Newsletter

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“A giant leap towards the future”

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CIGS thin film: With a total budget of more than €10 million, the European Union’s Scalenano project aims to increase Europe’s competitiveness in photovoltaic technology through the development of low cost and highly efficient manufacturing processes for CIGS thin film solar cells.

Scalenano is a so-called “integrated” research project, funded under the auspices of the 7th Framework Programme of the European Commission, which aims to develop and scale-up innovative chalcogenide PV technology using environmentally friendly and sustainable processes with lower costs and higher efficiencies. The project has a total budget of more than €10 million and runs from February 2012 to July 2015.

As the project coordinator Alejandro Pérez-Rodríguez, Head of the Solar Energy Materials & Systems Group at the Catalonia Institute for Energy Research, Spain (IREC) explains, CIGS-based PV technologies have already entered the stage of mass production. Current production methods typically rely on vacuum-based deposition processes that have enabled the achievement of a record cell efficiency of about 20%, with stable module commercial efficiencies in the 12 to 13% range.

“However, these processes are costly and difficult to control over large surfaces, and require very expensive equipment with initial high capital expenditure. This compromises the potential reduction of material costs inherent to these thin film technologies,” says Pérez-Rodríguez.

In response to these perceived limitations the project aims to develop alternative environmentally friendly and vacuum-free processes with high potential for cost reduction, that are also compatible with industrial implementation at a mass production level.

Low cost processes

In doing so, a key objective of the project is to develop reliable low cost processes based on the electrodeposition of nanostructured precursors. The team will also develop alternative new processes with “very high potential throughput and process rates” based on the use of printing techniques with novel nanoparticle ink formulations and new cost effective deposition techniques.

“Scalenano will develop alternative processes based on chemical and electrochemical approaches that do not require a high vacuum, and that have a high potential for reduction of manufacturing costs,” says Veronica Bermudez, Senior Scientist at project partner Nexcis (France). “This will include different kinds of processes, such as the electrochemical deposition of nanostructured precursors followed by a recrystallization step, which will be applied for the development of large area modules – with efficiencies comparable to those achieved with more expensive and complex vacuum-based approaches,” she adds.

Another key aim of the Scalenano project is the development of technologies based on printing processes. This will entail the development of new ink formulations based on the use of different kinds of nanoparticles. According to Pérez-Rodríguez, printing-based processes are of "strong interest" for these applications, mainly as a result of their compatibility with industrial stages at mass production level and their capability for achieving very high process throughput. "In the project, a special effort will be put into the design and development of scalable processes compatible with industrial mass production applications and with low environmental impact, including the development of suitable processes for the synthesis of the nanoparticles and the ink formulations," he says.

Scalenano will also investigate new concepts at the cell architecture level. New cell architectures "based on the implementation of zinc oxide nanowire arrays" will be investigated, to analyze their potential for achieving a significant increase in device efficiencies, explains Pérez-Rodríguez. Finally, the project will also investigate the "extension of developed concepts and processes" for photovoltaic devices based on new material alternatives to CIGS, such as kesterites, compounds that are only formed by earth abundant and low toxicity constituents, to address the material scarcity problem that will be created by the future massive deployment of CIGS technologies.

"Well-balanced and interdisciplinary"

For the development of the project, Pérez-Rodríguez explains that a "well-balanced and interdisciplinary" consortium has been formed – made up of participants from a total of 13 groups with "strong and well recognized experience." The consortium consists of five research institutes and four universities. Working alongside project coordinator IREC are the Swiss Federal Laboratories for Materials Science and Technology (EMPA), Istituto Italiano di Tecnologia, Italy (IIT), the Alternative Energies and Atomic Energy Commission, France (CEA), Helmholtz-Zentrum Berlin for Materials and Energy, Germany (HZB), the University of Nottingham, UK (UNott), Université de Luxembourg (UL), the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) and the Freie Universität Berlin, Germany (FU Berlin).

Photo: IREC – Catalonia Institute for Energy Research

Sputtering systems at the Catalonia Institute for Energy Research (IREC) for the development of back contacts and transparent conductive oxide (TCO) layers.

The consortium also includes four companies from different sectors "relevant to these fields." These are Nexcis, a PV company specializing in the development and production of electrodeposited CIGS modules; Innovative Materials Processing Technologies (IMPT), a thin film technology company that will be involved in the development of scaled-up processes and specialized equipment based on new cost efficient deposition processes; Semilab, a "leading company from the metrology sector in semiconductor technologies"; and Merck, a leading multinational company from the chemical sector that is involved in development and industrial and economic assessment for the production of new ink formulations. "With the development of nano-based, printed CIGS solar cells, photovoltaics is making a giant leap towards the future. The technology uniquely combines environmental and economic benefits, strengthening competitiveness and optimizing the energy supply," says Klaus Bofinger, Head of Advanced Technologies at Merck.

The project will be coordinated by IREC – while Nexcis, as the principal PV company involved, will also have a key role in the assessment of the implementation of all the developed processes in the pilot line available at the production plant of the company.

Milestones

At the end of the project, the consortium will measure its success against a number of specific measurable outputs. As far as the development of CIGS electrodeposition-based technology is concerned, the key targets are to develop a reliable process that costs 30% less than existing physical vapor deposition (PVD) processes, while still achieving efficiencies greater than 95% of current PVD techniques – as well as improved lateral homogeneity (±5%/m^2).

Other important targets are to develop a new alternative scalable process – using nanoparticle-based solutions compatible with high throughput requirements – at a pilot line level of 1 m/minute; and to develop "optimized" transparent conductive oxide (TCO) layers, with transparency levels greater that 80% and sheet resistance less than 100 Ohm^2, by using scalable non-vacuum-based processes.

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"To achieve the proposed goals in terms of cost-efficiency of the processes, a key feature will be the improvement of the process yield. This will be achieved by the development and implementation of quality control and process monitoring techniques suitable for the monitoring of scaled-up processes for fabrication of large-area modules at both in-situ 'realtime' and ex-situ 'on-line' levels," explains Nexcis' Bermudez.

Scalenano will also investigate the development of innovative techniques with a "high potential" for these applications, including light-scattering-based techniques, development of new electrochemical techniques, and tools and photoluminescence/ electroluminescence-based techniques.

"These are techniques that have already been evaluated at laboratory scale, and their capabilities for monitoring of scaled-up industrial processes will be evaluated," expounds Bermudez.

Commercial exploitation

According to Pérez-Rodríguez, a "strong effort" will be made by the different partners to promote the efficient dissemination of the project results. These activities are meant to "promote identified exploitation possibilities inside and outside the consortium," and to promote the research results for the benefit of the research community as well as European citizens at large.

An active dissemination plan has been defined as part of the project, including activities such as the production and distribution of a project leaflet, implementation of a project website, participation at relevant international scientific conferences and industrial national and international forums, publication of papers in relevant scientific journals, and the launch of press campaigns.

A key aspect regarding the exploitation of the results of the project is also the implementation of the processes that will be developed in the pilot line at Nexcis. The intention is that this will accelerate the implementation of the successful processes in terms of cost-efficiency for the commercial production of photovoltaic modules, which is planned in two years, according to the strategic road map of the company.

"The project also includes a specific activity, led by Nexcis – and with the active participation of all the companies involved in the project – for the design and cost analysis of a 500 MW pilot plant, with the study of its economical viability," says Bermudez. "These activities will be coordinated by a technology task force, chaired by Nexcis, that will also analyze and promote the exploitation of different project results including the industrial lines that will be proposed for the fabrication of new nanoparticlebased ink formulations and the development of new equipment and systems for quality control and process monitoring techniques," she adds.

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