Thermally-Activated Delayed Fluorescence in a Spiro-Acridine Derivative : Application for Efficient Organic Light-Emitting Diodes

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論文名　：Thermally-Activated Delayed Fluorescence in a Spiro-Acridine Derivative: Application for Efficient Organic Light-Emitting Diodes
(スピロアクリジン誘導体からの熱活性化型遅延蛍光および高効率有機 LED への応用)

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論　文　内　容　の　要　旨

Despite of the extensive efforts to develop high performance OLEDs by both academia and industry, there is still a need for introducing new, highly-efficient organic light-emitters for OLEDs and luminescent oxygen sensors. For example, the heavy metal-based phosphorescent emitters, although allowing for the preparation of high performance OLEDs, have prices tied to the availability of precious metals. Given the advantages of TADF emitters over phosphorescent and fluorescent molecules, as discussed in the previous sections, this thesis introduces a new type of metal-free TADF compound. We show that the new spiro-acridine derivative, ACRF, can be successfully utilized in OLEDs and has strong potential for application in molecular oxygen sensors. Moreover, we demonstrate that the most important PL and EL parameters of this compound, such as quantum yields and decay lifetimes, can be influenced, and therefore tuned for specific application, by using various small molecular host layers.

Chapter 2 contains the details of the experimental methods used throughout the thesis. We present two synthetic routes to obtain ACRF. Besides the fabrication methods of thin films and OLEDs and preparation way of solution samples, the methods used for obtaining the PL and EL results are described. Computation methods are also disclosed.

In **Chapter 3** we introduce ACRF. To achieve CT emission, following the guidelines from the previous sections of this chapter, we construct a *D*-*A* structure. Furthermore, the spatial separation of the HOMO and LUMO levels is addressed by twisting the conjugation between the *D* and the *A* moieties by a spiro-junction. We characterize the PL properties of ACRF in a neat film and doped into a small molecule host layer. Upon confirmation of an efficient TADF emission in ACRF, we investigate the EL performance of ACRF as an OLED-emitter, thereby mainly focusing on its ability to harvest both singlet and triplet excitons.

Realizing the importance of the host layer for ACRF, we devote **Chapter 4** to study the effects of various small-molecule host layers on the PL and EL performance of ACRF. Among the phenomena considered are energy transfer between the host and the guest molecules, and exciplex formation. Furthermore, since CT emitters have a significantly enhanced dipole moment in the excited state, we study how the PL properties in ACRF can be correlated with dipole field interactions between ACRF and the host molecules. Based on these effects, by choosing various host materials, we succeed in significant variation in the PL and EL quantum efficiencies and PL transient lifetimes of ACRF.

Chapter 5 demonstrates the quenching of the triplet excited state of ACRF doped into a host film by O_2. We explain the underlying mechanism of this effect, and show the potential of ACRF as an oxygen sensor doped into a polystyrene film, based on the quenching of its PL intensity and transient lifetime.

In **Chapter 6** we summarize and conclude the presented research.