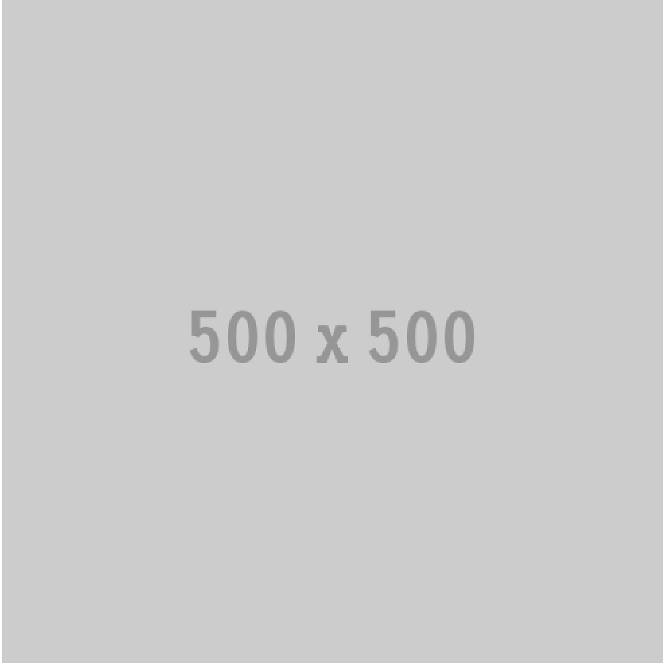








Aqueous and Plastic Scintillators Fulfill a Variety of Needs in Non-Proliferation Applications

Keith Armstrong
Mentors: Dr. Mitchell R. Anstey & Dr. Patrick L. Feng

Abstract

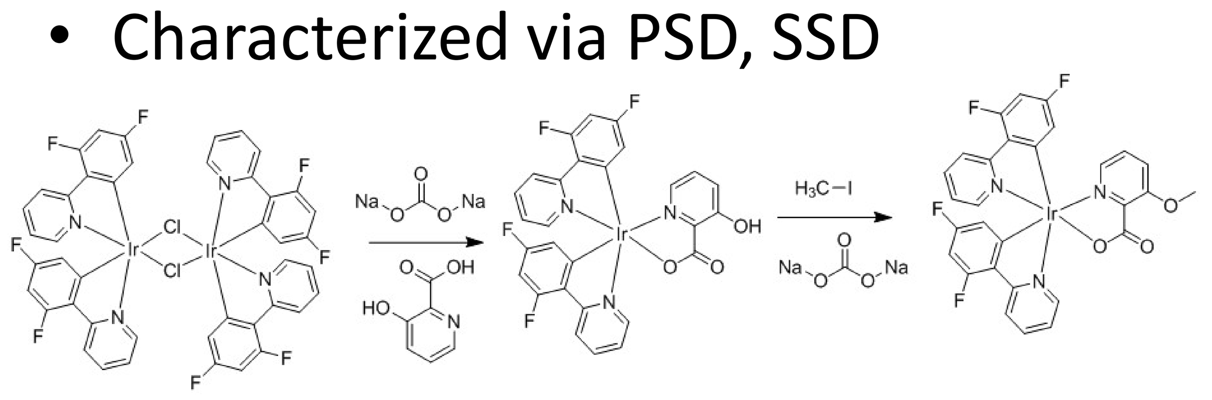
This project consisted of three sub-projects, all with the ultimate goal of aiding in non-proliferation applications for sensitive nuclear weapons materials. Scintillators consisting of organometallic scintillators and organic fluors embedded in aqueous or polymeric matrices were developed for various non-proliferation applications.

Introduction

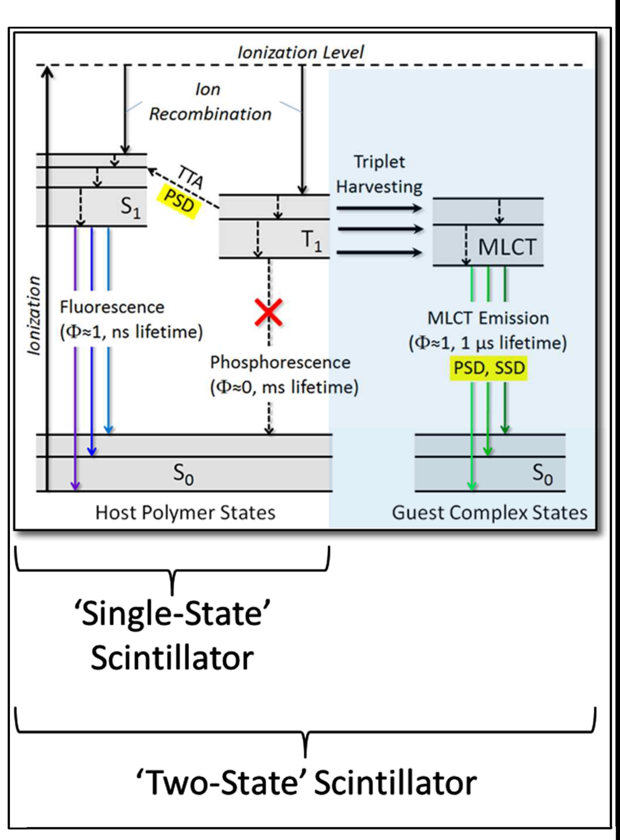
The illegal development and trafficking of nuclear weapons and sensitive nuclear materials is a security threat of global concern. The ability to detect the presence of such materials is integral to non-proliferation applications and is a core competency of the NNSA. Scintillators were developed to suit a variety of special nuclear materials detection needs.

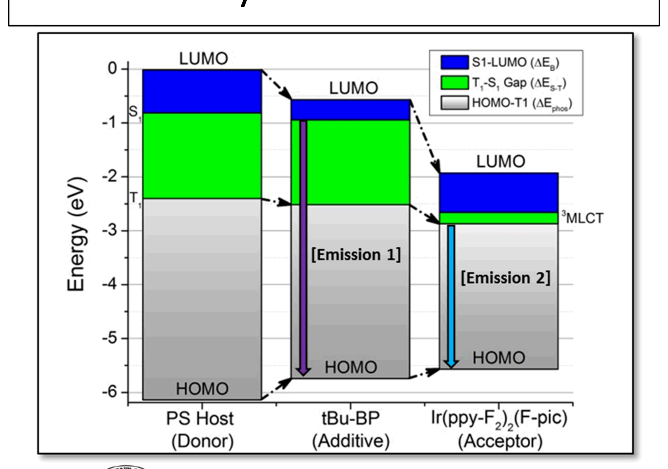
NA122

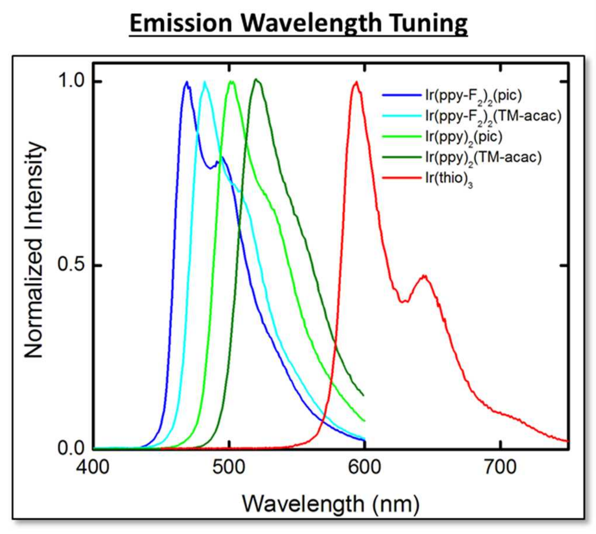
- Fast neutron/gamma ionizing radiation discrimination using organoiridium-doped plastic scintillators
- Novel triplet harvesting mechanism transfers energy to guest state in organoiridium complex
- Characterized via PSD, SSD



Counter-clockwise, from bottom left:
1. Diagram showing the energy transfer mechanism from the matrix to the Ir complex via an additive; energies calculated via DFT
2. The effects of electron-withdrawing or donating groups to blue- or redshift the emission spectrum of the complex
3. Orbital diagram illustrating electronic guest states in the Ir complex
4. Synthesis of one Ir triplet-harvesting complex from commercially available materials

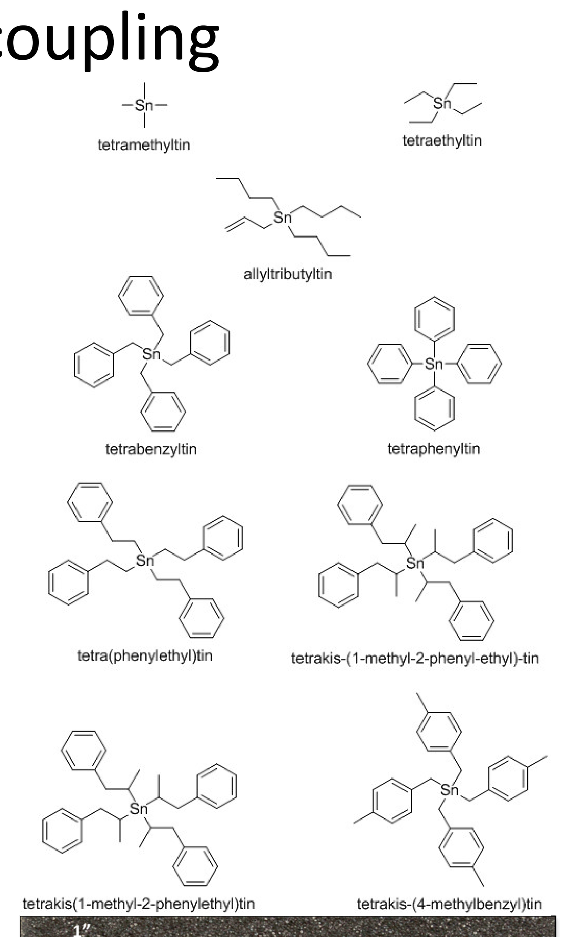




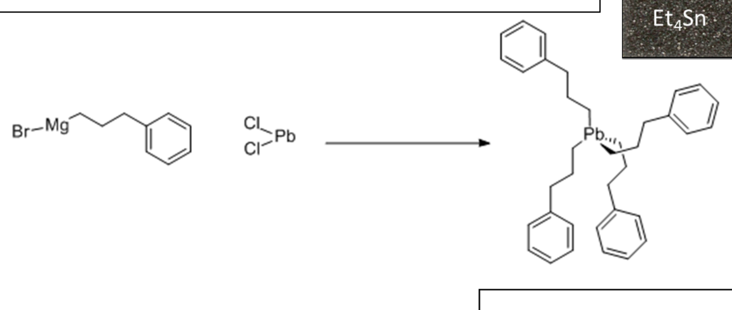


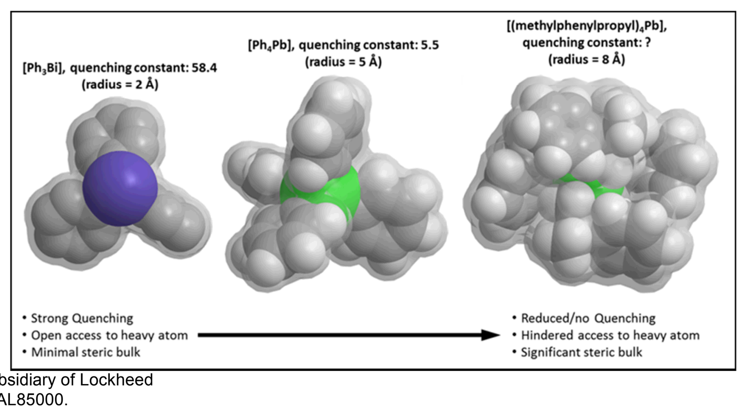
DNDO

- High-quantum yield plastic scintillators containing relatively high w/w % organo-heavy metal compounds for gamma ray spectroscopy
- Predicted and investigated effects of aliphatic and aromatic organic ligands: phase stability, quenching constant, aromatic π-metal coupling
- Devised syntheses for tin, lead, bismuth and indium organometallics



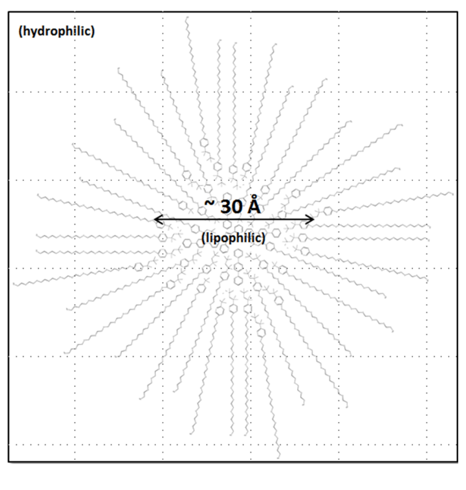
Right: some of the proposed tin compounds and the phase stabilities of a subset thereof
Below: Grignard synthesis of tetrakis(3-phenylpropyl)-plumbane
Bottom right: effects of progressively bulkier ligands on molecular radius and quenching constant





Aqueous scintillators

- Low-cost, low-toxicity and low-flammability; highly scalable; highly sensitive in gamma ray detection
- Matrix of water (ideally greater than 50% v/v), aromatic compounds, surfactants and/or phosphate-based emulsifiers



Caption

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NNSA National Nuclear Security Administration

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