PerTPV

Newsletter

June 2019

On the path to 30% efficiency

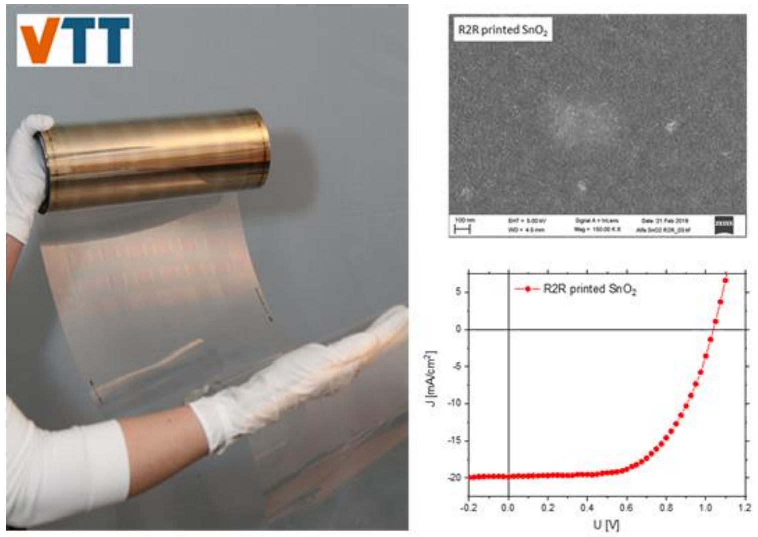
In March 2019, the PerTPV consortium met in Finland to share the progress on their road towards highly efficient multi-junction all-perovskite solar cells.

Designed as an ambitious collaborative effort, the first 12 months of the project resulted in the conception of a common device platform compatible with the hybrid, vapour and solution phase, deposition techniques required to attain the highest efficiencies. Low, mid and wide bandgap perovskite absorbers have been independently optimised and used in single junction devices. These materials, as well as the corresponding charge selective and recombination layers, will now be pieced together in tandem perovskite solar cells, according to the optimal stack designed from device simulations. During the journey, novel hole transport materials have been developed and highly stable devices have been demonstrated, which have led to reports already published or currently in the press. The project partners also sought advice from a high profile industrial advisory board, which confirmed the pertinence of the strategy and pointed out potential caveats associated with the evaluation of the stability of the solar cells, helping us to establish meaningful accelerated aging tests.

The PerTPV project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 763977.

Towards flexible Perovskite solar cells

Within the PerTPV project, the focus of the Finnish research institute, VTT, is to develop large area compatible coating and printing processes for the preparation of smooth, high quality perovskite thin-films, and subsequent perovskite mini-modules. For printable perovskite solar cells to be a viable reality, industrially acceptable solvents must be employed. Thus, the focus during the first year of the project has been to develop manufacturing compatible ink formulations for perovskite absorber layers and to the complete materials set in the perovskite solar cell stack.



In the “n-i-p” cell structure, the processing starts by the fabrication of an electron, “n”, transporting layer, ETL. For this layer, commercially available dispersions of tin oxide (SnO_2) nanoparticles have been utilized and successfully applied on top of a patterned transparent bottom electrode via printing. The printing experiments have been performed both in a laboratory as well as in pilot-scale. In the picture (left), a pilot-scale printed roll of SnO_2 nanoparticles is presented together with a high resolution SEM-image as well as a JV-curve of a perovskite solar cell with pilot-scale printed SnO_2 as ETL under illumination. For the intrinsic, “i”, perovskite layer, much effort has been put into finding a system based on inks dissolved in benign solvents as well as on the optimization of the perovskite formation conditions. This work is still ongoing as the project continues.

New materials for efficient Perovskite solar cells

Aniline, as one of the most basic and widely used precursors in the chemical industry has been used in synthesis of numerous chemicals and is extremely cheap and produced on a vast scale (over 7 million tons per year). Use of such a low cost and readily available reagent as a starting material is beneficial from both practical and commercial points of view. Teams from Kaunas University of Technology and Oxford University, jointly working under the PerTPV project, have successfully developed and tested in perovskite solar cells aniline-based organic semiconductors. The given approach results in a material cost reduction to less than 1/5 of that for the archetypal organic semiconductor spiro-OMeTAD. The synthesized materials exhibit comparably high efficiencies and greatly enhanced ambient-air stability in comparison to the cells with the state-of-the-art organic semiconductor spiro-OMeTAD.

A team of chemists and material scientists from Kaunas University of Technology, working under the PerTPV project, has succeeded in developing a new hole transporting material capable of forming a self-assembled hole-transporting monolayer (SA-HTM) on transparent electrodes.

The formation of SA-HTM on the transparent electrode circumvents the disadvantages of spin-coating while offering the benefits of uniformly formed layers with minimized thickness, very low material consumption and help avoiding doping procedures. Due to the covalent linking to the substrate surface, these layers are relatively tolerant against perovskite processing and can ensure a conformal coverage of textured surfaces.

P–i–n perovskite solar cells with dopant-free hole-selective contact SA-HTM were constructed and demonstrated very promising power conversion efficiency close to 18%, average fill factor close to 80% and undetectable parasitic absorption.