自組裝微小透鏡陣列與其在有機光電元件之應用

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中文摘要

因應可攜式電子產品輕量化的需求，同時兼顧效能提升，微小透鏡陣列扮演相當重要的角色。本研究之目的，在於利用自組裝微小透鏡陣列，提升有機發光元件的出光效率，以及提升有機太陽能電池的光電轉換效率。自組裝微小透鏡陣列的作法，首先利用微接觸印刷技術在親水性的基板表面製作疏水性的自組裝單分子層，再利用旋轉塗布或是噴墨印刷的方式將親水性的透鏡材料塗布於基板之上，藉由自組裝單分子層的排斥力與液體的表面張力形成透鏡的形狀，最後再利用紫外光固化形成透鏡陣列。透鏡的形狀由填充率、旋轉塗布的轉速與噴印的體積所決定。此透鏡陣列具有不同大小(直徑 50 到 100 微米)、間距(5 到 15 微米)與形狀(F 數最小為 1.2)。同時具有高均勻度(焦距的變異量小於百分之三)以及完整的表面(表面粗糙度小於一個奈米)。這種方法因為成本低廉，所以適合大量生產，同時整個製程在室溫下進行，可以做在可撓式塑膠基板之上，具有相當大的潛力。自組裝微小透鏡陣列應用在有機發光元件，可以有效提昇其發光效率(大於百分之二十)同時減少色差。當它應用在有機太陽能電池，可以提升能量密度與光電轉換效率，當有機太陽能電池操作在兩倍太陽光照射下以及凱氏溫度 320K，具有最佳的效率 3.75%。總而言之，自組裝微小透鏡陣列有效提升有機光電元件的效能，未來應用在電子產品上，十分具有經濟效益。

Self-organized Microlens Arrays and their Applications on Organic Optoelectronic Devices

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Abstract

Microlens arrays (MLA) are widely used in optoelectronic systems due to their small size and high performance. In this dissertation, the out-coupling efficiency of polymer light-emitting diodes (PLED) and the power conversion efficiency of organic photovoltaic (OPV) devices are enhanced after the self-organized MLA is incorporated. The MLA is fabricated using a hydrophobic effect on a self-assembled monolayer (SAM) pre-patterned substrate and its shape is determined by surface tensions. The SAM is patterned using micro-contact printing and the lens material (NOA65, refractive index-matched with the substrate) is deposited using spin-coating and ink-jet printing. As a result, self-organized MLAs are fabricated with diameters 50, 75, and 100μm and spacing 5, 10, and 15μm. After the MLA is integrated into the PLED, its out-coupling efficiency is enhanced more than 20% and the viewing angle dependent color difference is reduced due to the relief surfaces. From experimental results, the optimized operating condition of OPV devices is 3.75% under 320K and 2 Suns. The power conversion efficiency of OPV devices with MLAs increases due to the power density of solar irradiation increases. In conclusion, the performance of optoelectronic devices is enhanced due to the functions of self-organized MLAs. The proposed fabrication method has potential for mass production due to its low fabrication cost. Moreover, flexible PLEDs and OPV devices with MLAs can be realized because organic materials are used and the fabrication temperature is low.