Development of Ultrafast Benzothiadiazole-based Fluorophores for High-speed Optoelectronics

Mariia Stanitska[1,2], Alena Kimpel[2], Dmytro Volyniuk[2], Juozas Vidas Gražulevičius[2], Vidmantas Gulbinas[1]

[1]*Centre for Physical Sciences and Technology, Sauletekio Ave. 3, Vilnius LT-10257, Lithuania*

[2]*Department of Polymer Chemistry and Technology, Faculty of Chemical Technology, Kaunas University of Technology, Barsausko st. 59, LT-51423, Kaunas, Lithuania*

The visible light communication (VCL), that utilize only the visible light portion of the spectrum (approximately 380 – 780 nm), offers substantial prospects as a future communication technology. It has the potential to address many challenges in data transmission by offering a variety of advantages, such as minimal power consumption, large bandwidth, minimal-to-zero interference with radio bands, high level of data security. Importantly, VCL can be facilely integrated into already existing lighting infrastructure with minimal additional costs needed to set up VCL communication networks. The visible light spectrum of light-emitting diodes (LEDs) and organic light-emitting diodes (OLEDs) could be used in VLC for data transmission. In this case, lightning sources are utilized to their full potential, covering illumination and data transfer at the same time. White light of commercial LEDs is generated from blue-emitting GaN/InGaN-based LED with wavelength-converting phosphor that absorbs the blue light of the LED and converts it to longer wavelengths.
Phosphors, which are common light converters, usually exhibit microsecond-scale lifetimes that provides bandwidth up to about 1 MHz, thus greatly restricting the data transmission rate and creating a demand for faster colour converters. In this regard, organic semiconductors (OSCs) appear as promising alternatives to phosphors, due to their shorter radiative lifetimes (nanosecond or even sub-nanosecond) that allow to achieve up to GHz frequencies [1], [2]. Some OSCs also have high photoluminescence quantum yields (PLQY). They offer a cost-effective way to produce high-quality light without relying on the rare-earth elements of inorganic phosphors.
Herein, we present a series of benzothiadiazole-based compounds demonstrating ultrafast (>10 ns) deep-red photoluminescence (>650 nm) in solid state. The compounds were obtained in high yields through palladium-catalysed Buchwald-Hartwig cross-coupling reaction. The structures are lacking donor-acceptor architecture in order to minimize the charge-transfer character of emission that can lead to prolonged emission lifetimes. The branched structure is responsible for prevention of aggregation-caused quenching of emission. Compounds are characterized by low values of ionization potential (5.35 – 5.5 eV), high thermal and morphological stability, and high values of charge carriers mobility. Owing to the mentioned characteristics, the new derivatives of benzothiadiazole are applicable as emissive layers for fabrication of ultrafast host-based and host-free OLEDs, suitable for VLC.

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References

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