The Solid State Laser – An Important Tool for Solar Cell Production

As long as our Earth exists, we will get a free supply of energy from the sun. Photovoltaic cells enable us to trap this and convert it into the electrical energy that we need without harming the environment. It is, therefore, no surprise that this sector is developing at a phenomenal rate as was reflected at the Photon Photovoltaic Technology Show Europe 2008, held between April 2nd and 4th in Munich, Germany.

For the second time ever, exhibitors from around the world showed their solutions for the manufacturing and processing of silicon, wafers, solar cells and solar modules. Whereas last year 100 companies exhibited their products and services, the number has jumped to 170 this year – an increase of 70 %.

One of the most important tools in the production of solar cells is the laser. Consequently, nearly every reputable laser manufacturer was at the show presenting their products.

We used this opportunity to talk to Dr. Finlay Colville, the Marketing Director at Coherent Inc. exclusively responsible for the photovoltaic market, about the ways that lasers can be used to build solar technology.

▲ **Dr. Finlay Colville**

LASER MAGAZIN:
Which types of lasers are used in the solar cell production?
Dr. Finlay Colville:
The types of laser and way that they are used depend on the type of solar cell being produced. Today, crystalline-silicon cells dominate the market with a share of around 90 %. The remaining 10 % is divided among the various thin film solutions. These include amorphous silicon, cadmium telluride and CIS as well as CIGS cells. Thin film cells offer the prospect of considerably lower $/W manufacturing costs, but have one significant disadvantage compared to silicon cells: their energy yield of between 6% and 10% is only half as much as that of crystalline-silicon.

The production of solar cells consists of the manufacture of the solar cells themselves and the further processing to produce solar modules. Currently, lasers are used in two to three processing steps in the production of crystalline solar cells. The most important of these uses is the edge isolation. With this, the laser is used to produce a groove along the edge of the cell so as to electrically isolate the front and rear surfaces of the cell. Q-Switched IR, Green and UV lasers have all been used since this application opened up for lasers. These are pulsed nanosecond lasers with an output energy of about 10–20 Watt. Coherent has recently introduced a new range of AVIA lasers for this application that can output more than 23 W at 355 nm and 38 W at 532 nm. Their advantage: the short wavelengths reduce the risk of microcracks. At the same time, the higher output powers increase production throughput.

LASER MAGAZIN:
How many lasers are being used for this application in the photovoltaic industry at the moment?
Dr. Finlay Colville:
This is a growing market, and we can estimate several 10's to 100 lasers worldwide. With new installations on the rise.

LASER MAGAZIN:
What other applications are there?
Dr. Finlay Colville:
The way for further laser applications is being paved by the next generation of crystalline-silicon cells. Whereas current wafers are around 200 µm thick, the thickness will be reduced in the next three years to 180 µm with even thinner cells below 160 µm. This enables the solar cells to be produced more cheaply as less silicon is needed. These solar cells have already entered the pilot production phase at selected companies. As these thin wafers are a lot more brittle, contact-free machining is more important than ever – something that can only be guaranteed with the laser.

Depending on the exact application, diode pumped pulsed solid state lasers with wavelengths in the infrared, green and UV ranges are used. These have outputs of a few tens of Watt and repetition rates of 100 kHz. The pulse rates are in the nano and

▲ **Coherent's laser solution for the photovoltaic market: DPSS lasers PRISMA + AVIA**

sometimes even in the picosecond range. Picosecond lasers allow reduced thermal induced damage in selective material ablation.

One next generation application is that of laser fired contacts (LFC), a process pioneered by the ISE-Fraunhofer. Here, Coherent infrared PRISMA lasers can be used to produce small vias in the isolation layer with fired rear side aluminium ohmic contact. Compared to conventional processes, this procedure enables contact free firing at the rear surface. At the same time, the efficiency of the solar cells can be raised through high-efficiency cell concepts.

Another process that increases the efficiency of solar cells is emitter wrap through (EWT) that reduces the shadowed areas of the silicon solar cell by moving as many of the contacts as possible to the rear of the solar cell. This is achieved by laser micro drilling up to 20,000 holes (micro vias) with a diameter of 50 to 200 µm through the silicon layer of the solar cell.

Additionally, lasers are used to cut cells, for instance, to produce small solar cells for street lights.

Nevertheless, the number of lasers used for such applications is fairly limited at the moment, although this is sure to change over the next few years.

LASER MAGAZIN:

What laser applications are used in the fabrication of thin film cells?

Dr. Finlay Colville:

Laser patterning is one of the most important applications in this area. A thin film cell consists most commonly of a large glass panel – that can be up to a square meter in size – onto which three different layers are deposited: an electrically conductive front layer, an absorption layer and an electrically conductive rear layer.

These individual layers, that are only a few micrometers thick, are then divided into thin strips after each coating step. This enables the individual cells of the complete solar module to be connected in series.

Red or green – and sometimes UV – diode pumped nanosecond pulsed lasers are used. The type of laser particularly depends on the materials used in the different layer types used. Opportunities exist here with the availability of new picosecond short pulse lasers. The use of these lasers reduces the amount of heat in the processing zone which lowers the risk of damage. Coherent has two lasers meeting this demand – the PALADIN has a repetition rate of 80 MHz and an output of 8 W at 355 nm, and the Talisker laser released a few weeks ago provides high picosecond pulse energies at lower repetition rates at either 1,064, 532 or 355 nm

LASER MAGAZIN:

What type of thin film cell can most easily compete with crystalline-silicon cells?

Dr. Finlay Colville:

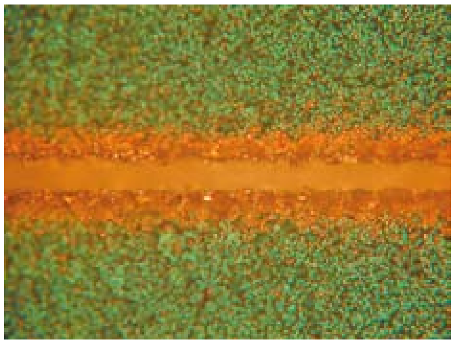
The market for amorphous silicon cells has the widest range of equipment suppliers and solar manufacturers today, and is likely to become a real competition to c-Si cells. The transition from single-junction amorph- to dual-junction micromorph offers higher efficiencies also. Currently there are a few players making CdTe panels where the $/W level is actually below that of c-Si today.

LASER MAGAZIN:

What type of solar cells will establish themselves in the future?

Dr. Finlay Colville:

Crystalline-silicon cells represent the first generation. The thin film cells will then follow as the second generation. The third generation will



▲ **Laser grooved buried contacts on a c-Si solar cell**

be made up of a number of completely different cells that, among others, include organic solar cells. However, in the next five-to-ten years, the first two technologies will continue to dominate the market. Additional R&D is required for generation 3 cell types still, but when this happens, we will have a wide range of solar cell types each offering niche application benefits in different installation types.

Thank you very much for talking to us