DOCTORAL THESIS

Synthesis, Characterization and application studies of new aggregation-induced emission (AIE)-active materials

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Abstract

The structural design, synthesis and characterization of luminogens with aggregation-induced emission (AIE) properties are studied in this thesis. The remarkable emission properties, thermal stability and biocompatibility of the AIE-active materials demonstrate the promising applications in bioimaging and organic light-emitting diodes (OLEDs).

Chapter 1 introduces the existence of aggregation-caused quenching (ACQ) effect in most conventional organic dyes as well as phosphorescent transitional metal complexes. Discovery of AIE and its mechanical study allow further exploration of usage in organic luminescent materials. This chapter also gives some examples and the applications these AIE-active compounds.

In Chapter 2, a series of cyanostilbenes with simple electron donor (D)-π-electron acceptor (A) structure are presented and synthesized. They exhibit remarkable AIE effect as well as deep red emission peak in 95 % water fraction in THF. These results indicate that attachment of these electron acceptors provides alternative strategy for designing highly emissive AIE-active materials.

In Chapter 3, strongly emissive cyanostilbenes with phenothiazine unit are designed and synthesized. This chapter also investigates the effect of substituents in phenothiazine and terminal cyanostilbene on the photophysical properties and

AIE effect. The results suggest that they are AIE-active with different sizes in nano-aggregates. Furthermore, these dyes exhibit clear and strong fluorescence in live cell imaging with excellent biocompatibility.

In Chapter 4, a series of AIE-active phosphorescent Pt(II) complexes made up of C^N^C tridentate ligands are designed and synthesized. They exhibit different morphologies and emission properties upon aggregation in 90 % water in acetonitrile although similar tridentate ligands are applied. One of the complexes in this chapter show nano-rod formation with the highest quantum efficiency in aggregated state, suggesting that rapid self-assembly process occurs to prevent non-radiative decay and oxygen quenching.

In Chapter 5, a series of bis-cyanostyryl fluorophores are designed and synthesized. They are emissive in solid state with colour range from orange to NIR region. Furthermore, they are AIE-active and some of them may contain hybridized local and charge transfer (HLCT) excited state to achieve highly efficient emission upon solvatochromic investigation. Some bis-cyanostyryl thiophenes are fabricated in OLED devices show deep-red to NIR emission, indicative of a promising way to design solid-state NIR-emissive compounds using bis-cyanostyryl derivatives.

Finally, Chapter 6 and 7 present the concluding remarks and the experimental details of the work in Chapters 2 to 5, respectively.

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