
Contents

1	Introduction	6
1.1	Polymeric light-emitting diodes and reasons for us to choose heavy metal complexes as dopants	6
1.2	Literature review	8
2	Fabrication Process for Devices	12
2.1	Etching for ITO patterns.	12
2.2	Preparations for the solutions	12
2.3	ITO cleaning process.	14
2.4	Spincoating.	15
2.4.1	Spin coating PEDOT-PSS on the ITO.	17
2.4.2	Spin casting the first layer on the PEDOT-PSS.	17
2.4.3	Spin coating the second layer in use of the buffer-layer technique.	17
2.5	Removing unwanted parts with Acetone.	21
2.6	Thermal-evaporating the cathodes.	23
2.7	Packaging and measuring of the devices	24
3	Highly Efficient Green-emitting Devices	27
3.1	Single-layer devices with different insulating layers between the light emitting layer and the calcium cathode.	28
3.2	Single-layer devices with the CsF/Al cathode in conditions of different thicknesses of the light-emitting layer and of the CsF layer	34

3.3	Double-layer devices with combinations of different insulating layers and different cathodes	40
3.4	Tri-layer structures with TPBI as the electron-transporting layer	45
3.5	Conclusions of Highly Efficient Green-emitting Devices	47
4	Future Work	49
A	The Effect of TPD Concentration on Device Efficiency	57
B	Double-layer Devices with PMMA-adulterated TPBI as the Electron-transporting Layer at the Cathode	60



List of Figures

1.1	Schematic structure of a Polymer Light Emitting Diode. . . .	6
1.2	Formation of an excitation.	7
1.3	Schematic structure of a Polymer Light Emitting Diode after improvements with multiple layers.	10
1.4	Energy diagram of the biased PLED with the multilayer structure.	11
2.1	Schematic description of photo patterning of our ITOs.	13
2.2	Two active areas of $3mm \times 3mm$ for each.	13
2.3	Four active areas of $2mm \times 2mm$ for each.	13
2.4	The chemical structure of Chlorobenzene.	13
2.5	A 1-centimeter magnetic stirrer.	14
2.6	Comparisons between films with solvents of THF or xylene. . .	16
2.7	The filtering gadget	16
2.8	The process of buffer-layer technique of Step 1.	19
2.9	The process of buffer-layer technique of Step 2.	19
2.10	The process of buffer-layer technique of Step 3.	20
2.11	The process of buffer-layer technique of Step 4.	20
2.12	Baking at a wrong temperature for PVK-PBD blend.	21
2.13	Successful double-layer samples and failed ones.	22
2.14	Removing unnecessary part by acetone.	23
2.15	A packaged device.	25
2.16	The cleaning process of ITO substrates.	26
2.17	Spin-coating organic films.	26

3.1	The energy diagram of the single-layer devices.	28
3.2	An example of a bad combination of shifted energy bands about the host and the guest.	29
3.3	Chemical structures of the materials.	29
3.4	J-V diagram for single-layer devices with CsF/Ca/Al or LiF/Ca/Al	30
3.5	L-V diagram for single-layer devices with CsF/Ca/Al or LiF/Ca/Al	31
3.6	Y-J diagram for single-layer devices with CsF/Ca/Al or LiF/Ca/Al	32
3.7	PCE-J diagram for single-layer devices with CsF/Ca/Al or LiF/Ca/Al	33
3.8	Y-J diagram for single-layer devices with various CsF thick- nesses.	34
3.9	L-V diagram for single-layer devices with various CsF thick- nesses.	35
3.10	J-V diagram for single-layer devices with various CsF thick- nesses.	36
3.11	PCE-J diagram for single-layer devices with various CsF thick- nesses.	37
3.12	Spectra of various CsF thicknesses	38
3.13	Devices with luminous efficiency of 49 cd/A.	39
3.14	Chemical structure of TFB.	40
3.15	Energy diagram of the bi-layer structure.	41
3.16	J-V diagram for bilayer devices.	42
3.17	Y-J diagram for bilayer devices.	42
3.18	L-V diagram for bilayer devices.	43
3.19	PCE-J diagram for bilayer devices.	43
3.20	Spectra of bilayer devices.	44
3.21	The tri-layer energy diagram and (inset) the chemical struc- ture of TPBI.	45
3.22	Performance of a tri-layer device.	46

4.1	EA-IPs of the 6-ingredient blend.	50
4.2	Spectra of 6-material blend.	50
4.3	The EA-IPs of the multilayer white device.	51
4.4	Performance of devices on the basis of LEP to convert to red-emitting with high efficiency.	52
4.5	Spectra of devices on the basis of LEP to convert to red-emitting with high efficiency.	53
A.1	Effect of TPD concentration on the single-layer devices with LiF/Ca/Al cathode.	58
A.2	Effect of TPD concentration on the double-layer devices with CsF/Al cathode.	59
B.1	The chemical structure of Poly(methyl methacrylate) (PMMA).	60
B.2	Electron current density of various blending ratios of TPBI-PMMA.	61
B.3	Improving the device performance by using the TPBI-PMMA blend as the electron-transporting layer.	62