THIANTHRENE-BASED COMPOUNDS FOR OXYGEN SENSING APPLICATIONS

Lukas Dvylys[1], Rasa Keruckienė[1], Matas Gužauskas[1], Melika Ghasemi[1], Juozas Vidas Gražulevičius[1]

[1]Department of Polymer Chemistry and Technology, Kaunas University of Technology, Lithuania
lukas.dvylys@ktu.edu

Room temperature phosphorescence (RTP) is a phenomenon where certain materials emit light at ambient temperatures, with a delay after the removal of the excitation source [1]. Unlike fluorescence, which has rapid nanosecond lifetimes, RTP involves the transition of excited molecules to long-lived triplet states lasting milliseconds to seconds [2]. RTP exhibits intensity differences between air and oxygen-free environments, indicating the involvement of oxygen-sensitive triplets [1]. Organic compounds used in oxygen sensing have crucial roles in analytical chemistry and sensor technology, showcasing unique optical or electrochemical properties that modulate in the presence of oxygen. These compounds are utilized for their sensitivity to oxygen concentration changes, leading to alterations in emission characteristics [3]. The implementation of these sophisticated organic materials in sensing platforms contributes to advancements in fields such as environmental monitoring, biotechnology, and medical diagnostics, facilitating precise and real-time detection of oxygen levels in diverse applications [4].

Thianthrene and its derivatives have garnered significant attention in recent years for their promising potential as effective materials in oxygen sensing applications [5]. Thianthrene derivatives possess a conjugated molecular structure that facilitates efficient intersystem crossing, a crucial process for phosphorescence. The presence of sulfur atoms in the thianthrene molecule contributes to enhanced spin-orbit coupling, which promotes efficient triplet state formation. The rigidity of the molecular structure and the extended conjugation in thianthrene derivatives further stabilize the triplet state, allowing for extended phosphorescence lifetimes at room temperature [5].

In this work, two thianthrene-based compounds with different electron acceptors were synthesized. Their thermal, electrochemical, and photophysical properties will be presented.

[1] J. Yang, et al., Stimulus-Responsive Room Temperature Phosphorescence Materials: Internal Mechanism, Design Strategy, and Potential Application, Acc Mater Res 2 (2021) 644-654.

[2] M. Gmelch, et al., High-Speed and Continuous-Wave Programmable Luminescent Tags Based on Exclusive Room Temperature Phosphorescence (RTP), Advanced Science 8 (2021) 2102104.

[3] E. Armagan, et al., Reversible and Broad-Range Oxygen Sensing Based on Purely Organic Long-Lived Photoemitters, ACS Appl Polym Mater 3 (2021) 2480-2488.

[4] Y. Wang, et al., A high-performance optical trace oxygen sensor based on the room-temperature phosphorescence from palladium (II) octaethylporphyrin, Measurement 206 (2023) 112275.

[5] A. Tomkeviciene, et al., Bipolar thianthrene derivatives exhibiting room temperature phosphorescence for oxygen sensing, Dyes and Pigments 170 (2019) 107605.