General Requirements for TIGP Doctorial Program

TIGP Advisor of Academic Affairs

Dr. Chun-Faye Chao

Selection of thesis advisor

By the end of 1st year (the end of 2nd year for some programs)

Course work

Total 30 credits for graduated requirements; includes 12 credits for thesis and 18 credits program listed courses.

Double confirm with program coordinators during the course selecting window.

Qualification examination for Ph.D. candidacy

Pass qualification examination (in general, by the end of 2nd year)

Publication

- Depending on the regulation of each program
- Publication can be represented PhD candidate has to be listed as the 1st author
- Advisor has to be the correspondents
- Affiliation (See 2 examples from following slides)

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Binaphthalene bridged bipolar transporting materials for blue electroluminescence: toward high EL efficiency via molecular tuning

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ABSTRACT

Two isomeric bipolar transporting molecules containing arylamine and benzimidazole moieties linked by 1,1′-binaphthalene bridge have been synthesized and used for blue light-emitting diodes. The highly twisted binaphthalene bridge is beneficial for amorphous morphology, good solubility, high thermal stability and high photoluminescence quantum efficiency (Φ_{PL}). The charge transfer bands of these compounds exhibit interesting solvent-polarity dependent fluorescence properties. The physical properties of the compounds were tunable upon binding of the benzimidazole with binaphthalene group via C- (**BINAPC**) or *N*- (**BINAPN**) linkage. Three-layered blue-emitting OLEDs using **BINAPC** or **BINAPN** as the emitting layer, NPB as the hole transporting layer, and TPBI as the electron transporting layer as well as hole-blocking layer exhibit good performance. External quantum efficiencies of 2.48% with color coordinates of (0.15, 0.11) and 2.67% with color coordinates of (0.16, 0.16) were achieved for **BINAPC** and **BINAPN**, respectively.

1. Introduction

Organic light-emitting diodes (OLEDs) have potential applications in display and solid-state lighting.[1] In recent years, significant progress has been made on light-emitting materials for full color display and light source, including luminous efficiency, color purity, and lifetime.[2] Blue-, green-, and red-emitting materials provide three prime colors needed for OLEDs application. Though the development of red- and green-emitters for organic light emitting diodes (OLEDs) has been very satisfactory so far, progress on blue emitters with good stability and high efficiency still lag behind and there is much room for improvement in order to speed up light-emitting device technology.[3] Critical requirements for emissive materials in OLEDs include high luminescence quantum yield and color purity in the solid state, bipolar transport, good film morphology, and good thermal and redox stability.[2]

Both small molecules and polymers are commonly used as emitters of OLEDs. Compared to polymers, small molecules are easier to purify and have well-defined molecular weight. In contrast, small molecules have higher tendency to form crystals,[4] which frequently result in device failure. Therefore, proper design of small molecules for forming amorphous morphology is desired for OLEDs application. Moreover, amorphous materials with a high glass transition temperature have advantages over crystalline materials due to their good solubility and easy processability.[5] The binaphthalene entity is widely incorporated in molecules for sensor,[6] asymmetric catalysis,[7] non-linear optics,[8] and light-emitting diodes.[9] It was demonstrated that the binaphthalene moiety in a molecule could resist molecular crystallization and facilitate formation of glassy morphology.[10]

Our group has been interested in bipolar transporting materials because these molecules can more effectively confine excitons and improve the device performance and stability.[11] A straightforward design strategy for bipolar transporting molecules is to incorporate the hole- and electron-transporting moieties into a single molecule, i.e., the donor-acceptor type approach.[12] For blue emitters, the choice of suitable interconnection between the hole-transporting, electron-transporting, and π-conjugated spacer is crucial to avoid prominent bathochromic shift due to extended π-conjugation.[13] In 2011, Huang and co-workers reported bipolar blue-light emitting materials containing a hole-transporting triphenylamine moiety and an electron-transporting benzimidazole moiety at the C-9 and C-10 position of the anthracene.[14] By modified the number and position of phenyl bridge between functionalized moieties and anthracene core, the color and the energy levels of these materials were adjustable.

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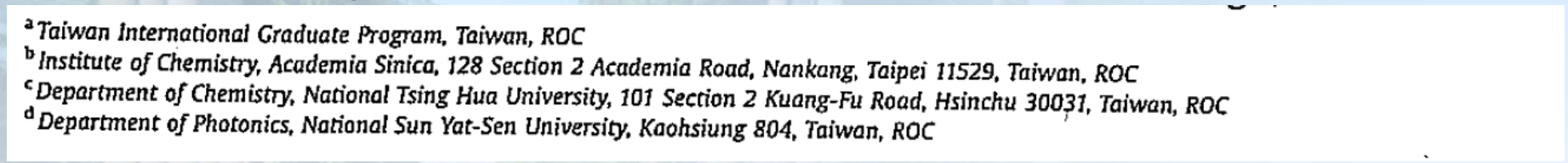
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Thesis defense

Depending on the regulation of the partner university