Solar cells

# Guiding light

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**Another new way of turning sunlight into power**

THE main impediment to the widespread use of solar power—clouds and nightfall aside—is the cost of the silicon cells that actually convert the sun's rays into electricity. To keep the expense down, people have been searching for ways to minimise the size of solar panels relative to the amount of light they can harvest. Often, this is done using clunky pieces of kit called solar trackers, which tilt an array of mirrors so as to direct large amounts of sunlight onto small, high-performance cells.

Such trackers, however, are expensive to install and run, and are prone to heat the cells up too much, which reduces their efficiency and may damage them. That, in turn, means the cells have to be fitted with pricey cooling systems. An alternative now being tested is called the luminescent solar concentrator (LSC). Instead of focusing the sun's rays on a cell, as a solar tracker does, an LSC first traps them, wherever they have come from, and then delivers them to the cell using what is known as a waveguide. No moving parts are involved.

Many researchers around the world are working on LSCs. The latest group to report, in a paper in this week's *Science*, is led by Michael Currie and Jonathan Mapel of the Massachusetts Institute of Technology. They reckon they can triple the efficiency of such devices, and thus launch them on the path to success.

A standard LSC is made of a sheet of plastic containing molecules of dye and stretched within a frame that is, in effect, a single long, thin solar cell. The dye absorbs incoming sunlight, and then re-emits it. The re-emitted light is trapped inside the plastic sheet by a process called total internal reflection, which causes it to bounce between the sheet's surfaces without being able to escape, and thus guides it towards the circumferential solar cell. (Optical fibres work in a similar way.)

Alas, this approach, too, has its limits. In particular, some of the light is reabsorbed as it bounces around, and is lost as heat. The more dye molecules there are, the more light is lost. On the other hand, you want a lot of dye molecules in order to absorb a lot of light in the first place. A difficult balance has to be struck.

Dr Currie and Dr Mapel think they have found a way round this problem and, as a bonus, one that will also make LSCs easier to manufacture. Their answer is to get rid of the plastic sheet. Instead, they spray a sheet of glass with a mixture of dyes combined with a substance called tris(8-hydroxyquinoline) aluminium. In combination, the dyes and the glass act as the waveguide, preventing light from escaping. Meanwhile, the interaction between the different dye molecules and those of the tris(8-hydroxyquinoline) aluminium allows a quantum-mechanical phenomenon, called Förster energy transfer, to come into play. This eliminates the reabsorption loss by ensuring that light is re-emitted at a frequency which the dye molecules cannot then reabsorb.

On top of this—literally—Dr Currie and Dr Mapel have come up with another trick: placing a second sandwich of dye and glass over the first. The upper layer of dye intercepts high-energy light, such as ultraviolet. The lower one captures longer wavelengths that have passed unperturbed through the upper, and also any lower-energy light that has been re-emitted within the top layer and somehow escaped. The upshot is a device that, even as a prototype, converts ten times more of the incident light into electricity than a conventional solar cell—and another contestant in the increasingly crowded race to replace old-fashioned power generation with electricity from the sun.