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The only way to dramatically lower the price of photovoltaic solar cells is by changing the manufacturing process. Organic solar cells aim at such a challenge. They are flexible, lightweight and potentially less expensive than traditional silicon-based photovoltaic cells. The main drawback, so far, is that organic photovoltaic cells are still less efficient at converting light into electrical power. But that is a matter of time.

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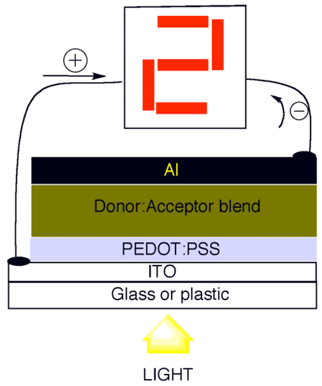
Plastic Solar Cells — OPVs

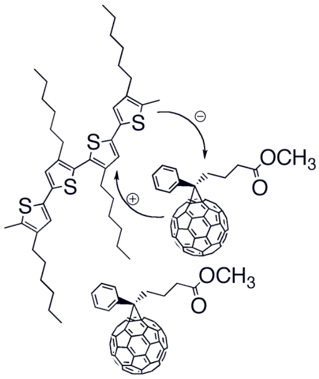
Oil prices and ecological concerns have reinforced the interest in renewable energy sources. Among these, photovoltaics (PVs) play a key role, with a quite significant worldwide engagement in research and technological development. To date, the most efficient and world wide used PVs are based on silicon, with modules reaching power conversion efficiencies of ≈20%, and even higher values with complex structures. The ability to convert solar into electric energy using organic semiconductors was demonstrated in 1986. A quite significant performance improvement has been reached, with actual power conversion efficiencies reaching around 6%. While efforts are under way to increase conversion efficiencies of organic photovoltaics (OPVs), the emphasis is put in developing low-cost manufacturing processes, such as printing, which are possible for organic materials. In addition, such a technology is suitable for the production of very large area flexible (plastic) OPV panels, which could be adapted to surfaces with various shapes.

OPVs have lower efficiencies than Si-based PVs because organic materials have lower charge mobilities, they are usually disordered materials, their absorption spectrum has a poor overlap with the solar spectrum, and the nanometer-scale phase separation between donor and acceptor molecules, which have to be combined for charge generation, is poorly controlled.

Our present line of research addresses the last two topics by preparing and testing new materials and developing new approaches to control donor/acceptor separation.



Structure of a photovoltaic cell.



One of most successful donor:acceptor composites used in photovoltaic cells (PVs).

The overall objective of this research is the development of new materials (conjugated polymers, both electron acceptors and electron donors, and new low molecular weight acceptors), to tune the energetic position of their frontier energy levels (which controls charge generation from absorbed photons), the donor/acceptor phase separation and the absorption spectrum (and its overlap with the solar spectrum).

Among the acceptors, we have been studying the use of anthocyanines to be combined with conjugated polymers. Anthocyanines are found in nature, acting as antioxidants. In view of their strong electron acceptor ability, synthetic compounds of this type are being tested in OPVs, blended with conjugated polymers.

Another approach relies on the synthesis of copolymers, combining electron acceptor and electron donor blocks, along the main chain. This should allow a finer control over the donor/acceptor separation in the solid state, favouring charge generation and transport.

Finally, we have synthesised and characterised various crosslinkable polymers, with varying absorption spectra and frontier levels energy. These are being tested with two main purposes:
i) use them to achieve micro- or, eventually, nanostructured interfaces between donors and acceptors in bilayer polymeric devices;
ii) use the ability to be transformed into an insoluble network to allow the fabrication of multilayer devices, in particular tandem cells, without restrictions of the solvents used to form the thin films.

Further information at http://www.lx.it.pt/~alcacer/TM_Group/

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