Nanowire device characterization

Development of radial junction solar cells based on silicon nanowires requires constant device performance testing as well as the characterization of the fundamental properties of devices. At LPICM, we have wide range of characterization tools which are used to determine the performance of fabricated devices as well as the optical properties and radial junctions on nanoscale.

Radial junction devices are characterized using a **standard AAA class solar simulator** with a cell area estimated from the ITO contact mask size. A typical measurement curve is shown in Fig. 1.

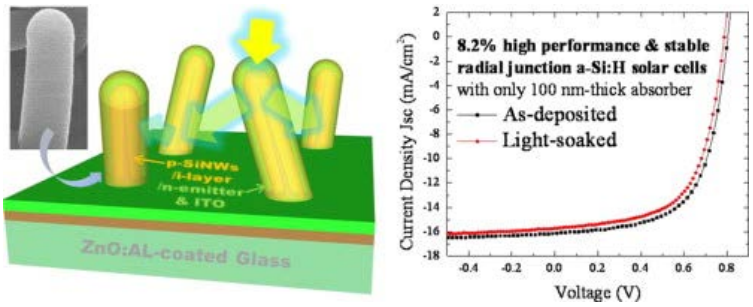

Figure 1. *Left:* Schematics of radial junction solar cells. *Right:* Example of measured J-V characteristics and corresponding performance of a solar cell before and after the light soaking.

In order to better understand fabricated silicon nanowire based devices, we are using our **external quantum efficiency** (EQE) measurement setup to identify opportunities to further improve the performance. For instance, examples of measured EQE on different radial junction devices in Fig. 2 show reduced values in the blue spectral range due to a parasitic absorption. Also, we can identify the improvement of the light trapping efficiency from such measurements, as it is illustrated in Fig. 2 on the gradual shift of the edge of EQE characteristics to the near infrared. In order to identify the absorption inside our devices, we are also measuring **total absorptance** of nanowire based devices by using an equipment with an integration sphere as shown in Fig. 2. Measured absorption curves show a clearly that a major part of the photons is absorbed in radial junction devices. Nevertheless, as shown on EQE measurements, a significant part of the light is absorbed in non-active materials and reduce amount of light which can be transformed to the electric current.

The main goal of the device characterization is to identify opportunities to improve the performance of radial junction solar cells and to identify and remove possible existingshortcomings which can hinder the performance.

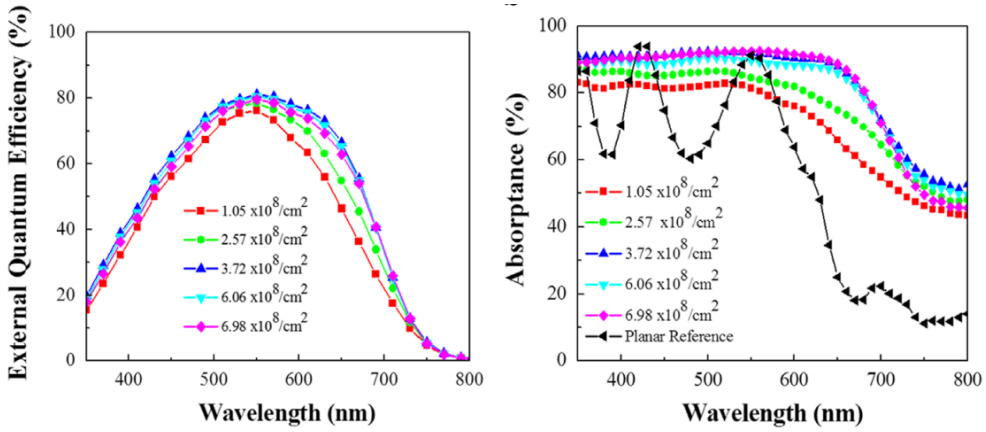

Figure 1. *Left:* Measured external quantum efficiency of different radial junction solar cells as a function of the wavelength. *Right:* Measured total absorptance of the same solar cells as a function of the wavelength.

For information on internships, doctoral studies, opening post-doctoral positions or collaboration, please contact Dr. Martin Foldyna (martin.foldyna@polytechnique.edu).

References

[1] S. Misra, L. Yu, M. Foldyna, and P. Roca i Cabarrocas, "A review of plasma-assisted VLS synthesis of silicon nanowires and radial junction solar cells," *J. Phys. D: Appl. Phys.* **47**, 393001 (2014).

[2] S. Misra, L. Yu, M. Foldyna, and P. Roca i Cabarrocas, "New Approaches to Improve the Performance of Thin-Film Radial Junction Solar Cells Built Over Silicon Nanowire Arrays," *IEEE Journal of Photovoltaics* **5**, 40 (2015).

[3] S. Misra, L. Yu, W. Chen, M. Foldyna, and P. Roca i Cabarrocas, "High efficiency and stable hydrogenated amorphous silicon radial junction solar cells built on VLS-grown silicon nanowires," *Solar Energy Materials and Solar Cells* **118**, 90 (2013).