Synthesis and characterization of ultraviolet (UV) light emitting electrochemical cells using phenanthrene fluorene derivatives for flexible applications

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Abstract

Two novel phenanthrene based small molecules, UV1 and UV2, were designed and synthesized with simple synthetic procedures for UV light emitting applications. Herein, we report the device fabrication methods using different deposition techniques such as spin and spray coating methods. We show how ink formulation is improved by increasing the solubility of the molecule through extension of the alkyl chain length with the counter ion CF_3SO^{3-}. The standard devices fabricated on ITO glass substrates via spin and spray coating method to demonstrate the UV emission of the synthesized molecules. The optimized solution processed devices showed the UV emission in the region of ~400nm through the bottom ITO electrode. Thus, EL emission within the UV range has been demonstrated successfully with the synthesized molecules via solution processed onto glass slides.

Introduction of UV-OLECs

- Organic light emitting electrochemical cells (OLECs) and light emitting diodes (OLEDs) are both thin film devices fabricated to emit any wavelength, including UV and infrared, based on the functional character in the organic semiconductor active layer at low voltage. The difference between the OLEC and OLED devices is the existence of mobile ions in the active material of the OLEC active layer rather than pristine active layer in the OLED active layer.
- The mobile ions is blended internally or externally with the organic semiconductor in the OLEC active layers redistribute across the junction in the active layer when the device is biased. The electrons and holes formed can be efficiently injected into a single layer of the LEC active material from the top (cathode) and bottom (anode) electrodes to emit bright light.
- Spin coating of UV1 molecule dissolved in acetonitrile whereas spray coating of UV2 dissolved in ethanol for device processing. As the organic semiconductor in the OLEC active material becomes unstable when doped and the excitons formed in the active layer readily reacts with oxygen and moisture in the air. Therefore, the devices must be sealed prior light emission.

UV-OLECs Architecture and Fabrication

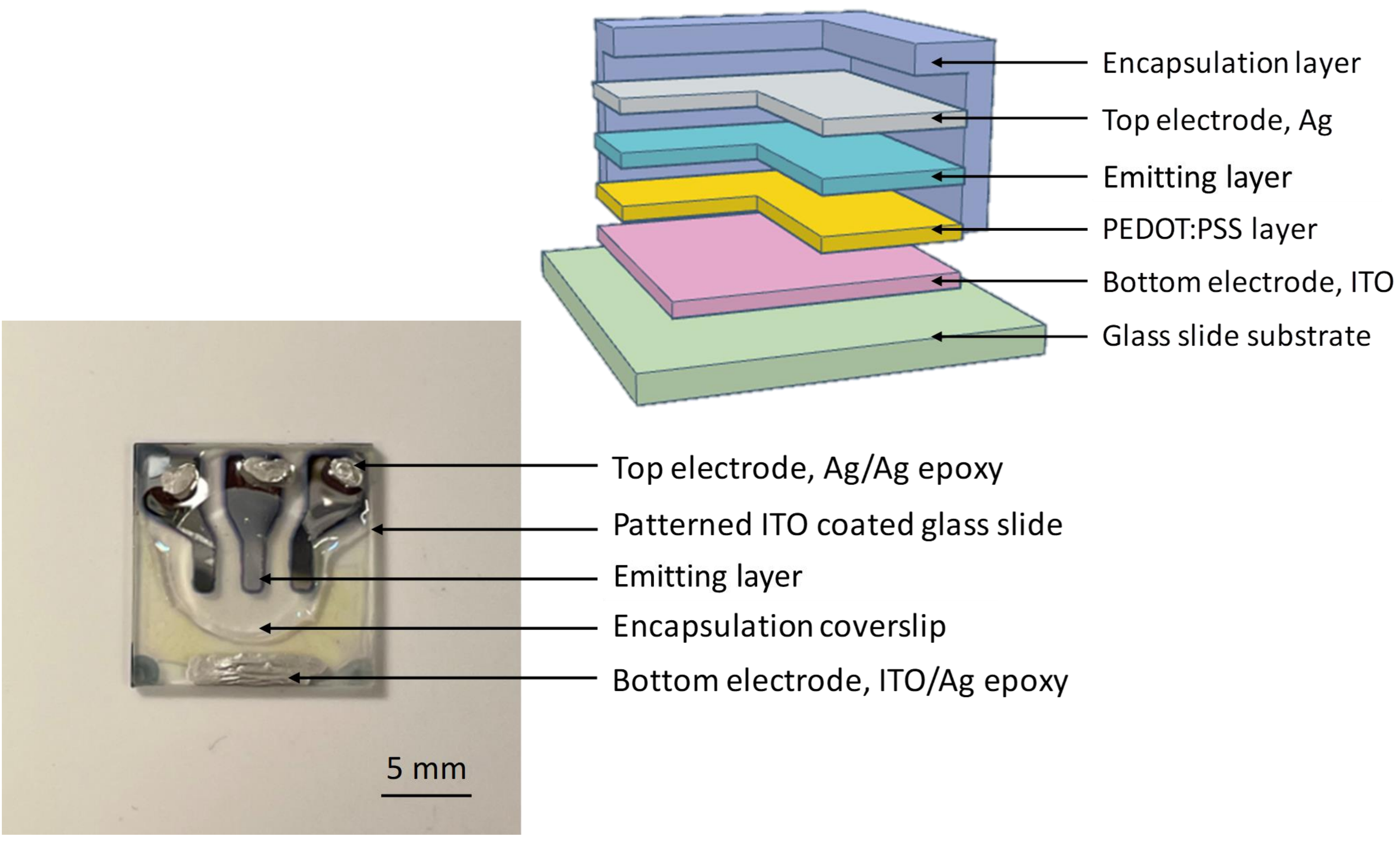

Figure 1. Pictorial representation of the solution processed OLECs on glass slide (bottom left), and isometric view of the schematic OLEC architecture (top right).

Result and Discussion

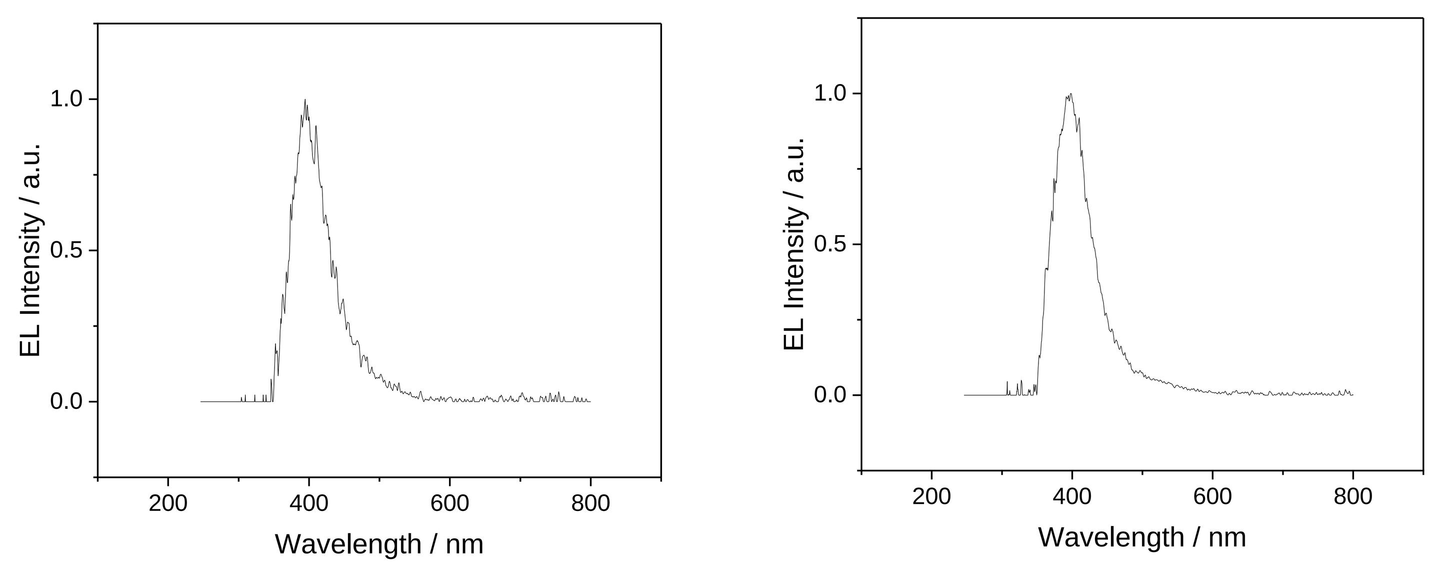

Figure 2. *(left) Electroluminescent (EL) spectrum in arbitrary unit, obtained by electrical biased at 8 V on the UV1 OLEC, with the peak emission at 394nm; (right) EL spectrum in arbitrary unit, obtained by electrical biased at 8 V on the UV2 OLEC with the peak emission at 391.5nm.*

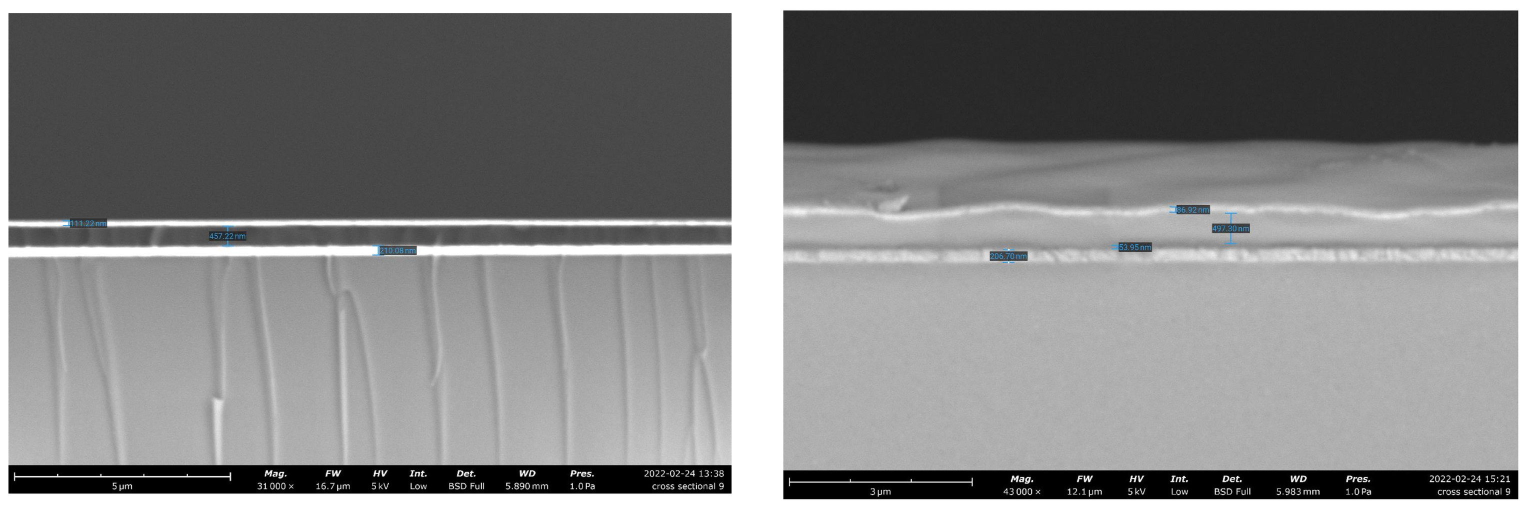

Figure 3. *(left) Cross sectional SEM image on the OLEC based on UV1 emitting molecules, the image shows the smooth emitting layer with thickness ~ <1µm. (right) Cross sectional SEM image on the OLEC based on UV2 emitting molecules, the image shows the smooth emitting layer with thickness ~ 500nm. Top to bottom layers: Silver/Emitting layer/PEDOT:PSS/ITO glass slide*

Conclusions

- UV emitting OLEC devices have been successfully fabricated and encapsulated with the two novel synthesized emitting molecules, in an ambient atmosphere, on ITO pre-coated glass substrates. Both emission peaks are under 400nm in wavelength.

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