Overview of Projects in INCML

Abhejit Rajagopal, Integrated NanoMaterials Core Lab, UCLA
Advisor: Diana L. Huffaker

- GaAs(P) passivation study with G. Mariani
- GaAs-Si NWSC with V. Vo, D. Ren, R. Laghumavarapu
- NOADD with P. Senanayake, A. Farrell
- Midwave IR detector with P. Senanayake, W. Lee
- Optical modulator with P. Senanayake, W. Lee

GaAsP NWSC Passivation Study

- Presented by G. Mariani at SPIE Photonics West in February 2014

- Project materials prepared for:
  - Optical simulation and ITO geometry optimization
  - Electrical simulation and parameter matching
    - GaP and InGaAs passivation, effective SRH tau
  - Demonstrated solar-cell engineering concepts
    - junction location, light concentration

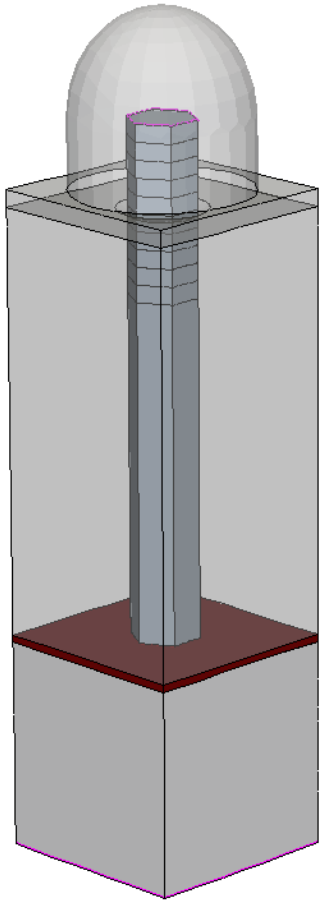
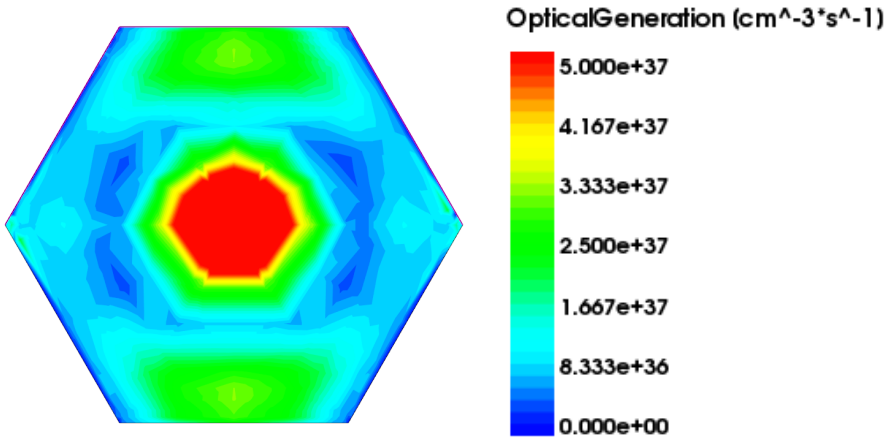


Figure: GaAsP nanowire on GaAs substrate with ITO light concentrator and BCB dielectric

NOADD

- Submitted to Nature Nanotechnology with A. Farrell
- Project materials prepared for:
  - Importing Lumerical FDTD to Sentaurus SDevice
  - Electrical AC simulation (modified from C. Hung's)
  - Extracting electrical results (E-field and PG) to CSV
  - (Hayat Group) DSMT using Matlab/Fortran



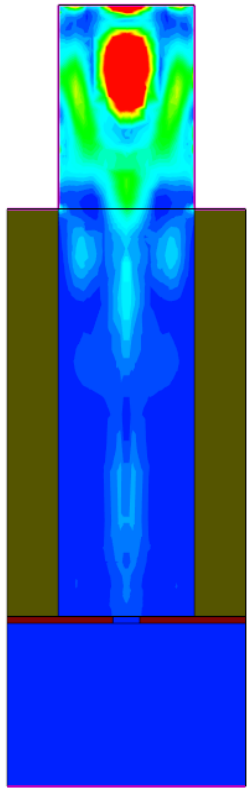


Figure: 3D Interpolation between Tensor FDTD and Electrical FEM grids

GaAs-Si NWSC

- Working with V. Vo, D. Ren, R. Laghumavarapu

- Project materials prepared for:
  - PG optimization in Lumerical FDTD (V. Vo)
  - Importing Lumerical FDTD to Sentaurus SDevice
  - Dark and light electrical simulation
  - Extracting electrical results (E-field and PG) to CSV

- Additional simulations required for substrate contribution
  - 500nm substrate considered, will consider 5um+

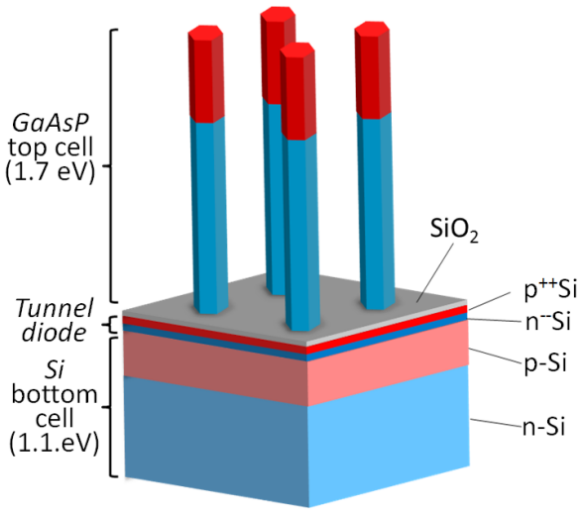
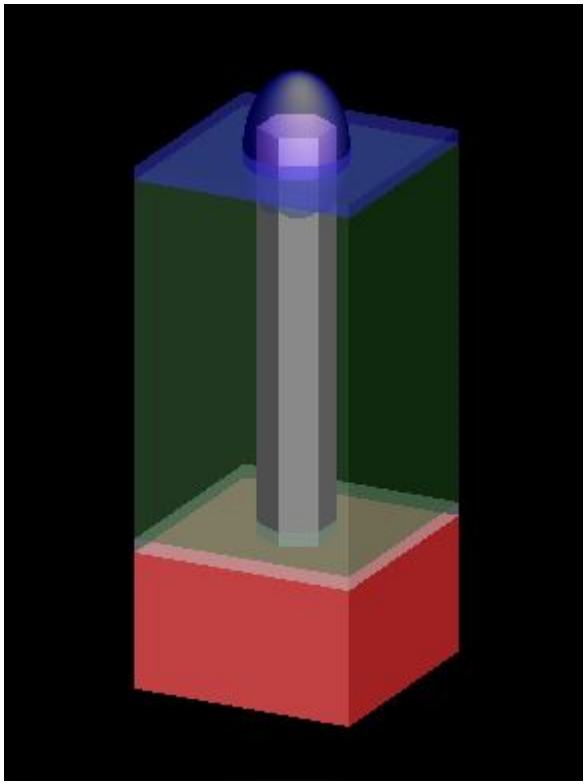


Figure: Proposed device structure of GaAsP nanowire junctions on Silicon solar-cell substrate

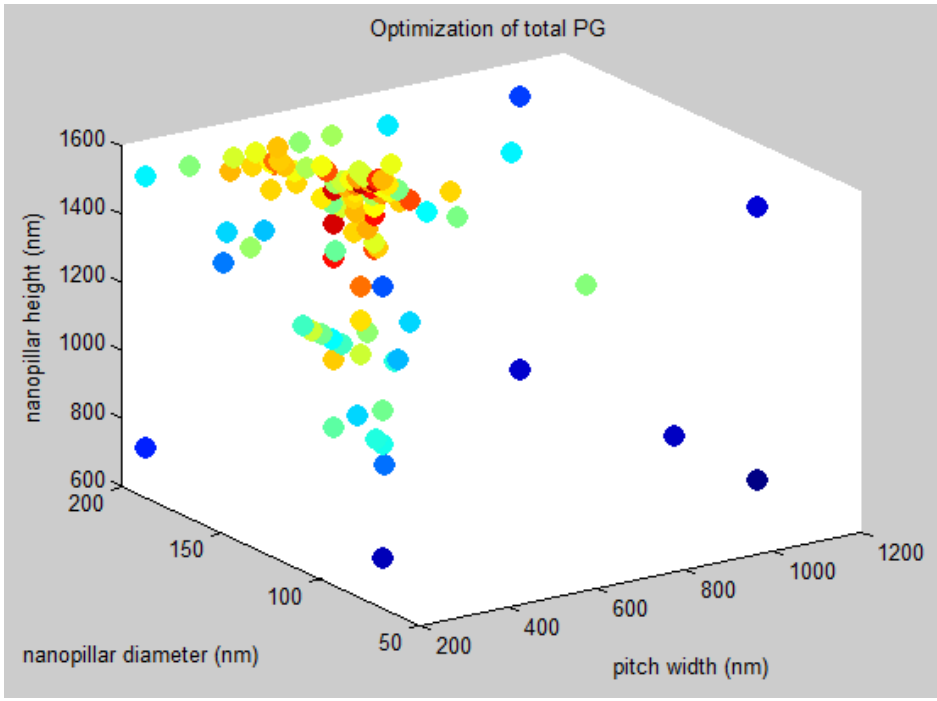
FDTD Optimized GaAs-Si Structure

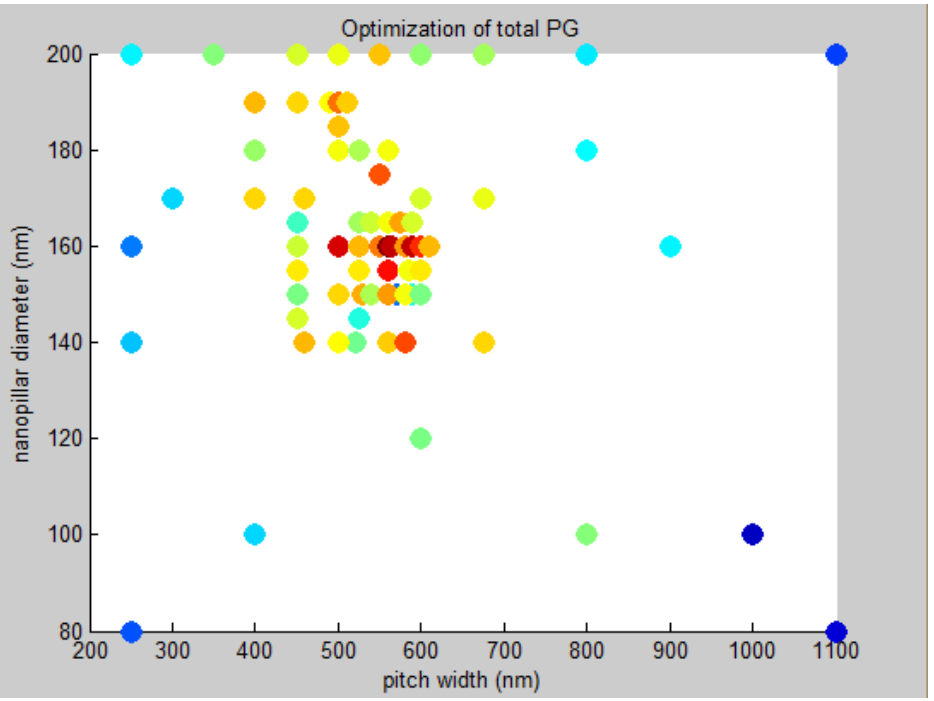


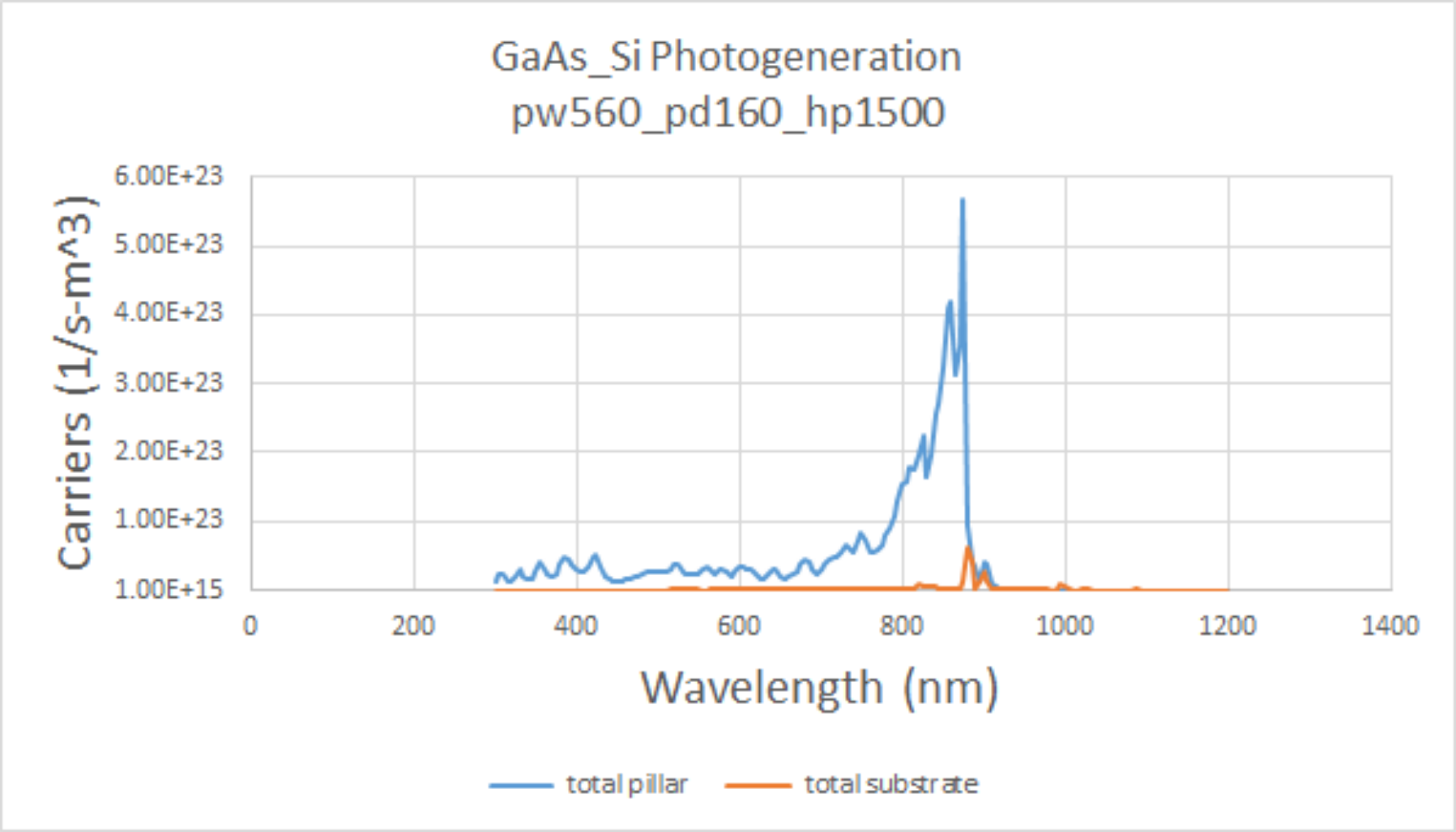
- *Optimized structure: 560 nm pitch width, a 160 nm pillar diameter, and a 1500 nm pillar height.*

- *From bottom up, structure consists of Si substrate (Red), SiO2 (transparent), BCB (green), GaAs pillar (gray), ITO layer and cap (blue).*

8-Point Optimization on Matlab







$$I(z) = I_0 e^{-\alpha z}$$

- Using the Beer-Lambert Law we calculated the absorption to be around 5% at 800 nm wavelength which explains the extremely low photogeneration we received from the substrate at shallow depths (tens of microns).

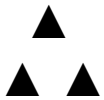
Midwave IR and Optical Modulator

- Working with P. Senanayake, W. Lee, N. Hseih

- Project materials prepared for:
  - Importing Lumerical FDTD to Sentaurus SDevice
  - Dark and light electrical simulation
  - Extracting electrical results (E-field and PG) to CSV

- MIR:
  - requires alignment (align.py) and electrical simulation
- Optical Modulator:
  - requires verification of modulation physics, extraction of desired ▲n and ▲k

Thanks!



Working here has been an awesome experience, and I've enjoyed all my interactions with the group.