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Printing and Patterning for Plastic Electronics and Photonics

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Abstract – In this paper I describe recent work at the Imperial College London Centre for Plastic Electronics concerning highly conductive polymer electrode materials and metal-oxide injection layers. I also describe the development of deposition and patterning processes suited to polymer semiconductor device fabrication including 'interlayer lithography' and 'stamp transfer' and gravure printing. Examples are be drawn from our programmes on LEDs, transistors, photodiodes and lasers.

Realizing the full potential of conjugated polymer semiconductors requires the simultaneous development of effective electrode systems and flexible processes for deposition and patterning. In respect of electrodes I will describe selected work on highly conductive vapour phase polymerized poly(3,4-ethylenedioxythiophene) (VPP-PEDOT) films that reach conductivities ≤ 1200 S/cm with good transmission and work function characteristics [1]. VPP-PEDOT can now be used as a replacement for standard indium tin oxide transparent conductive oxide electrodes in a variety of device types including LEDs and photodiodes [1]. Metal oxide injection layers represent an opportunity to improve device stability by moving away from reactive metal cathodes and/or to enhance oxidative stability [2]. They can also assist in reducing optical losses. One need here is to find successful methods to deposit these injection layers without damaging the substrate or other active layers in the device, a requirement that drives low temperature approaches. Low temperature, high throughput fabrication (both deposition and patterning) is also more generally needed to achieve breakthroughs in cost and functionality. In the latter respect, we have been developing a new 'interlayer' lithography approach [3] and two printing approaches, namely 'stamp transfer' [4] and gravure [5] printing and I will describe results for LEDs, transistors and photodiodes fabricated via these processes. Finally, I will discuss some approaches to molecular patterning for applications in photonics [6].

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