Advanced Device Architectures for Printable OLEDs

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Today, organic light emitting diodes (OLEDs) and displays have achieved commercial relevance due to their unique contrast and low power consumption. While most state-of-the-art OLEDs for OEM applications are deposited in vacuum, science and industry work hard on solution processable and hence potentially low-cost fabrication alternatives. The main objectives are to overcome solvent limitations during the deposition of multi-layer devices and to enhance the lifetime of the devices. One very beneficial material class for (vacuum deposited) OLEDs are transition metal oxides. In this work, we use a variety of metal oxide precursors in order to fabricate charge carrier transport layers from MoO_3 or WO_3 for OLEDs from solution. The respective layers are transparent to visible light and become insoluble to most solvents after deposition enabling the subsequent deposition further layers. Charge carrier injection and transport through these metal oxides allow the fabrication of efficient inverted OLEDs, transparent OLEDs and in particular tandem OLEDs. Incorporating the emitter polymer Super Yellow in both OLEDs in a tandem device allows for the fabrication of efficient monochromatic tandem OLEDs. In order to generate white light, an orange and a blue polymer OLED were stacked, utilizing an intermediate charge carrier generation layer (CGL) for monolithic device interconnection. The CGL comprises a modified low-work function zinc oxide layer and a high-work function interlayer that was realized from various solution processable metal oxides or PEDOT:PSS derivatives. Since, in this configuration, every injected electron-hole pair generates two photons, only half the driving current density is needed to match the device luminance of a single reference OLED. The white tandem OLEDs exhibit a CRI of 75. The full solution processability will enable up-scaling of these devices in future printing or coating processes, e.g., by utilizing slotdie coating, as it has been demonstrated for organic tandem solar cells comprising a similar set of functional materials before.

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