

# 發光硒化鎘量子點與其複材之製備 特性鑑定與應用

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## 摘 要

摘要本篇論文主要是探討螢光硒化鎘量子點與其複材之製備 特性鑑定與應用。其中包括：

第一章介紹螢光半導體奈米材料發現、合成、發光原理與應用，以及文獻回顧與研究動機。

第二章記錄螢光硒化鎘量子點材料相關的合成與特性鑑定方法。主要敘述硒化鎘量子點可由有機物（十六烷基胺）或是無機物（硫化鋅）包覆，達成防止聚集的效果。由十六烷基胺包覆的硒化鎘量子點，具有絕佳的螢光性。此外將少量的奈米金粒子與硒化鎘摻混，可以提升螢光性，推測這是由於奈米金所具備的表面電漿偶合作用，增強了硒化鎘的螢光性放射。

第三章敘述將親油性的螢光硒化鎘量子點，進行表面改質，形成具有親水性的螢光硒化鎘量子點。並將親水性的硒化鎘量子點與生物分子進行結合，利用其特殊的螢光特性，可達到生物檢測與標定功能，並期能應用於生物晶片。

第四章主要研究發現少量奈米硒化鎘可以有效增強磷光銥有機金屬錯合物的發光強度。只要奈米量子點的螢光發射波長符合銥有機金屬錯合物的吸收波長，量子點所發射的螢光將會被銥-錯合物所吸收，轉而增強銥有機金屬錯合物的磷光發射，推測一種由量子點→銥有機金屬錯合物的能量轉移機制在其中發生。本論文將實驗結果導入有機電激發光元件應用中，

以適量硒化鎘與鈦-錯合物作為發光層，製備有機電激發光元件，獲得不錯的成果。

第五章報導藉由少量的奈米金粒子與硒化鎘摻混，可以提升硒化鎘螢光發射強度，此乃由於奈米金所產生的表面電漿偶合作用，增強了奈米硒化鎘的螢光性。其發光效率約可提升 1.5 倍。我們以金-硒化鎘共摻物做為有機電激發光之發光層，並製備發光元件，研究顯示最佳發光效率可提升為原來的兩倍。

第六章總結本論文之研究成果與未來研究目標，本研究成功地將奈米硒化鎘量子點整合於有機發光元件(OLEDs)並能有效增強元件之發光效率，未來將研究如何將奈米無機螢光材料導入電激發光元件中，進而取代傳統之有機螢光材料。另一項研究重點是將水溶性奈米螢光量子點運用於生化檢測研究，相較於傳統有機螢光物，無機螢光量子點具有更佳之光學特性(如較窄之發射波長與較寬之激發能帶)，其取代傳統有機螢光劑並應用於生物檢測指日可期，上述都是未來研究之重點。

# **The Synthesis, Characterizations and Applications of Luminescent Core-Shell Type CdSe/ZnS and Au-CdSe/ZnS Quantum Dots**

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## ABSTRACT

This thesis is divided into six chapters. The contents in each chapter are described as followings.

In Chapter 1 an introduction of the general background of nanoparticles and luminescent materials for the current engineering science or bio-technology applications is presented.

Chapter 2 describes the synthesis of various II-VI semiconductor nanocrystals (i.e., CdSe, CdSe/ZnS, Au-CdSe) of desired sizes by chemical colloid methods and characterizations of their optical properties.

Chapter 3 reports the applications of surface-functionalized CdSe quantum dots in immuno-assay. Hydrophobic CdSe NPs were transferred to hydrophilic CdSe using MAA (or MSA) as the modified agents.

In Chapter 4 the interesting enhancement effects of phosphorescence and electroluminescence from triplet emitter by CdSe quantum dot doping are discussed.

Chapter 5 presents the enhanced luminescence of CdSe/ZnS by doping Au nanoparticles. These results are applied on electroluminescence devices. The quantum efficiencies of OLEDs were enhanced by about two times as compared to the corresponding blank device.

Chapter 6 summarized all experimental results and future works in the dissertation.



# 誌 謝

經過漫長的等待與努力，終於不負眾人的期待，完成博士學位，而轉眼求學生涯即將暫告結束，回想往日種種仍然歷歷在目，其中歡樂痛苦與痛苦夾雜，編織成美好的回憶，感謝所有在這段日子給我鼓勵與幫助的每一個人。

首先感謝我的指導教授 陳登銘老師，在這段求學的歷程中給予我的種種幫助，提供我良好的研究環境與發展空間，學生今日與將來的成就都將歸功於陳老師的無私的付出與指導，而老師平易近人的親切個性與廣博的知識也將是學生學習的典範。

另外，非常感謝材料所的 韋光華教授與應化系的 許千樹教授，有他們的實驗設備與材料上面的支持，學生才能專心的完成實驗，也感謝他們在研究上的指導與建議，使研究能更趨完善。感謝 刁維光老師與其實驗室學弟立揚與仕勳在光學量測上的協助與疑問的解答。感謝 陳金鑫老師實驗室的 榮安同學與 周卓輝老師實驗室的 永昇學弟在發光元件製作的協助與建議。

感謝我的好朋友也是好老師 Dr. Laskar，相處四年來讓我獲益良多，幫我解決了許多研究上的問題，也讓我學習到許多回教與印度人的生活知識，跟他相處也讓我的英文精進不少。感謝之前在許千樹老師實驗室的 清華、文欽與書文學長，以及學弟妹，晉彥、敏華、鐘毅、志偉、思源等人與大學同學 亮仁的支持與鼓勵，那段期間共處的日子令人懷念。

感謝眾多的實驗室學弟妹，信輔、映萱、曉雯、伯昌、康權、盈志、創弘、靜萍、德茹、婉甄、馨怡、怡今、彥吉、政玄、巨澤、繪茹、佳蓁、佩君、慧茹等等，感謝他們陪我度過了這漫長的求學生涯，我將永遠記得你們。其中尤其感謝 靜萍、康權、與慧茹在實驗上所給予的協助。感謝以前高師大化研所的師長、同學與學弟妹的鼓勵與支持，他們不時的鼓勵與關心，背後支持我完成這學業，蔡文亮老師與柯明育學長，在此致以感謝。其他在此未能提及的師長與朋友，感謝你們無私的支持與協助，希望你們也能收到我的感謝與分享我的喜悅。

特別感謝我的父母與家人無私的付出、關懷與支持，讓我能無後顧之憂安心完成學業，如今順利完成學位，也算達成父母的期盼。

最後感謝一直在背後默默支持我，我最親愛的老婆 志文，也因為進入交大就讀讓我得以結識她，感謝他陪我這麼久，如今我們也將步入禮堂，希望能將這份喜悅與她一同分享，未來的日子將一同渡過。

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## Abbreviations

<b>&lt; &gt;</b>	Averaged value
<b>Alq<sub>3</sub></b>	Tris(8-hydroxyquinolinato)aluminum(III)
<b>Au</b>	Gold
<b>Au-CdSe</b>	Gold-Cadmium Selenide (composite)
<b>Au-CdSe/ZnS</b>	Gold-Cadmium Selenide/Zinc Sulfide (composite)
<b>BSA</b>	Bovine serum albumin
<b>CdSe</b>	Cadmium Selenide
<b>CdSe/ZnS</b>	Cadmium Selenide/Zinc Sulfide (Core/Shell structure)
<b>EDAC</b>	1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide
<b>EDC</b>	Ethyl-3-(dimethylaminopropyl)-carbodiimide
<b>EDX</b>	Energy dispersive X-ray
<b>FWHM</b>	Full Width at Half Maximum
<b>HDA</b>	Hexadecylamine
<b>HRTEM</b>	High Resolution Transmission Electron Microscopy
<b>Ir-complex</b>	Iridium (III) complex
<b>ITO</b>	Indium tin oxides
<b>LED</b>	Light Emitting Device
<b>MA</b>	2-Mercapto-ethylamine
<b>MAA</b>	Mercaptoacetic acid
<b>MSA</b>	Mercaptosuccinic acid
<b>NC</b>	Nanocomposite
<b>NHS</b>	N-hydroxysulfo-succinimide
<b>NP</b>	Nanoparticle

<b>PBS</b>	Phosphate buffer solution
<b>PEDOT</b>	Poly(3,4-ethylenedioxythiophene)
<b>PL</b>	Photoluminescence
<b>PMMA</b>	Poly(methylmethacrylate)
<b>PSS</b>	Poly(4-styrenesulfonate)
<b>PVK</b>	Polyvinylcarazole
<b>P-XRD</b>	Powder X-Ray Diffraction
<b>TOPSe</b>	Tri-n-octylphosphine selenide
<b>PVK</b>	Polyvinylcarbazole
<b>QD</b>	Quantum Dot
<b>QE</b>	Quantum Efficiency
<b>RT</b>	Room Temperature
<b>SA</b>	Streptavidin
<b>SAXS</b>	Small-angle X-Ray Scattering
<b>SERS</b>	Surface-enhanced Raman scattering
<b>TBP</b>	Tri-n-butylphosphine
<b>TCSPC</b>	Time-correlated single photon counting
<b>TEM</b>	Transmission Electron Microscopy
<b>TOP</b>	Tri-n-octylphosphine
<b>TOPO</b>	Tri-n-octylphosphine oxide
<b>TOPS</b>	Tri-n-octylphosphine sulfide
<b>TOPSe</b>	Tri-n-octylphosphine selenide
<b>UV-Vis</b>	Ultraviolet-visible