PV research at ISMN-CNR

G. Ruani, M. Muccini, R. Zamboni
Istituto per lo Studio dei Materiali Naostrutturati – CNR
via Gobetti, 101 – 40129 Bologna - ITALY

The research activity on non-conventional photovoltaics at the ISMN-CNR is mainly concentrated on two distinct approaches:
a) all organic *p-n* junction (bilayer and bulk heterojunction)
b) solid state dye sensitized solar cells (DSSC) both hybrid and all inorganic.

Our strategy, both for *p-n* junction and for dye cells, focuses on the tailoring of the device architecture to control and optimize fundamental processes like exciton dissociation, charge separation, charge transport etc.
The correlation of spectroscopical and morphological information at the micro/nano-scale can provide a unique knowledge about the quality and the photo-physical properties of nanostructured materials. We address this problem using state of the art spectro-microscopy facilities.

Organic p-n junction

For all organic *p-n* like junction based PV cells we have focused our attention on the possibility to obtain a large diffuse interface by co-sublimation, in High or Ultra-High Vacuum, between the two active (*p* and *n*) materials in order to improve the probability of dissociation of the photogenerated excitons.
The material's selection and the role of interfaces represent also one of the fundamental aspect, our research activity.

Solid state DSSC

DSSC mesoporous titania structures are specially prepared in order to obtain large area, micron thick but easily fillable mesoporous TiO_2 films. We have shown the advantage of using ordered porous structures like inverse opals (IO) in making easy to infiltrate such a thick film with solid state components like hole conductors. Now we are optimising the procedure to deposit IO titania films by using the doctor blade technique.
We are also investigating the possibility to prepare solid state DSSC with a transparent top electrode on opaque elements like tiles, using methods and materials compatible with traditional industrial processes.

Facilities @ ISMN-CNR

Fabrication:

- O-MBD: Organic molecular beam deposition in UHV
- Glove-boxes(<1ppm): integrated high vacuum film dep. (organic/inorganic), Spin-coating (organic), encapsulation, *in situ* I-V PV cells characterisation
- Ultrasonic spray pyrolysis
- Spin coating (organic/inorganic precursors)

Advanced Characterisations:

- Confocal PL spectro-microscopy with nano-scale (*150 nm in plane*) and time (*2 ps*) resolution
- TIRF microscopy (*150 nm in depth*)
- μ-Raman confocal spectroscopy (*1 μm in plane*)
- AFM-STM microscopy
- SEM microscopy