Exploring Schottky Junction Solar Cells

RYAN POWERS

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Overview

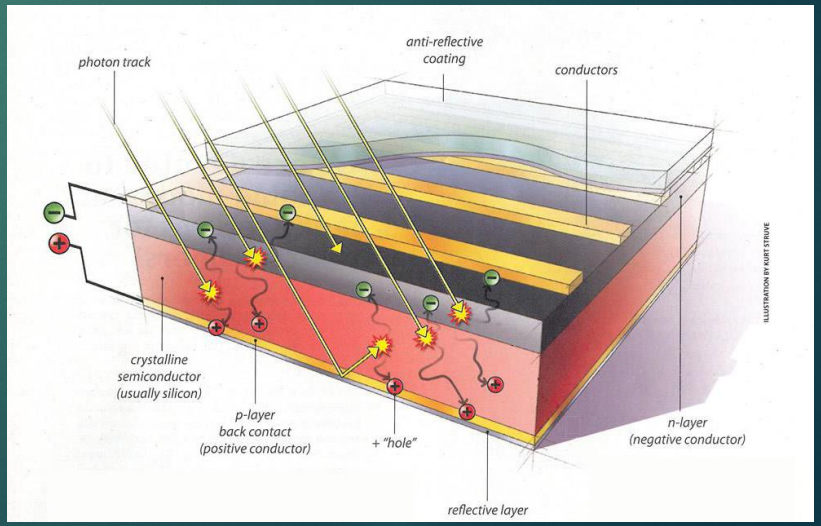
- Introduction to solar energy
- Basic solar cell design
- Schottky junction
- Purpose
- Materials and methods
- Results
- Conclusion
- Future research

Why Solar?

- Clean
  - No carbon footprint
- Abundant
  - Most available renewable energy source
- Dependable
  - Lasts 20+ years, little maintenance
- Sustainable
  - Can provide energy indefinitely

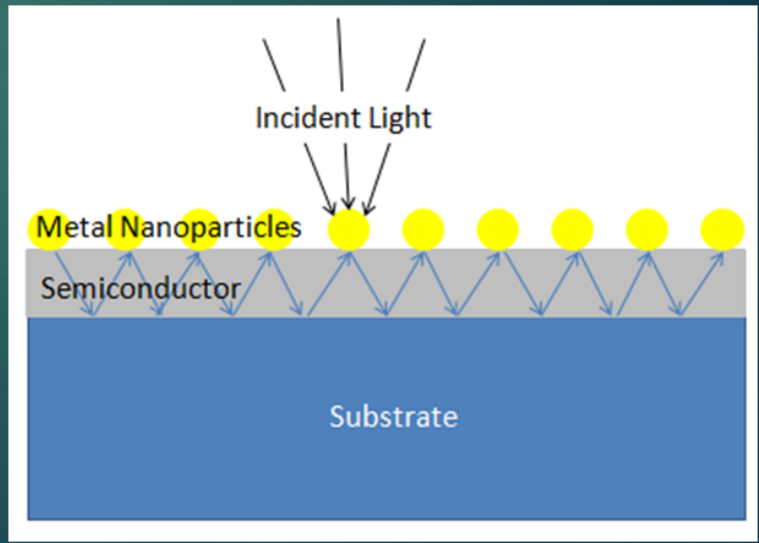
Solar Cells

- Basic principle
  - Absorption of photons
  - Excitation of electrons
  - Current flow
- Inefficiencies
  - Reflected light
  - Si bandgap
    - Near-IR: too weak
    - UV: excess heat



Schottky Junction

- Metal-Semiconductor interface
  - Metallic nanostructures
- Simpler, thinner design
  - Lower resistance
- Greater absorption spectrum
  - Surface plasmons



Purpose

- Proof of concept
- Cheaper, simpler solar cell
- Driving down energy costs

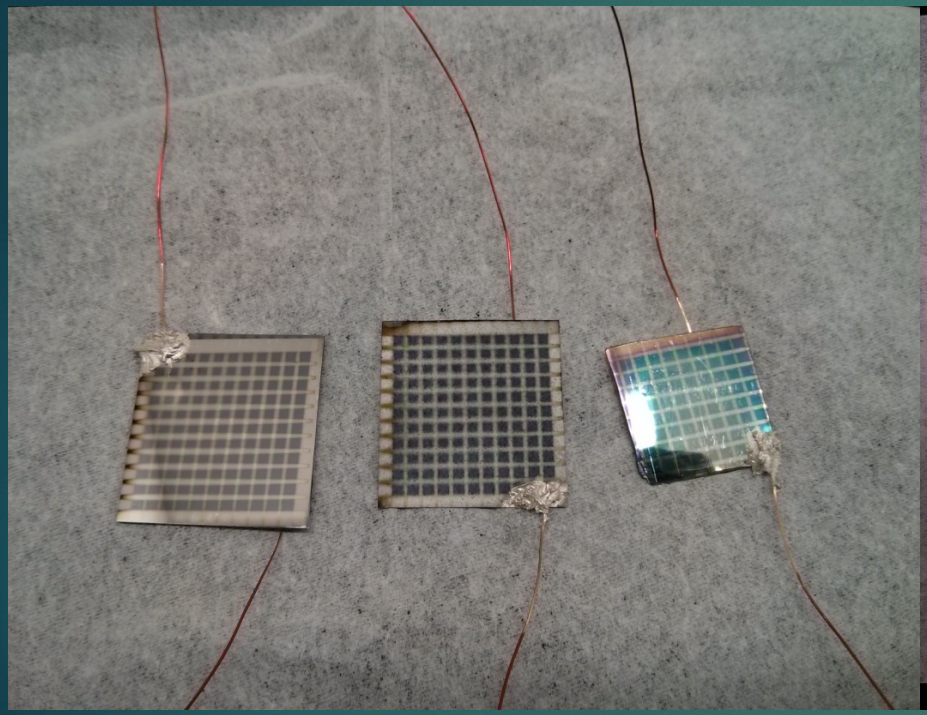
Materials

- Gold Nanoparticles (AuNP)
  - Diameter 3-5nm
  - Suspended in Hexane
  - Used for inert properties
- Multi-walled Carbon Nanotubes (MWCNT)
  - Suspended in Ethanol
  - Used for metallic properties

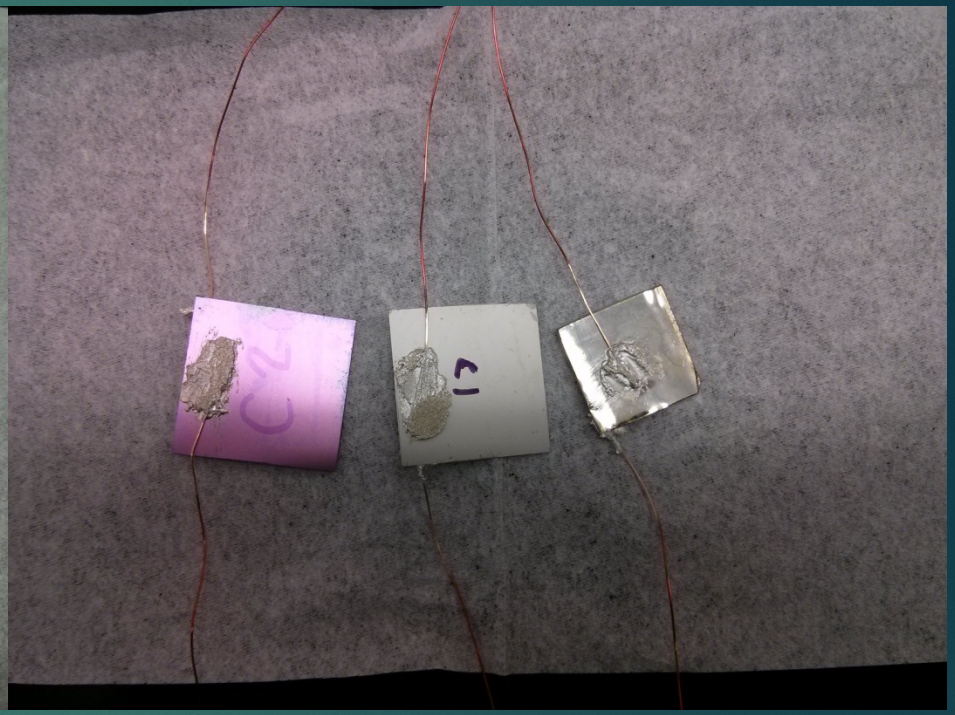
Deposition

- Atomizer spray gun
- Substrates used:
  - Evaporated Si on stainless steel
  - 170μm P-type Si – highly doped
  - 650μm P-type Si
- Various concentrations

Finished Product



AuNP, MWCNT, Evap. Si



650µm , 170 µm (Al Coated), Stainless Steel

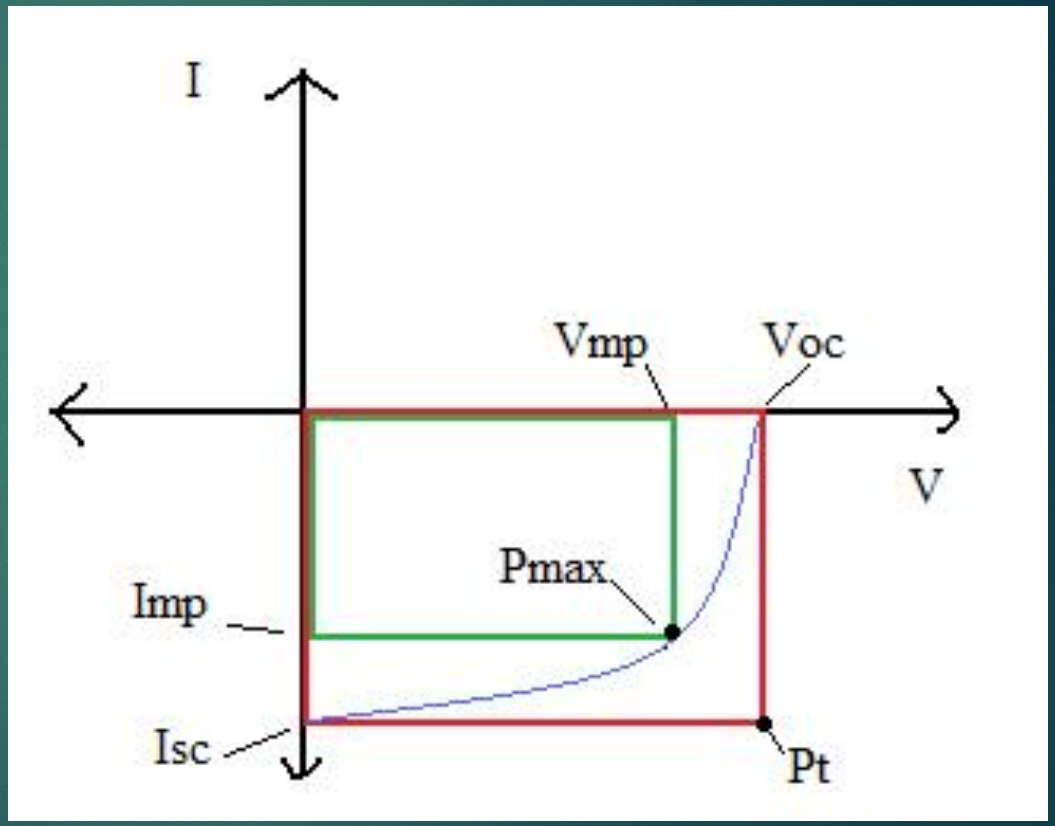
Analysis

- IV plots
- Fill Factor

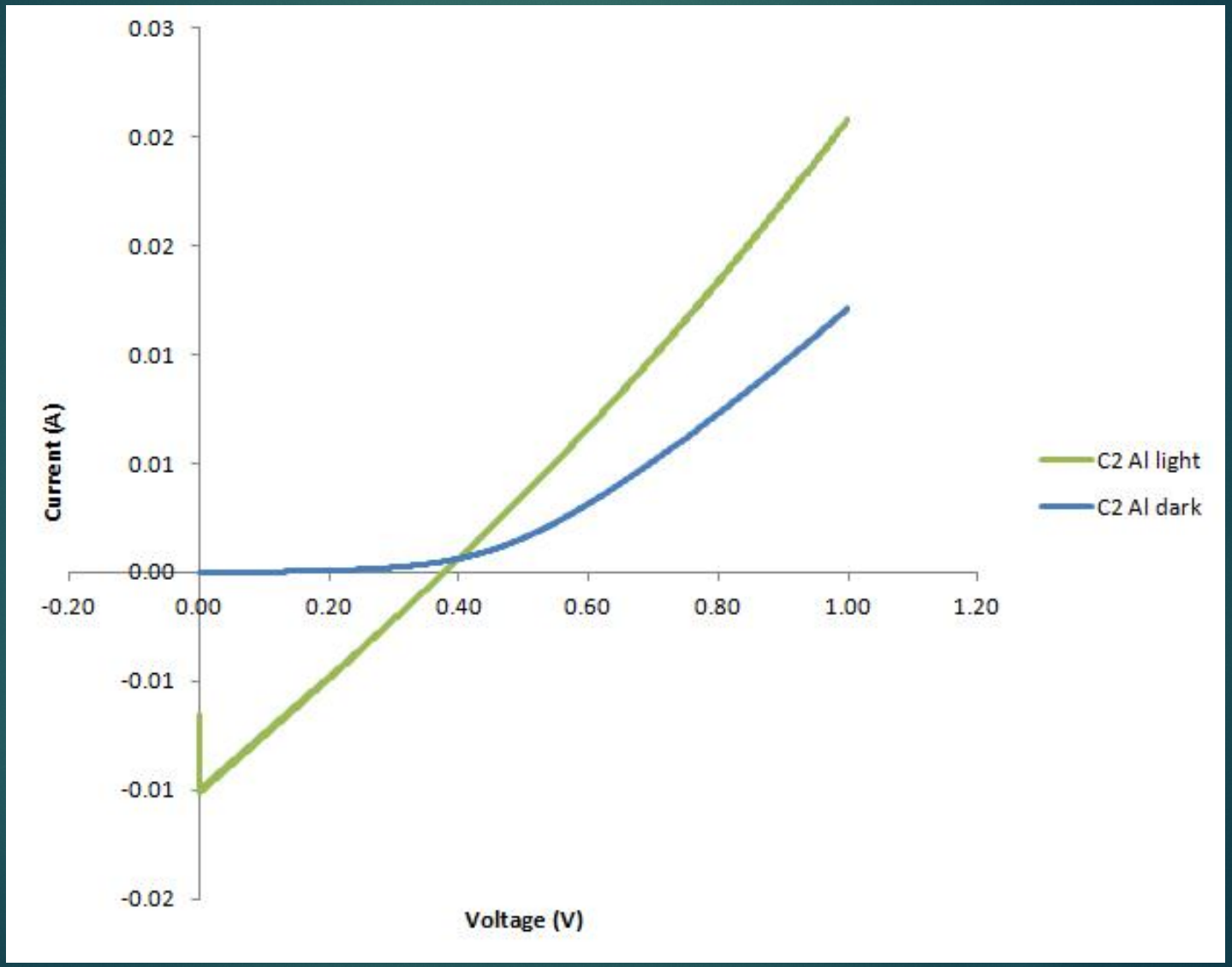
$$FF = \frac{I_{mp} * V_{mp}}{I_{sc} * V_{oc}}$$

- Efficiency

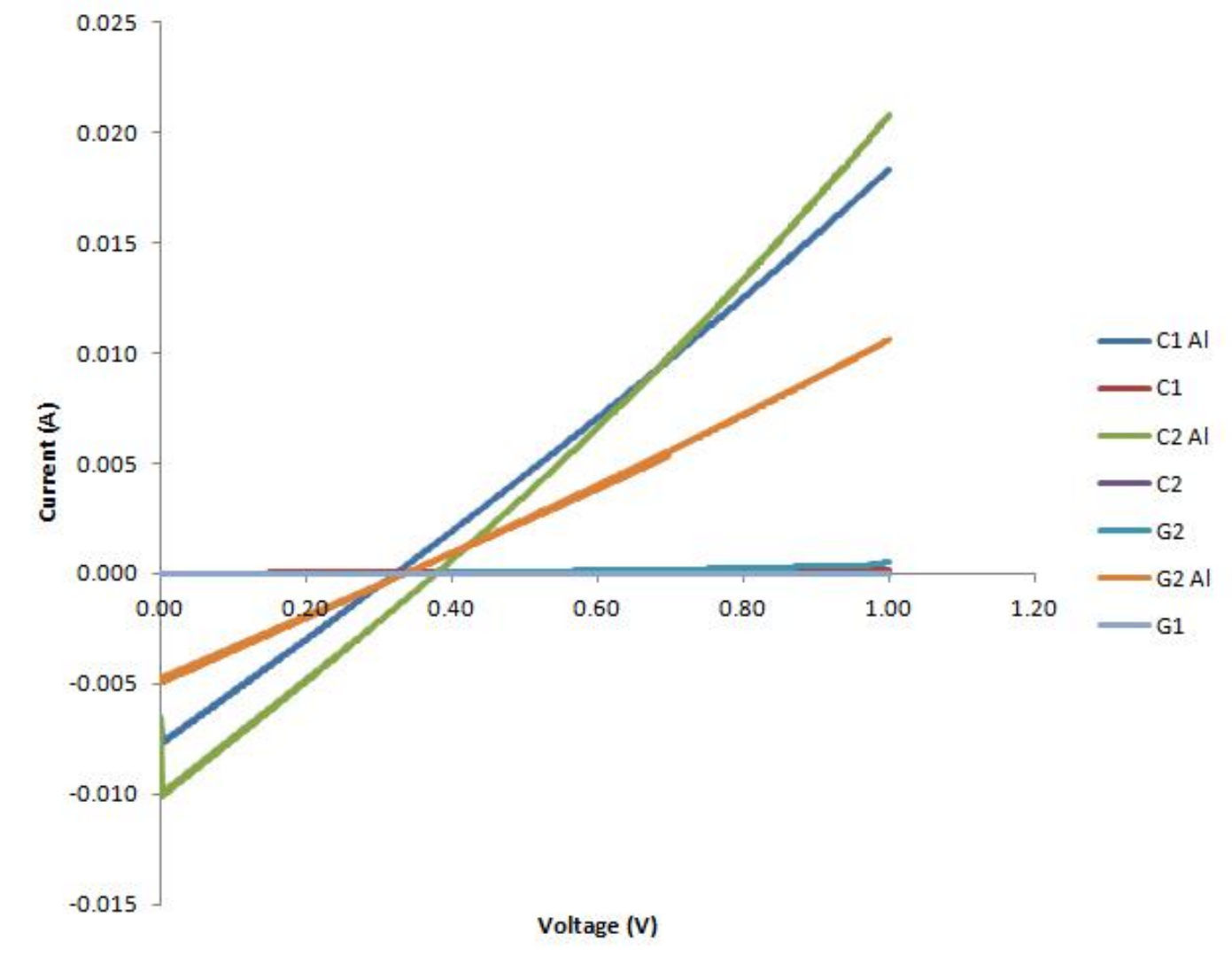
$$\eta = \frac{FF * I_{sc} * V_{oc}}{Area}$$



It’s a solar cell



Results


0.025
0.020
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
Current (A)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Voltage (V)
C1 Al
C1
C2 Al
C2
G2
G2 Al
G1

Data

- Au NP Solar Cell
  - Fill Factor: 0.25
  - Max efficiency: 0.10%
- MWCNT Solar Cell
  - Fill Factor: 0.26
  - Max efficiency: 0.25%
- Typical Cr-Si
  - Fill Factor: 0.70
  - Efficiency: 10-20%

Conclusion

- Opportunity for technological advancement
- Lower cost of production
- Increase solar popularity

Future Research

- Optimization
  - Si thickness / doping density
  - Nanostructure concentration
- Refined nanostructures
  - Gold nanorods
- Increased efficiency
- Improved deposition method
  - Uniformity

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Questions?