Project update

Hybrid cells to revolutionize PV generation

Project details

Project title	Hybrid photovoltaics of the future: 'Inorganics-in-organics'
Participant	University of Surrey, UK
Start date	2008

Key aims

- A new generation of multi-purpose devices for capturing solar energy
- A renewable energy system which can be mobile or static
- Widespread use of solar energy to save CO_2 emissions.

Project summary

Affordable, mass-produced photovoltaic units aimed at revolutionizing solar energy generation are proposed in a project supported by E.ON's International Research Initiative

Nanotechnology is being used to develop a hybrid solar cell module which can be scaled into a family of devices for applications that range from buildings to personal electronic equipment.

The hybrid cells will use complex carbon nanotubes in thin film semiconductors to harvest high levels of light and give long-term service.

This research seeks a breakthrough in photovoltaic (PV) costs and ease of manufacturing. The thin film format allows production of the cells in large sheets, using processes that are similar to those in the printing and coating industries.

The project was put forward by the University of Surrey's Advanced Technology Institute (ATI). Professor Ravi Silva, the institute's director and head of the university's Nano-Electronics Centre, is the project's principal investigator. He is supported by Dr Maxim Shkunov and Dr Simon J. Henley, also of the ATI.

Starting point for the research was to identify an efficient and reliable solar power option with a better electricity output to cost ratio than current PV cells. These are usually manufactured from inorganic materials and are mostly silicon based.

As a core technology, the university selected OPV, a system of photovoltaics using organic materials.

From this it intends to create its hybrid PV cell by using both organic and inorganic materials – giving rising to the phase 'Inorganics-in-organics'.

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Three major areas of work were launched successfully at the start of this project.

Activities were focused on different aspects of the development and use of multi-wall carbon nanotubes (MWCNTs) which will be the 'broadband light harvesters' generating electricity in the new hybrid cells.

The main parts of the first work package were:

- Selection and optimization of the organic photovoltaic (OPV) material for reference device fabrication to which the MWCNTs will be integrated
- Upgrading the measurement set-up to be able to measure solution-processed, organic photovoltaic devices, for characterization with simulated sunlight
- Acquisition of a tool, known as an incident photon conversion efficiency (IPCE) measurement system. This is for measuring the effectiveness of the project's concept cells in converting solar energy over the whole solar spectrum.

Installation of the IPCE system enables a number of further steps to be taken. These include the optimization of reference devices using MWCNTs, the introduction of carbon nanotube layers and confirmation of the engineering feasibility of the system.

A further aim of the work was to increase the mobility of the light-generated, mobile electrons to achieve greater collection of charges to improve device output current

This involved testing different techniques for adding MWCNTs to the reference devices to create charge transport pathways between the electron donor semiconductor and the acceptor semiconductor.

The team successfully incorporated MWCNTs and further detailed investigations are being carried out into how the transport mechanisms work in the hybrid system, and into possible enhancements.

In addition, attention is also centered on developing the hybrid cells as a flexible sheet of energy-harvesting devices. This is to be achieved by developing electrodes which can be produced and processed in the form of a solution whose properties are not altered by flexing.

In the project, the MWCNTs were treated with acids to make them water soluble and then mixed with a transparent conducting liquid polymer, before mixing with acceptor material.

The feasibility of these MWCNTs for use in an OPV system was tested. The results indicated that they could be developed as a transparent electrode which, crucially, can be processed as a solution.

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