

Approaching the 29% limit efficiency of silicon solar cells

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Abstract:

The so-called "limit efficiency" of a silicon solar operating at one-sun is well established at approximately 29%, and laboratory cells have reached 25%. The efficiencies of commercially available silicon solar cells have been increasing over time, however, only recently have the highest performance commercial cells reached 20% efficiency. This presentation discusses the prospects of how the limit efficiency may be approached more closely in practical cells. Surprisingly, presently available silicon has sufficient minority carrier lifetime to achieve the goal. In fact, all aspects are in place for approaching 29% except for the existence of a suitable passivated contact technology.

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A BRIEF HISTORY OF LIMIT EFFICIENCIES

Since shortly after the announcement of the first silicon solar cell, whose efficiency was around 6% there has been an ongoing sport of calculating how efficient a solar cell can potentially be. This has become known as the "limit efficiency." Two parallel tracks have been followed in this endeavor, The first tack exercises semiconductor device models to see how best to make the cell, and how efficient it could be if various losses were eliminated or reduced as much as possible. The first stab at predi models was done by Prince only one year after the original cell announcement[1] of 21.6% for silicon using a cell model that would be familiar to workers today. A problem with this approach is that it is dependent on assumed material parameters, particularly the minority carrier lifetime. A cursory observation of the solar cell modeling equations reveals that if one assumes infinite carrier lifetime, the voltage and efficiency also become infinite. Clearly there

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