A Swiss-based company specialising in the manufacture of production lines used for producing thin film silicon solar modules is working alongside universities, a gas supplier, and producers of solar modules from around Europe to maximise the productivity of solar cells while reducing the manufacturing costs. We spoke with **Dr Tobias Roschek** and **Professor Christophe Ballif** to find out more

Making solar energy an affordable alternative

An example of a public Oerlikon Kai System.

The project (codenamed PEPPER), which is coordinated by Dr Tobias Roschek of Oerlikon Solar, aims at optimising the process to produce photovoltaic modules that will be competitive with other energy technologies in future. Today, they already compete successfully with other solar cell technologies.

It has been postulated in the past that the production of large-area, low-cost semiconductor panels is virtually an impossible task, but it has been proven wrong, with solar photovoltaic electricity at just a few cents per kilowatt-hour now proven to be an achievable target, especially in countries with high levels of sunshine.

Oerlikon Solar, in collaboration with academic partners from EPFL, the University of Patras, and the University of Northumbria, have been evaluating every aspect of the production process involved in creating solar modules in an attempt to maximise the speed of creation, conversion efficiency, and reliability of the modules whilst keeping cost and environmental damage as low as possible. The modules will eventually deliver upto 200 kilowatt hours per square metre per year, for a production cost of less than 55€/m2. This will help to ensure that Europe maintains technology leadership in the field.

Professor Christophe Ballif of EPFL explains how his photovoltaic laboratory team became involved in the process.

"Oerlikon Solar were in fact originally making equipment designed for producing flat panel displays. We were working on designing new ways to create solar cells, and realised that the same machinery that is used to make the flat panel displays could be used to carry out our new process. In 2001, we struck up a partnership with Oerlikon Solar and began to try to adapt our new process to work with their equipment."

One of the main problems tackled in the project is transferring the measures for improvement which are identified on a small scale under laboratory conditions into large-scale industrial applications. That requires on the one hand small scale process directly optimised taking production requirements into account (e.g. deposition rates) and on the other hand production equipment optimised to be suitable for the new processes coming from small scale, e.g. the newly developed electrode for high pressure PECVD, a process that utilises plasma in specific conditions to allow the creation of high-quality silicon layers at low temperatures. The shared goal of all the members of the project is to achieve 157Wp modules (a measure of photovoltaic power capacity) at a cost of 0.5€/Wp. This equates to an increase in efficiency of approximately 10-20 per cent. One of the areas being worked upon is the first layer of the solar cells that is responsible for scattering the light.

This layer must have the dual properties of being transparent and conductive, and in addition it has to feature a nanotextured surface allowing a good light trapping (i.e. helping the light to be absorbed in the silicon).

However, this process must be carefully controlled so that subsequent layers can be built upon it in a stable fashion.

The creation of these layers is integral to the production process of solar cells, and so it is here that a lot of ground can be made in increasing their efficiency. Much of EPFL's work in the laboratory is researching how to create layers that have the necessary properties to function as well as being so thin as to be measured in nanometres.

As well as the structure of the layers, the speed at which they are deposited during manufacturing is also being worked upon, so increased productivity as well as efficiency is a means by which the project hopes to reach its targets.

After these advances in the manufacturing process are made in the lab, they are then upscaled and integrated into the solar cell production tools produced by Oerlikon Solar.

Afterwards, they will be transferred to the production lines of Bosch and HelioSphera, two of the companies who are already manufacturing Micromorph® Modules on Oerlikon Solar production lines.

Another axis of the research being carried out is to make the production process even more environmentally friendly wherever possible. Professor Christophe Ballif gives some examples: "For instance, there is a gas that we are using at the moment, nitrogen fluoride, for cleaning the reactors after each module is produced. This gas is not ideal as it is a greenhouse gas. Although the exhaust gas is cleaned and therefore cannot escape to the atmosphere, we are nevertheless evaluating alternatives. In this project, we do tests with pure fluorine gas that has no equivalent greenhouse effect, meaning that the equivalent CO2 grams per kilowatt hour of solar electricity will be decreased."

By making small adjustments such as this to the processes throughout the production chain, Oerlikon Solar hopes to be able to create cells that – with the lowest CO2 equivalent/kWh – have the lowest environmental impact. The energy put into their production is produced in less than half a year in the sunniest countries (the current level is between nine months and a year).

The University of Northumbria contributes to the project by creating lifecycle assessments of the products, ensuring that the products are reliable and long lasting while not sacrificing on performance levels. The aim is to create products that last at least 25 years, instead of the current 20 years, and improvements in materials and packaging solutions are essential to make this possible.

Dr Roschek concludes; "Obviously one of our main aims is to be technology leaders in the field of thin film silicon technology. However, by reaching grid parity, we hope not only to be competitive in comparison to other solar cell technologies but also to all other available energy technologies. We hope that our work will help to enhance the share of solar power in energy supplying significantly."

The project is due to run for another two and a half years, and the integration of technological enhancements in the production process into the production lines is an ongoing process. This ground-breaking project will help to bring solar power up to a new level of performance and aid the important global efforts of bringing renewable energy technologies

Prof. C. Ballif

Prof. C. Ballif is director of the Phototovoltaics and Thin Film Electronics Laboratory (PVLab, IMT Neuchâtel) of EPFL.
He graduated as a physicist from the EPFL in 1994, where he also obtained his PhD degree working on novel PV materials in 1998.
He has (co-) authored over 180 journal and technical papers, as well as several patents.

Dr. T. Roschek

Dr. T. Roschek is Product Development Manager at Oerlikon Solar and is the coordinator of the PEPPER project.
Studying at Jülich Institut he obtained his diploma in physics in 1999 and completed his PhD in 2003, again in Jülich Institut for Photovoltaltaik Research Centre.

At a glance

Project Information

Project Title:
DEMONSTRATION OF HIGH PERFORMANCE PROCESSES AND EQUIPMENTS FOR THIN FILM SILICON PHOTOVOLTAIC MODULES PRODUCED WITH LOWER ENVIRONMENTAL IMPACT AND REDUCED COST AND MATERIAL USE

Project Objective:
Demonstration and partial implementation of a new technology with:
- Reduction of the Cost of Ownership (CoO) for fabrication of modules down to 0.5€/Wp,
- Increase of module power to 157Wp stabilized (corresponding to 11%)
- Reduction of the environmental impact of the fabrication process with the target of 20% lower energy pay back time.

Project Duration and Timing:
3 years – From September 1, 2010 to August 31, 2013

Project Funding:
The European Commission (DG Energy) is supporting the project with EUR 9.4 M

Project Partners:
Oerlikon Solar (Dr. T. Roschek) is coordinating PEPPER.
Further project partners are the Photovoltaics Laboratory (PVLab) of EPFL (Switzerland) , the Universities of Northumbria (UK) and Patras (Greece), Bosch Solar Thin Film (Germany, module production), Heliosphere (Greece, module production) and Linde (Germany, gas supply).

EU-FP7 PEPPER

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