

## **R & D Challenges and Opportunities in Si Photovoltaics**

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Solar Cell Materials and Processes  
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# R&D Challenges and Opportunities in Si Photovoltaics

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Since 1997, the PV sales have exceeded 100 MW/yr with > 85% of the production coming from silicon photovoltaics (Si-PV). As the PV demands increase in the new millennium, there will be a host of challenges to Si-PV. The challenges will arise in developing strategies for cost reduction, increased production, higher throughput per manufacturing line, new sources of low-cost Si, and introduction of new manufacturing processes for cell fabrication. At the same time, newer thin-film technologies, based on CdTe and CIS, will come on board posing new competition. With these challenges come new opportunities for the Si-PV—to detach itself from the microelectronics industry, to embark on an aggressive program in thin-film Si solar cells, and to try new approaches to process monitoring.

The PV industry has already begun to address the use of thinner Si wafers, dropping from 400  $\mu\text{m}$  toward 200  $\mu\text{m}$ . Such a reduction in the wafer thickness is expected to conserve Si usage with an added advantage of higher cell efficiencies. The test production lots, fabricated with thin wafers, have verified such improvements in the device performance with a reduction in wafer thickness. However, the yield of thin cells is far lower than that of its thicker counterparts. It is expected that automation can mitigate part of this problem. However, it is necessary to investigate the basic mechanisms of wafer breakage. In particular, factors such as sawing, texturing, and warpage by the asymmetric metal patterns, which cause a propensity to breakage, need to be well understood. The final frontier of the thinner cells, the thin-film Si solar cell, is already above the horizon. The transition of this laboratory device into pilot line and then to production, is a strong challenge.

Process monitoring will be an important issue in the future. The current monitoring approaches are reminiscent of the microelectronic technology and are not well suited for PV. New methods that can yield meaningful results on large-area, textured wafers and cells are needed for process control and monitoring.

On the research side, continued work is needed toward understanding the role of defects and impurities. This understanding is apt to culminate in the fabrication of very-high-efficiency (about 20%) cells using low-cost material. This knowledge is also needed to deal with thin-film cell issues, such as the effects of impurities and defects becoming considerably more important. Other issues are related to metallization and processing that can achieve many conventional processes in one step so as to minimize the number of process steps for solar cell fabrication.

The 9<sup>th</sup> Workshop on Crystalline Silicon Solar Cell Materials and Processes will address these issues in a number of sessions. In addition to covering the usual topics of impurity gettering, defects, passivation, and solar cell processing, we have included sessions on poly feedstock, mechanical properties of Si, metallization, and process monitoring.

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