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ULTRA-THIN METAL FOR INDIUM FREE ORGANIC LIGHTING AND PHOTOVOLTAICS

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Abstract: Novel transparent electrodes based on a metallic bilayer structure are developed and their use in OLEDs is investigated. The devices show similar efficiency compared to those incorporating state-of-art indium based ITO. In addition, the proposed transparent electrodes are easy to fabricate, inexpensive, and environmentally friendly.

1. INTRODUCTION

Transparent electrodes (TEs) are an integral part of optoelectronics industry because of the wide range of applications, e.g. photovoltaics, OLEDs, and electro-chromic devices. Wide band-gap semiconductors, doped with metals are the current state-of-art solution, with indium doped tin oxide (ITO) being the most popular one. Although ITO has excellent transmission and low sheet resistance, it possesses several drawbacks, for example, high cost due to indium scarcity, slow deposition rate, need of post deposition treatments, dependence of performance on doping, deposition conditions, and a multi-component structure which can lead to incompatibilities with some active materials. In fact, more than 70% of the cost of a typical photovoltaic cell is due to the ITO [1]. Ultrathin Metal Films (UTMFs) based TEs are potential replacement which can overcome the high cost of raw materials and can be grown using a simple process technique, therefore they can be fabricated in a low-energy consumption way (“Green”). Contrary to TCOs, they also possess high compatibility with nearly all organic and semiconductor materials and related device fabrication steps [1, 2].

2. EXPERIMENTAL

Polycrystalline UTMFs were deposited by magnetron sputtering on double-side optically polished UV grade silica substrates. Bi-layer metal films of different thickness were prepared, with an overall thickness $\leq$ 10nm. A Perkin Elmer lambda 950 spectrometer was used for optical transmission measurements while Cascade Microtech 44/7 S 2749 four-point probe system with a Keithley 2001 multimeter for electrical resistance measurements. The morphology of the fabricated films was characterized with the digital instrument D3100-AFM and FEI- SEM.

3. RESULTS AND DISCUSSION

We compared the performance of bi-layer UTMFs with ITO for devices like OLEDs.

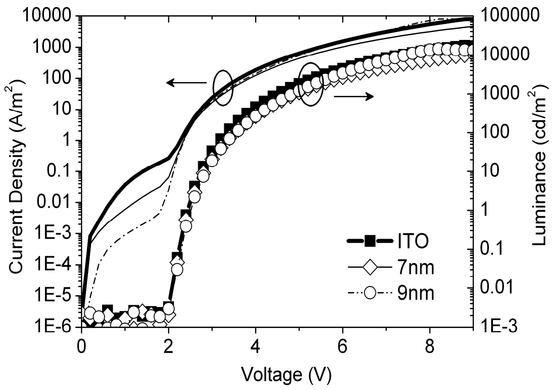

Fig. 1. Current density and Luminance of the OLED structure: Anode/PEDOT-PSS/SY/CaAg

Compared to ITO, similar efficiencies were reached for bilayer metallic films. The thin metallic films show similar roughness, slightly higher sheet resistance and lower transmittance. Nevertheless, these characteristics lead to lower current densities at low voltages but similar threshold voltage and luminance levels. Lifetime measurements of the device are currently under way to assess the stability of the device with different electrodes. In addition similar performances with respect to ITO are also being achieved in organic photovoltaic cells.

4. CONCLUSION

Thin bilayer metallic films are effective TEs for light emitting diodes and photovoltaic cells, with several advantages with respect to ITO, including simple and faster deposition, no need of post-deposition treatment and lower cost. This work shows potentials for efficient ITO-free organic devices.

REFERENCES

[1] C. G. Granqvist, “Transparent conductors as solar energy materials: A panoramic review”, *Appl. Opt.*, **29**, 5336 (1990)

[2] D. S. Ghosh, L. Martinez, S. Giurgola, P. Vergani, V. Pruneri, “Widely transparent electrodes based on ultrathin metals”, *Opt. lett.*, **34**, 325(2009)