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Synergy RTD 2013

FNSNF

Conductive-AFM characterization of nanowire-based solar cells

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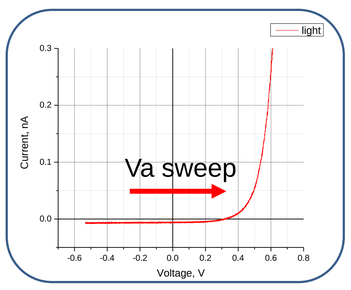
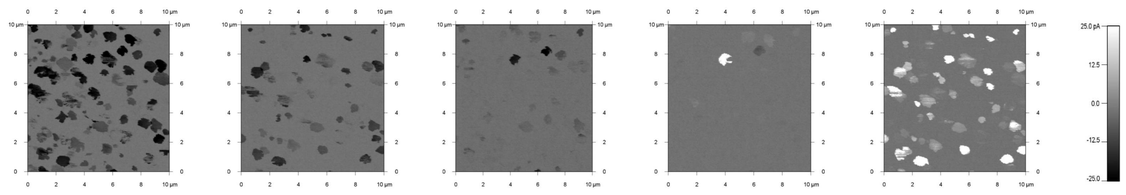
LMSC Laboratoire des Matériaux SemiConducteurs

Scan regime – current map

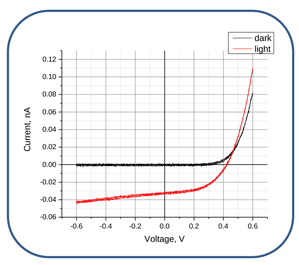


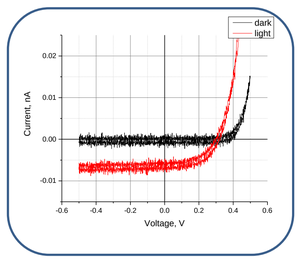
Current mapping of the solar cell surface provides the level of non-inhomogeneity of dozens of NWs. With the sweeping applied voltage, rough value of open-circuit voltage of the each nanowire in the image can be found.

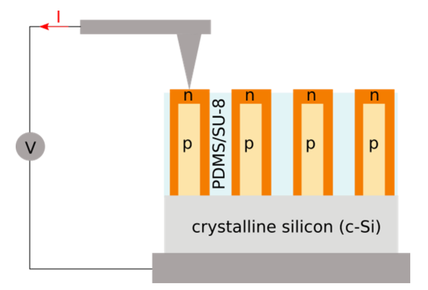


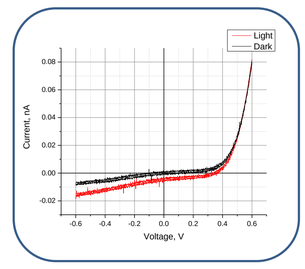
Va = -1 V | Va = 0 V | Va = 0.3 V | Va = 0.5 V | Va = 1 V

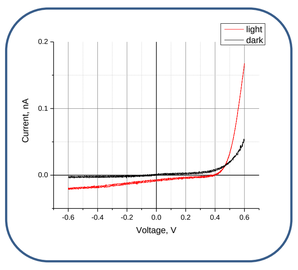
Single NW IV measurements







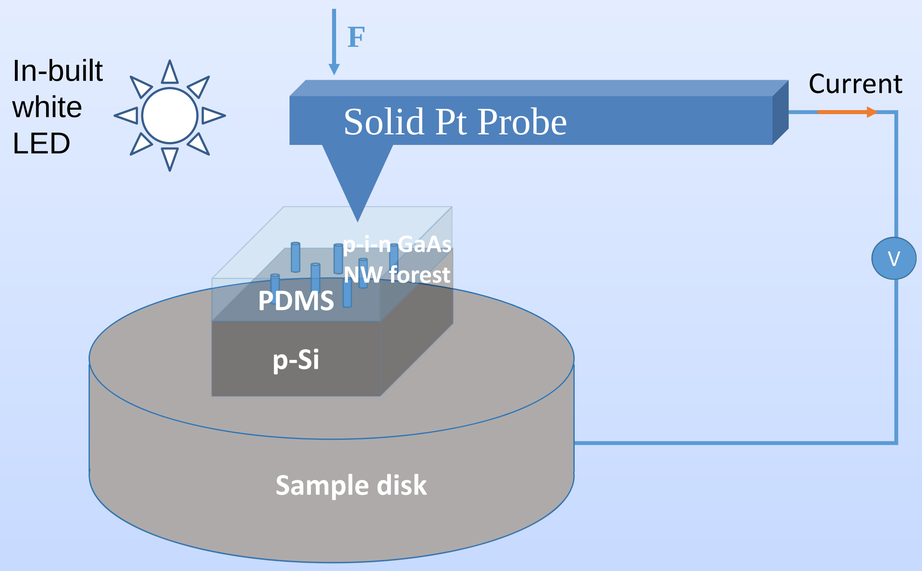


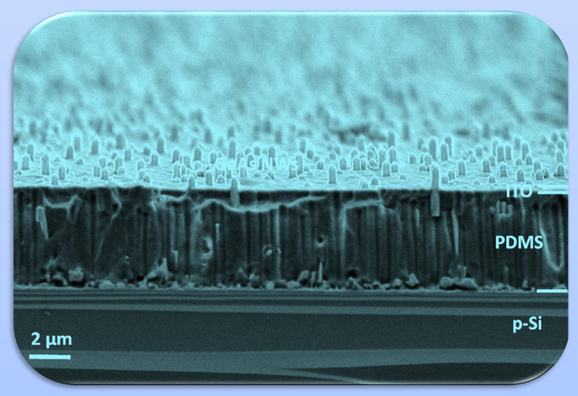


By contacting the exposed extremity of single NW with the AFM tip, we can measure IV curve of each p-n junction separately and relate it with the previously recorded NW's topographical appearance.

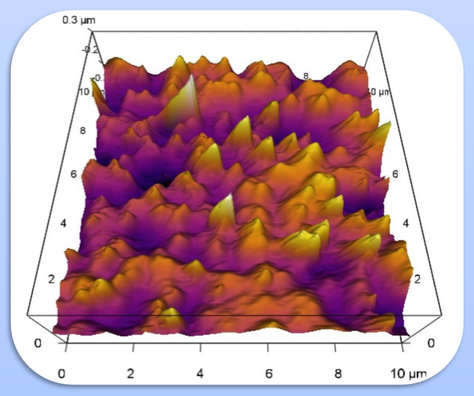
Motivation

Uniformity of photovoltaic characteristics of each single nanowire (NW) plays a significant role in full array solar cell performance due to parallel connection of nanowires. To evaluate it, single NW characterization in array has to be performed.





SEM image of the GaAs NW solar cell



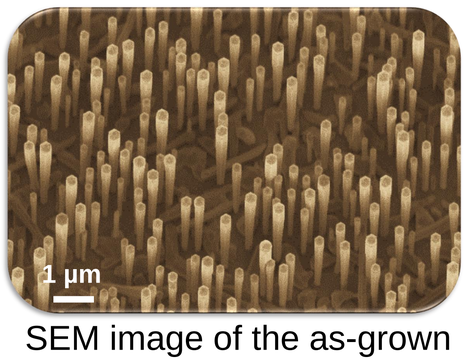
AFM image of the GaAs NW solar cell

Description

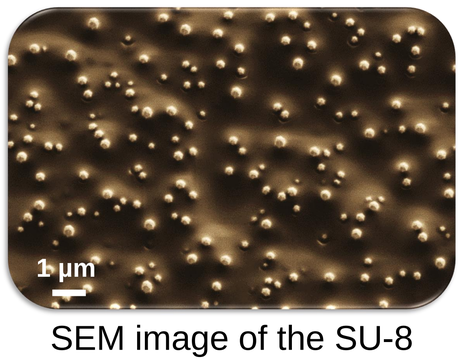
With conductive AFM (C-AFM) it is possible to obtain both surface topography and local electrical characterization with nanoscale resolution. Here we present:

- Topography and current mapping of NW forest
- Measuring single NW in array
- Light on-off IV measurements

Sample preparation



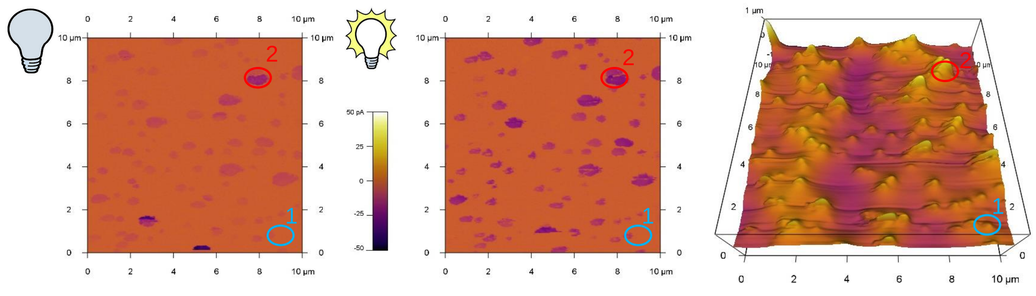
SEM image of the as-grown GaAs NW array



SEM image of the SU-8 coated GaAs NW array

- Reducing surface roughness by coating SU-8/PDMS polymer
- Etching SU-8/PDMS film to open NWs (if needed)
- Back Al contacts to p-Si to prevent surface oxidation

Light effect and surface morphology



By comparing surface morphology and current maps under and without* light, we can distinguish:

1. If nanowires have light sensitivity – "good" or "bad" p-n junction
2. The dependence of the current area with the protruding length of nanowires due to
   - Surface contact area between AFM tip and NW
   - Light absorption in NW (reflection losses from SU-8/PDMS)

*in presence of background light in AFM

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