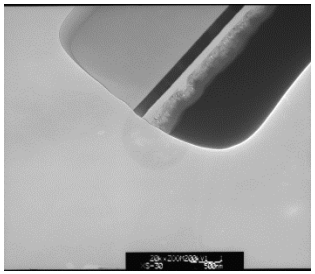
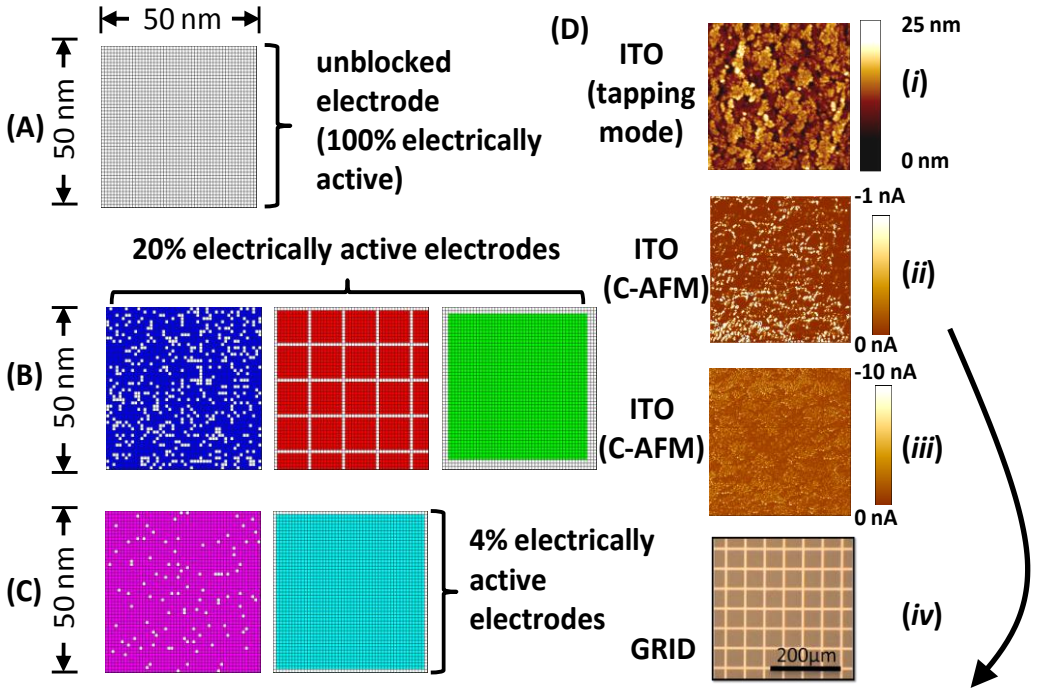
Electrical Contacts in Excitonic Photovoltaics

Research group of Professor Neal Armstrong



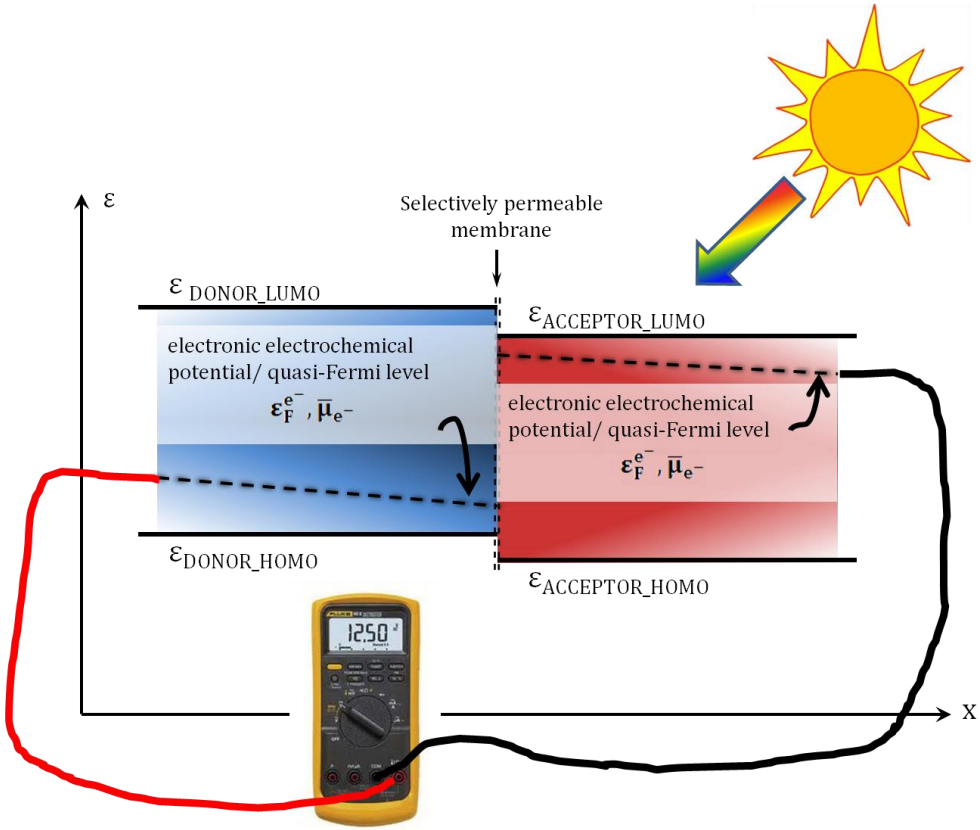


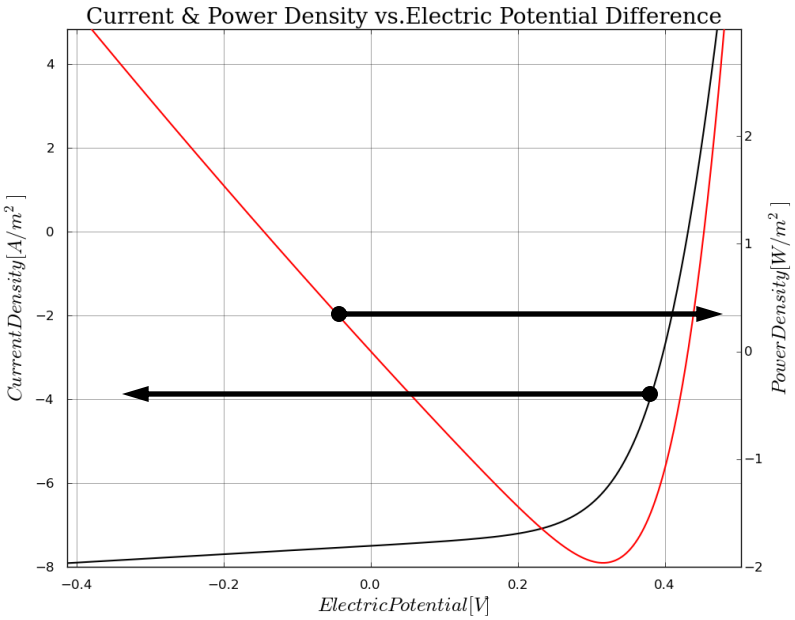
Brumbach, M.; Veneman, P. A.; Marrikar, F.S.; Schulmeyer, T.;Simmonds, A.; Xia, W.; Lee, P.; Armstrong, N. R. Langmuir 2007,23, 11089–11099.

CIS:SEM

THE UNIVERSITY OF ARIZONA

Photovoltaic (PV) Device Synopsis



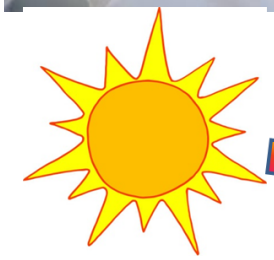


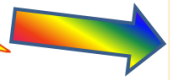
$$\varepsilon_{F,DONOR}^{e^-}(x) = \bar{\mu}_{e^-,DONOR} = E_{DONOR\_HOMO}(x) - k_B T \ln \frac{p(x)}{N_{HOMO}}$$

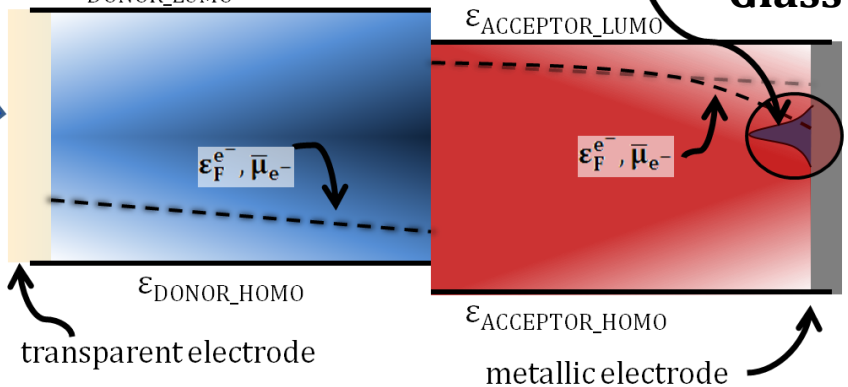
$$\varepsilon_{F,ACCEPTOR}^{e^-}(x) = \bar{\mu}_{e^-,ACCEPTOR} = E_{ACCEPTOR\_LUMO}(x) + k_B T \ln \frac{n(x)}{N_{LUMO}}$$

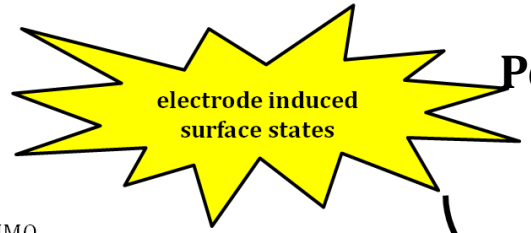
$$J_{NET}(x) \alpha q U_{e^-} n(x) \nabla \varepsilon_F^{e^-}$$

PV Electrodes

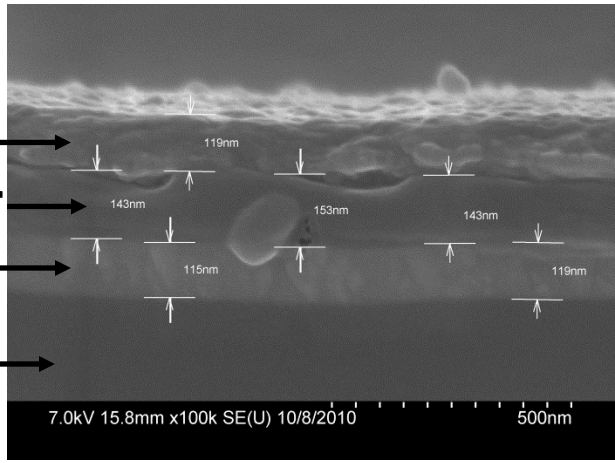








Al
Polymer
ITO
Glass



! Reduction in electron electrochemical potential difference across device!

Two aspects we'll discuss:

1) **Electrode heterogeneity**
2) **Asymmetric charge transfer rate at electrode interface**

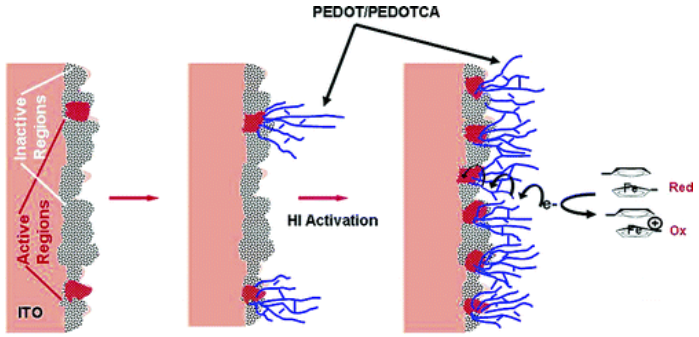
Electrode Heterogeneity

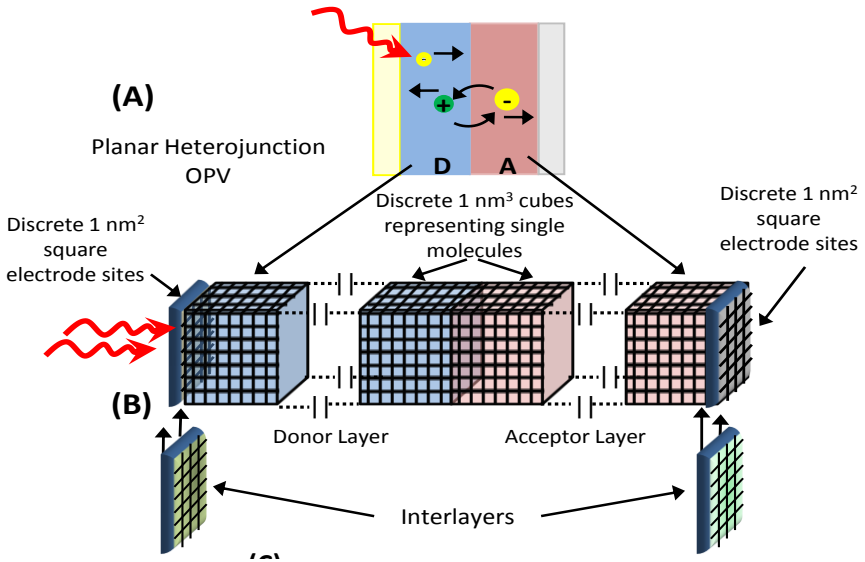
THE JOURNAL OF PHYSICAL CHEMISTRY C

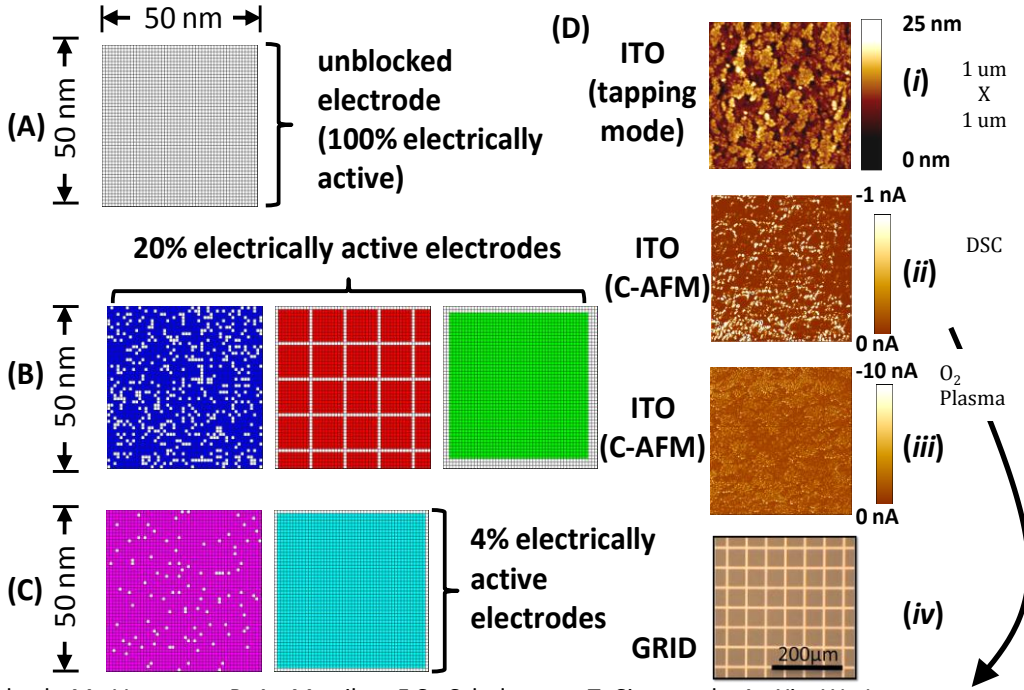
Modeling the Effects of Molecular Length Scale Electrode Heterogeneity in Organic Solar Cells

Brian Zacher and Neal R. Armstrong*

Department of Chemistry and Biochemistry, University of Arizona, Tucson, Arizona 85721, United States







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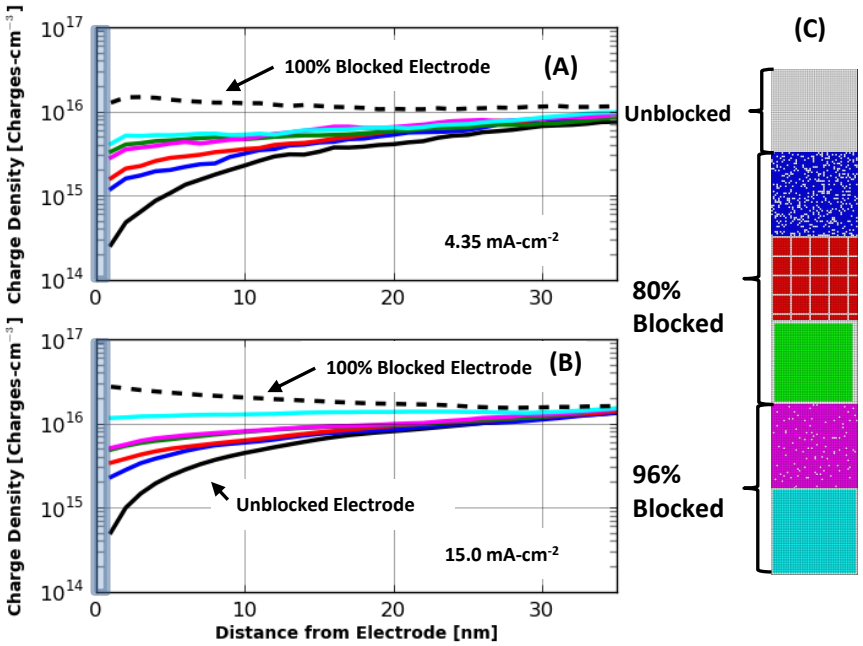
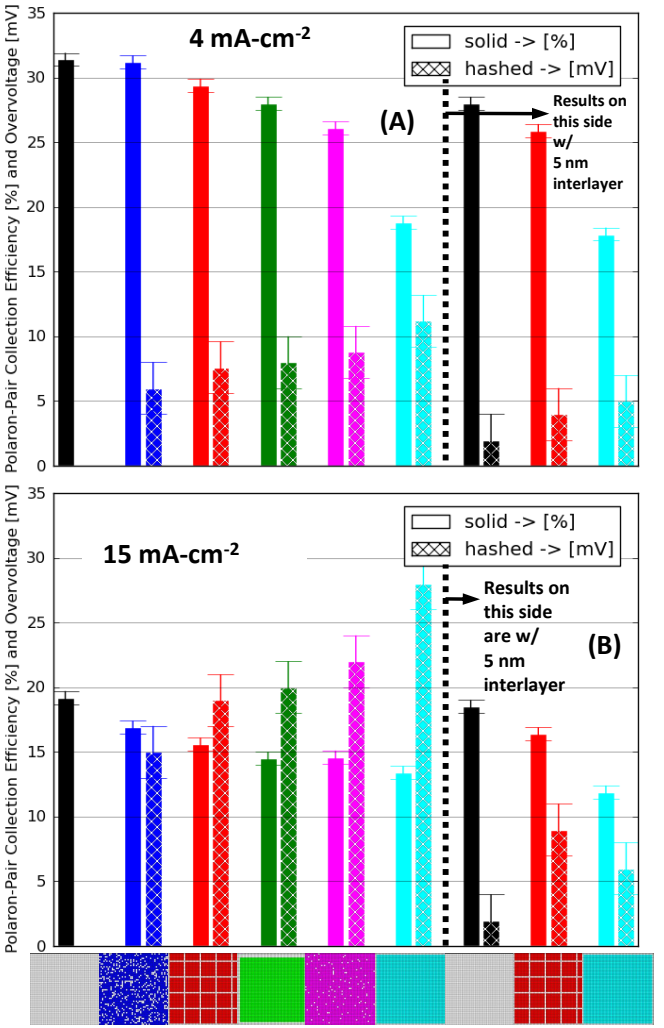
Simulated Results

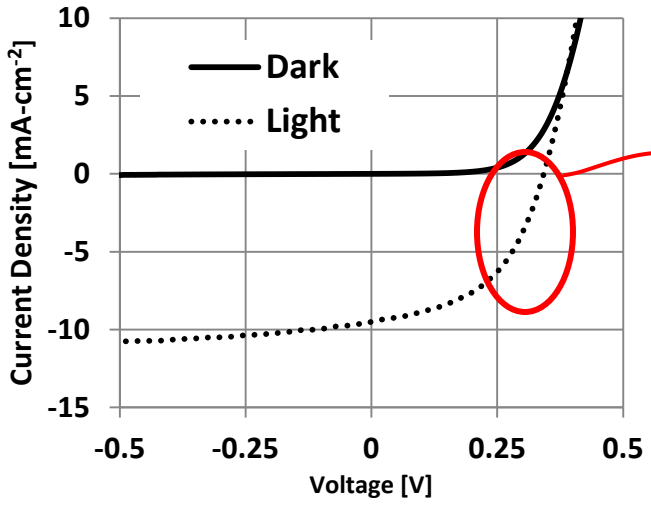


Silicon based PV cell

SiTec.com



Asymmetric Charge Transfer
(e.g. polarizable electrode)

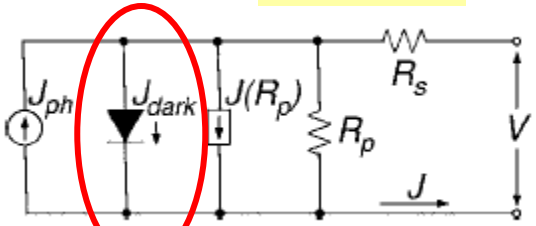


Opposing and concurrent 'light' and 'dark' processes describe behavior

APPLIED PHYSICS LETTERS 94, 023307 (2009)

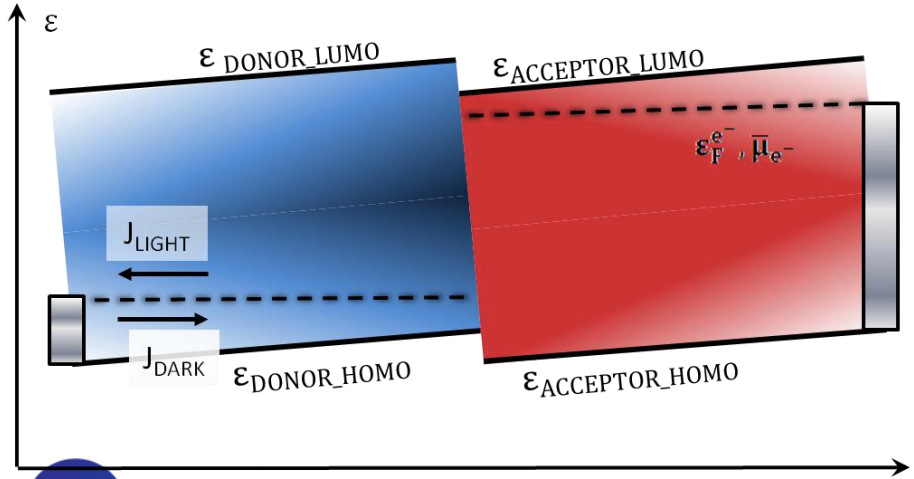
Open circuit voltage enhancement due to reduced dark current in small molecule photovoltaic cells

Ning Li,[1] Brian E. Lassiter,[1] Richard R. Lunt,[1,2] Guodan Wei,[1] and Stephen R. Forrest[1,a)]



$$V_{OC} = \frac{nk_BT}{q} \ln\left(\frac{J_{ph}(V_{OC})}{J_S} + 1 - \frac{V_{OC}}{J_S R_p}\right).$$

$$J_S = J_{00} \exp\left(\frac{-\phi_B}{kT}\right)$$



PHYSICAL REVIEW B 81, 205307 (2010)

Interface state recombination in organic solar cells

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$$J_G(V) = J_{DARK}(V) - eP_C(V)G_{PH}$$

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- The entire Armstrong research group past and present

- Contact me – bzacher@email.arizona.edu

- Thank you for your time and attention!