Organic Fluorophores for Plastic Scintillators (2016-019)

New class of organic fluorophores allows for more efficient and inexpensive polymer scintillators for detecting radioactive materials

Market Overview

These organic fluorophores have enhanced luminosity in response to ionizing radiation, increasing the efficiency of plastic scintillators and providing greater environmental stability. With increasing investments in radiation monitoring for homeland security, the scintillator market is expected to reach $607.21 Million by 2025. Currently available plastic scintillators use a polystyrene as the matrix due to its high optical transparency, however, more efficient and inexpensive scintillators are needed for detection of radioactive materials in homeland security, nuclear forensics, and nuclear safeguards applications. Clemson University researchers have developed a new class of organic pyrozaline-based fluorophores with enhanced emission and luminosity in response to ionizing radiation. These compounds offer higher efficiency of plastic scintillators, reduced cost and fluorophore loading, and enhanced chemical and environmental stability.

Technical Summary

These synthesized fluorophore compounds show superior performance as plastic scintillators when dissolved in polystyrene or polyvinyltoluene matrices. Different optical and physical properties were tested to evaluate their efficiency in preparing bright plastic scintillating polymers for radiation detection and measurement. These included molar absorptivity, absorption and emission wavelengths and finally their quantum yield relative to a reference material. The compounds exhibit 3x high photoluminescence and 5x high luminosity in comparison to existing analogs. The effect of luminosity enhancement allows for significant reduction in fluorophore concentration in the plastic scintillator material without jeopardizing their properties. It also allows application of these fluorophores in neutron/gamma pulse shape discrimination materials at a reduced concentration in comparison to the existing composites. In addition, the chemical structure of the suggested fluorophores allows their functionalization for further covalent bounding to the matrix thus enhancing chemical and environmental stability of the scintillating material.

Application

Homeland security, nuclear forensics, nuclear safeguards

Development Stage

Preliminary Prototype

Advantages

- Utilizes simple chemical synthesis with common compounds, allowing scale-up to industrial level
- Uses reduced concentration and echibits higher luminosity, making it highly cost effective compared to currently commercially-available organic fluorophores
- Higher luminosity results in higher efficiency with enhanced detector stability against hazard chemical environment

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Utility	United States	62/326,391	US-2017-0306220A1	2016-019	Dr. Timothy Devol Dr. Valery Bliznyuk

About the Inventors

Dr. Timothy Devol

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Dr. Timothy DeVol, CHP is the Toshiba Professor of Nuclear Engineering in the Department of Environmental Engineering and Earth Sciences at Clemson University. He earned his Ph.D. in Nuclear Engineering for the University of Michigan. Dr. DeVol was the recipient of the Clemson University Innovation Award twice, the Elda E. Anderson Award, and he has two issued patents. His research interest include environmental monitoring of alpha- and beta-emitting radionuclides in water, statistical analysis of monitoring data, numerical modeling of detectors, and nuclear forensics.

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Dr. Valery Bliznyuk is a Research Assistant Professor in the Department of Environmental Engineering and Earth Science, Clemson University. He received a PhD degree in Polymer Science from the Institute of Macromolecular Chemistry of National Academy of Sciences, Kiev, Ukraine, and a DSc degree in Polymer Chemistry in the field of nanostructured organic materials from Kiev State University. His research is focused on development of advanced polymer materials for molecular electronics, photovoltaics, and radioluminescent sensors.

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