PROJECT I.1 MATERIALS FOR LITHOGRAPHY AND ORGANIC/HYBRID ELECTRONICS

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Objectives

A. Development of new lithographic materials and micro- nanopatterning processes

Research topics
- Investigation of new resist chemistries
- Lithographic schemes for patterning in the areas of MEMs, bio-MEMs and related fields
The current research priorities include new resists based on imaging through polymer backbone breaking and new patterning processes for biosystems fabrication

B. Materials research for organic/hybrid electronic devices of improved performance

Research topics
- Electron/hole transporting interfacial layers of organic optoelectronic devices
- Emission colour tuning in Organic Light Emitting Diodes (OLEDs)
- Material options for improving charge separation and transport in organic/hybrid photovoltaics (OPVs)
The current research priorities include investigation of W or Mo polyoxometallates (POMs) and corresponding oxides as electron transporting layers in OLEDs and OPVs, photochemically induced emission tuning of OLEDs, nanostructuring of p-n junctions in OPVs and development of processing technology for POMs-containing materials

MAIN RESULTS IN 2011

1. Patterning schemes using higly sensitive, polyacetal-based, lithographic materials

Polyacetals are synthesized and proposed by our group as components of lithographic materials with or without a photoacid generator. An innovative patterning scheme for cell patterning and cell harvesting was introduced in collaboration with Univ of Crete/FORTH enabled by using higly sensitive polyacetal polymers as photodegradable substrates. The scheme is based on back side laser illumination of transparent substrates covered with photosensitive polyacetals. The high polymer sensitivity allows substrate degradation without cell damaging (published in Angew. Chemie, Int. Ed. Eng., in 2011, G. Pasparakis T. Manouras et al., see also publication list)
Fig. 1. The scheme introduced for cell patterning/harvesting and the proposed photodegradation mechanism of a polyacetal (P1) polymer used as a photodegradable substrate.

2. Metal oxide interfacial layers in organic/hybrid electronics

Controlled reduction in hydrogen atmosphere of certain transition metal oxides results in the formation of intragap states that provide new routes facilitating electron/hole injection and transport when films of such oxides are used as interfacial layers between the emissive layer and the electrodes in organic light emitting devices. The reduced oxide film deposition is based on the hot wire technique and is carried out in hydrogen or forming gas atmosphere by the group of Dr. D. Davazoglou.

As a characteristic successful case it is presented below the use of **Reduced Tungsten Oxides as Efficient Electron Injection Layers in Hybrid Light Emitting Diodes**. Dramatic increase in device current and luminance is obtained when reduced (substoichiometric) tungsten oxide (WO\(_{2.5}\)) is used as electron injection layer using either PEDOT-PSS or WO\(_3\) as Hole Injection Layer. The work has been published in Adv. Funct. Mater. in 201, M. Vasilopoulou et al., see publication list.

Fig. 2. Device architecture and proposed transport mechanisms in the case where substoichiometric tungsten oxide (WO\(_{2.5}\)) is used as an efficient electron injection layer and stoichiometric tungsten oxide (WO\(_3\)) is used as hole injection layer.
Fig. 3. Luminance-Volt (left) and luminous efficiency (right) plots of devices where reduced (substoichiometric) tungsten oxide is used as cathode interfacial layer. The red curve corresponds to the device architecture shown in Fig.2. The blue curve corresponds to devices where WO$_{2.5}$ is used at the cathode but PEDOT–PSS at the anode. The green curve corresponds to a reference device with no WO 2.5 at the cathode (but with PEDOT–PSS at the anode).

3. Organic salts as additives in the emissive layer of OLEDs for improved charge injection

Triphenyl sulphonium salts are proposed as emissive layer additives to improve OLED characteristics. In particular upon application of a bias, salt anions –due to their smaller size compared to the bulkier cation– accumulate at the anode side and form a space charge that greatly facilitates hole injection, resulting to improved charge balance and more efficient recombination. Consequently higher luminance and current efficiency are obtained as well as lower turn-on and operating voltage. Furthermore, by replacing the triflate anion with the slightly bigger nonaflate, the effect of the anion size on the PLED performance was investigated. (published in J. Mater. Chem, in 2011, D.G. Georgiadou et al., see publication list)

Fig. 4. Current density – Voltage (J-V-L) characteristics of PLED devices based on F8BT, where TPS-triflate or TPS-nonaflate has been added in the emissive layer in order to demonstrate the effect of the anion size on the performance of the devices (left). Schematic representation of the suggested operational mechanism before and after the application of forward bias (right).
PROJECT OUTPUT IN 2011

Publications in International Journals


Publications in International Conference Proceedings


Publication in National Conference Proceedings


Conference Presentations


Master theses

1. “Synthesis of diblock copolymers based on poly(ethylene oxide) and poly(tert-butyl methacrylate) for use in top-down and bottom-up lithography”, Anastasia Giakoumaki, Graduate Program on Polymer Science and Applications, Department of Chemistry, University of Athens, October 2010, Supervisors: M. Chatzichristidi, P. Argitis