化學系師生陳志欣邱軍豪謝佳勳研究上國際期刊

【記者麥嘉儀淡水校園報導】化學系教授陳志欣實驗室專題生邱軍豪及謝佳勳，於去年就讀本校化學四時，研究高亮度下高效率之OLED主發光體材料，撰寫論文：「A phosphorescent OLED with an efficiency roll-off lower than 1% at 10□000 cd m□2 achieved by reducing the carrier mobility of the donors in an exciplex co-host system」，今年3月發表於J. Mater. Chem. C, 2022, 10, 4955.國際知名學術期刊。

陳志欣表示，邱軍豪及謝佳勳非常認真做實驗，為開發OLED材料的穩定性，在高亮度性下也可以穩定運作，經過縝密的實驗步驟細心求證，得出結果。該期刊為英國皇家化學學會出版，其影響因子為7.393（2021-2022），陳志欣表示，已算是在該領域影響力相當高的期刊。

有機發光二極體（Organic Light-Emitting Diodes, OLEDs）在高操作電壓下，常會因為電子電洞傳遞效率的不平衡，產生元件效率大幅下降的現象。在此研究中，不同於過去OLED材料追求的高電荷遷移率，在常見主發光體材料9,9’-Diphenyl-9H,9’H-3,3’-bicarbazole（BCzPh）的分子結構中，引入拉電子基團，刻意降低激發複合主發光體系統的電荷遷移率，使OLED在高操作電壓下的電子電洞傳輸維持平衡，並以Ir(ppy)2(acac)為綠色磷光客發光體，製作出外部量子產率達到22.31%的OLED元件。值得一提的是，此元件在亮度超過10000 cd/m2的外部量子產率，還可維持在22.16%，其效率衰退率只有0.67%，和過去的文獻相比，此研究首次發表亮度超過10000 cd/m2時，效率衰退率小於1%的OLED元件。此類高亮度維持高效率的元件，對於OLED在照明和光療等高亮度需求的使用上，有很高的應用價值。

邱軍豪目前就讀陽明交通大學材料所，謝佳勳則就讀臺灣科技大學材料所，謝佳勳坦言，一開始不是研究這個題目，本來想做的題目，研究後發現做不了，但透過網路新聞的啟發，改成現今的題目。邱軍豪也表示，做研究曾遇上挫折，後面真不知道該做什麼，不過，那才是代表真的在做研究，他們透過整合此前已做的研究資料，慢慢找到新題目可以使用的數據。邱軍豪回憶成當初寫文章，他覺得當研究寫成文章又是另外一件不同的事，需要學習參考別人的文章架構。他也指出：「這一路都不容易，有部分運氣，需要不停的補發資料數據去證明論文的內容，讓期刊採用。」

最後，謝佳勳和邱軍豪都認為這次成功發表國際期刊，對他們日後研究或是其他方面都很大的幫助，而陳志欣作為指導教授，也相信他們對日後找工作或進修都會加分

，可以連結臺灣的光電界。

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A phosphorescent OLED with an efficiency roll-off lower than 1% at 10 000 cd m^{-2} achieved by reducing the carrier mobility of the donors in an exciplex co-host system†

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9,9′-Diphenyl-9H,9′H-3,3′-bicarbazole (BCzPh)-based molecules have been applied as donors in an exciplex co-host system in OLEDs to achieve high device performance. In this work, to investigate the effect of charge mobility of the donor on the performance of OLEDs using an exciplex co-host system, we synthesized two bipolar BCzPh analogs, i.e., BCzPh-pimi and BCzPh-mimi, by introducing 1-phenyl-1H-benzimidazole to the para- and meta-positions of the phenyl ring of BCzPh. The ΔE_{ST} values of BCzPh-pimi and BCzPh-mimi are 0.60 eV and 0.59 eV, respectively. In contrast, the ΔE_{ST} values of the exciplex formed by BCzPh-pimi and BCzPh-mimi with an electron acceptor, i.e., B3PyMPM, are 0.26 eV and 0.19 eV, respectively. In addition, the photoluminescence (PL) decay lifetimes of BCzPh-pimi and BCzPh-mimi increase remarkably from 5.39 ns and 9.46 ns to 247.79 ns and 263.21 ns, respectively, when mixed with B3PyMPM. The OLEDs fabricated by using BCzPh-pimi with B3PyMPM as an exciplex co-host for a green phosphorescence emitter, i.e., Ir(ppy)$_2$(acac), exhibited a maximum external quantum efficiency (EQE) of 22.31%. Notably, the BCzPh-pimi-based device showed an extremely low efficiency roll-off. Its EQE was retained at 22.16% even at a high luminance of 10 000 cd m^{-2}, corresponding to the efficiency roll-off of only 0.67%. Such an extremely low efficiency roll-off of the device can be attributed to the reduced hole mobility of BCzPh-pimi resulting from the electron-withdrawing benzimidazole moiety in the molecular structure of BCzPh, which improves balance in charge recombination in the exciplex co-host system of OLED devices at high applied voltages.

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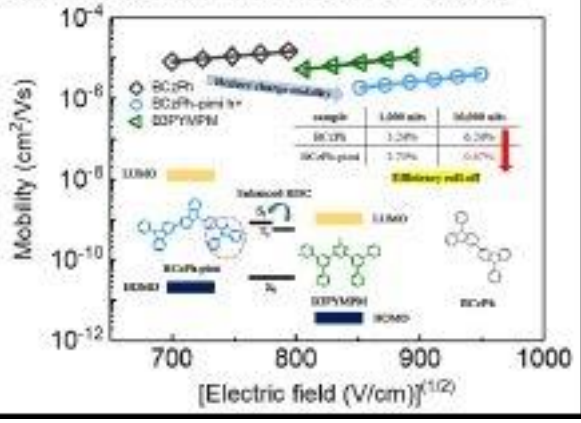

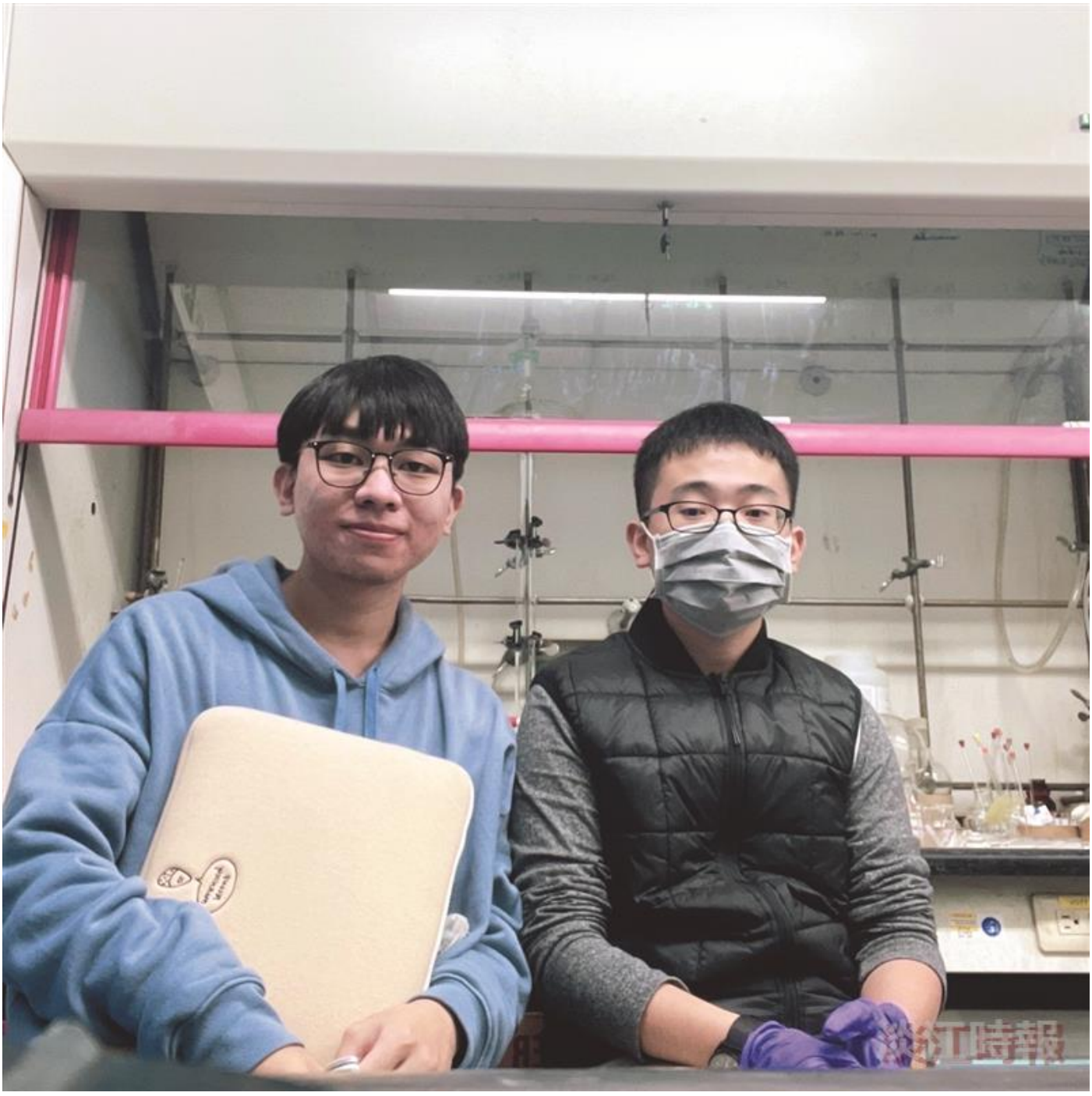
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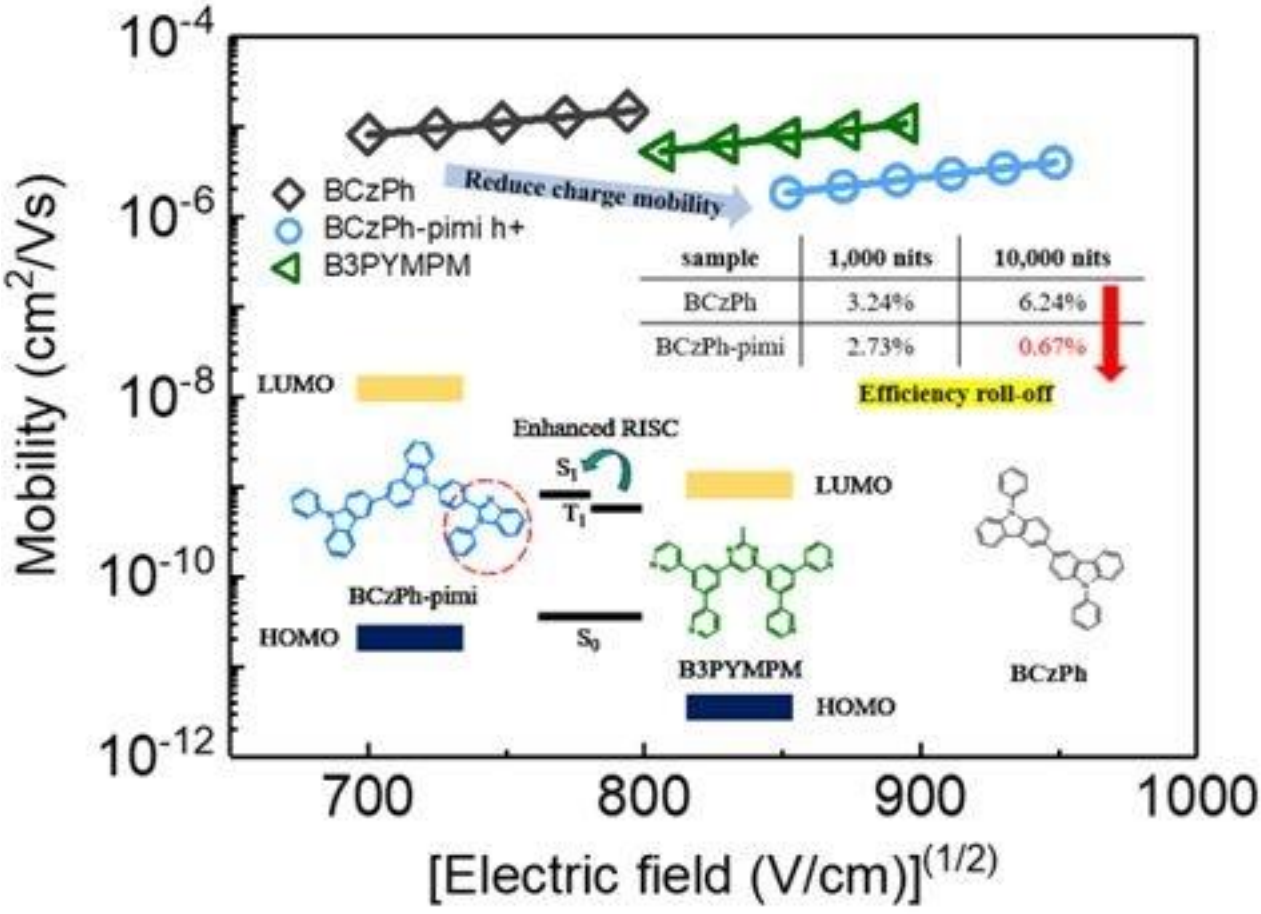
Mobility (cm²/Vs)
10-4
10-6
10-8
10-10
10-12
700
800
900
1000
[Electric field (V/cm)](1/2)
BCzPh
BCzPh-pimi h+
B3PYMPM
Reduce charge mobility
sample
1,000 nits
10,000 nits
BCzPh
3.24%
6.24%
BCzPh-pimi
2.73%
0.67%
Efficiency roll-off
LUMO
Enhanced RISC
S1
T1
S0
HOMO
BCzPh-pimi
LUMO
B3PYMPM
HOMO
BCzPh