ISSN 2229-5518

Laser processes to help reduce the cost of manufacturing of solar panels.

As a source of energy, nothing matches the sun. It out-powers anything that human technology could ever produce. Only a small fraction of the sun's power output strikes the Earth, but even that provides 10,000 times as much as all the commercial energy that humans use on the planet.

Already, the sun's contribution to human energy needs is substantial — worldwide, solar electricity generation is a growing, multibillion dollar industry. But solar's share of the total energy market remains rather small, well below 1 percent of total energy consumption, compared with roughly 85 percent from oil, natural gas, and coal.Those fossil fuels cannot remain the dominant sources of energy forever.

For a long-term, sustainable energy source, solar power offers an attractive alternative. Its availability far exceeds any conceivable future energy demands. It is environmentally clean, and its energy is transmitted from the sun to the Earth free of charge. But exploiting the sun's power is not without challenges. Overcoming the barriers to widespread solar power generation will require engineering innovations in several arenas

But today's commercial solar cells, most often made from silicon, typically convert sunlight into electricity with an efficiency of only 10 percent to 20 percent, although some test cells do a little better. Given their manufacturing costs, modules of today's cells incorporated in the power grid would produce electricity at a cost roughly 3 to 6 times higher than current prices, or 18-30 cents per kilowatt hour. To make solar economically competitive, engineers must find ways to improve the

- **Efficiency of the cells**
- **Lower manufacturing costs of cells.**

http://www.engineeringchallenges.org/cms/8996/9082.aspx

IJSER © 2013

ISSN 2229-5518

This paper discusses the role of laser technology with respect to the two ways of making solar cell competetive.

Soldering and encapsulating of solar cells are the main processes for the photovoltaic modules. Poor soldering process will damage or crack the solar cells, induce a reliability problem, and even decrease the power output and lifespan of a solar module significantly.

Response Surface Method (RSM) is used to analysis the factors affecting the grooving quality of soldering quality through strategic experiments. At first, list the quality factors that will influence the soldering quality of solar cells. Choose the control factors such as hot-air temperature, soldering time, flux, and etc. to set their levels.

RSM can build effective mathematic models with response characteristics from experimental results. Finally, following the soldering process of solar cells, apply the optimum collocation of parameters which have been calculated by the RSM. The average loss of power output after soldering is 4.688%. Compared to that of the original procedure, the average decline ratio is 10.65%. The optimization process in this research reduced 5.962% of power loss; therefore, the RSM for the optimization of soldering parameters can improve the quality of hot air soldering process efficiently.

The current photovoltaic market includes crystalline silicon and other different thin film technologies. Each technology produces different solar cell efficiencies. The mainstream is currently crystalline silicon solar cells, which has a larger share of the market. Other products include single-crystal silicon solar cells and multi-crystalline silicon solar cells. All commercial solar cell structures are produced by the screen printing and firing process

(1)selection of solders, (2)optimization of soldering factors, (3) soldering methods

WuChang Yang, Herchang Ay †, YangJyunCiou
A study of optimal manufacturing parameters with lead-freesolder on the c-si photovoltaic cells by using hot-airtabbing.

---

cost-competitive solar energy systems

manufacturing process

Examples of achievements under the PV Manufacturing Research and Development Project include the development of a manufacturing process that increase the production of silicon solar modules by **8%** without increasing costs

"NREL PV Research".*Photovoltaic (PV) Manufacturing Research and Development (R&D) Project*.NREL.http://www.nrel.gov/pv/pv_manufacturing.html. Retrieved 18 April 2011.

C:\Users\Sachin Pore\Desktop\PV_Cells\National Renewable Energy Laboratory - Wikipedia, the free encyclopedia.mht

---

ISSN 2229-5518

The wide range of available wavelengths, high brightness and increasing reliability are breaking new ground for diode lasers. Material processing with high power diode lasers in industrial manufacturing is getting more and more important. In solar cell production, they are important tools for automated production. [1]

One of the major advantages of the laser as a tool for material processing is the abilityto precisely control where in the material and at what rate energy is deposited.This control is exercised through the proper selection of laser processing parametersto achieve the desired material modification.[2]

ExcimerLaser Annealing (ELA) is used to recrystallizepoorly conducting amorphous silicon to produce larger grain sizes andreduce defects. ELA has also been used in the production of poly-Si thin films forsolar cells.[2]

There are two distinct methodologies which have been investigated for lasertexturing surfaces to enhance absorption. The first is direct-write micromachining where a focused beam is scanned across a surface in a pattern to selectively ablate material and define the structures.[2]

In summary, multiscale texturing plays an important role in a material's optical properties, and such behavior can be exploited for applications such as photovoltaics or electron emitters. At the cutting edge of this is the laser structuring of silicon to produce a variant often referred to as black silicon. Such a structure has been shown to absorb 95% of incident radiation with energy above its bandgap [250–1,100nm]

There are several laser-based processes which are currently used in solar cell manufacturing or show a high potential for being implemented in series production in the future. Among these are laser edge isolation, laser fired contacts,metal/emitter wrap through, laser doping as well as P1, P2 and P3 structuring of thin film solar cells. Currently, all these direct-patterning processes are mostly performed by single-mode lasers with Gaussian intensity distributions. In contrast, top hat profiles offer larger process stability as well as cost savings.

For laser-based machining of holes and trenches single-mode solid state lasers and their harmonics are widely used. In solar cell production the most prominent lasers Arens-pulsed Nd:YAG and Nd:VYO4 lasers at1064 name and their harmonics at 532 and355 nm. Additionally, single-mode ps-lasers are entering the production process lately.Compared to NS-lasers they have the advantage of very precise ablation due to their pulse energies and negligible thermal effects because of the ultra-short pulse durations.

Hence, the quality of solar cells as well as the throughput in production lines can be improved by using top-hat-converted Gaussian beams instead of original radiation beams. Further development work focuses on combining scanners and appropriate f-θ objective lenses with the Gaussian-to-top-hat converter beam lines, in order to further increase the processing speed.

Dr. Oliver Homburg
Dr. Paul Harten
"PHOTOVOLTAICS"

Using lasers in new solar cell desings promises to offer significantly better performance over the existing screen-printed technologies and yet the new cells are relatively simple and inexpensive to implement in existing production lines.

This new, elegant process (of laser doping of selected emitters) has been shown to increase cell efficiencies for both mono and multi crystalline cells by up to as much as much as 2 percent in absolute terms. This is a 10 percent improvement over more traditional screen-printed cells.

Dave Clark
Newport corp./spectra-physics

---

[1] Wolfgang Horn ,Welding and Soldering with High Power Diode Lasers
[2] Matthew S. Brown and Craig B. Arnold Fundamentals of Laser-Material Interaction and Application to Multiscale SurfaceModification, Chapter 4.

Photovoltaic solar cells are thin silicon disks that convert sunlight into electricity.

Read more:
file:///C:/Users/Sachin%20Pore/Desktop/PV_Cells/How%20solar%20cell%20is%20made%20-%20material,%20manufacture,%20making,%20used,%20parts,%20structure,%20procedure,%20steps,%20industry,%20Raw%20Materials,%20The%20Manufacturing%20Process%20of%20solar%20cell.mht#ixzz2KfbVvYG2

From the boule, silicon wafers are sliced one at a time using a circular saw whose inner diameter cuts into the rod, or many at once with a multiwire saw. (A diamond saw produces cuts that are as wide as the wafer—. 5 millimeter thick.) Only about one-half of the silicon is lost from the boule to the finished circular wafer—more if the wafer is then cut to be rectangular or hexagonal. Rectangular or hexagonal wafers sometimes use in solar cells because they can be fitted together perfectly, thereby utilizing all available space on the front surface of the solar cell.

Read more:
file:///C:/Users/Sachin%20Pore/Desktop/PV_Cells/How%20solar%20cell%20is%20made%20-%20material,%20manufacture,%20making,%20used,%20parts,%20structure,%20procedure,%20steps,%20industry,%20Raw%20Materials,%20The%20Manufacturing%20Process%20of%20solar%20cell.mht#ixzz2KfatRsSn

---

A **solar cell** (also called a **photovoltaic cell**) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect.
C:\Users\Sachin Pore\Desktop\PV_Cells\Solar cell - Wikipedia, the free encyclopedia.mht