



UNIVERSITI PUTRA MALAYSIA

**OPTICAL AND ELECTRICAL PROPERTIES OF
ORGANIC AND POLYMER LAYERS OF LIGHT
EMITTING DIODE STRUCTURE**

**LIM MEI YEE
FS 2011 23**

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The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a central red shield with a white book and a white torch. The shield is flanked by two white wings. The letters 'UPM' are written in white on a red background at the top of the shield. The shield is set against a light blue background.

LIM MEI YEE

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**OPTICAL AND ELECTRICAL PROPERTIES OF ORGANIC AND
POLYMER LAYERS OF LIGHT EMITTING DIODE STRUCTURE**

By

LIM MEI YEE

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

OPTICAL AND ELECTRICAL PROPERTIES OF ORGANIC AND POLYMER LAYERS OF LIGHT EMITTING DIODE STRUCTURE

By

LIM MEI YEE

March 2011

Chairman: Professor W. Mahmood Mat Yunus, PhD

Faculty: Science

The double and triplet layers of organic light emitting diode (OLEDs) and polymer light emitting diodes (PLEDs) were successfully fabricated by using thermal evaporation and dip coating method. The optical and electrical properties of OLEDs and PLEDs prepared from different thickness organic layers were studied.

For the double layer heterostructure OLEDs, N, N'-bis (Inaphthyl) - N, N'-diphenyl-1, 1'-biphenyl-4, 4'-diamine (NPB) used as hole transport layer (HTL) while tris (8-hydroxyquinolato) aluminum (Alq₃) used as a electron transport layer (ETL), Indium Tin Oxide (ITO) as the anode aluminium (Al) as a cathode, respectively. The optimum condition for the double layer OLEDs devices prepared with ITO / NPB (55 nm) / Alq₃ (84 nm) / Al (300 nm). In term of optical properties, this device has the lowest intensity of the light reflectance and the highest intensity of luminescence. This indicated that higher efficiency of the devices can be achieved

with the lower current efficiency. This double layer heterostructure OLEDs has the lowest turn on voltage 5.1 V.

The triplet layer OLEDs were fabricated in following order: ITO / NPB (55 nm) / CdS (130 nm) / Alq₃ (84 nm) / Al, where Cadmium sulfide (CdS) used as hole blocking layer (HBL) in the devices. The luminescence intensity increase for the device due to the 130 nm of CdS has high enough to efficiently prevent the migration of the triplet excitons out of the luminescent layer. The effect of the CdS blocking layer can also be seen in I-V characteristic. The turn on voltage for the 130 nm CdS multilayer OLED devices was predicated 2.9 V.

For the double layer heterostructure PLEDs, Poly (9-vinylcarbazole) (PVK) used as hole transport layer (HTL) while Alq₃ used ETL, ITO as the anode and aluminium (Al) as a cathode. The optimum condition for the double layer PLEDs devices prepared with ITO / PVK (77 nm) / Alq₃ (84 nm) / Al (300 nm). The photoluminescence for this device exhibit the highest intensity. The devices also obtained lowest turn on voltage, 5.9 V.

The triplet layer for the PLED fabricated with ITO / PVK (77 nm) / CdS (115 nm) / Alq₃ (84 nm) / Al (300 nm). In the PLED devices, a CdS layer was inserted between the 77 nm PVK and 84 nm Alq₃ which absorb the ambient light to reduce the reflection of device. With the inserting 115 nm of CdS layer between the PVK and Alq₃, a lower turn on voltage can be obtained at 5.4 eV.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doctor Falsafah

**KECIRIAN OPTIK DAN ELEKTRIK UNTUK LAPISAN ORGANIK DAN
POLIMER DALAM STRUKTUR DIOD PEMANCARAN CAHAYA**

Oleh

LIM MEI YEE

Mac 2011

Pengerusi : Profesor W. Mahmood Mat Yunus, PhD

Fakulti : Sains

Diod pemancar cahaya organik (OLEDs) dan diod pemancar cahaya polimer (PLEDs) terdiri daripada dua dan tiga lapisan filem telah berjaya dihasilkan melalui kaedah pengewapan therma dan salutan pencelupan. Kecirian optik dan elektrik untuk OLEDs dan PLEDs dengan ketebalan yang berlainan telah dilakukan.

Untuk lapisan berganda heterostruktur OLEDs, N, N'-diphenyl-1, 1'-biphenyl-4, 4'-diamine (NPB) digunakan sebagai lapisan pengangkut lohong (HTL), tris (8-hidroksiquinolin) aluminium (Alq₃) digunakan sebagai lapisan pengangkut elektron, indium timah oksida (ITO) sebagai anod dan aluminium sebagai katod. Lapisan berganda OLEDs berstruktur ITO / NPB (55 nm) / Alq₃ (84 nm) / Al (300 nm) telah disediakan dalam keadaan optima. Dari segi kecirian optik, peranti ini menunjukkan keamatan terendah dari kepantulan cahaya dan keamatan luminesens yang tertinggi. Keadaan ini membolehkan pencapaian kecekapan yang tinggi dalam

peranti itu apabila kecekapan arus yang rendah. Lapisan berganda heterostruktur OLEDs ini men dapat voltan mula menyala yang terendah iaitu 5.1 V.

Lapisan triplet OLEDs telah dihasilkan mengikut susunan berikut: ITO / NPB (55 nm) / CdS (130 nm) / Alq₃ (84 nm) / Al, di mana Cadmium sulfide (CdS) digunakan sebagai lapisan sekatan lohong (HBL) dalam peranti itu. Keamatan luminesens semakin bertambah dalam peranti kerana 130 nm CdS mempunyai kecekapan yang cukup untuk mengelakkan penghijrahan eksiton keluar dari lapisan luminesen. Kesan lapisan CdS boleh melihat dalam pencirian I-V. Voltan mula menyala untuk 130 nm CdS dalam multilapisan peranti OLEDs telah dijangka 2.9 V.

Untuk lapisan berganda heterostruktur PLEDs, poli (9-vinilkarbazol) (PVK) telah digunakan sebagai HTL, Alq₃ digunakan sebagai ETL, ITO sebagai anod dan aluminium sebagai katod. Keadaan optima untuk lapisan berganda PLEDs telah disediakan mengikut ITO / PVK (77 nm) / Alq₃ (84 nm) / Al (300 nm). Keamatan luminesens untuk peranti ini adalah tinggi. Peranti ini juga mencapai voltan mula menyala yang rendah, 5.9 V.

Lapisan triplet PLED telah dihasilkan mengikut ITO / PVK (77 nm) / CdS (115 nm) / Alq₃ (84 nm) / Al (300 nm). Dalam peranti PLED ini, lapisan CdS telah dimasukkan di antara 77 nm PVK dan 84 nm Alq₃ bertujuan menyerap cahaya sekeliling untuk menurunkan pantulan dalam peranti itu. Dengan menggunakan 115 nm CdS di antara PVK dan Alq₃, voltan mula menyala yang rendah iaitu 5.4 V telah dicapai.

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I certify that an Examination Committee has met on 11 March 2011 to conduct the final examination of Lim Mei Yee on her Doctor of Philosophy thesis entitled “Optical and Electrical Properties of Organic and Polymer Layers of Light Emitting Diode Structure” in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P. U. (A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Examination Committee are as follows:

Abdul Halim bin Shaari, PhD

Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Azmi bin Zakaria, PhD

Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Zaidan bin Abdul Wahab, PhD

Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Zhiyan Xie, PhD

Professor
ChangChun Institute of Applied Chemistry
Chinese Academy of Science
China
(External Examiner)

NORITAH OMAR, PhD

Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 24 May 2011

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

W. Mahmood Mat Yunus, PhD

Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Zainal Abidin Talib, PhD

Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Anuar bin Kassim, PhD

Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

HASANAH MOHD GHAZALI, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

LIM MEI YEE

Date: 11 March 2011

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