NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
School of Electrical and Electronic Engineering

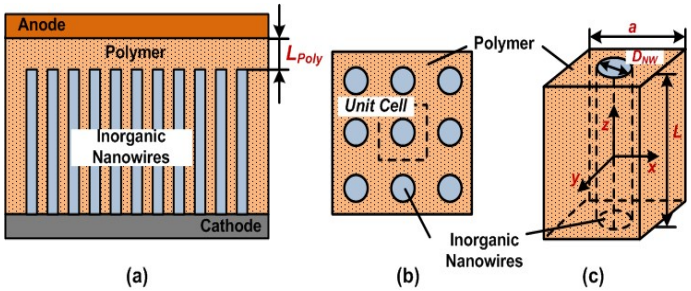
COEB PHOTONICS
COEB - Centre for OptoElectronics and Biophotonics

Design and Simulation of the GaAs Nanowires/P3HT Hybrid Solar Cell

Introduction

To meet the huge global energy demand, solar cells are considered as the most promising route to deplete fossil fuels and environmental pollution. Hybrid solar cells taking the advantages of both organics and inorganics are gaining great attentions. Here, we provide a systematic optical simulation analysis for the design guidelines of GaAs nanowires (NWs) geometrical parameters fully infiltrated in the P3HT for optimal hybrid solar cell (HSC) performance. Comparative study is carried out about optical absorption of GaAs NWs/air and GaAs NWs/P3HT active layer. The absorption properties are further analyzed upon the solar illumination and the optimized structure displays 39% of total absorption efficiency.

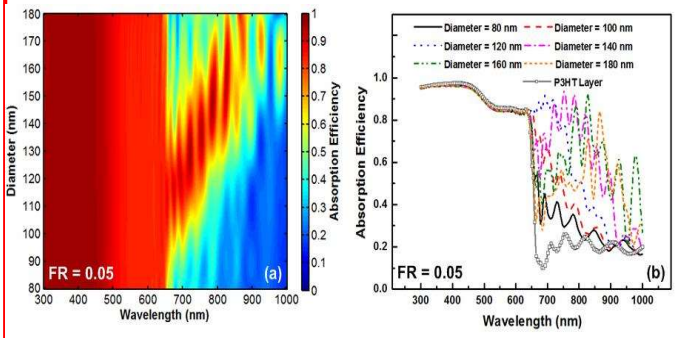
Schematic of Hybrid Active Layer



Photovoltaic Process

- Both GaAs and P3HT absorb photons & generate excitons
- Excitons dissociate at donor acceptor interfaces
- Electrons transport along NWs
- Holes transport along P3HT

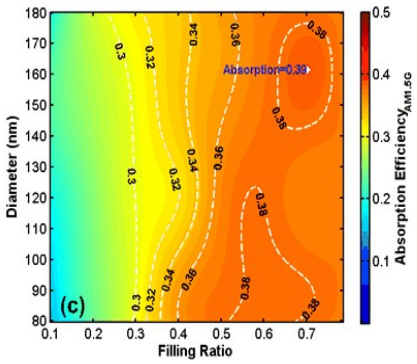
Light Absorption of GaAs NWs/P3HT



- High and uniform absorption spectrum is found below the band edge (650 nm) of P3HT
- Beyond the absorption edge, P3HT serves as dielectric shell
- HE_{11} mode of GaAs NWs dominates the selectivity of high absorption in the long wavelength region
- Fabry-Perot mode (longitudinal mode) within the P3HT layer also tunes the hybrid layer's absorption

Optimal Absorption at AM1.5G

- A variety of geometrical parameter combinations lead to high absorption
- Highest light absorption exits in large volume filling ratio and a diameter of 162 nm



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