Polymeric Benzopyrylium Chemistries for Peroxynitrite Detection in Disease

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BACKGROUND

Monitoring progression is critical for effectively treating illnesses including cancer, Alzheimer's disease, and heart disease. Oxidative stress, an imbalance of free radicals and antioxidants, leads to cell damage, which plays a role in many illnesses. Understanding the role of oxidative stress in disease progression is essential to the improvement of diagnostic imaging and targeted delivery. Peroxynitrite, a highly reactive oxygen and nitrogen species, has been linked to the onset and severity of oxidative stress, and its continual detection is crucial for real-time monitoring of disease progression. Unlike other redox biomarkers of oxidative stress, peroxynitrite is present only in diseased tissue, making it a powerful tool in disease detection. Benzopyrylium (BZP)-based two-photon fluorogenic probes offer promising selectivity, however small molecule designs are hampered by short detection lifetimes, poor solubility, narrow pH stability, limited modularity, and rapid clearance in vivo.

DESCRIPTION

Researchers at the University of California, Santa Barbara have created innovative benzopyrylium polymer sensors that enable continuous, real-time monitoring of oxidative stress by detecting peroxynitrite with enhanced stability and biocompatibility. This novel technology introduces benzopyrylium-based (co)polymers engineered via controlled living polymerization to develop water-soluble fluorescent probes capable of continuous two-photon detection of peroxynitrite, a key reactive species linked to oxidative stress. The polymers self-assemble into nanoparticles or hydrogels that fluoresce and change morphology upon interacting with peroxynitrite, transforming into macromoelcules that move more slowly and fix themselves to the position of the detected peroxynitrite. This enables prolonged detection lifetimes and tunable response kinetics. Their modular design allows attachment of diverse fluorophores and targeting groups, supporting scalable manufacturing and improved biocompatibility versus traditional small-molecule probes.

ADVANTAGES

- Continuous, real-time monitoring with prolonged detection lifetime
- High selectivity and broad pH stability for reliable sensing
- Fully water-soluble and biocompatible polymeric platforms
- Modular architecture for customized fluorophores and targeting ligands
- Programmable morphological changes for enhanced signal readouts
- Improved cytocompatibility compared to small-molecule probes

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OTHER INFORMATION

KEYWORDS

polymeric, polymeric benzopyrylium, peroxynitrite detection, peroxynitrite, diagnostics, benzopyrylium polymer, benzopyrylium, polymer, sensor, oxidative stress, macromoelcules, biosensors

CATEGORIZED AS

- **Materials & Chemicals**
  - Polymers
- **Medical**
  - Diagnostics
  - Disease: Cancer
  - Disease: Cardiovascular and Circulatory System

RELATED CASES

2026-557-0

- Compatible with scalable polymer manufacturing processes
- Avoids mislabeling healthy tissue

APPLICATIONS

- Early diagnostics for cardiovascular, neurological, and inflammatory diseases
- High-throughput screening of antioxidant and therapeutic agents
- Preclinical imaging in research laboratories and pharmaceutical studies
- Bedside continuous monitoring devices for oxidative stress
- Implantable biosensors for real-time tissue health assessment
- Development of disease models for chronic and acute oxidative stress research
- Micron-scale disease targeting

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