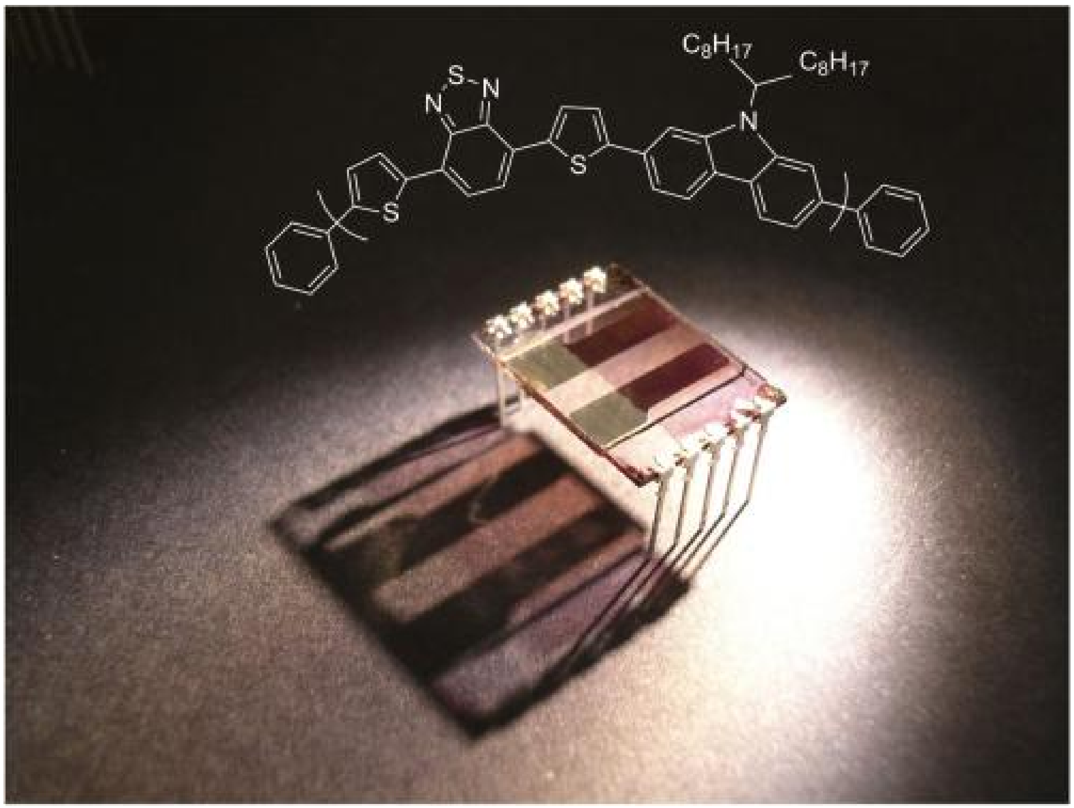
'Cling-film' solar cells could lead to advance in renewable energy

July 4 2011



A polymer solar cell ready for testing; the metal connections allow us to measure different areas of the film and measure the device efficiency amongst other parameters. Credit: Andrew Parnell

(PhysOrg.com) -- A scientific advance in renewable energy which promises a revolution in the ease and cost of using solar cells, has been announced today. A new study shows that even when using very simple and inexpensive manufacturing methods - where flexible layers of material are deposited over large areas like cling-film - efficient solar cell structures can be made.

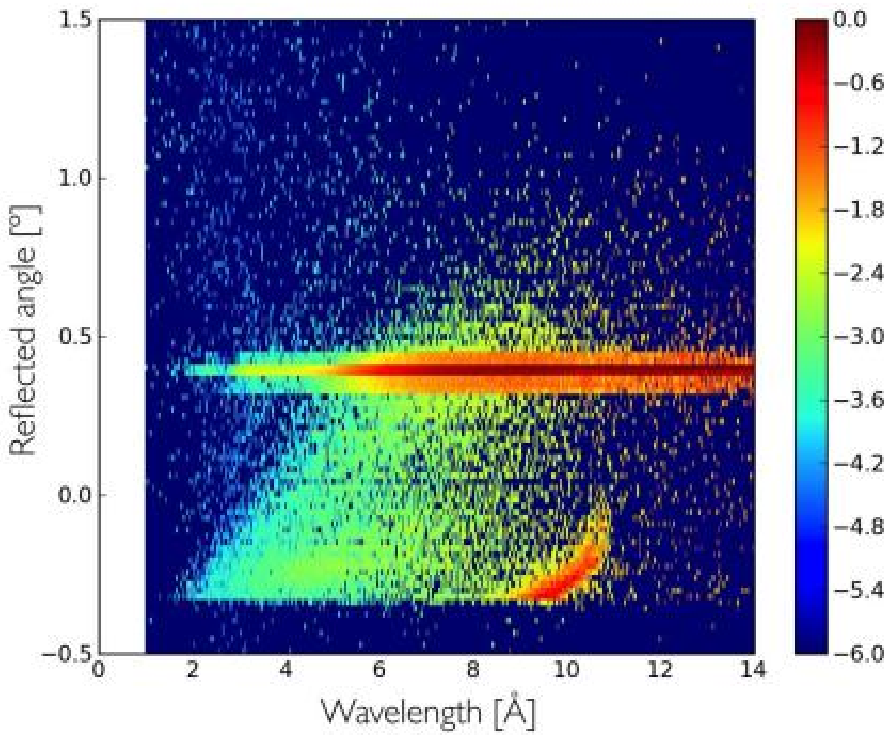
The study, published in the journal *Advanced* Energy Materials, paves the way for new solar cell manufacturing techniques and the promise of developments in renewable solar energy. Scientists from the Universities of Sheffield and Cambridge used the ISIS Neutron Source and Diamond Light Source at STFC Rutherford Appleton Laboratory in Oxfordshire to carry out the research.

Plastic (polymer) solar cells are much cheaper to produce than conventional silicon solar cells and have the potential to be produced in large quantities. The study showed that when complex mixtures of molecules in solution are spread onto a surface, like varnishing a table-top, the different molecules separate to the top and bottom of the layer in a way that maximises the efficiency of the resulting solar cell.

ISIS' Target Station 2 at STFC Rutherford Appleton Laboratory in Oxfordshire. Credit: STFC

Dr Andrew Parnell of the University of Sheffield said, "Our results give important insights into how ultra-cheap solar energy panels for domestic and industrial use can be manufactured on a large scale. Rather than using complex and expensive fabrication methods to create a specific semiconductor nanostructure, high volume printing could be used to produce nanoscale (60 nanometers) films of solar cells that are over a thousand times thinner than the width of a human hair. These films could then be used to make cost-effective, light and easily transportable plastic solar cell devices such as solar panels."

Dr Robert Dalgliesh, one of the ISIS scientists involved in the work, said, "This work clearly illustrates the importance of the combined use of neutron and X-ray scattering sources such as ISIS and Diamond in solving modern challenges for society. Using neutron beams at ISIS and Diamond's bright X-rays, we were able to probe the internal structure and properties of the solar cell materials non-destructively. By studying the layers in the materials which convert sunlight into electricity, we are learning how different processing steps change the overall efficiency and affect the overall polymer solar cell performance."



This image shows how neutrons are scattered from one of the solar cell layers. Modelling this information helps us understand the composition and structure within the layer. The intense horizontal line is the mirror-like reflection (specular reflectivity) from the solar cell. The data was taken on the instrument Offspec at ISIS' Target Station 2. Credit: STFC

"Over the next fifty years society is going to need to supply the growing energy demands of the world's population without using fossil fuels, and the only renewable energy source that can do this is the Sun", said Professor Richard Jones of the University of Sheffield. "In a couple of hours enough energy from sunlight falls on the Earth to satisfy the energy needs of the Earth for a whole year, but we need to be able to harness this on a much bigger scale than we can do now. Cheap and efficient polymer solar cells that can cover huge areas could help move us into a new age of renewable energy."

Solar cells

Photovoltaics are semiconductor devices that are used to generate low-cost renewable energy - most commonly as solar panels. When sunlight hits a photovoltaic cell, it is absorbed and its energy is converted into an electrical current. Most photovoltaic devices are made with silicon; however, devices can also be made from plastic (organic photovoltaic devices).

Plastic films can be deposited from solution by low-cost, roll to roll printing techniques resulting in significant overall savings in energy and cost. This is where the film is put on a roll and goes through a series of processes similar to the way newspapers are printed and taken off a roll at the end. There are currently products using this type of technology. To increase usage further, however, the technology needs to be more efficient. Polymer solar cells are currently 7-8% efficient.The next step is to develop cells which are 10% efficient or more for commercial viability.

The materials used in the research carried out by the collaboration are called PCDTBT (poly [N-9′-heptadecanyl-2,7-carbazole-alt-5,5-(4′,7′-di- 2-thienyl- 2′,1′,3′-benzothiadiazole): PCBM ([6,6]-phenyl-C61-butyric acid methylester), a material based on Nobel-prize-winning (Chemistry 1996) work of Professor Richard Smalley and Professor Harry Kroto (amongst others) on the C60 Buckminsterfullerene or buckyball form of carbon.Bright X-rays using instruments at Diamond Light Source were used to study the crystallinity of the material; neutrons at ISIS were used to examine the material's composition profile.

More information: The research is published in *Advanced Energy Materials*, volume 1, issue 4 July 2011. The paper is also available to view online.

Provided by Science and Technology Facilities Council