

Ultra-high solar concentration for ultra-efficient photovoltaics: 1,000 suns and beyond

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Summary

Photovoltaic conversion under high solar flux concentration (1000 suns and more) has been popular for many years, because of the prospects it offers in terms of solar-to-electric conversion efficiency, but also because of the lower cost of the electricity produced by these systems (the cell surface area required being considerably reduced compared with conventional PV systems).

However, the interest aroused by very high solar concentrations a few years ago now seems to be fading, despite its proven theoretical interest.

In this presentation, we will try to take a step back from this technology by reviewing the physical principles justifying the development of PV cells under ultra-high solar flux (UH-CPV), discuss the limiting mechanisms leading to a degradation of actual cell performance, and establish an overview of cell technologies likely to benefit from ultra-high solar concentrations.

We will begin with a few reminders related to the theoretical motivations underlying the development of PV cells for ultra-high solar concentrations.

The second part of this presentation will review the principal limiting mechanisms that are likely to impact the efficiency of UH-CPV cells in practice. We will then examine the various solutions that have been developed to address these limitations. Particular attention will be paid to the subject of resistive losses, which is one of the most significant limiting mechanisms under high solar flux concentration, and which has inspired a great deal of work aimed at reducing their amplitude.

The final section of this presentation will provide a review of solar cell technologies compatible with ultra-high solar concentrations, recalling the physical principles underlying each of these technologies, discussing the role of ultra-high solar concentrations in their operation, and listing the scientific and technological challenges to be overcome for each of them.

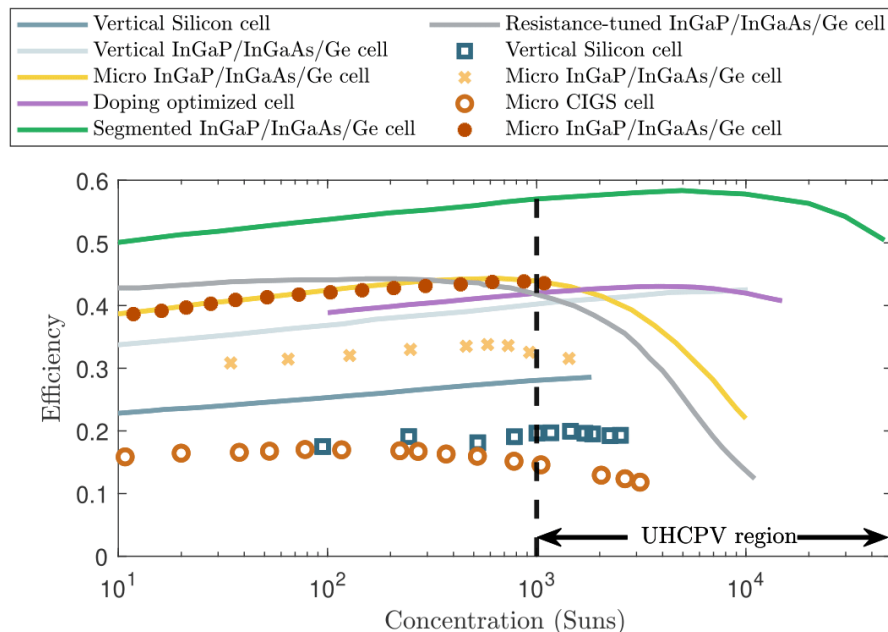


Figure 1: evolution of the conversion efficiency as a function of concentration factor for several of UH-CPV technologies