Conference Report

Organic Photovoltaics Summit: October 15–16, 2009 - Boston, USA

J. Genoe

This conference was organized by OPV Today and held for the first time now, in 2009. It has gathered around 100 attendees with a broad scope ranging from academia, industry and market intelligence organizations.

The conference had technical sessions with oral presentations. Some panel sessions have been also organized to create a higher level of engagement of the attendees to interact with specialists as well as with each other. The interaction in these panel sessions took a slow start since it is not a very common and well-known approach to most of the attendants, but after some hesitating moments in most cases it took off quite well, with good interactions.

Highlights of panel discussions:

Market Overview:

Currently, there is no existing OPV market. First initiatives are introduced, like **Konarka**'s module production and **Plextronics**' materials and ink supplies. But these initiatives are still too premature to be able to make any reasonable projections about where the OPV market will go. On the other hand, it is clear that OPV will have to compete initially with existing thin-film PV markets and gain its position in that market to be able to become a real PV technology. It can enter this market segment in niche applications but will have to prove its potential in large – area applications in the next 5 to 10 years, otherwise it will remain a niche product in itself. Current results show promising indoor performances and stability and a strong leveraging with the printed electronics markets. This will enhance the entrance of OPV in niche applications where its low weight and flexibility can be a differentiator to other technologies. For outdoor and BIPV applications much more stringent requirement will have to be fulfilled before a real OPV market can start. Even for application in like the Third World or emerging economies, issues like reliability are also not to be underestimated.

A specific issue for the OPV developments is the fact that the optimal material system is constantly changing and still under development. Instead of other thin-film PV technologies, OPV has not identified one master material yet. Further material developments are therefore still needed and in progress. This will take lots of time and efforts e.g. in screening many possible candidates.

Stability and lifetime:

These issues are clearly still more in a research phase. Degradation effects are commonly categorized as extrinsic and intrinsic. To improve the lifetime of OPV, both effects are important to be tackled. For the extrinsic effects, the development of a suitable packaging technology is required. Comparisons between flex and rigid barriers are ongoing and it has been identified that blocking side ingress of oxygen and humidity will be a key issue in both cases.

Furthermore, attention will be required to develop suitable industrial standards for accelerated lifetime tests. On one hand, own standards can be defined to ensure appropriate benchmarking within the OPV community. On the other hand, existing industrial standards can be challenged to see how OPV behaves in such circumstances.

Efficiency improvement:

It is clear that the progress in conversion efficiency in OPV has been strongly driven by photo-active material developments. Furthermore, there remain still knobs to turn on current or newly upcoming materials systems that can result in further efficiency increase.

At this moment, lot of effort is focused on new donor materials, with quite some success. Fullerenes are considered as the standard acceptor compound, at this moment not being the limiting factor in performance improvements. It is unclear how long this situation can withstand and when there will be a clear need for new acceptor compounds to enter the field.

There is a belief that the 10 % efficiency threshold can be reached with single junction device concepts. But to go beyond this value, new device concepts have to come up. Currently, research efforts are mainly focusing on multijunction

architectures. Others are considered like light incoupling to enhance the optical pathlengths, or use of plasmonic effects to enhance charge generation. Although these concepts have theoretically indeed potential to lead to higher efficiency, their practical implementation is not successful yet and therefore it remains uncertain whether a positive impact can be expected from them.

Highlights of technical presentations:

Konarka presents a broad portfolio of products for which they are currently supplying printed OPV modules. They are also making prospection on new application areas like busstations, window integration etc. In this respect, they have outdoor lifetime tests running, claiming operational lifetimes on flex foils of 3 to 5 years. For longer lifetimes like 10 to 15 years, in relation with reasonable cost targets, rigid packaging (glass) might be needed. The production runs now at 25 ft/min and is targeted to be speeded up to 100 ft/min.

Plextronics presents an overview of their OPV materials and stresses their strength as material supplier, focusing on ready-to-use ink systems.

Fraunhofer ISE presents a study where they try to identify degradation mechanisms in organic solar cells by means of impedance spectroscopy. They could observe that exposure of OPVs to oxygen and light leads to p-type doping and thereby to a strong decrease in charge carrier mobility. If the electrode is not oxidized in this process, this effect is reversible.

IMEC presents its recent results in OPV, achieving best efficiencies over 5% and starting to study lifetime and degradation in a dedicated set-up that can run under continuous illumination and electrical stress. Another important result is the realization of fully solution processed OPVs demonstrated by spray coating. Hole and electron injection layers, the photo-active layer and the metallic backside electrode are thereby processed from solution.

Riso DTU shows inline processed organic solar cell modules that have been used in the project 'Lighting Africa', by combining these OPVs with small LEDs. They used ToF-SIMS and XPS to study chemical degradation of such polymer solar cells. Preparation and treatment conditions have been debated to be not fully consistent such that results are not conclusive yet.

Sandia National Laboratory presents an evaluation of the lifetime of organic solar cells with different top electrodes. Using Ca/Al as composite electrode, it has been identified that there is void evolution and that oxygen can penetrate through the Al capping layer, reaching the Ca. This leads to oxidation of this Ca layer and thereby degradation of the device performance. Using Ag instead shows an abrupt interface with the P3HT:PCBM active layer. Any oxygen penetration is in that case from side ingress. Oxidation of the Ag contact leads to higher work function and eventually to a change of polarity in the device operation. Using PEDOT can prevent this change in polarity.

NREL showed further some results on the effect of PEDOT on lifetime of OPVs. When on indium tin oxide (ITO), PEDOT can lead to degradation because PEDOT in combination with water becomes acidic and thereby can chemically attack the ITO. In inverted cells much less degradation is observed, since PEDOT is then not in contact with ITO. In another presentation they report on the fact that the reference spectrum for simulated solar illumination has been changed in 2009. The new reference can be found on the NREL website.

Institute for Applied Photo Physics presents results obtained in collaboration with **Heliatek**, reaching device efficiency of 6% (modules close to 4%) and extrapolated lifetimes of more than 20 years. The devices are based on evaporated small molecules in tandem configuration, whereby current matching of the cells is achieved by optimizing the optical interference by tuning the layer thicknesses.

Solarmer reports on their materials developments with further improved efficiency to 6.77%, as measured at NREL. In their own lab they have reached efficiency up to 7.07% already. They present also plans to set up a pilot production line in 2010.

Center for Organic Photonics and Electronics shows modelling results on resistive losses in organic solar cells and how this influences the scaling towards larger areas. On the development of flexible barriers they study different oxides or nitrides in combination with parylene layers.

University of Michigan works on the technology to coat fibers with organic solar cells, since they consider integration into textiles as one of the biggest markets for

OPV.

VTT Technical research centre of Finland reports on the progress in the European FP7 project FACESS. The objective of this project is to realize an autonomous energy system by combining organic solar cell modules with flexible thin film batteries. An additional challenge is to realize as many steps as possible by roll-to-roll printing.

Holst Centre/TNO presents their results on the development of an all-printed current collecting grid for ITO replacement in organic solar cells. An important breakthrough is the possibility to embed the printed Ag-grid in the flexible substrate. This offers the possibility to have the Ag-grid thick enough for low resistance and at the same time the surface roughness as low as possible for the deposition of subsequent layers like PEDOT and the photo-active layer.