Structuring graphene as an electrode for organic light emitting diodes: challenges and outlook

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Since its first successful isolation in 2004, graphene has become potentially interesting as a transparent electrode material due to its (theoretical) high charge carrier mobility of ≈ 10,000 $cm^2V^{-1}s^{-1}$ at room temperature. Given its good conductivity and inherently high mechanical strength, due to its two-dimensional hexagonal lattice structure, graphene could revolutionize the world of flexible electronics, if graphene of a suitable quality can be produced over large areas using high volume manufacturing. In order to be integrated as transparent electrode, graphene has to have both high transparency (90%) and low sheet resistance (50 Ω/sq.). Since these challenging requirements demand an almost perfect graphene over large area with very low defect density, such graphene has to be grown by chemical vapour deposition, with subsequent transfer from the metal catalyst to the (insulating) target substrate. Along with other integration steps such as cleaning the electrode prior to device fabrication and encapsulating the resulting device, it is mandatory to define the active area of such a device starting from a (insulating) target substrate fully covered by graphene. In order to be commercially useful, the applied patterning method has to be (i) inexpensive, (ii) fast, (iii) reproducible and (iv) to yield reliable devices. Although patterning technologies such as screen printing or laser ablation are only able to provide feature sizes in the µm regime, they have much lower installation and running costs compared to photolithography, are fast and are known to result in reliable organic electronic devices when using indium tin oxide (ITO) as the transparent electrode.[1]

Here, we will give an overview of several possible structuring techniques to define the shape of the graphene electrode, concentrating on their benefits and potential for mass fabrication along the entire processing chain (Figure 1), for both small and large area devices (Figure 2).

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References

[1] D. Wynands et al. "Graphene in OLED technology: challenges and successes" ID-tech ex graphene 2016, Berlin

Figures

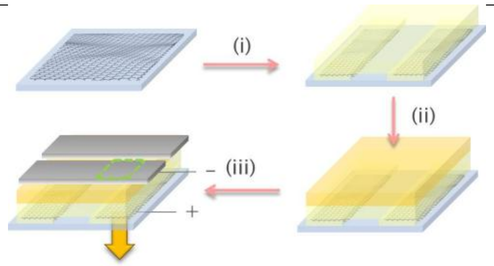

Figure 1: Process chain to fabricate OLED devices.

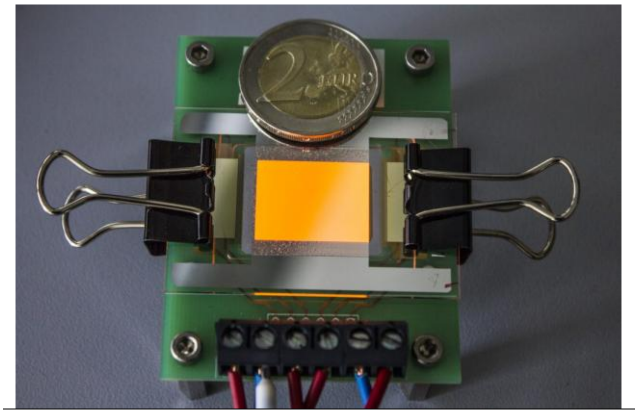

Figure 2: Graphene-based OLED with an active area of 1.5×2 $(cm)^2$.