INVESTIGATION OF ORGANIC LIGHT-EMITTING DIODES AND OPTICAL SENSORS BASED ON RED AND NEAR-INFRARED EMITTING BENZOTHIADIAZOLE DERIVATIVES

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Numerous advanced technological fields, including telecommunications, healthcare, physiological monitoring, military systems, medicine, sensing technologies, and optogenetics, rely on light sources operating in the red and near-infrared (NIR) spectral regions. In this work, we studied three derivatives of 2,1,3-benzothiadiazole containing a central acceptor and two donors with varying electron-donating strengths, namely acridan, spiro[acridine-9,9'-fluorene] and phenoxazine. They exhibit thermally activated delayed fluorescence with photoluminescence maxima in the red or infrared regions. The phenoxazine derivative exhibits emission at 748 nm in toluene solution. The neat film of this compound emits near-infrared light, with a photoluminescence spectrum peaking at 726 nm. This compound was tested as an emitter in organic light-emitting diodes (OLEDs) using host-free, host-based, and multilayer light-emitting layers. OLEDs based on the neat film of the phenoxazine derivative emit near-infrared light, with an electroluminescence spectrum peaking at 745 nm. The external quantum efficiency (EQE) of this device is relatively low at 0.19%. In multilayer and host-containing light-emitting-layer-based OLEDs, this compound achieves maximum EQE values of 0.29% and 0.7%, respectively. Using the red-emitting derivative of 2,1,3-benzothiadiazole and spiro[acridine-9,9'-fluorene], red TADF OLEDs were developed with EL spectra at 621 nm and the highest EQEs of 3.42%. In addition, this compound demonstrated high oxygen sensitivity. Oxygen sensors containing this compound as the active material showed high Stern-Volmer coefficients of $3.4 \times 10{-}4$ ppm−1 in the range of oxygen concentrations from 0 ppm to 2000 ppm.[1] Three compounds were characterized by long-lived thermally activated delayed fluorescence, which is advantageous for organic light-emitting diodes and oxygen-sensing optical devices. The modifications to the molecular structure enabled us to shift the emission spectra of the films from the red to the near-infrared region. The near-infrared emitting compound was used for organic light-emitting diodes. The red-emitting compounds were used as the active materials in oxygen sensors.

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[1] Volyniuk, Lesia, et al. "Highly oxygen-sensitive red to near-infrared emitting benzothiadiazole derivatives for electroluminescent devices and optical sensors operating within the biological window". Sensors and Actuators B: Chemical, vol. 449, no.15, pp. 139066, Feb.2026, doi.org/10.1016/j.snb.2025.139066