Planar Organic Photodetectors

T. Agostinelli, M. Binda, L. Fumagalli, D. Natali[a)], M. Sampietro
Dipartimento di Elettronica e Informazione, Politecnico di Milano
P.za L. da Vinci32, 20133, Milano, Italy
[a)] natali@elet.polimi.it

Our Lab has a strong expertise in the realization and characterization of **planar organic photodetectors**. This technology is appealing: *i)* the low device capacitance ensures a very low electronic noise; *ii)* the metal for the contacts can be freely chosen to increase injection barriers thus lowering dark currents; *iii)* the substrate does not need to be transparent; *iv)* the planar technology is compatible with the one of organic field effect transistor, this being a premium feature for the development of low cost organic optoelectronic systems.

Our capabilities span from **device realization** (deposition of the organic semiconductor on pre-lithographed substrates) to **detailed optoelectronic characterization**:
- ***I/V curves;***
- ***EQE spectrum***, made with 25 calibrated LEDs covering a range from 370nm to 2μm;
- High accuracy ***EQE/mobility correlations***, made by measuring charge carrier mobilities on organic field effect transistor[1] of identical geometry as the detectors;
- ***Time response*** to fast (down to the ns range) light pulses;
- ***Frequency response*** with modulated light (DC to 500MHZ), from 370nm to 2μm*;*
- ***Noise/impedance spectroscopy*** and analysis on the detected current.

Our recent research on the physical phenomena peculiar to planar structures can be summarized as follows:
- we studied how planar photodetectors performances are affected by the active materials transport properties. By *correlating charge carrier mobility, quantum efficiency and speed response* in annealed PCBM/P3HT blend based devices, we demonstrated the role of a balanced hole and electron transport[2];
- we directly measured the *extent* of the device *active area* by means of spatially resolved photocurrent mapping, showing that it is primarily ruled by the slowest charge carrier: in a MDMO-PPV based photodetector, where the mobility-lifetime product is larger for holes, a negative space charge builds up close to the negatively biased electrode localizing the active region close to the positively biased one[3];
- we studied the *frequency response* and we elucidated the role of traps: on the basis of modulated photocurrent spectroscopy in a dithiolene based device we revealed the presence of a Gaussian distribution of traps under the transport energy level[4].

Currently, we are investigating the problem of detecting ***red/near infrared light***, which is of relevance for *emerging plastic optical fibers* and also for the extension of the spectrum in *organic solar cells.*

The group has participated to the EU-VI framework with project "NOSCE MEMORIAS".

---

[1] Natali et al., J. Appl. Phys. 101, 014501 2007
[2] Caironi et al., J. Appl. Phys. 102, 024503 2007
[3] Agostinelli et al., J. Appl. Phys. 101, 114504 2007
[4] Agostinelli et al., Synth. Met. 157, 984–987 2007