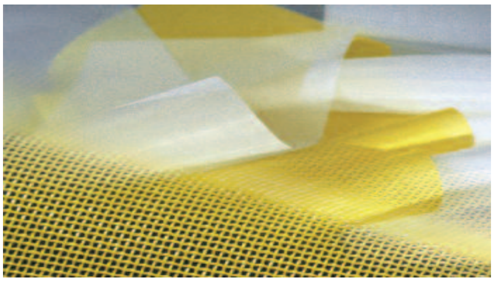
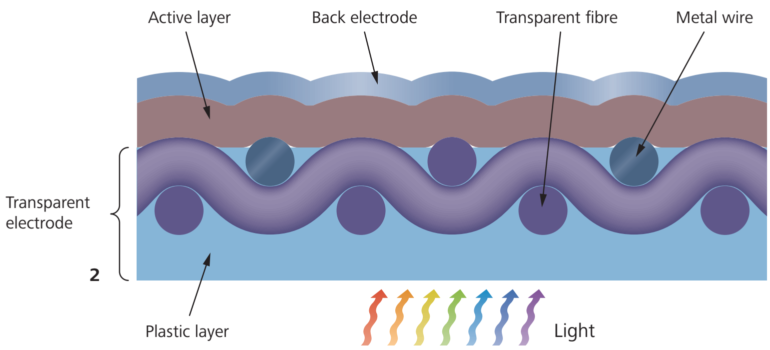
Plastic fabric for solar cells & co

In pliable thin-film solar cells, a transparent and flexible electrode collects the light and conducts the electric current. Empa researchers have developed a polymer-based fabric electrode which is now showing first promising results and presents an alternative to indium tin oxide coatings.

TEXT: Rémy Nideröst

1


2


Shortages of raw materials along with increased consumption of rare earth metals are making electronic components and equipment increasingly more expensive. These metals are used, for example, in transparent electrodes for touch screens on mobile phones, in LCDs, organic light-emitting diodes and thin-film solar cells. The material of choice for such applications is indium tin oxide (ITO), a conductive and largely transparent mixed oxide. However, because ITO is relatively expensive, it is not well suited for applications covering large areas such as in solar cells.

The search for alternatives

Indium-free transparent oxides do exist, but supply bottlenecks are becoming more frequent due to increasing demand. Furthermore, fundamental disadvantages such as brittleness and deformation remain an issue. As a result, alternative transparent conductive coatings are being researched intensely, examples being conductive polymers, carbon nanotubes and graphenes. Carbon-based electrodes, however, generally have an excessively high surface resistance and thus are insufficiently conductive. If a metallic grid is integrated into an organic layer, the resistance drops, but so does the mechanical stability; if a solar cell produced by this method were to be bent, the layers would break and loose their conductivity. The challenge thus consists of manufacturing flexible yet stable conductive substrates, ideally in a cost-effective industrial roll-to-roll process.

One solution: woven electrodes

A very promising possibility turns out to be a transparent, flexible polymer fabric. It was developed by Empa researchers in the Functional Polymers Laboratory in cooperation with the Swiss company Sefar AG and financially supported by the Swiss Commission for Technology and Innovation CTI. Sefar, which specialises in precision fabrics, is able to produce the fabric at an attractive price in large quantities using roll-to-roll processing similar to that in newspaper printing. Woven-in metal wires provide the necessary electrical conductivity. In a second step, the fabric is embedded in an inert plastic layer without covering the metal wires completely and thus electrically insulating them. The resulting electrode is transparent, stable and yet flexible. On top of it, Empa researchers applied a layered organic solar cell. Its efficiency is comparable to conventional ITO-based cells; moreover, the woven electrode is clearly more stable during deformation than commercially available flexible plastic substrates, onto which ITO is deposited as a thin, conductive layer. //

Literature reference

"Flexible Mesh Electrodes: Woven Electrodes for Flexible Organic Photovoltaic Cells", W. Kylberg, F. Araujo de Castro, P. Chabrecek, U. Sonderegger, B. Tsu-Te Chu, F. Nüesch and R. Hany, Adv. Mater. 8/2011, page 920, doi: 10.1002/adma.201190019

1
Flexible precision fabric which was developed into an electrode for thin-film solar cells in collaboration with Swiss company Sefar AG.
(Photo: Sefar AG)

2
Cross-section of a thin-film solar cell with a woven electrode.
(Graphic: André Niederer)