STRUCTURAL, OPTICAL AND ELECTRICAL PROPERTIES OF MOLECULAR HYBRID FILMS BASED ON RARE EARTH QUINOLINE COMPLEXES (REQ_3) CHELATED WITH BIDENTATE LIGANDS

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Abstract

The molecular hybrid compound based on metal quinoline, Mq_3 complexes were expected to give good electroluminescence and carrier transport properties. However, obtaining pure emission colour from the metal quinolinate complexes has always been a problem because most of the materials exhibit broad emission spectra with a full width at half maximum (FWHM) around 50-200 nm. The combined properties of rare earth as the metal centre and tris-(8-hydroxyquinolates) (8Hq) as the chelating ligand (centre ligand) as well as the adduction of the bidentate ligand which are 1,10-phenanthroline (Phen) and 2,2- bipyridine (Bpy) as the secondary ligand make these rare earth quinoline (Req_3) ternary complexes ideal for use in optoelectronic devices. In this work, four different Req_3 ternary complexes namely, Euq_3bpy_3, Euq_3phen_3, Tbq_3bpy_3 and Tbq_3phen_3 were synthesized and coated as thin films by spin coating technique. The FTIR and XRD measurements were performed in order to study the spectroscopic and structural nature of the film. The thermal properties were evaluated from TGA/DTG analysis. The UV-Vis and PL measurement were also carried out. UV-Vis absorption results reveal that the absorption process of the Req_3 complexes are dominated by the neutral ligand (secondary ligand) indicating that chelated ligand has overcome the limitation of an intrinsically absorption coefficient for the rare earth metals (Re^{3+}) . It is also proven that the different degree in the green coloured fluorescence detected in the PL spectra is due to the fact that the energy transfer between the triplet state and the Re^{3+} is inefficient. The J-V characteristics of Req_3 ternary complexes film are also investigated. The Richardson-Schottky thermionic emission is found to dominate the transport mechanism. The electronics parameters of the ITO/Req_3 ternary complexes/Al are also extracted from the conventional ln J- V and Cheung's functions.

Abstrak

Kompleks hibrid logam quinoline, Mq_3 dijangka akan memberikan ciri-ciri elektroluminensi dan angkutan pembawa yang baik. Walaubagaimanapun, adalah sukar untuk memperolehi pancaran warna tulen daripada bahan ini yang kebanyakannya memaparkan spektrum pancaran yang lebar penuh pada maksimum setengah (FWHM) di antara 50-200 nm. Gabungan ciri-ciri daripada logam nadir bumi, Re^{3+} sebagai pusat logam dan tris-(8-hydroxyquinolates) (8Hq) sebagai ligan pusat dan juga bidentate ligan sebagai ligan neutral menjadikan kompleks nadir bumi quinoline ternari Req_3 ini sesuai digunakan untuk aplikasi optoelektronik. Di dalam penyelidikan ini, empat jenis Req_3 iaitu Euq_3bpy_3, Euq_3phen_3, Tbq_3bpy_3 and Tbq_3phen_3 telah disentesis dan dijadikan filem nipis dengan mengunakan kaedah salutan putaran. Pengukuran transformasi inframerah Fourier (FTIR) dan analisis belauan sinar-x (XRD) telah digunakan untuk mengkaji spektroskopi dan jenis struktur filem tersebut. Sifat haba bahan tersebut dikaji melalui analisis termogravimetrik (TGA / DTG). Pangukuran penyerapan ultra-lembayung-nampak (UV-Vis) dan fotoluminensi (PL) juga dijanakan. Daripada pengukuran UV-Vis, didapati proses penyerapan kompleks ternari Req_3 didominasi oleh ligan neutral. Ini menunjukkan bahawa ligan tersebut telah mengatasi had penyerapan logam Re^{3+}. Selain itu, warna hijau berpendaflour yang berbeza juga telah dikesan di dalam spektra PL disebabkan oleh pemindahan tenaga diantara keadaan triplet dan logam Re^{3+} adalah tidak cekap. Kajian keatas pengukuran J-V bagi ITO/Req_3/Al juga dibuat. Mekanisme Richardson-Schottky termionik didapati mendominasi kesuluruhan mekanisma angkutan. Parameter elektronik juga di ekstrak dari keadah konvensional ln J- V dan fungsi Cheung.

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Table of Contents

ORIGINAL LITERARY WORK DECLARATION ii
Abstract iii
Abstrak iv
Acknowledgement v
Table of Contents vii
List of figures xi
List of tables xvi
List of abbreviations xvii
List of publications xviii
Chapter 1. Introduction 1
1.1. Motivation and research overview 1
1.2. History on molecular hybrid compound 4
1.3. Research objectives 6
1.4. Organization and scope of the thesis 7
Chapter 2. Theoretical background 11
2.1. Introduction 11
2.2. Organic semiconductor 11
2.3. Absorption and optical band gap in organic semiconductor 13
2.4. Luminescence of organic semiconductor 15
2.5. Organic light emitting devices (OLED) 21
2.6. Operating principle in OLED 23
2.6.1. Charge injection mechanism (injection limitation at the contact) 26
2.6.2. Charge transport mechanism (transport limitation in the bulk) 27
2.7. Rare-earth metal complexes 31
2.7.1. Eu^{3+} luminescence 33
2.7.2. Tb^{3+} luminescence 34
2.7.3. Energy transfer mechanism (sensitization) 35
2.7.4. Ligand 37
Chapter 3. Experimental Details 38
3.1. Introduction 38
3.2. Materials 38

3.3. Synthesis of molecular hybrid compound based on the rare earth metal quinoline ternary complexes (Req_3) chelated with 2,2-bipyridine (Bpy) and 1,10-Phenanthroline (Phen) as neutral ligand 39

3.3.1. Europium (III) Tris-(8-hydroxyquinoline)-Tris-(2,2-Bipyridyl) (Euq_3bpy) 39

3.3.2. Terbium (III) Tris-(8-hydroxyquinoline)-Tris-(2,2-Bipyridyl) (Tbq_3bpy)40

3.3.3. Europium (III) Tris-(8-hydroxyquinoline)-Tris-(1,10-phenanthroline) (Euq_3phen3)..... 41

3.3.4. Terbium (III) Tris-(8-hydroxyquinoline)- Tris-(1,10-phenanthroline) (Tbq_3phen_3)..... 42

3.4. Preparation of rare earth quinoline, Req_3 ternary complexes thin films by spin coating method 43

3.4.1. Overview..... 43

3.4.2. Substrates cleaning procedure..... 44

3.4.3. Solution preparation..... 45

3.4.4. Thin film deposition..... 45

3.5. Device Fabrication 47

3.5.1. Overview..... 47

3.5.2. ITO preparation..... 47

3.5.3. Thermal vacuum evaporation system 48

3.5.4. Aluminum electrode deposition..... 49

3.6. Measurement and Characterization..... 51

3.6.1. Overview..... 51

3.6.2. Thickness measurement 51

3.6.3. Fourier Transform Infrared (FTIR)..... 53

3.6.4. X-ray diffraction (XRD) 54

3.6.5. Analyzer and Differential Scanning Calorimeter 55

3.6.6. UV-vis Spectrometer 56

3.6.7. Photoluminescence Spectrometer 58

3.6.8. Current- voltage (I-V) and luminescence (L) measurement 59

Chapter 4. Structural and thermal properties.....61

4.1. Introduction..... 61

4.2. Fourier Transform Infrared Spectroscopy (FTIR) 62

4.2.1. Euq_3bpy_3 and Euq_3phen_3..... 62

4.2.2. Tbq_3bpy_3 and Tbq_3phen_3..... 65

4.3. X-Ray diffraction analysis 68
4.3.1. Euq_3bpy_3 and Euq_3phen_3 68
4.3.2. Tbq_3bpy_3 and Tbq_3phen_3 69
4.4. DSC-TGA analysis 70
4.4.1. Euq_3bpy_3 and Euq_3phen_3 70
4.4.2. Tbq_3bpy_3 and Tbq_3phen_3 73
4.5. Conclusion 75
Chapter 5. Optical properties 76
5.1. Introduction and overview 76
5.2. UV-Vis absorption spectroscopy 77
5.2.1. Euq_3bpy_3 and Euq_3phen_3 77
5.2.2. Tbq_3bpy_3 and Tbq_3phen_3 80
5.2.3. Effect of different rare earth metals 82
5.3. Band gap analysis 84
5.3.1. Euq_3bpy_3 and Euq_3phen_3 84
5.3.2. Tbq_3bpy_3 and Tbq_3phen_3 87
5.3.3. Effect of different rare earth metals 90
5.4. Photoluminescence study 91
5.5. Energy transfer study 93
5.5.1. Euq_3bpy_3 and Euq_3phen_3 93
5.5.2. Tbq_3bpy_3 and Tbq_3phen_3 98
5.5.3. Effects of the rare earth metals on the energy transfer mechanism of Req_3 ternary complexes 100
5.6. Conclusion 102
Chapter 6. Electrical properties 103
6.1. Introduction 103
6.2. Electrical analysis for single layer OLED device with ITO/Euq_3 ternary complexes/Al structure (Europium as the metal centre) 104
6.2.1. I- V characteristics of ITO/Euq_3 ternary complexes/Al structure 104
6.2.2. Charge transport mechanism of ITO/Euq_3 ternary complexes/Al structure: Contact limited versus bulk limited 107
6.2.3. Evaluation of electronic parameters for the ITO/Euq_3 ternary complexes/Al structure 111
6.3. Electrical analysis for single layer OLED device with ITO/Tbq_3 ternary complexes/Al structure (Terbium as the metal centre) 121

6.3.1. I-V characteristics of ITO/Tbq_3 ternary complexes/Al structure 121

6.3.2. Charge transport mechanism of ITO/Tbq_3 ternary complexes/Al structure Contact limited versus bulk limited..... 123

6.3.3. Evaluation of electronic parameters for the ITO/Tbq_3 ternary complexes/Al structure..... 126

6.4. Electrical analysis for single layer OLED device with ITO/Req_3 ternary complexes/Al structure: Effect of different metal centre. 132

6.4.1. I-V characteristics of ITO/Req_3 ternary complexes/Al structure 132

6.4.2. Charge transport mechanism of ITO/Req_3 ternary complexes/Al structure 134

6.4.3. Evaluation of electronics parameter for the with ITO/Req_3 ternary complexes/Al structure..... 134

6.5. Conclusion 137

Chapter 7. Conclusions and future works.....138

7.1. Conclusions..... 138

7.2. Future works 143

References.....145

List of figures

Chapter 1

Figure 1.1 Research methodology design 10

Chapter 2

Figure 2.1 Schemes of (a) a double bond of two sp2-hybridised carbon atoms, which consists of σ and π bond, and (b) a delocalized π system of a benzene molecule. 12

Figure 2.2 Molecular structure of (a) anthracene (small molecule) and (b) the monomer repeat unit of substituted polythiophene (polymer) 13

Figure 2.3 Jablonski diagram illustrated absorption, internal and external conversion, fluorescence, intersystem crossing and phosphorescence process..... 16

Figure 2.4 Schematic diagram showing (a) spin pair and unpaired in S1 and T1 respectively and (b) absorption, fluorescence and phosphorescence spectra. 17

Figure 2.5 Molecular structure of (a) small molecules and (b) polymer fluorescent materials (JUNHONG, 2009) 19

Figure 2.6 Molecular structures of transition heavy metal complexes that have been widely used as emitter in OLED (JUNHONG, 2009). 20

Figure 2.7 (a) Schematic of the structure of an OLED, (b) mechanism in OLED (1) Charge injection (2) Charge transport (3) Exciton formation (4) Light emission. 21

Figure 2.8 Step by step mechanism of generation of light in a typical OLED structure. 22

Figure 2.9 Schematic energy band diagrams for charge carrier injection, transport, recombination and leakage as a function of applied voltage (Y. Kim & Ha, 2008). 25

Figure 2.10 Schematic illustration of charge transport regimes consists of ohmic, SCLC, TCLC and TSFCL..... 28

Figure 2.11Molecular structures of (a) $Eu(TTFA)_3$phen and (b) $Tb(ACA)_3$ phen (He et al., 2008; Male, Salata, & Christou, 2002) 32

Figure 2.12 Typical emission spectrum of europium complexes (Liang & Xie, 2010) . 33

Figure 2.13 Typical emission spectrum of terbium complexes (Yan & Wang, 2007) ... 35

Figure 2.14 Energy transfer process of rare-earth metal complexes..... 36

Chapter 3

Figure 3.1 Molecular structure of (a) europium(III)nitrate, (b) terbium(III)nitrate, (c) 8Hq, (d) Bpy and (e) Phen 38

Figure 3.2 Synthesis process and molecular structure of Euq_3bpy_3 40

Figure 3.3 Synthesis process and molecular structure of Tbq_3bpy_3 41

Figure 3.4 Synthesis process and molecular structure of Euq_3phen_3 42

Figure 3.5 Synthesis process and molecular structure of Tbq_3phen_3 43

Figure 3.6 Photograph depicting the spin coater used in this research. The spin speed and time are set in the program provided by this machine 46

Figure 3.7 Schematic diagram showing process of spin coating to produce thin film. This spin coating process involve three major step which are; first, the dispense of an excessive amount of substance, second, spin casting and the third one is the drying process 46

Figure 3.8 Schematic diagrams showing the preparation of ITO substrate for device fabrication 48

Figure 3.9 Schematic diagram showing thermal evaporation arrangement within the vacuum chamber 49

Figure 3.10 Photograph depicting the thermal evaporator (EDWARDS 306) used in this research 50

Figure 3.11 OLED architecture consists of spin coated Req3 ternary complexes layer sandwiched between the ITO and aluminum electrode 50

Figure 3.12Schematic diagram showing the thickness measurement 52

Figure 3.13 Photograph depicting KLA TENCOR P-6 surface profilometer used to measure thickness in this research 52

Figure 3.14 Schematic diagram showing optical path of Fourier transform infrared spectrophotometer 53

Figure 3.15 Photograph depicting the Perkin-Elmer System 2000 Fourier transforms infrared (FTIR) spectrometer that has been used to examining the FTIR spectra of the films 54

Figure 3.16 (a) schematic diagram of TGA/DTG and (b) photograph depicting the Perkin Elmer (TGA)/ Pyris 1 (DSC) Thermogravimetric instrument that has been used to investigate the thermal properties. 56

Figure 3.17 Schematic of double beam UV-Visible spectrometer to measure absorption spectra in the wave length range of 200 nm -2500 nm. 57

Figure 3.18 Possible electronic transition of π,σ and n electrons 57

Figure 3.19 Photograph depicting the UV-VIS/NIR Spectrometer (model Jasco 570) that have been used to investigate the absorption properties. 58

Figure 3.20 (a) A schematic diagram of the photoluminescence mechanism and (b) Photograph depicting Perkin-Elmer Luminescence Spectrometer (model LS50B) that has been used to investigate the photoluminescence properties 59

Chapter 4

Figure 4.1 FTIR spectra of Euq_3bpy_3 and Euq_3phen_3 thin films range from 400- 1800 cm^{-1} 63

Figure 4.2 FTIR spectra of Tbq_3bpy_3 and Tbq_3phen_3 thin films range from 400- 1800 cm^{-1} 66

Figure 4.3 X-ray diffraction (XRD) patterns of (a) Euq_3bpy_3 and (b) Euq_3phen_3 68

Figure 4.4 X-ray diffraction (XRD) patterns of (a) Tbq_3bpy_3 and (b) Tbq_3phen_3 69

Figure 4.5 TGA and DTA traces of Euq_3bpy_3 71

Figure 4.6 TGA and DTG traces of Euq_3phen_3 72

Figure 4.7 TGA and DTG traces of Tbq_3bpy_3 74

Figure 4.8 TGA and DTG traces of Tbq_3phen_3 74

Chapter 5

Figure 5.1 UV-Vis absorption spectra of (a) Euq_3bpy_3 and (b) Euq_3phen_3 thin films.... 78

Figure 5.2 UV-Vis absorption spectra of (a) Tbq_3bpy_3 and (b) Tbq_3phen_3 thin films.... 81

Figure 5.3 UV-Vis absorption spectra of (a) Euq_3bpy_3 and (b) Tbq_3bpy_3 thin films 83

Figure 5.4 UV-Vis absorption spectra of (a) Tbq_3phen_3 and (b) Euq_3phen_3 thin film ... 84

Figure 5.5 Graph of $d\ln(\alpha hv)/dhv$ vs. hv of Euq_3bpy_3 and Euq_3phen_3 thin films that is used to determine the estimate value of E_g. 86

Figure 5.6 Graph of ln (αhv) vs ln (hv-Eg) of (a) Euq_3Bpy_3 (b) Euq_3phen_3 thin films. The slope of the graph gives the estimation value of n which indicates the transition of the band gap. 86

Figure 5.7 Graph of $(\alpha hv)^2$ vs hv of (a) Euq_3bpy_3 and (b) Euq_3phen_3 thin films thin film. The band gap can be extrapolated from a straight line to $hv = 0$ 87

Figure 5.8 Graph of dln(αhv)/dhv vs. hv of Tbq_3bpy_3 and Tbq_3phen_3 thin films that is used to determine the estimate value of E_g 88

Figure 5.9 Graph of ln (αhv) vs ln (hv-Eg) of (a) Tbq_3phen_3 and (b) Tbq_3bpy_3 thin films. The slope of the graph gives the estimation value of n which indicates the transition of the band gap. 89

Figure 5.10 Graph of $(\alpha hv)^2$ vs hv of (a) Tbq_3bpy_3 and (b) Tbq_3phen_3 thin film. The band gap can be extrapolated from a straight line to $hv = 0$ 89

Figure 5.11 Graph of $(\alpha hv)^2$ vs hv of (a) Euq_3bpy_3 and (b) Tbq_3bpy_3 thin film. The band gap can be extrapolated from a straight line to $hv = 0$ 90

Figure 5.12 Graph of $(\alpha hv)^2$ vs hv of (a) Euq_3phen_3 and (b) Tbq_3phen_3 thin film. The band gap can be extrapolated from a straight line to $hv = 0$ 91

Figure 5.13 Req_3 ternary complexes luminescence characteristics 92

Figure 5.14 A schematic diagram of the proposed energy transfer process in the Euq_3phen_3 and Euq_3bpy_3 ternary complexes 96

Figure 5.15 A schematic diagram of the proposed energy transfer process in the Tbq_3phen_3 and Tbq_3bpy_3 ternary complexes 99

Figure 5.16 A schematic diagram of the proposed energy transfer process in Req_3 ternary complexes 101

Chapter 6

Figure 6.1 I- V characteristics of single layer devices of (a) ITO/ Euq_3bpy_3/Al (b) ITO/ Euq_3phen_3/Al..... 105

Figure 6.2 Logarithmic plot of I- V characteristic of ITO/ Euq_3bpy_3/Al..... 109

Figure 6.3 Logarithmic plot of I- V characteristic of ITO/ Euq_3phen_3/Al..... 109

Figure 6.4 Richardson-Schottky (R-S) plot of I- V characteristics of (a) ITO/ Euq_3bpy_3/Al and (b) ITO/ Euq_3phen_3/Al 111

Figure 6.5 I- V characteristics (I- V) of single layer devices of (a) ITO/ Euq_3bpy_3/Al and (b) ITO/ Euq_3phen_3/Al 113

Figure 6.6 dV/d(lnI)-I plot of single layer devices of (a) ITO/ Euq_3bpy_3/Al and (b) ITO/ Euq_3phen_3/Al..... 116

Figure 6.7 H(I)-I plot of single layer devices of (a) ITO/ Euq_3bpy_3/Al and (b) ITO/ Euq_3phen_3/Al..... 117

Figure 6.8 Schematic band diagram of (a) ITO/ Euq_3phen_3/Al and (b) ITO/ Euq_3bpy_3/Al after contact..... 120

Figure 6.9 I-V characteristics of single layer devices of (a) ITO/ Tbq_3bpy_3/Al, (b) ITO/ Tbq_3phen_3/Al..... 122

Figure 6.10 Logarithmic plot of I-V characteristic of ITO/ Tbq_3bpy_3/Al..... 124

Figure 6.11 Logarithmic plot of I-V characteristic ITO/ Tbq_3phen_3/Al 124

Figure 6.12 Richardson-Schottky plot of I- V characteristics of (a) ITO/ Tbq_3bpy_3/Al and (b) ITO/ Tbq_3phen_3/Al 125

Figure 6.13 I- V characteristics of single layer devices of (a) ITO/ Tbq_3bpy_3/Al and (b) ITO/ Tbq_3phen_3/Al..... 127

Figure 6.14 dV/d(ln I)- I plot of single layer devices of (a) ITO/ Tbq_3bpy_3/Al and (b) ITO/ Tbq_3phen_3/Al..... 128

Figure 6.15 H(I)- I plot of single layer devices of (a) ITO/ Tbq_3bpy_3/Al and (b) ITO/ Tbq_3phen_3/Al..... 129

Figure 6.16 Schematic band diagrams of (a) ITO/ Tbq_3phen_3/Al and (b) ITO/ Tbq_3bpy_3/Al after contact 131

Figure 6.17 I- V characteristics of single layer devices of ITO/ Euq_3bpy_3/Al and ITO/ Tbq_3bpy_3/Al 132

Figure 6.18 I- V characteristics of single layer devices of ITO/ Euq_3phen_3/Al and ITO/ Tbq_3phen_3/Al..... 133

List of tables

Chapter 4

Table 4.1 Assignments for the vibrational spectra of Figure 4.1……... 63

Table 4.2 Assignments for the vibrational spectra of Figure 4.2……... 67

Table 4.3 Characteristics parameters of thermal decomposition for Euq_3bpy_3 and Euq_3phen_3 complexes……... 72

Table 4.4 Characteristics parameters of thermal decomposition for Tbq_3bpy_3 and Tbq_3phen_3 complexes……... 75

Chapter 5

Table 5.1 Electronic transition of Eu^{3+} and Tb^{3+} from higher excited state with their assignments. These values are obtained from literature (Biju, Reddy, & Freire, 2007) ……..... 98

Table 5.2 Triplet and singlet excited values for 8Hq, Bpy and Phen ligand…… 98

Chapter 6

Table 6.2 Various parameters extracted from the I- V characteristics of ITO/ Euq_3phen_3/Al and ITO/ Euq_3bpy_3/Al……..... 113

Table 6.3 Various parameters extracted from the I- V characteristics of ITO/ Tbq_3phen_3/Al and ITO/ Tbq_3bpy_3/Al……..... 130

Table 6.4 Various parameters extracted from the I- V characteristics of ITO/ Euq_3bpy_3/Al and ITO/ Tbq_3bpy_3/Al……..... 133

Table 6.4 Various parameters extracted from the I- V characteristics of ITO/ Euq_3phen_3/Al and ITO/ Tbq_3phen_3/Al……..... 136

List of abbreviations

Eu	Europium
Tb	Terbium
8Hq	8-hydroxyquinoline
Phen	1,10- phenanthroline
Bpy	2,2-bipyridine
Mq_3	Metal (III) Tris-(8-hydroxyquinoline)
Req_3	Rare earth (III) Tris-(8-hydroxyquinoline) / rare earth quinoline
Erq_3	Erbium (III) Tris-(8-hydroxyquinoline) / erbium quinoline
Euq_3	Europium (III) Tris-(8-hydroxyquinoline) / europium quinoline
Tbq_3	Terbium (III) Tris-(8-hydroxyquinoline) / terbium quinoline
Euq_3phen_3	Europium (III) Tris-(8-hydroxyquinoline)-Tris-(1,10-phenanthroline)
Tbq_3phen_3	Terbium (III) Tris-(8-hydroxyquinoline)-Tris-(1,10-phenanthroline)
Euq_3bpy_3	Europium (III) Tris-(8-hydroxyquinoline)-Tris-(2,2-bipyridine)
Tbq_3bpy_3	Terbium (III) Tris-(8-hydroxyquinoline)-Tris-(2,2-bipyridine)
R-S	Richardson Schottky
F-N	Fowler Nordheim
SCLC	Space charge limited current
TFSCLC	trapped filled space charge limited current
P-F	Poole Frenkel

List of publications

Full-paper and conference proceeding (ISI-cited)

Eny Kusrini, Muhammad I. Saleh, Rohana Adnan, Yoki Yulizar, Ng Sha Shiong, H.K. Fun, M.A. Adhha Abdullah, Mazidah Mamat, **N.K. Za'aba** and W.H. Abd. Majid, "Structural, optical and electrical properties of europium picrate tetraethylene glycol complex as emissive material for OLED" Journal of Luminescence 132 (2012) 91

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