Phosgene-Free Synthesis of an Isocyanate-Containing Boron-Dipyrromethene Fluorescent Probe, Which Allows Direct Fluorescent Labeling of Nucleophilic Sites on Substrates

Tech ID: 34815 / UC Case 2026-814-0

BACKGROUND

Fluorogenic probes and imaging kits are advanced, fluorescent reagents used for high-contrast bioimaging, molecular detection, and real-time tracking of biological events. They are essential tools for live-cell microscopy, disease diagnostics, and drug discovery. Isocyanate–boron-dipyrromethene (BODIPY) dyes are specialized, highly stable, and intense fluorescent probes that are valued for their high quantum yields, photostability, and easily modified structures. BODIPY derivatives bearing isocyanate groups have been created by others. However, current syntheses rely on toxic phosgene-based reagents, which require specialized equipment and expertise and pose significant health and safety concerns. Additionally, the dyes created with phosgene-based reagents have not been demonstrated for labeling inorganic materials. There is a need for alternative processes to create BOPIPY based dyes with safer commercially available reagents.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a novel, safe, phosgene-free method to produce isocyanate-containing BODIPY dyes by coupling an amine-functionalized BODIPY precursor with a commercially available toluene diisocyanate (TDI). The resulting dye covalently binds to nucleophilic surface groups on inorganic particles and polymer films such as polyurethane under mild conditions. This labeling produces stable, bright fluorescence observable via confocal microscopy, including Fluorescence Lifetime Imaging Microscopy (FLIM), enabling chemical specificity in imaging of heterogeneous materials. This approach advances fluorescent labeling beyond biological systems to materials research, facilitating enhanced visualization and characterization of a broader range surfaces, interfaces, and their structure-property relationships.

ADVANTAGES

- Safe, phosgene-free synthetic process
- Bright, stable fluorescence suitable for advanced imaging techniques like confocal FLIM
- Enables chemical specificity and differentiation of heterogeneous material mixtures through FLIM imaging
- Accessible synthesis route using commercially available reagents
- Versatile covalent bonding to a wide range of nucleophilic substrates, including inorganic particles and polymers

APPLICATIONS

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OTHER INFORMATION

KEYWORDS

fluorogenic, fluorogenic probe, probe, fluorescent probe, fluorescent, isocyanate, BODIPY, imaging

CATEGORIZED AS

- **Materials & Chemicals**
  - Biological

RELATED CASES

2026-814-0

- Materials research involving surface chemistry and interface characterization
- Imaging and sensing of inorganic particles and polymeric materials
- Development of advanced fluorescent labeling kits and probes for industrial and academic research with uses in materials development, failure analysis, and aging studies.
- Polymer engineering and quality control using fluorescence-based surface analysis
- Catalysis and complex material studies requiring spatial and chemical resolution

PATENT STATUS

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Multiple Nanoemulsions and Complex Nanoparticles for Encapsulation and Release

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