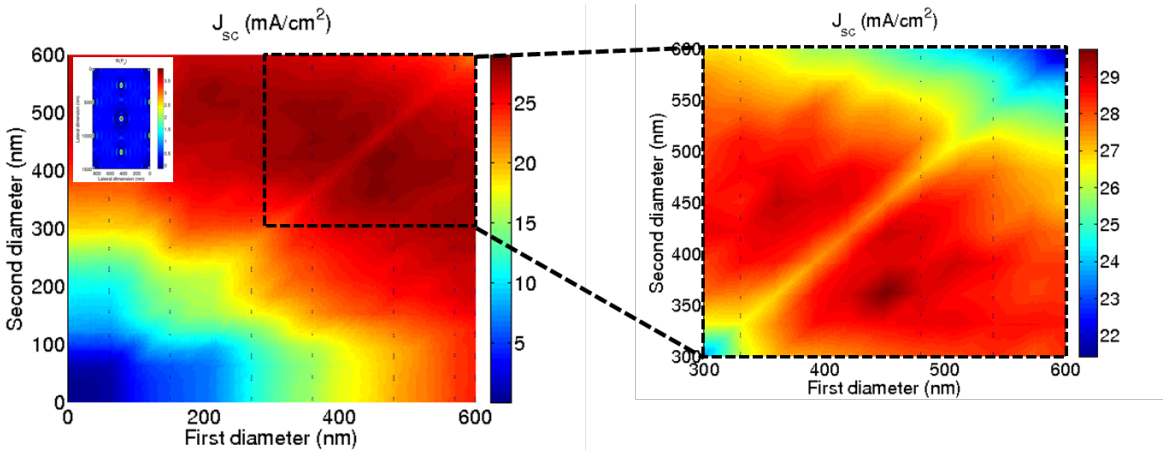
Optical modeling of nanowires

The reduction of active material in silicon solar cells, driven by the promising economic prospects, needs to be compensated by more efficient light trapping strategies. When trying to maximize material efficiency, nanowires represent a very viable choice.

Indeed, vertical nanowire arrays exhibit an excellent light absorption due to their unique structure combining individual optical properties with collective behavior of the arrays. An individual nanowire works as a nanoantenna allowing trapping of the light from the area superior to its geometrical dimensions. At the same time, an individual nanowire can play the role of a waveguide with the light propagating in the form of modes localized inside the nanowire. In addition, nanowires organized in periodic arrays can benefit from additional diffraction effects which can further increase the absorption inside them.

At LPICM, we are working on the optimization of the light absorption inside nanowire arrays. As a result, we have found critical diameters and densities maximizing the theoretical integrated short circuit current density. We are further investigating impact of the geometrical parameters on the nanowire solar cell performance. Combining individual nanowire properties with the closely packed periodic arrangement, we have designed a double-diameter nanowire arrays enabling to efficiently trap the light from the broader part of the solar spectrum and provide performance beyond the optimized single diameter periodic arrays.



Integrated short circuit current density as a function of two diameters in dual-diameter 3 µm long periodic vertical silicon nanowire hexagonal array [1].

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

References

[1] M. Foldyna, L. Yu, P. Roca i Cabarrocas, "Theoretical short-circuit current density for different geometries and organizations of silicon nanowires in solar cells," *Solar Energy Materials and Solar Cells* **117**, 645 (2013).