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A RADICALLY SIMPLER WAY TO MANUFACTURE THIN-FILM SOLAR PANELS ON THE SCALE-UP TO MEET FUTURE PHOTOVOLTAIC GOALS

In partnership with: Empa Materials Science and Technology

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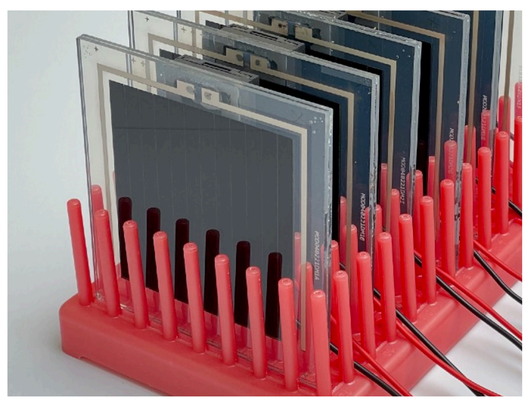
WHY OUR PEROVSKITE THIN-FILM PANELS?

Photovoltaics are undeniably playing an increasing role in the transition to renewable energy sources. Consequently, solar installations are poised to grow at a staggering rate.

Solar panel manufacturing is particularly under pressure to scale up production in order to match even the most conservative photovoltaic deployment scenarios. Mainstream solar panels have seen impressive improvements in efficiency, though with increased manufacturing complexity.



Affordable solar energy for all

While cost per panel has gradually decreased, the initial investments to build production facilities remains all-time high.

Herein, we demonstrate a radically simpler way to produce stable perovskite thin-film solar panels with extremely low material usage, and industry-proven high throughput techniques.

As a result, we project that such panels will require much lower capital expenditure and achieve unrivaled production cost.

This also represents an opportunity to localize photovoltaic panel production, and hereby further reduce environmental impact.

A TECHNOLOGY THAT SCALES UP

STABLE

The solar architecture presented here rely on a ceramic-like scaffold that's hosting a perovskite absorber. This especially skips the use of the fragile organic compounds commonly employed in other perovskite solar cells, making our technology inherently stable.

Best, we have proven stability of over 11'000 hours under continuous simulated solar sunlight[1]. That is already the equivalent of over 11 years in real daylight cycles!

Winning technologies can scale up big

SCALABLE

Perovskite solar cells are certainly all the rage in scientific research, but very few could actually scale up to any meaningful device area.

Our modules are capable of retaining the same efficiency as obtained with small R&D cells. This is notably thanks to our module design that is already on par with state-of-the-art thin-film panel geometrical fill factor (>93%).

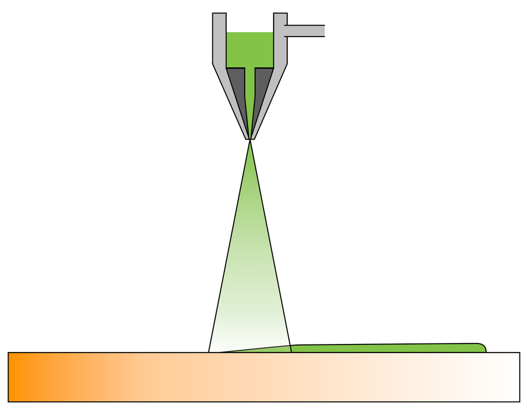
NIMBLE

Ingredients are used in very small amounts: the active component is as thin as a fifth of a human hair.

More importantly, they are only made of low-cost, abundant materials that do not threat of any supply shortage. Our devices don't employ precious metal back-contact but simply rely on a carbon layer instead.

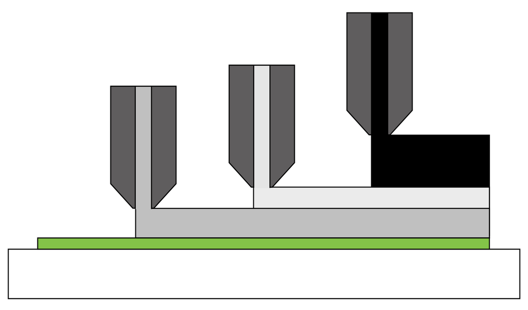
Our wet coating fabrication methods are relying on own-developed functional inks that we formulated with green solvents in the perspective of mass manufacturing.

UNRIVALED EASE OF FABRICATION



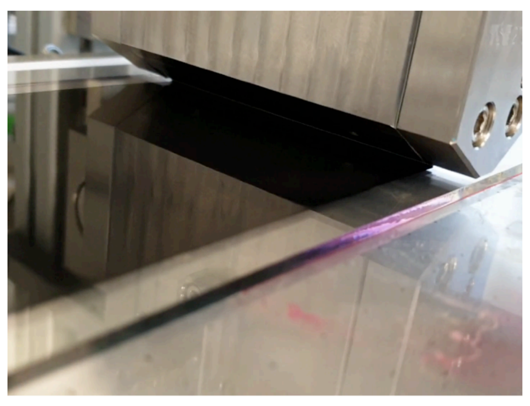
❶ *Spray coating of conductive and underlayer on float glass.*

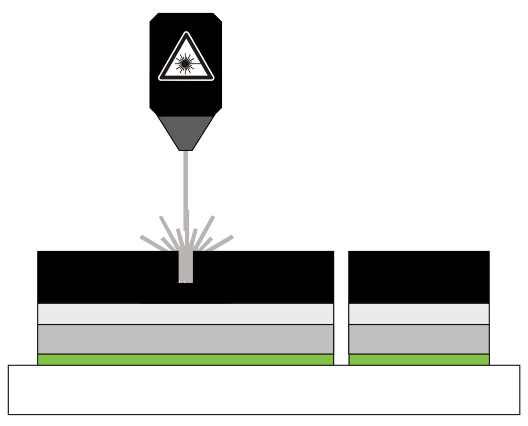
Likewise any thin-film solar panel, the fabrication starts with a float glass that is coated with a transparent and conductive layer. In the present case, the substrate also takes an underlayer similarly to existing self-cleaning glasses.



❷ *Slot-die coating of anode, spacer, and cathode layers.*

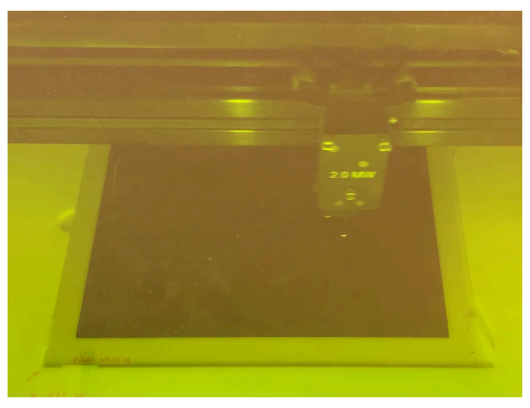
Next, the layered metal-oxide and carbon structure is deposited by means of slot-die coating[3,4], undeniably the fastest deposition method found in the industry. This is also how electric car batteries are being produced.

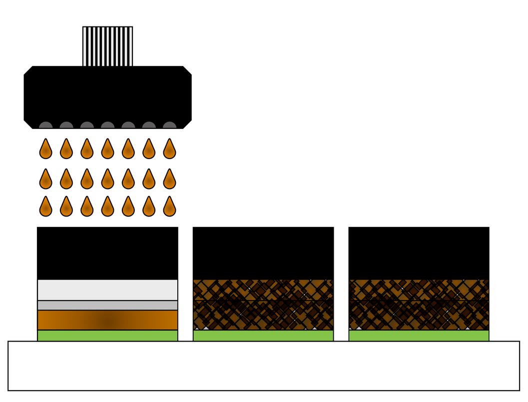




❸ *Selective laser ablation of interconnections.*

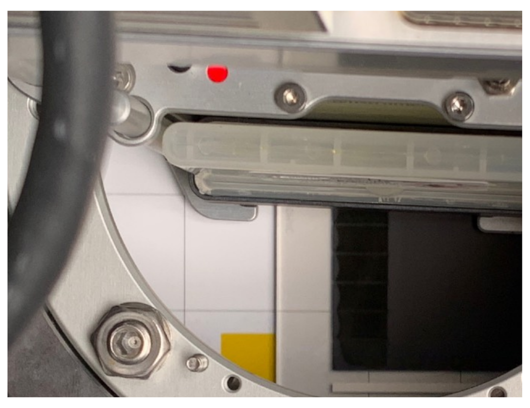
Solar cells are individualized and connected in series by selective laser ablation of the different layers. This layout commonly found in thin-film solar panels greatly reduces resistive losses and maximizes power output.

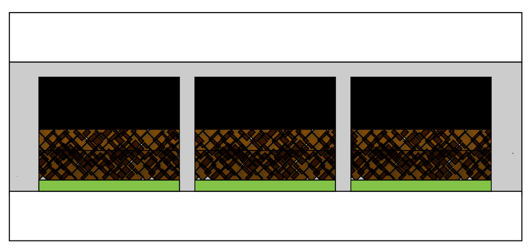




❹ *Deposition and annealing of the perovskite absorber.*

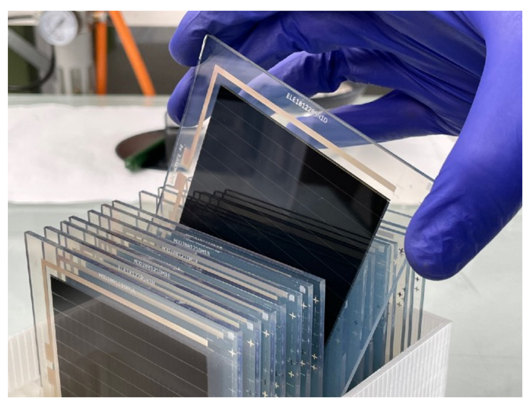
The perovskite absorber is introduced last, via inkjet deposition of a precursor solution that crystallizes upon drying. We found this digital coating method extremely clean and precise, while offering excellent device performance.

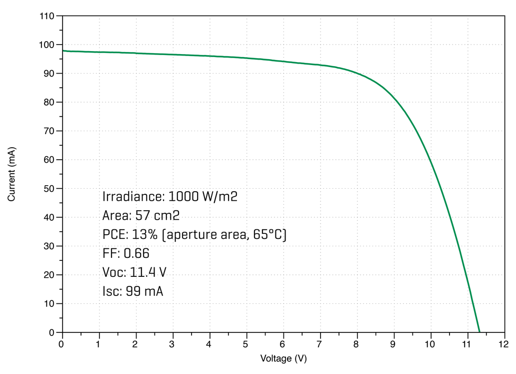




❺ *Lamination and connection with existing methods.*

Finally, the solar module is laminated with a back glass to protect it from the environment, and receives junction box and wiring just like any other solar panel technology.





Typical current-voltage plot of a module prototype.

This entire fabrication relies on extremely simple manufacturing processes already being employed in other high volume industries.

A paradigm shift in PV manufacturing

All is realized in ambiant air, and does not require ingot growth nor vacuum deposition. As a result, such photovoltaic panels feature a reduced embodied energy, and a lower carbon footprint than incumbent technologies.

A VERSATILE TECHNOLOGY

In addition to the above fabrication path, we actually developed a host of alternative methods to choose from, depending on targeted application.

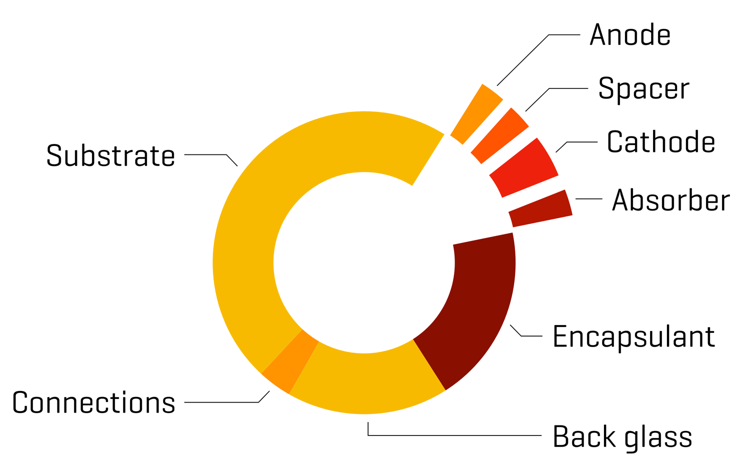
Many more options

All of the ingredients could very well be casted by slot-die coating, screen-printing, or even inkjet[2].

While the first offers the highest throughput, the other two printing techniques bring interesting patterning methods, even able to replace laser interconnection patterning.

BILL OF MATERIALS

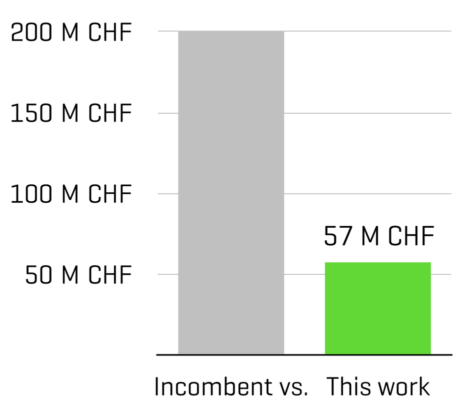
The active materials employed in our solar technology are so inexpensive that most of the bill of materials is constituted by ancillary items such as glass and encapsulant.



Total materials: 0.07 CHF/Wp

SETUP COSTS

The use of simple fabrication techniques really shines when it comes to capital expenditure. Initial investments are much reduced.

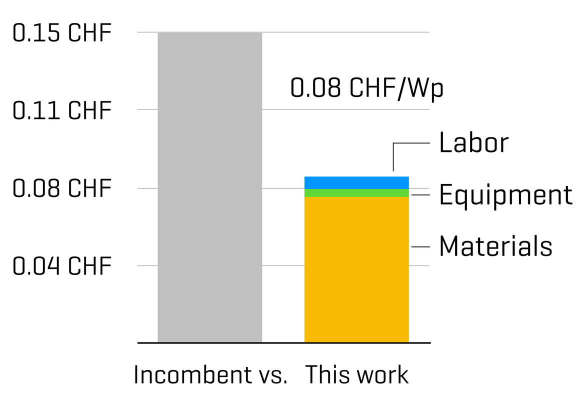


CAPEX for a 2 GWp/year facility

Slashed setup costs & halved production costs

PRODUCTION COSTS

By combining inexpensive materials and extraordinary simple fabrication techniques, we forecast production costs to almost half of incumbent technologies.



Production cost/Wp

Acknowledgment:

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