An upside-down cake throws a new light on photovoltaics

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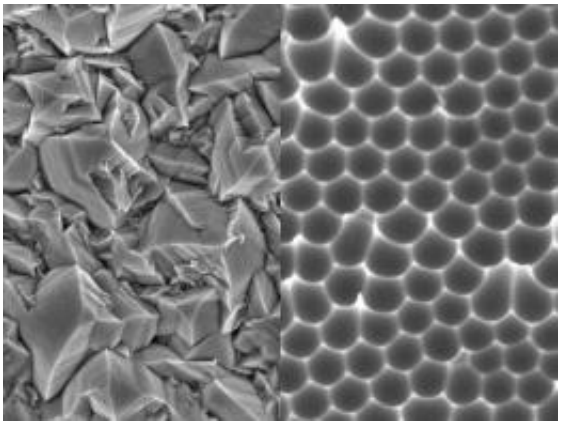
Credit: PV-LAB, EPFL/SNSF

Do better with less. That is the challenge the researchers of the Swiss Federal Institute of Technology in Lausanne (EPFL) have set for themselves, supported by the Swiss National Science Foundation and the Federal Office of Energy. Their specialty: manufacturing solar cells that are one thousand times thinner than conventional cells. In order to boost the output of the cells, they have developed a new nanopatterning technique.

Even though silicon is one of the most abundant elements, the energy required to make silicon from sand is immense. It is for this reason, but also to reduce manufacturing costs, that Professor Christophe Ballif and his team from the Photovoltaics and Thin-Film Electronics Laboratory at the EPFL have been working for several years on thin-film silicon solar cells that are a thousand times thinner than conventional cells.

There's just one catch: the thinner the cells, the less they absorb the rays of the sun and the less electricity they produce. So researchers are trying to trap light in the thin silicon layers to increase their absorption. Traditionally, thin layers of zinc oxide—a material that is very abundant, completely non-toxic, and that grows in the form of small pyramid-shaped crystals—are used for this purpose. These crystals scatter light efficiently into the underlying silicon layer. With such zinc oxide layers, even a new world record cell efficiency was achieved.



Layers of zinc oxide seen through an electronic microscope, on the left: natural pyramid structure, on the right: structure when grown on a mould (height of images 5 microns).

Reducing costs

But scientists are attempting to beat this record. "It is difficult to modify the natural pyramidal shape of these crystals in order to obtain even better light scattering," explains researcher Corsin Battaglia, "so we had the idea to force the crystals to grow on a different support, an inverted mould with the desired structure." The idea is as ingenious as it is simple. Once the thin layer of zinc oxide is deposited on the mould all

that needs to be done is to “demould” it—as you would a tarte tatin, for example—to obtain a film with the desired structure.

This procedure, described in the September edition of the journal Nature Photonics, not only increases the amount of light that is trapped, thereby increasing output, but it also has the potential to reduce the cost of the cells because of its compatibility with mass production. These are interesting arguments at a time when photovoltaics is seeking to produce electricity at a lower price than the current grid price.

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