Watt efficiency

Reducing the overall dollar per watt in the PV production is a lucrative target. Silicon Genesis aims to provide a cost effective solution.

Figure 1: PolyMax Solar Substrate - 125 mm X 125 mm, 50 µm

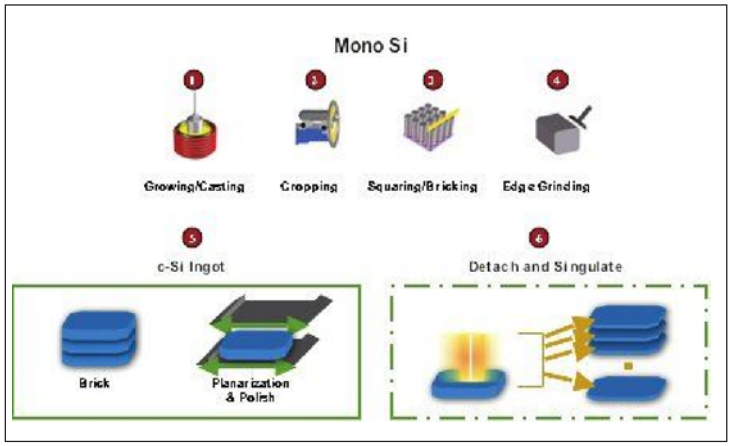
With the ever increasing dependence and cost of oil and the demand for clean energy, there has been a growing demand for cost effective clean solar photovoltaic (PV) energy sources. The PV market is based on about 90% of the technology using crystalline silicon (c-Si) with the remaining 10% based on thin films such as amorphous silicon (a-Si) and cadmium telluride (CdTe). This high demand for photovoltaics has dramatically increased the price of polysilicon feedstock material in recent years and has driven the industry to use thinner wafers in order to reduce the quantity of silicon material and overall cost. The starting material used by the c-Si PV industry are wafers generated either from cutting mono crystalline or multi crystalline bricks. The lack of adequate technology to cost effectively process the bricks into thin wafers has been a persistent industry challenge. The c-Si market is projected to maintain that general proportion of the overall market into the foreseeable future and well past 2010 when the poly silicon supply shortage is expected to ease.

PV Market

The main driver for the PV market is simple: reduction of the production costs of making cells and modules, as well as the associated installation costs at a specific solar to electricity conversion efficiency (dollars per watt produced or $/W). The ultimate target is to lower the module production costs to about $1/W to $1.50/W. The current level for c-Si modules is on the order of $2.25/W and greater. A general rule of thumb is that the installation and system costs, typically referred to as the 'Balance of System' (BOS), are about equal to the $/W of the module production costs.

A reduction of the module costs by a factor of 2 and the subsequent lowering of the BOS by the same factor leads to an overall drop in cost of the electricity generating ensemble to of its value. With current total system costs at about $6/W to $9/W installed, the reduction of would lead to total system costs around $3/W to $4.5/W which would put PV electricity in the sunbelt region (i.e. California, Spain, Greece, etc.) at about $0.10/kW-hr. At this level, the price of electricity generated by PV becomes comparable to electricity generated by standard sources which power the grid.

Figure 2: PolyMax DFT PV Wafering Process



Economic Factors

The economic factors in the PV industry are measured by the cost metric of $/W defined as the cost required to manufacture a cell, or a module, divided by the amount of peak power capable of being produced by the PV technology. Typically, the unit of time is a year so that the metric is:

$$\frac{\text{(Cost of production in \$/year)}}{\text{(Number of watts from panels manufactured produce from that year of production)}}$$

The elements which go into the determination of the cost of production include: the raw materials, the equipment capital expense depreciated, the consumables, the labour costs, the electricity costs, the land and building depreciation costs, and other incidental expenses.

The goal for the PV industry is to drive costs lower to achieve so called ìgrid parityî becoming an economically viable source of energy.

PolyMax

To address the industry's need to reduce manufacturing cost and waste, SiGen has developed a process that has the potential of reducing the $/W metric through a savings on the starting polysilicon raw material. This is accomplished by eliminating kerf loss, a major cost and material inefficiency in wafered PV technology linked to the loss of about 50% of the starting raw material when traditional wire based sawing processes are used.

Called PolyMax, the process and specialised equipment set can substantially reduce the utilisation of polysilicon within the 'ingot to wafer' manufacturing process by eliminating sawing losses. SiGen has successfully produced wafer samples of 50μm thickness with excellent yield, mechanical and electrical characteristics.

High volume manufacturing equipment is being designed to process ingots into thin wafers suitable for high efficiency PV cell processing. First targeted to process monocrystalline silicon, the equipment is expected to help the PV industry reach grid parity while simultaneously relaxing the shortage of polysilicon feedstock.

PolyMax cost benefits cascade to all links in the PV production chain and the PolyMax silicon substrate itself adds value to the full chain resulting in lower $/W.

SiGen's PolyMax Process

SiGen's PolyMax process is a Direct Film Transfer (DFT) technology to produce thin silicon wafers for the PV industry with a customer selected 50-150μm thickness range.

The basic process is to prepare a shaped piece of a silicon ingot and using a proton beam, successively shave films of a desired thickness from the top of the ingot or ìbrickî. The new bottom of the film remaining on the brick surface will be the new top of the next film to be detached. Because the technology inherently produces a highly uniform thickness linked to the mono energetic proton beam used to develop the cleave plane, the process allows numerous films to be detached / cleaved without brick resurfacing or treatments. Successive film cleaves without brick treatments such as polishing or lapping further reduces wafering cost.

The basic DFT cleave sequence is shown:

The immediate benefit of the SiGen PolyMax process is that there is no Kerf loss, which provides a substantial savings of poly-silicon starting material as compared with the standard approach using multi wire slurry saws (MWSS). SiGen PolyMax process would take the place of several conventional MWSS process steps such as sawing, washing and singulating.

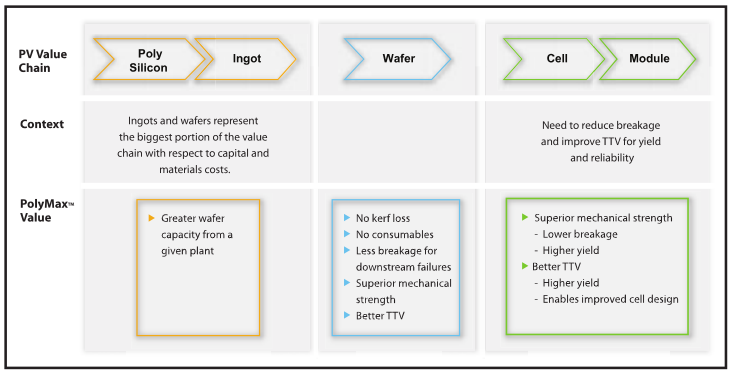


Figure 3: Wire Saw, PolyMax Process and HVM

The following illustrates the general comparison wire saw vs. the SiGen PolyMax process and a PolyMax high volume manufacturing (HVM) layout:

Conclusion

SiGen PolyMax technology provides a cost effective solution in reducing the overall $/W in the overall PV production chain by providing thin wafers at a lower production cost, with enhanced wafer properties, benefiting the entire chain.

It is a two step cost effective process:

- Implant & Cleave
- Eliminates kerf loss
- 1$/wafer less vs. wire saw
- Improved utilisation of Si: about 2-4x gm/W vs. wire-saw
- Eliminates consumables

In summary, the SiGen PolyMax approach to wafering provides the PV supply chain with an innovative approach and solution in its quest to meet grid parity.