

PV Manufacturing

From Equipment and Materials to Solar Business

ISSUE N° 10

OCTOBER 2010

EDITORIAL



Maturing solar industry develops mature supply chain

The photovoltaics industry will likely add some 35% more production capacity this year to meet continued healthily increasing demand, but we think the really good news is how the industry's supply chain is growing up. Now the solar sector is getting big enough, and established enough, to support a sophisticated supply chain investing in advancing practical technologies

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ANALYSIS

Sanyo aims to combine HIT technology and thin film for 30% efficient cells

Nikkei's new Green Device Magazine sat down with Sanyo Electric Co. Ltd. VP Shinya Tsuda, general manager of strategic business promotion, R&D and environmental management, to discuss the future of solar technology.



Shinya Tsuda, Sanyo (Photo: Masahiko Miyata)

Sanyo reports efficiency of its commercial heterojunction with intrinsic thin layer (HIT) technology is now 19.8% at the cell level, 17.4% at the module level, and the company counts on continuing to combine different forms of silicon as the most practical path to get significantly higher efficiencies and lower costs...

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COMPANY VISION

1366 Technologies to offer its texturing and fine-line metallization through RENA, plans production of lower cost silicon

Making some other potentially significant process improvements available to a wider market now is 1366 Technologies, a Lexington, MA, startup commercializing technologies developed by Professor Emanuel Sachs and his research group at the Massachusetts Institute of Technology.

First products from the three-year old company are a honeycomb surface texturing technology and a related fine-line metallization process, now in pilot production on process tools from RENA.

When founded in 2007, the company originally planned to make its own solar cells with its processes, which it hyped aggressively as solar power at the price of coal...

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(Courtesy of 1366 Technologies)

ANALYST CORNER

Best hope to bring down solar costs? New ways to do the old things from the supply chain

What's really going to bring down solar costs to create a healthy industry as government subsidies decline? By Yole Développement.

Cell and module makers are making incremental improvements to their current technology every day, but tweaking existing processes is likely to bring only gradual change. Researchers meanwhile announce radical new approaches that could make big jumps, but there's a long, long road to ever getting even some of those to work in

low cost, volume production. What's really going to make a difference in the near- to mid-term is likely the middle ground, of new approaches that make significant improvements to the established processes – which likely means serious investment by equipment suppliers in developing these new technologies...

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PLATINUM PARTNERS:

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EDITORIAL

for manufacturing. These improvements in surface texturing, surface shading, contact resistance, and module assembly may resemble some of the in-house developments that leading crystalline silicon cell producers have been using for some time on the best and highest cost cells. But they are now becoming available commercially as add-on processes to boost the efficiency of conventional lower cost multicrystalline modules to the 16%-18% range.

We highlight some of these developments we think are of particular interest in this issue, focusing on metal wrap-through technology, thin-line metallization and silicon wafer technology from the Energy Centre of the Netherlands and 1366 Technologies, now being brought to production levels with equipment makers Eurotron, AT&S and RENA, in modules from Solland Solar, SCHOTT Solar, and Yingli Solar. But we think this is just the beginning for this kind of lower cost manufacturing improvements to come from the supply chain.

Of course upgrading the general level of commercial solar technology also ups the level of competition. Sanyo Electric VP Shinya Tsuda, in an interview here, warns that the PV industry's current coming of age is rather like the samurai traditional putting on of adult dress — getting ready for its first real battle.

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ANALYSIS

Sanyo aims to combine HIT technology and thin film for 30% efficient cells

From page 1

Green Device Magazine: We hear good things about Sanyo's high efficiency HIT cells that sandwich crystalline silicon between layers of amorphous thin film silicon.

Shinya Tsuda: Solar technology is supposed to be good for the environment. But if making solar cells consumes too much energy, or deploying them consumes too much land, they can still have significant environment cost. HIT cells are better for the environment because they are more efficient than many. And because they are so thin, they use little silicon. Making silicon wafers uses really a lot of energy, so thinness is very important. We chose HIT technology because we were looking for a better environmental solution.

Of course, our main motivation was to get as much energy as possible from a given surface area. I believe conversion efficiency is the most important factor for solar cells. Then we can keep our production costs down by making the cells

extremely thin. Since the silicon wafer accounts for such a big part of the cost of crystalline solar cells, it's key to use a little of it as possible. Silicon prices have also been extremely volatile, first soaring a while ago and then plummeting back down to about a third of peak prices. Prices will likely continue to fluctuate unpredictably, so the best long term solution is to use thin wafers to control costs.

GDM: Thin film solar technologies like Si or CIGS on glass are also getting attention.

ST: Of course we have also considered compound semiconductors like CIGS. But we are concerned about a stable supply of material. CIGS needs In and Ga. We are also in the battery business, and we have learned there that it is extremely difficult to build a business model that depends on high volumes of rare elements. The volatile price of cobalt makes the battery business very difficult to manage.

But we don't have to worry about the supply of silicon. Though temporary shortages in the supply chain may cause the price to jump, silicon remains the second most common element on earth after oxygen. Nor are there any complex environmental concerns. Silicon is plentiful and it is safe, so it's by far the best choice for something that will be mass produced in vast acres of surface area like solar cells.

GDM: Crystalline silicon technology like HIT seems to be gradually nearing its theoretical limit of efficiency. Thin film silicon's efficiency is around 10%. Is there much further margin for improvement?

ST: Crystalline silicon solar cells can only convert some 20% of sun light because of the mismatch between the broad spectrum of wavelengths of light, and the narrow spectrum of wavelengths that any single material or simple cell structure can convert. So one way to make higher efficiency cells is to combine materials with different bandgaps, using one material suited to the long wave lengths with one suited to the short wave lengths, such as crystalline silicon with a bandgap of 1.1eV with a material with a bandgap of 1.7eV. Theoretically, using materials with bandgaps of 1.0eV, 1.4eV



Shinya Tsuda, General Manager of strategic business promotion, R&D and environmental management, Sanyo (Photo: Masahiko Miyata)

...“Cost is also a huge factor for the adoption of solar energy. To make the best tradeoffs between efficiency and cost we must make smart use of low cost materials. And for that, silicon is an extremely good material,” explains Shinya Tsuda

EVENTS



- **Semicon Europa**

October 19 to 21, 2010 - Dresden, Germany

- **Solar Meetings**

November 17 to 18, 2010 - Chambéry, France

- **Semicon Japan**

December 1 to 3, 2010 - Tokyo, Japan

GOLD PARTNERS:



and 1.8eV would be even better, though issues of combining the materials make it difficult to reach the expected efficiencies in practice. And the materials must also be cheap, and easy to produce without environmental harm. All these concerns make multijunction cells of various exotic semiconductor materials a difficult prospect, though they are the best solution purely for efficiency. But cost is also a huge factor for the adoption of solar energy. To make the best tradeoffs between efficiency and cost we must make smart use of low cost materials. And for that, silicon is an extremely good material. Crystalline silicon's bandgap of 1.1eV is a little smaller than the ideal 1.4eV. But amorphous silicon has a bandgap of 1.6-1.7eV, so combining the two forms approaches an ideal type of solar cell. Though the HIT cell uses both amorphous silicon and crystalline silicon, its emitter layer is still essentially single junction. Its theoretical maximum efficiency, however, is a point or two higher than the 27%-29% theoretical maximum of just crystalline silicon, or about 30%. Though it will take some time to achieve, this is where we are aiming.

GDM: Is Sanyo developing multijunction cells?

ST: The thin film silicon cells we are developing are essentially multijunction structures, using amorphous and crystalline silicon with their nearly

“Our goal is to find a solution for high quality silicon thin film, and then combine it with crystalline silicon HIT technology for a high efficiency future cell,” he adds

ideal band gaps. The problem, however, is that the film quality of amorphous and microcrystalline or nanocrystalline silicon remains very low, so they don't approach their theoretical efficiency. Good film quality, especially for micro/nano crystalline materials, requires thick layers, now some 2-3µm. Thicker layers need higher speed deposition technologies, but the faster the films are grown, the worse the quality. Solving this problem is the biggest issue for thin film silicon. Our goal is to find a solution for high quality silicon thin film, and then combine it with crystalline silicon HIT technology for a high efficiency future cell.

GDM: Solar technology has been around for half a century, but it's still under development. In human terms, how mature do you think the solar industry is?

ST: I'd say it's around genpuku, [the traditional samurai coming of age ceremony when teenage boys put on adult dress and become men]. Japanese solar makers struggled along for 20 or 30

years on government subsidies, but in the last 5-6 years they've started to make money. Sales have finally taken off, and companies have finally started to see solar as a real business. But the industry is now coming of age because the real battle is about to start, as Korea's Samsung Electronics Co. Ltd. enters the solar market. That's going to bring a new level of competition, just like it brought to the LCD and the DRAM industries. So we are about to begin a new phase, just like a samurai coming of age about to face his first battle. I think it's the same as that.

Paula Doe for Yole Développement
Interview by Satoshi Okuba.
Translated by permission
of Nikkei BP's Green Device Magazine.

PV Incentive Programs Country Profiles

Understand the impact of incentive programs on PV installations in more than 25 countries

After discussing with key experts of each country, Yole has analysed their programs to provide an in-depth analysis on the PV demand.

This report provides the best information on each country active in the PV field with data summarizing the type and the definition of incentive programs in a concise way.

KEY FEATURES

- For each country the following information is provided:
 - General country data
 - Share of electricity by source
 - Irradiation map
 - Description of the incentive program
 - Breakdown of installation
 - Past amount of installation and forecast of governments

CONTACT US

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• Basic data

Population 2006 (million)	61.35
GDP 2006 (billion 2006\$)	1485.3
Growth of GDP 1990-2006 (%)	2%
Total Energy production (Mtoe)	137.02
Energy use (Mtoe)	272.67
Energy use growth 2005-2006 (%)	-1.18
Electricity production (GWh)	574473
Electricity consumption (GWh)	429913
Electric Power consumption per capita (kWh per capita)	7585

• Source of electricity

Oil	1.24%
Gas	3.84%
Nuclear	78.37%
Hydro	10.63%
Coal/pep	4.58%
Renewable & waste	0.96%
Geothermal/Solar Thermal/wind	0.37%
Solar PV	0.0038%

• Irradiation

Type of installation	Type of building	Feed-in-tariff
BPV installations	Houses, schools and hospitals	0.58 €/kWh
	Industrial, commercial and agricultural buildings	0.50 €/kWh
Roof mounted	Industrial, commercial and agricultural buildings	0.42 €/kWh
Ground mounted	< 250 Kw	0.314 €/kWh
	> 250 Kw	0.314 €/kWh (High irradiation) 0.377 €/kWh (Low irradiation)

*Feed-in-tariffs will not change for the next 2 years. They will then be revised in 2012 based on inflation rate and price of installation by the Ministry of the environment and sustainable development.

• Photovoltaic support scheme is today based on the "Decree of July the 10th, 2006, modified on January the 13th, 2010.

• Type of installations

- Grid Connected: 99 %
 - Residential (72%)
 - Commercial (15.7%)
 - Solar farms (12.3%)
- Rural electrification: 1%

• Capacity planned by the government (connected installations in MWp)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual	12	28	97	110	170	270	380	550	550	550
Cumulative	45	73	170	280	450	720	1100	1650	2750	5500

