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Doctoral dissertation. titled: *Small furan-based donor-π-acceptor molecules and their photonic properties*

A summary of the thesis in English:

The research presented in the following doctoral thesis was mainly conducted as a part of the project funded by the National Science Centre, under the PRELUDIUM BIS2 grant. The Principal Investigator, Prof. Lech Sznitko was also the supervisor of this work.

The experimental research described in this dissertation concerns the characterisation of small furan-based organic molecules with a Donor-π-Acceptor molecular design. The following work mainly focuses on three properties of the studied systems: Aggregation-Induced Emission (AIE), the possibility of obtaining light amplification, and optical photoswitching between the *E* and *Z* isomers. The selected methods for basic spectroscopic analysis were used to investigate absorption and photoluminescence phenomena, including the determination of fluorescence quantum yields and lifetimes. In addition, part of the study was conducted on both liquid and solid samples, enabling evaluation of the applicability of dyes across different matrices. Finally, based on the gained experience, new types of compounds, representing the aforementioned furan-based Donor-π-Acceptor family, were synthesised during a long-term internship at École Normale Supérieure de Lyon under the scientific supervision of Dr. Yann Bretonnière and Prof. Chantal Andraud. Obtained molecules were planned in a way that, by a relatively small change in the structure, could directly tailor their properties, thus enabling the obtaining of desired optical features.

A broad experimental study was performed not only in the abroad university, but also at Wroclaw University of Science and Technology, as well as at the University of Warsaw (in the Ultrafast Phenomena Laboratory), thanks to the kindness of Dr. Piotr Fita. Within the scope of the research, particular attention was paid to the phenomenon of AIE and its effects on the stimulated and spontaneous emission, excited both via one- and two-photon processes. Also determined were the threshold parameters and the impact of the quantitative addition of dye on overall efficiency stimulated emission.

In the context of confirming functionalization of the given materials as an active matrix. Simultaneously, for the part of the compounds that differ from each other by the donor part of the molecule, examined was the possibility of photoisomerisation and photoinduced

birefringence. The photoswitching capability was evaluated across various matrices, from liquid samples to polymeric films, thereby confirming their multifunctionality.

The presented research works are characterized by their interdisciplinary nature, encompassing the fields of chemistry, spectroscopy, and physics with a broad materials-oriented focus, therefore aligning with modern trends in materials science. Obtained results outline a strategy for optimising organic dyes and provide a basis for analysing the functionalization of organic molecules in the context of their design and future use in optoelectronic and photonic applications.

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