Small Molecule Organic Glass Scintillators For Radiation Detection

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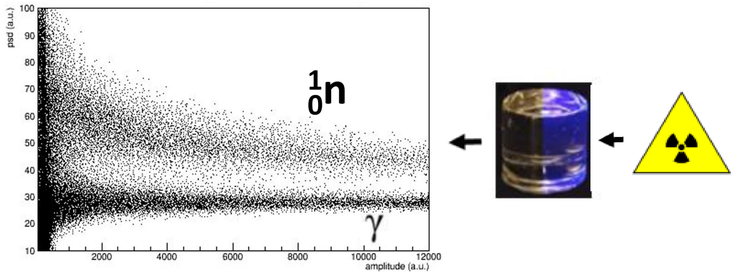
ETI Annual Workshop, February 20 - 21, 2024
#16

Goals & Objectives

- Tune the thermal properties of organic glass scintillators through synthesis
  Goal: Glass transition temperature (T_g) of 80-120 ^oC
- Synthesize organic glass scintillators with the ability to discriminate between gamma and neutron radiation
  Goal: High light output and Figure of Merit (FoM) above or equal to 1.27

Introduction

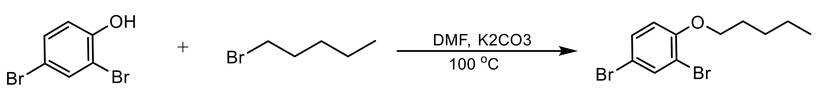
- Scintillators emit light when they interact with ionizing radiation
- An organic glass must form a stable glassy phase and avoid crystallization to allow transmission of light
- Current synthesis of organic glass scintillators is difficult and includes a n-BuLi step (pyrophoric!)



Methods

Alkylating Phenol Core

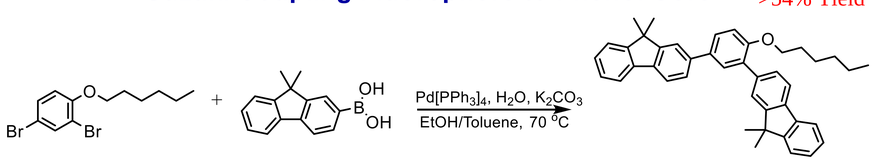
>90% Yield



- Alkylation of a bromo-functionalized phenol ring is used to increase molecular weight and inhibit crystallization

Suzuki Coupling Fluorophore to Phenol Core

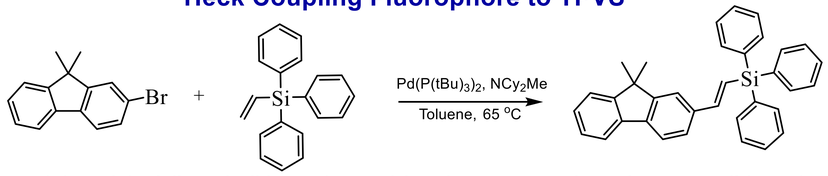
>54% Yield



- We propose this method will allow a milder scalable syntheses of OGS 2.0 materials

Heck Coupling Fluorophore to TPVS

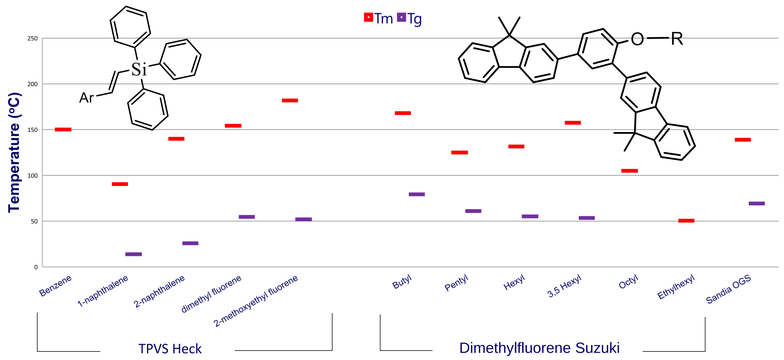
>66% Yield



- Triphenylvinylsilane bulkiness is used for glassy properties, also very mild syntheses

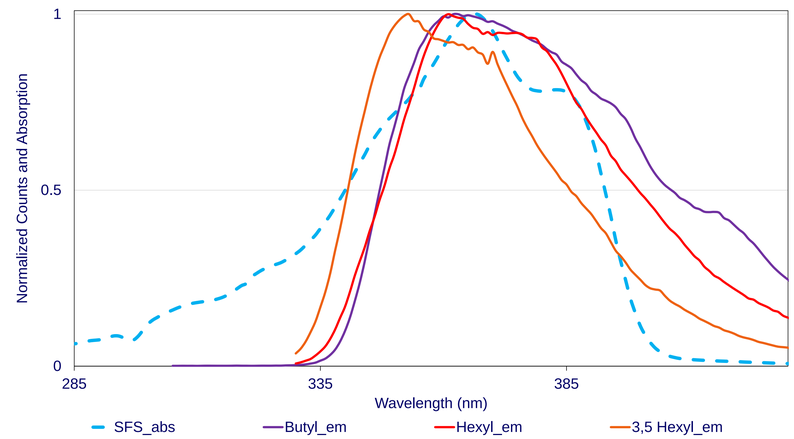
Results

GLASS AND MELTING TRANSITIONS OF OGS MATERIALS

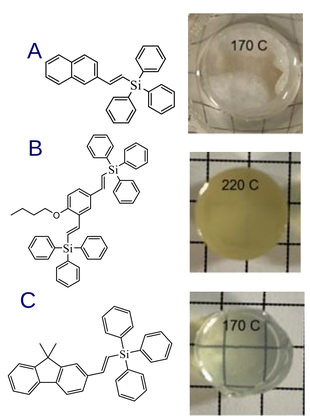


Increasing chain length leads to a decrease in T_g

EMISSION OF SUZUKI PRODUCTS



3,5 derivative leads to blue shifted emission and absorption

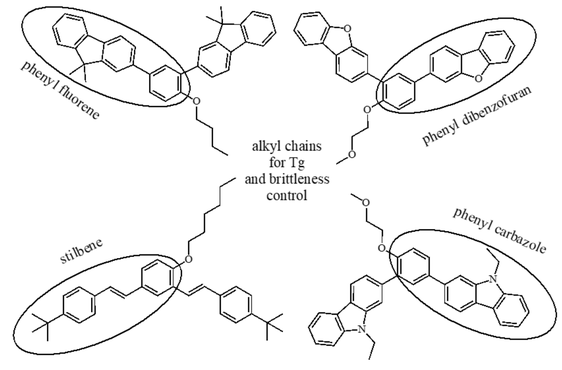


Sample	Rel LY EJ2000	PSD FoM
EJ200	---	---
A	No Compton	---
B	0.16	0.36
C	0.83	1.46
C w/bis-MSB	0.79	1.40

Discussion

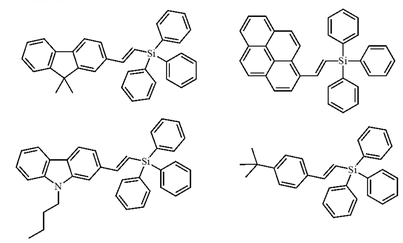
Suzuki

- The 3,5 derivative leads to a blue shift that can aid in tuning the emission properties of scintillators
- Increasing chain length leads to a decrease in T_g and brittleness that can aid in tuning thermal properties
- Will create 2, 5, 10, 20 wt% of octyl to butyl glasses which may lead to nice intermediate thermal properties and minimize cracking
- Will continue to optimize new Suzuki coupling methods to reduce byproduct formation



Heck

- Dimethyl fluorene shows good PSD that is comparable to commercial products
- Will continue to optimize Heck coupling methods to reduce byproduct formation



Conclusion

Suzuki

- Butyl derivative has the most promise with emission
- Butyl derivative has most promise with T_g

Heck

- Fluorene shows promise with high PSD FoM and high light yield

Relevance to NA-22 Nonproliferation Mission
Reduces the threat to national security posed by illicit trafficking of nuclear materials by detecting and differentiating between threats at international borders

This material is based upon work supported by the Department of Energy / National Nuclear Security Administration under Award Number(s) DE-NA0003921.