Nanoimprinting for Organic Solar Cell Fabrication

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Goals

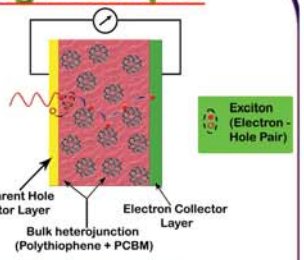
- *Develop nanopatterned electrodes for fabricating organic solar cells (OSC) with improved efficiency.*
- *Demonstrate nanoimprinting of active polymer layer at dimensions on the order of exciton diffusion length.*
- *Align single walled carbon nanotubes as electron transport pathway.*

Organic Solar Cell

Operating Principle

OSC Operation:

- Absorption of photons
- Exciton diffusion
- Charge separation
- Charge collection



Merits: Large absorption coefficients and band gap

Demerits: Poor charge carrier mobility (PCBM +Nanopatterning)
Small exciton diffusion length (SWNT + Nanopatterning)

Why Nanoarchitecturing ?

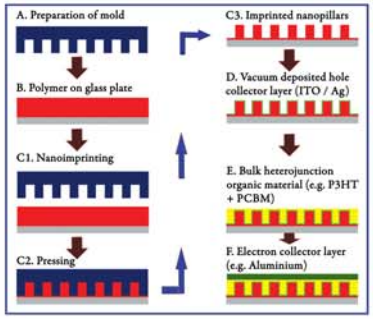
Exciton diffusion length (LD) ~ 5-20 nm (for polymers)
Photo Conversion Efficiency : $\eta E=\eta a+\eta b+\eta c$

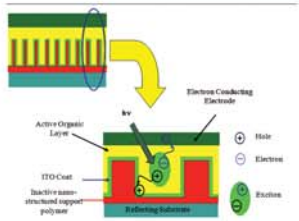
ηa = photon absorption efficiency (PAE)
ηb = exciton dissociation efficiency (EDE)
ηc = charge collection efficiency (CCE)

Advantages of Nanoarchitecturing:

PAE is enhanced due to the highly increased surface area.
EDE is greatly improved by having electrode or D/A interface within LD.
CCE is enhanced due to accelerated escape of charges to the electrodes before recombination.

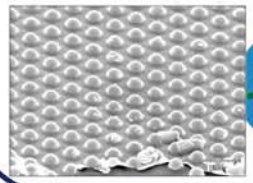
Nanopatterned Electrodes





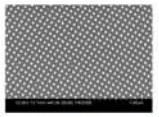
Steps:

1. Nanoimprint pillar structures on transparent polymer.
2. Deposit electrode material.
3. Prepare overlying layer.

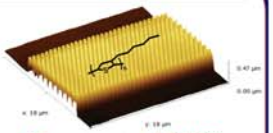


- Silver deposited nano patterned APC polymer
- Nanostructuring can be well controlled by mold design

Nanopatterned active polymer layer



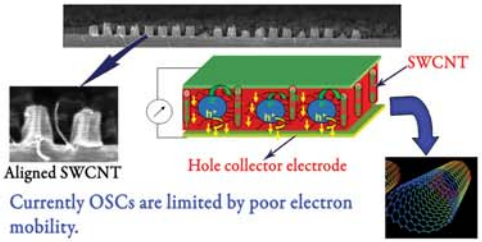
30 nm pillar structure



Nanostructured P3HT

- Active layer deposited on the hole collector electrode can be nanostructured.
- A semiconductor (multilayer heterojunction) or an electrode (bulk heterojunction) material can be deposited on top of the nanostructured layer.

Aligned Single Walled Carbon Nanotubes



- Currently OSCs are limited by poor electron mobility.
- Aligned SWCNT will be a highly efficient pathway for electron transport to the electrode.

Conclusions:

- Successfully fabricated nanostructured electrodes for OSCs.
- Nanostructuring of conjugated polymers used in OSCs has been demonstrated.
- SWCNT were aligned in polymer to be used as an efficient electron carrier.
- Potential to make highly efficient OSCs.

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