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CTCI Science and Technology Research Scholarship

高效率透明有機發光二極體研究

The Study of High Efficiency Transparent Organic Light-emitting Diodes

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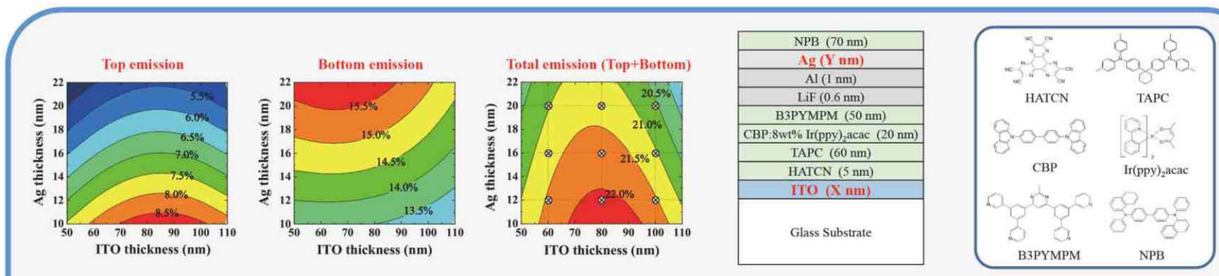
研究重點：

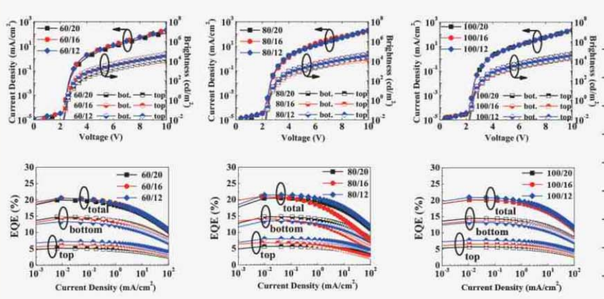
We conduct both simulation and experiment studies of impacts of simultaneously varying the thicknesses of transparent bottom electrodes and semi-transparent top thin metal electrodes on optical characteristics (e.g., transmission, reflection) and efficiencies of transparent organic light-emitting devices (OLEDs). We demonstrated efficient transparent green phosphorescent OLEDs exhibiting a high peak transmittance of up to 81% and rather high total external quantum efficiencies of up to 21-21.5%. By varying the thicknesses of transparent bottom electrodes and semi-transparent top metal electrodes, the ratio of top to bottom emission, and the transmissive or reflective hues/appearances of transparent OLEDs in the off state can be tuned, yet without sacrificing total EL efficiencies or changing their EL colors/patterns. Such tunable optical characteristics of transparent OLEDs may find some interesting applications.

Furthermore, we report efficient transparent small-molecule organic light-emitting devices (OLEDs) with laminated top transparent electrode. This was made possible via the aid of the transparent conductive adhesive based on conducting polymers. With use of small-molecule materials and efficient phosphorescent emitters, rather high external quantum efficiency and current efficiency of up to 11.4%, much higher than those in previously reported OLEDs using laminated top electrodes, were obtained. The transparent OLEDs exhibited rather balanced electroluminescent intensities and spectra from both sides of the devices, a broad optical transmission band, and a high optical transmittance of up to 77%. It provides a simple and yet effective approach for fabrication of efficient transparent OLEDs and can be extended to flexible devices or even roll-to-roll processes in future.

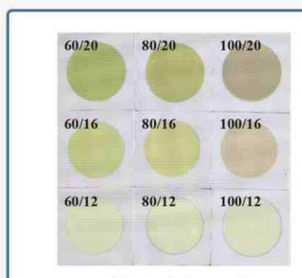
研究成果：



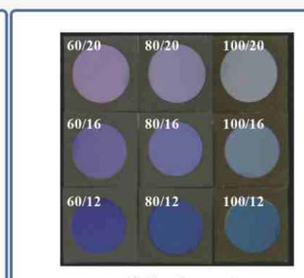
NPB (70 nm)
Ag (Y nm)
Al (1 nm)
LiF (0.6 nm)
B3PYMPM (50 nm)
CBP:8wt% Ir(ppy)$_2$acac (20 nm)
TAPC (60 nm)
HATCN (5 nm)
ITO (X nm)
Glass Substrate



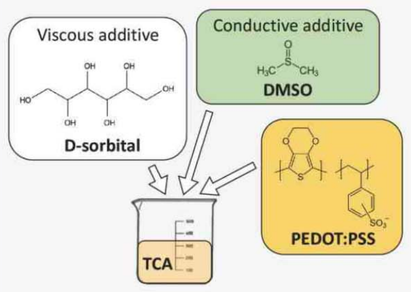
Device ITO (nm)/ Ag (nm)	EQE (%)			Power Efficiency (lm/W)			Current Efficiency (cd/A)		
	bottom	top	total	bottom	top	total	bottom	top	total
60/20	14.7	5.2	19.9	65.9	23.1	89.0	54.5	19.2	73.7
80/20	14.8	5.7	20.5	66.5	25.6	92.1	55.1	21.2	76.3
100/20	14.5	5.7	20.2	68.3	26.9	95.2	56.5	22.2	78.7
60/16	14.4	6.2	20.6	64.2	27.6	91.8	53.1	22.8	75.9
80/16	14.2	6.8	21.0	64.9	31.1	96.0	53.7	25.7	79.4
100/16	13.6	6.5	20.1	64.4	30.8	95.2	53.3	25.5	78.8
60/12	13.3	7.3	20.6	59.5	32.4	91.9	49.3	26.8	76.1
80/12	13.5	8.0	21.5	60.7	36.0	96.7	50.2	29.8	80.0
100/12	13.2	7.7	20.9	62.4	36.4	98.7	51.6	30.1	81.7

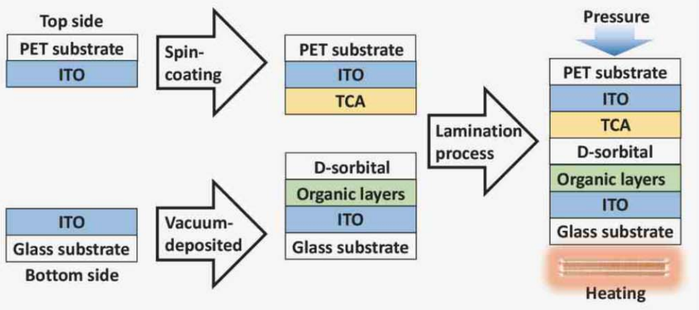


• Transmission mode

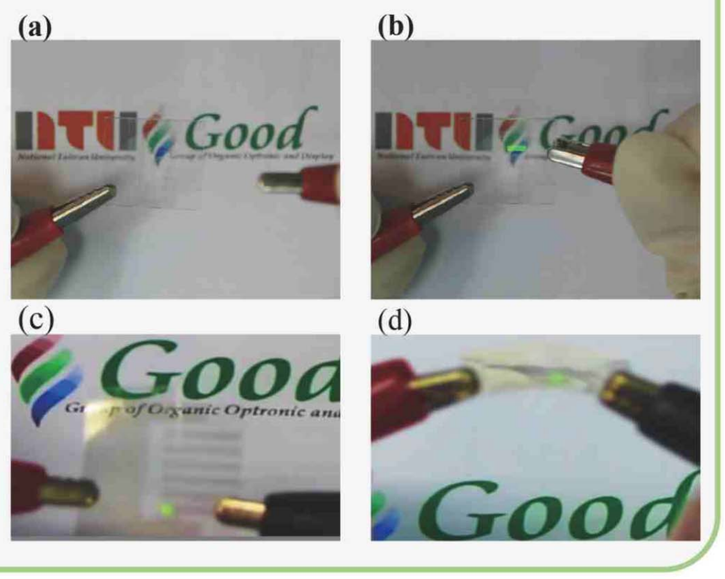


• Reflection mode





		Max. EQE (%)	Max. current efficiency (cd/A)
Ref. 1		16.6	62.1
Ref. 2		16.4	61.3
DUT1	Top	5.7	19.3
	Bottom	4.9	17.1
	Total	10.6	36.4
DUT2	Top	6.2	23.1
	Bottom	5.2	20.0
	Total	11.4	43.1
DUT3	Top	6.2	23.1
	Bottom	5.2	20.0
	Total	11.4	43.1



研究生活及心得：

在大學時期第一次接觸到有關OLED的相關資訊，從那時候便開始對OLED的相關研究感到濃厚的興趣，很幸運地在四年多前如願進入台大電子所吳忠幟教授的有機光電元件與顯示科技實驗室。這四年多以來實驗室致力於發展各種不同材料與結構之高效率OLED，感謝吳老師的悉心指導，令我在研究過程中不斷精進自己的知識，開拓自己的視野。研究室同學之間相處和樂，在研究中互相砥礪，在生活中也會互相扶持。感謝吳忠幟老師，感謝實驗室的每一位成員，也感謝我學習生涯中所遇見的每一個人，最後，我要感謝扶養我長大、一路上支持我的父母與家人，因為你們，我才有勇氣去面對求學過程中所遇到的重重挑戰。未來，我願貢獻所長給栽培我的國家以及社會，盼為社會回饋一份心力。

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