Creating more efficient solar power

There are cost and efficiency barriers stopping photovoltaics from being a mainstream energy supply – but research from the University of Oxford is helping change that.

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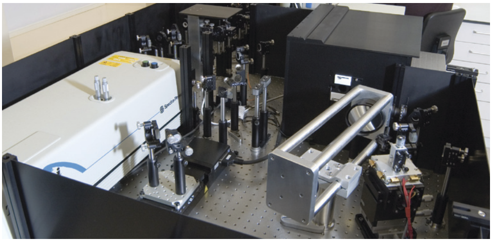

Image: L.Herz

The use of photovoltaics as a renewable energy source has been gaining traction over recent decades - but it still only represents a tiny fraction of the world's massive power demands. One of the reasons is that the most effective photovoltaics are prohibitively expensive, whilst the new breed of affordable organic devices are still too inefficient. Researchers from the Department of Physics, led by Dr Laura Herz, are helping to change that.

Working collaboratively with industrial figureheads, they are using their cutting-edge facilities to probe the new materials being used in organic photovoltaics, in order to understand the subtle differences in their properties. The results feed back directly into industrial R&D to develop more effective materials that will make the technologies viable contenders in the energy market.

Organic photovoltaics tend to be made up of electron donor and acceptor materials, separated by an interface. When the material is illuminated with incident light, a neutral exciton is initially created, which can dissociate at this interface into its constituent electron and hole. These charges can then move through the corresponding materials to their respective anode and cathode - to create a DC voltage.

But if the electron and hole do not move apart quickly enough they can recombine, rendering the excitation ineffective and resulting in low photocurrents – and low efficiencies. Because many of the materials for these devices are exotic and created specifically for this application, they have to be closely analysed in order to understand why some work so much better than others.

Using femtosecond spectroscopic techniques, the team are able to follow the dynamics of photo-excitations. Time-resolved photoluminescence and VIS pump systems allow them to measure exciton density, charge carrier density and conductivity of new photovoltaic materials - measurements that probe the interface where excitons are created, revealing how intermolecular arrangements in the materials affect the mobility of charge carriers and the diffusivity of photo-excitations. These qualities are all measured as a function of time, at a staggering 100 fs resolution.

By studying these material properties, the team are able to provide industry with the technical insights they require. Currently, Dr Herz's group are working with Merck Chemicals to help develop conjugated polymer photovoltaics, and with BASF to create a new breed of hole-transporting materials for dye-sensitized solar cells. The results look set to break down the existing efficiency barriers and transform organic photovoltaics to a technology that can compete with the more expensive silicon-based technologies - an energy breakthrough worth celebrating.

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