

Electron transport in dye-based solar cells

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European scientists studied electron flow in systems of organic photosensitive dyes and titanium-based materials. Results are particularly relevant to increasing the efficiency of a cost-effective class of solar cells and have potential broad application to nanotechnology and clean energy science.

Dye-sensitised solar cells (DSSCs) rely on deposition of a thin film of photosensitive dye on a conductive substrate such as a porous layer of titanium oxide (TiO₂) nanoparticles.

While DSSCs represent a simple and cost-effective alternative to conventional (p-n junction) solar cells, issues with efficiency have been a stumbling block to widespread implementation.

European researchers supported by EU-funding of the Nanosol project sought to conduct a detailed analysis of the photobehaviour of three novel metal-free organic dyes.

Specifically, they studied the dyes in solution and on 9 different morphologies of titanium-doped

mesoporous (with pores of diameter 2 - 50 nanometres) materials in the absence and presence of TiO₂ nanoparticles.

Studies of the free dyes in solution demonstrated the importance of the state of the charge transfer complex (the distribution of charge over molecules at the donor-acceptor interface) in the dye's photobehaviour and the role of the solvent in efficiency.

Further studies of dyes in the presence of conventionally used TiO₂ nanoparticles illustrated important electron dynamics on the femtosecond (quadrillionth of a second) scale providing insight into efficient charge separation and solar cell performance.

Titanium nanotubes with one-dimensional (1D) structure were also studied and compared with TiO₂ nanoparticles, demonstrating similar electron dynamics.

Finally, titanium-doped silica mesoporous sieves, another 1D class of materials, were evaluated. Although promising electron dynamics were observed in the material itself, the resulting [solar cells](#) performed poorly due to less efficient dye loading and limited electron transport.

Nanosol researchers effectively characterised the interaction of titanium-based materials with an important class of organic [dyes](#) relevant to DSSCs with a focus on solar cell efficiency.

Results should prove useful in future design of more efficient DSSCs and thus encourage their widespread implementation. Such developments will provide cost benefits to manufacturers and consumers and help reduce dependence on fossil fuels.

Provided by CORDIS

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