Pyrene-based emitter materials for lasing and super-fast light emission

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Polycyclic aromatic hydrocarbons are frequently used as gain medium in organic lasers, due to their chemical tunability and large stimulated emission cross section.[1] Pyrene derivatives are promising candidates in optoelectronic devices, as their rigid molecular structure provokes excellent photoluminescence efficiency and high charge carries mobility combined with great hole injection ability.[2,3] However, there are only a few examples of pyrene gain materials and the tuneability of the lasing behavior through substituents is not yet examined and optimized. Here, we design simple blue emissive pyrene derivates with different substituted electron donors.

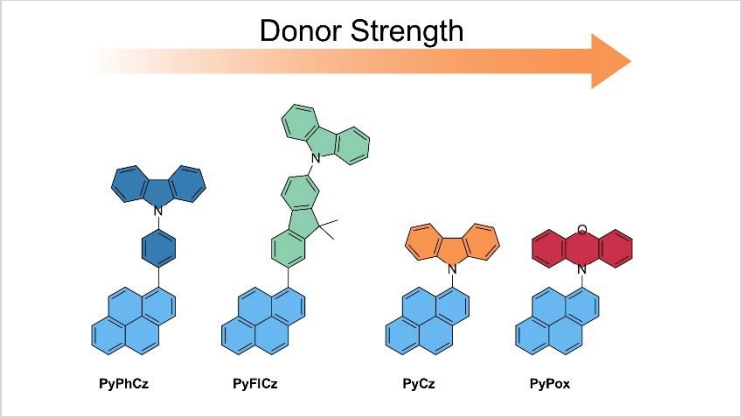

Figure: Structure of the examined pyrene-based compounds arranged according to the donor strength as determined by the dipole moment.

We investigate the influence of the electron donating substituents on the ability of pyrene derivatives to exhibit Amplified Spontaneous Emission (ASE) and observe low thresholds down to 1.73 µJ cm^{-2}. Through comprehensive spectroscopic and theoretical analysis, we outline the correlation between electron density and ASE threshold, emission efficiency, and excited state lifetime. Our results demonstrate that higher electron density inhibits ASE performance, attributed to the stabilization of excited states, while lowering the photoluminescence quantum yield.

References:

[1] A. J. C. Kuehne, M. C. Gather, Chem. Rev. 2016, 116, 12823–12864.
[2] L. Ma, Y. Yu, L. Li, T. Lei, B. Jiao, X. Hou, Z. Wu, Org. Electron. 2018, 57, 123–132.
[3] M. Fang, J. Huang, Y. Zhang, X. Guo, X. Zhang, C. F. Liu, W. Y. Lai, W. Huang, Mater. Chem. Front. 2017, 1, 668–676.