Black Silicon Solar Cells

Grøn Dyst

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Concept: Nanostructured solar cell

- Increased surface area + structures on the order of light-wavelengths
- Improved absorption material for solar cells
Nanostructures

$\text{SF}_6 + \text{O-ions}$
Process Advantages

- Process:
  - Upscalable: RIE-chambers can potentially be HUGE!
  - Fast, simple and cheap method:
    4 minutes process time, maskless process.
Optimal Structure

Structure Data:
- Peak Height = 100 nm
- Process: 4 min RIE
Improved Absorption

Reflectance

Reflectance [%]

Wavelength [nm]

Nanostructured
Blank reference

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Quantum Efficiency

Quantum Efficiency

QE [%] vs. Wavelength [nm]

Nanostructured
Blank reference
IV-characteristic for nanostructured and blank solar cell

Data for nanostructured cell:

- $V_{OC} = 0.56 \text{ V}$
- $I_{SC} = 6.5 \text{ mA}$
- $J = 34.6 \text{ mA/cm}^2$
- Efficiency = 11.8 %
- Fill Factor = 61 %

Higher Photocurrent
Power conversion efficiency of 11.8% for nanostructured solar cell compared to 7.9% for blank reference!
State-of-the-art

• VLS-growth
  • Kayes, Lewis et al., California Institute of Technology, CA
    \[ \eta = 0.46 \% \]

• Chemical Etching
  • Peng et al., Tsinghua University, Beijing
    \[ \eta = 9.31 \% \]

• This Project:
  \[ \eta = 11.8 \% \]
Conclusion

• A new kind of solar cell – based on nanotechnology – introduced
• Promising results: Nanostructures improve efficiency of solar cells (with \( \approx 4\% \))
• Further optimization and improvements

• Potentially improving existing solar cells’ efficiency + creating new kinds of solar cells for the future
Thank you!