

# Air stable solution processable OLEDs using metal oxides as electron injecting layer

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A new class of bottom emission electroluminescent device is presented. This architecture makes use of metal oxides as electron injecting materials into the light emitting polymer, avoiding the use of reactive cathodes that are commonly employed in organic light-emitting diodes. Therefore it allows, in principle, for a low cost electroluminescent device as no rigorous encapsulation is required.

The structure of this kind of device is inverted with respect to standard OLEDs (figure 1). The metal oxide cathode ( $\text{TiO}_2$ ,  $\text{ZnO}$ ) is deposited as a thin layer on top of an indium tin oxide covered glass substrate by spray pyrolysis. The light emitting layer is then processed by conventional spin-coating methods.

Subsequently an inorganic hole injecting layer ( $\text{MoO}_3$ ) and the gold anode are thermally evaporated on top of the polymer. All deposition processes are performed in a clean room environment and thermal evaporation is carried out in a high vacuum chamber integrated in a glove box.

The light emitting polymer employed in the device is the poly(9,9-dioctylfluorene-*co*-benzothiadiazole) (F8BT). The choice comes from the need of decreasing the energy gap between the conduction band of the metal oxide and the lowest unoccupied molecular orbital (LUMO) of the polymer and thus to help electron injection.

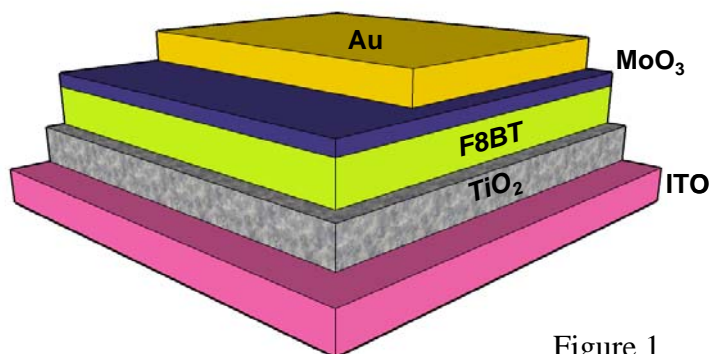


Figure 1

This new electroluminescent device shows promising performance reaching brightness levels of  $6500 \text{ cd/m}^2$  at voltages as low as 8 V. A model that explains the observed experimental results and provides avenues for further optimization of these devices is presented. It's based on the idea that the barrier for electron injection is lowered by the space charge field over the metal oxide-light emitting polymer interface, due to the build up of holes in the light emitting polymer. Furthermore we demonstrate how electron injection can be efficiently enhanced through the functionalisation of the cathode.

A monolayer of an ionic ruthenium complex was deposited on the surface of titanium oxide by the Langmuir-Blodgett technique. The redistribution of ions under the applied bias creates an ionic space charge at the interface that permits electrons to overcome the barrier between the conduction band of the metal oxide and the LUMO of the polymer (figure 2).

We show how with this approach it is possible to inject electrons in different active materials, opening the doors for further improvements of this novel class of air stable devices.

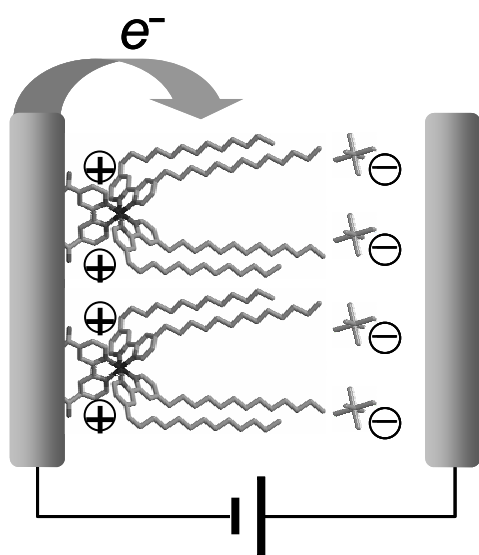


Figure 2