首届致远学术节
学生科研成果展示

Design, Synthesis and Property of Efficient Red Light-Emitting Materials with Aggregation Induced Emission

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RAISE OF THE QUESTION

Organic light emitting material has made great progress in recent decades. Red material plays an important role in the luminescent material, which has a wide application in organic light emitting diode (OLED) and biological imaging. Compared with blue, green light emitting material, not only does it have promising prospect in the photovoltaic device, but also it performs much better in the field of biological imaging, because of higher contrast and smaller influence of background noise. Our goal is to get efficient red light-emitting materials.

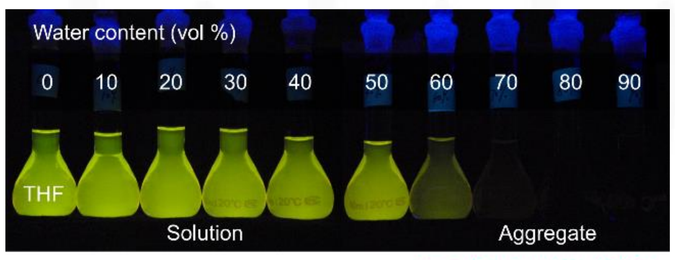

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Figure. 1, AIE phenomenon

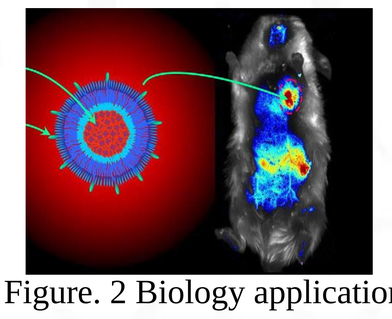

Figure. 2 Biology application

However, red light emitting material is harder to prepare.
Firstly, most of fluorescence molecules to emit blue or green light. We need to adjust the molecular energy gap to get red fluorescence molecules. Secondly, ACQ (aggregation-caused quenching) impedes its wide application. Vast majority of the red light-emitting molecules performs well in dilute solution, however, fluorescence quenching occurs in concentrated solution or solid state due to the strong interaction between molecules. Aggregation caused quenching (ACQ) fluorogens tend to decay through non-radiative relaxation pathways, contributing to low efficiency in solid state. An strategy to weaken or eliminate the ACQ effect is in needed.

STRATEGY OF DESIGN MOLECULES

The problem of ACQ is solved with introducing twisted structure to produce restriction of intramolecular motions, which is main cause of Aggregation induced emission (AIE). AIE is exactly opposite to ACQ, namely, molecule emits weak light in dilute solution, however, emits bright light in concentrated solution or in solid state where molecules are aggregated.

Meanwhile, previous work indicates that adding strong electron donating group and electron accepting group into the molecule to create a donor - acceptor (D-A) system enables light emission redshift. Introducing D-A system affect the electron cloud distribution, then decrease molecular energy gap, enabling molecule emits red light. The molecules designed are as following.

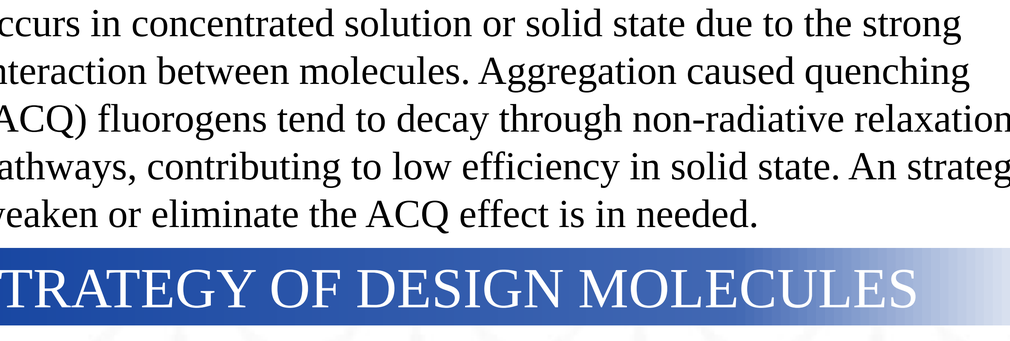

Figure. 3 Designed molecules

RESEARCH APPROACH

Task1 Design and synthesize molecules

Base on D-A structure and twisted structure of AIE(AEE) molecular，we design three molecules，（Take molecule 1 as an example）

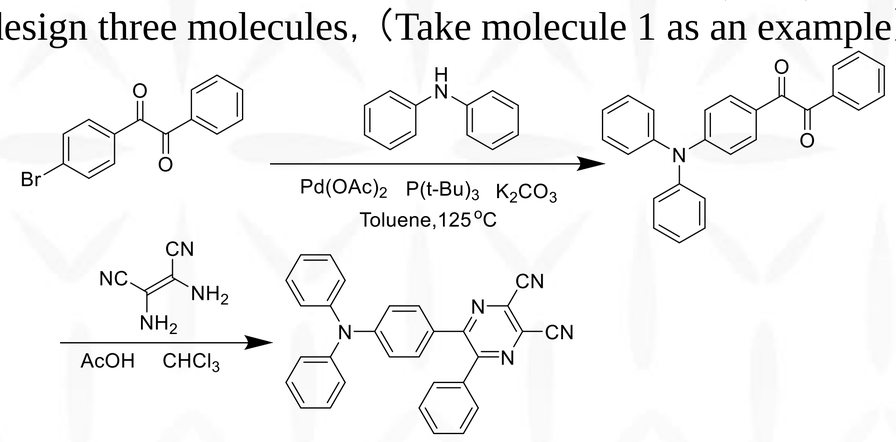

Figure. 4, Synthesis route of molecule 1（TPABZ）

Task 2 Characterization

1H NMR (400 MHz) and 13C NMR(100 MHz) spectra were recorded on a Bruker AMX-400 NMR spectrometer in deuterated solvent at room temperature, and chemical shifts were reported in ppm relative to tetramethylsilane (TMS, 0 ppm).

Task 3 Photophysics property measurement

Emission spectra were recorded on a Perkin-Elmer LS-55 luminescence spectrometer.

Task 4 Luminescent photography

Luminescent photographs are taken by a Canon 70D camera.

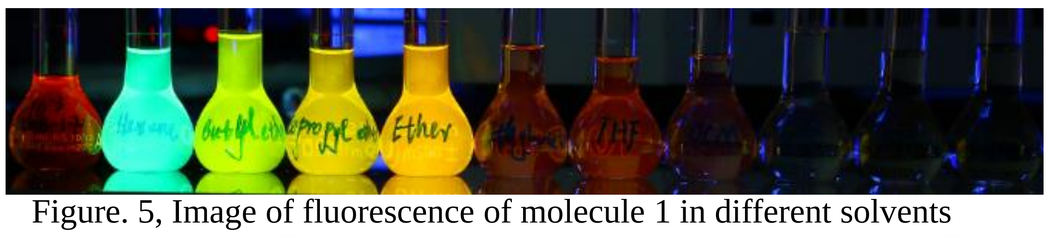

Figure. 5, Image of fluorescence of molecule 1 in different solvents

CONCLUSION

In summary, two novel D–π–A-structured luminogens, with AIE characteristics and high solid-state efficiency up to 40.2% have been synthesized. TPABPZ and TPABBPZ emit orange to red light with maxima at 572 and 594 nm respectively and both luminogens show high thermal and morphological stabilities. The AIE feature, high solid-state efficiency and excellent thermal and morphological stability render them highly promising candidates for versatile optoelectronic applications.

ACKNOWLEDGEMENT

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