A short overview of PV, materials and systems R&D in Neuchâtel

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R&D in photovoltaics in Neuchâtel

EPFL

IMT/PV-Lab (1984)

- Fundamental research
- Advanced devices

CSEM, RTO

PV-Center (since 2013)

- Focus on techn. transfer
- Dev. for industry, innovation

PV-Center

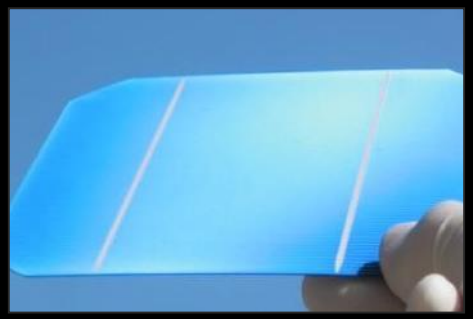
Production and commercialization

Industrial partners

Spin-off, Start-ups

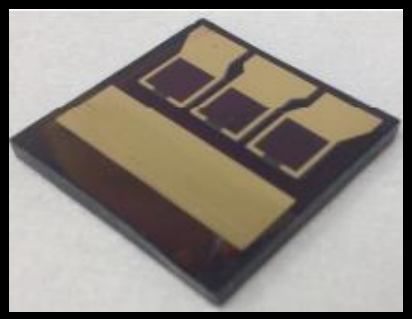
In contracts with over 40 companies

PV R&D's in Neuchâtel, Switzerland



Silicon heterojunction (SHJ) cells/ passivated contacts

Multi-junction thin films/optics



Perovskite cells for tandem

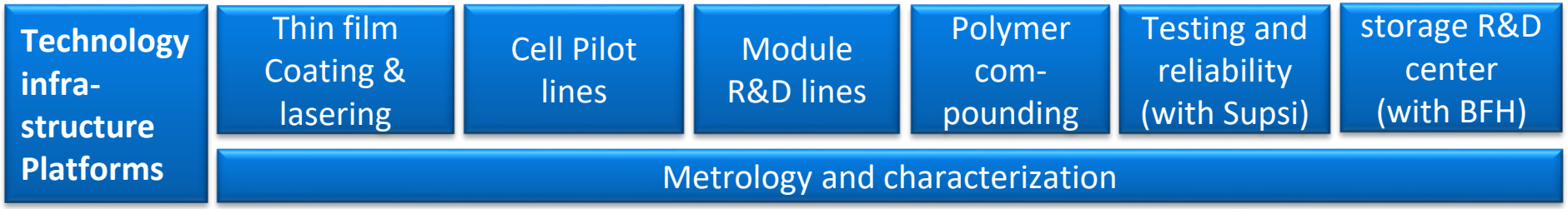
Module fabrication & design, polymer reliability

Advanced Coatings, Plasma, TCO

Building integrated PV

Storage and systems

Key infrastructures

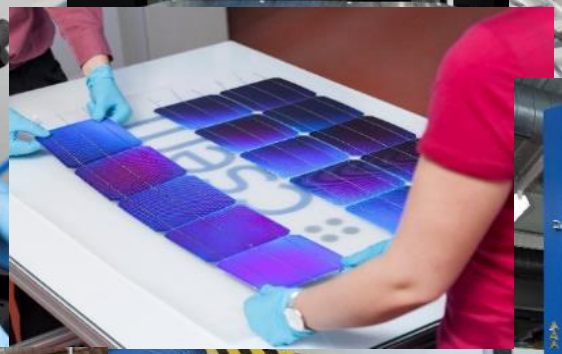


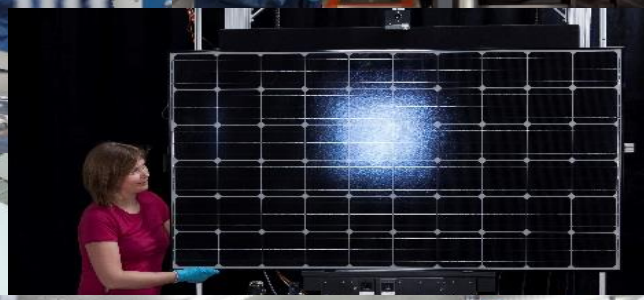
- Over 2000 m2 of lab and facilities in Neuchatel
- 800 m2 at EPFL and 1200 m2 at CSEM
- including around 700 m2 of clean rooms

2000 m2 research and piloting… Contracts with over 40 companies along the chain











Tools for specialty PV products




Formulation, compounding, extrusion, diffusion layer


Special tool for assembly, light weight modules

Tailored Polymer synthesis

Example:

< 700 g/m2 modules at 21%, passing 200 cycles of -70°C – 85°C and 1000h in damp heat (85°C/85% RH)

PV module monitoring station on EPFL roof

- Individual module monitoring (MPPT tracking and IV characteristics)
- DC microgrid (700 V) with DC/DC converters and little load (heat pumps & elevators connected)
- Mini-module and cell monitoring station
- Weather station (Irradiance monitoring, spectrophotometry, Full sky camera)

➔ Complete characterization for study of grid integration of PV

PV-lab IMT NEUCHATEL

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

csem

Application Fields

Powerpure
Technologies for lowest cost solar electricity

2020>20%, < 0.4€/Wp, > 30 years
2026 >23% <0.3€/Wp, > 40 years
high energy yield

Elegance and architecture
Transforming building and cities with solar

All shapes, all colors, and/or active construction material

Smart
Intelligent E-management, efficiency in building, storage, renewable

Algorithms and electronics/ IT services
managing light, heat, electricity

Explore
Customized PV products from the water to the air

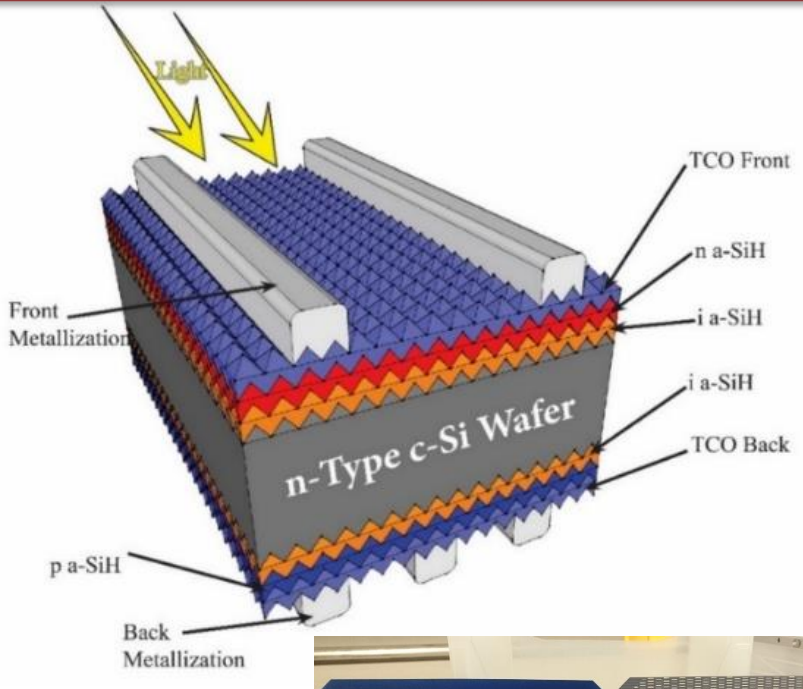
Lightweight modules and power solutions for planes, drones, cars and more

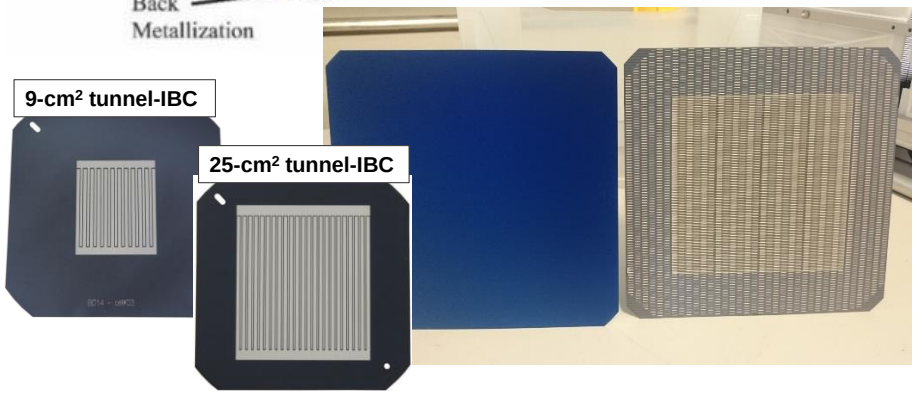
E-tonomy
Energy scavengers and ubiquitous power sources

20% indoor
autonomous harvesters, connected

Powerpure

Technologies for lowest cost solar electricity





Various sets of technology at lab-scale

- **Heterojunction (24.2%)**
- **Back-contacted heterojunction (25%)**
- **Passivating contacts devices (22.6%)**

PV-lab IMT NEUCHATEL

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Exemples: High efficiency, « lean but subtle » process for c-Si heterojunction

2005 — 2008 — 2009 — 2011 — 2013 — TODAY

First high efficiency solar cells

Hosting and transfer of technology to Roth&Rau Switzerland

Industri-alisation phase

First production lines and tools sold

Large scale demonstrator

Swiss Electric Research award 2007

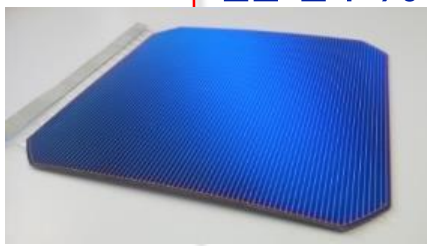
19.2%

Creation Roth and Rau Switzerland

22-23 %

Meyer Burger Acquires Roth and Rau

22-24 %



MEYER BURGER

Powerpure

Examples of market penetration, with silicon heterojunction technology, initiated at Neuchâtel

Hevel completes first heterojunction-based PV power plants in Russia

By Mark Osborne | Sep 20, 2017 1:11 PM BST | 0 Share

Sept 2017 Hevel puts in place 160 MW of capacity in Russia
(Mix of technology, Oerlikon/Meyer-Burger)

INDEOtec to supply Saudi Arabia's KAUST with heterojunction solar cell deposition system

By Mark Osborne | Mar 03, 2017 9:52 AM GMT | 0 Share

Summer 2017, ISE and Kaust 2017 client of Indeotec at Neuchâtel

MEYER BURGER OUR TECHNOLOGIES OUR PRODUCTS AND SYSTEMS

10/23/2017

Meyer Burger awarded major strategic contract for around CHF 45 million by an Italian photovoltaic manufacturer for bifacial Heterojunction lines enabling production capacity of up to 200MW

Meyer Burger's high performance Heterojunction (HJT) solar cell coating technology has been selected for the installation of a manufacturing line to produce bifacial Heterojuction solar cells in Catania, Italy. The contract volume is around CHF 45 million.

Octobre 2017
CHF 45 million sale of equipment in Italy by MB

Nov 2018, 600 MW sold to Asian Customers

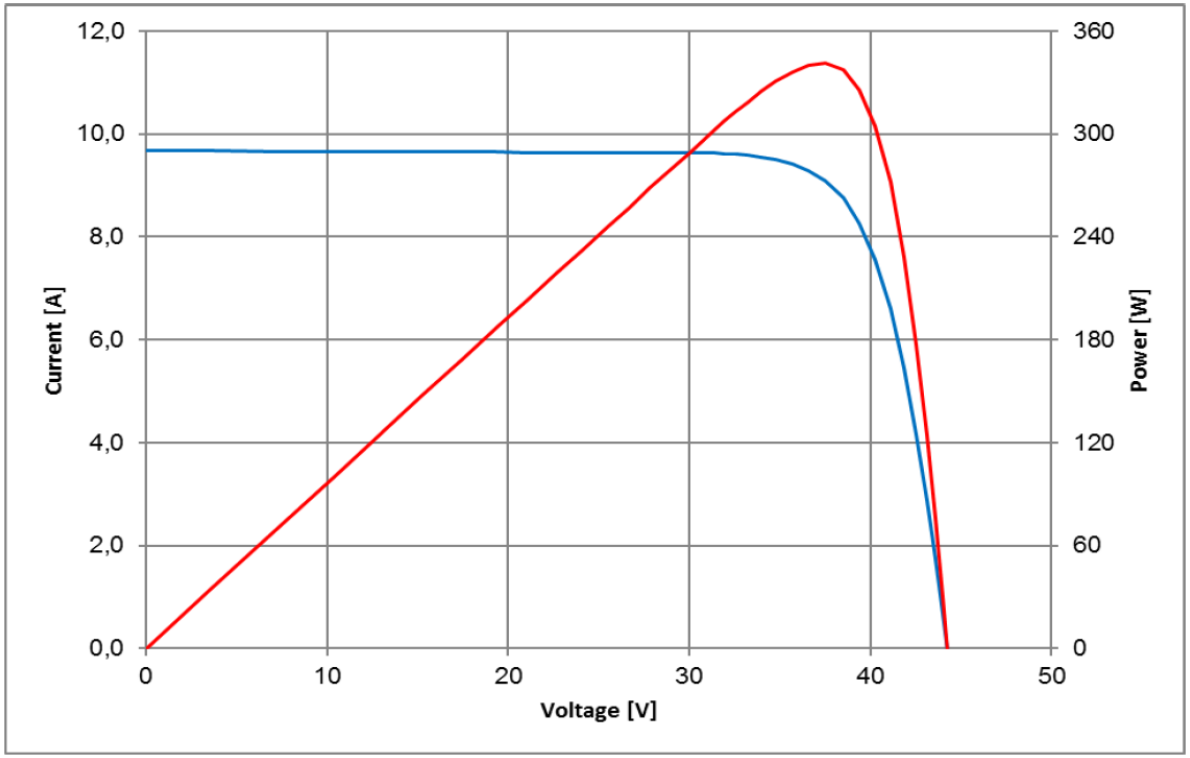
341W champion module – 60 cells
Regular cell size (M2), no half cells, potential for 350 W and more

MEYER BURGER

With new «wire interconnection»
No rare element
Thicker wire
Up to 80% FF modules

341W
Module power (mono facial)

Barcode	P_{max} [W]	V_{mpp} [V]	I_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]
HV2018002279	340.7	37.13	9.17	44.20	9.70	79.6



[Courtesy of Jun Zhao, Meyer Burger Germany]

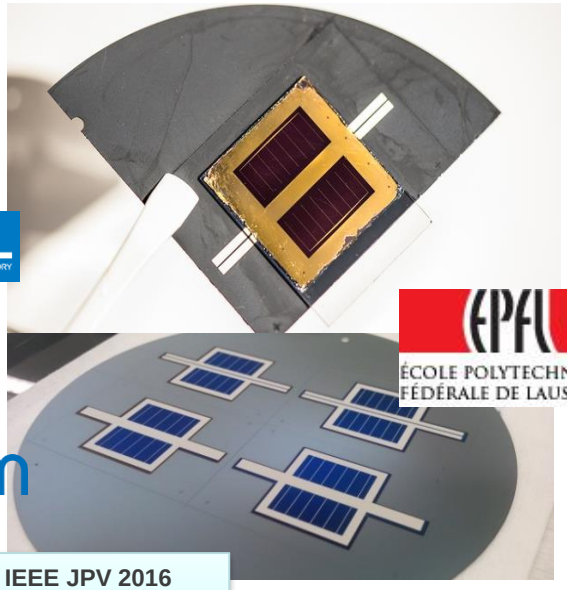

Example: CSEM bi-facial, «smart-wire»
Heterojunction facade, with 22% cells

Powerpure : tomorrow

Examples of cutting edge research

Custom designed small HJT cells 4 terminals III-V /c-Si tandem,

> 32.8% World Record



NREL NATIONAL RENEWABLE ENERGY LABORATORY

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csem

S. Essig et al. IEEE JPV 2016
S. Essig et al. Nature Energy 2017

«Potential low cost» Perovskites on Silicon

> 25% World Record

(for 2 weeks)

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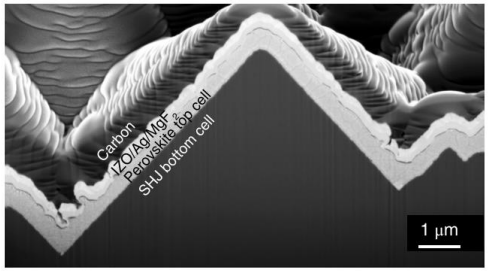
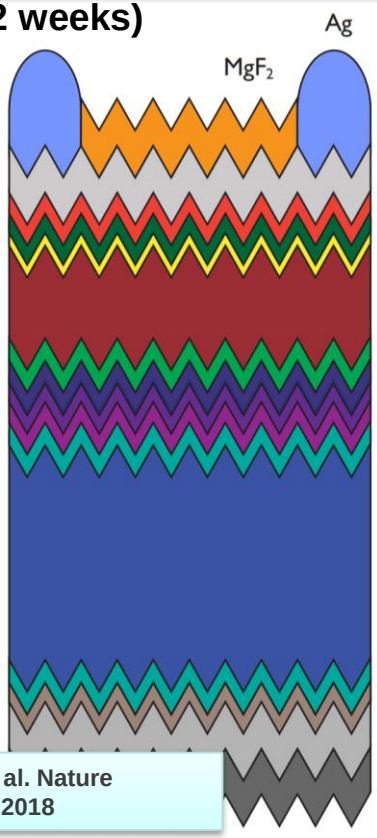


Potential for 30%



F. Sahli et al. Nature Materials, 2018

Elegance and architecture

Transforming building and cities

- Based on polymer and module platforms
- Technological support or transfer to companies

Manipulation of adhesion, temperature, creating color films, ….

~ 10 companies active in CH

White PV panels, together with Solaxess

White PV panels!

Elegance and architecture

Transforming building and cities: new crystalline tiles in protected environment

One of the Terra-cotta Tones, with ISSOL, Userhuus, SFOE

Elegance and architecture

Transforming building and cities: new crystalline tiles in protected environment

These are solar modules with colored meshes of a Swiss Supplier

Until when we can modify PV?

Introducing project Kaleo…


Banque Cantonale Neuchâteloise


Banque Cantonale Neuchâteloise

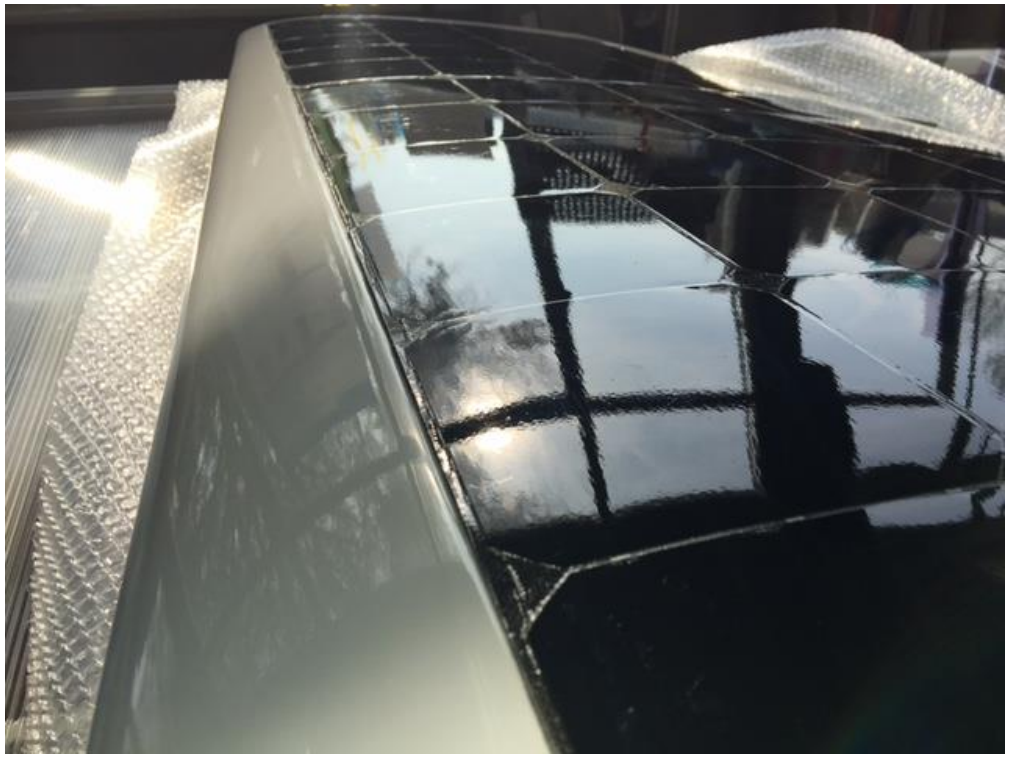
Explore

Customized PV products from the water to the air

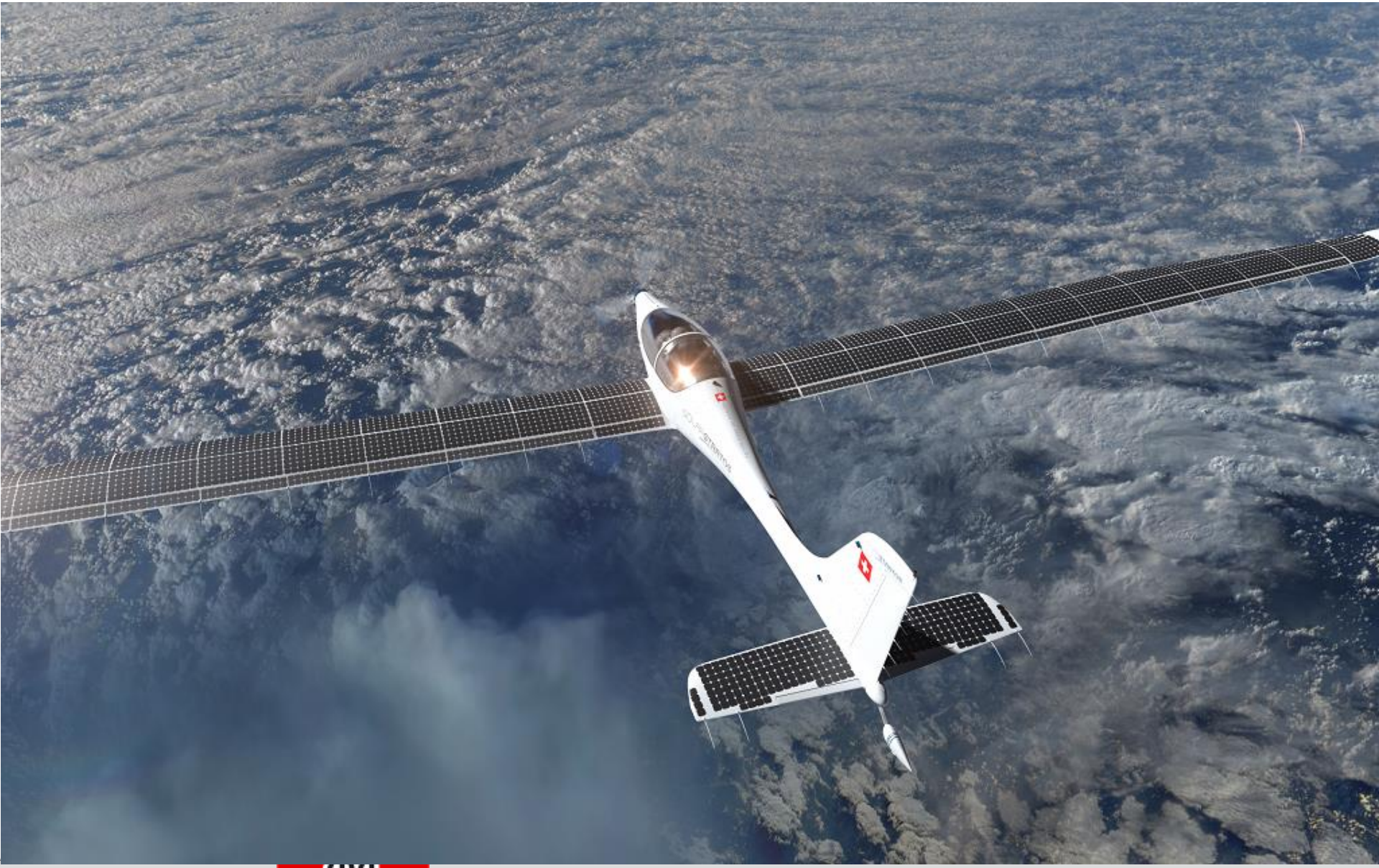
- Light weight specialty modules for terrestrial and space

Solarstratos first flight

Lightest weight



Solar Stratos… à la frontière de l'espace



Explore

Customized PV products from the water to the air

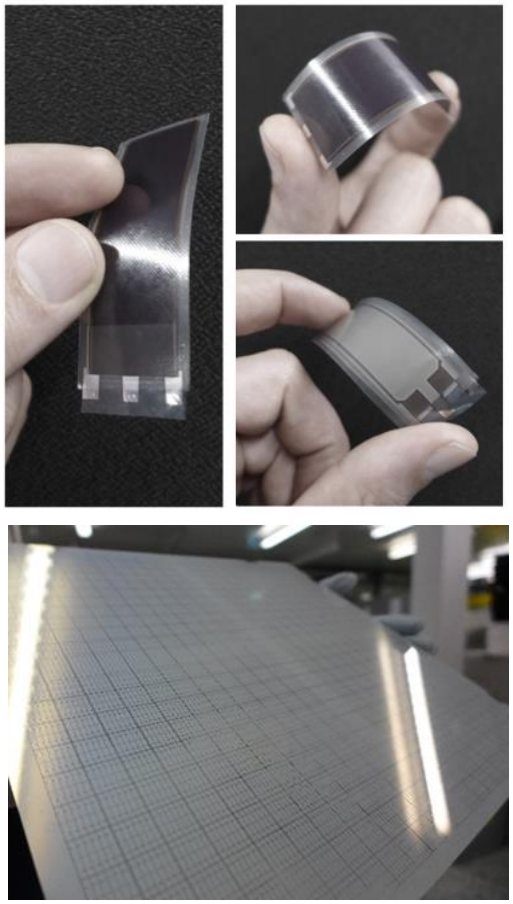
Artic solar with Anne Qéméré

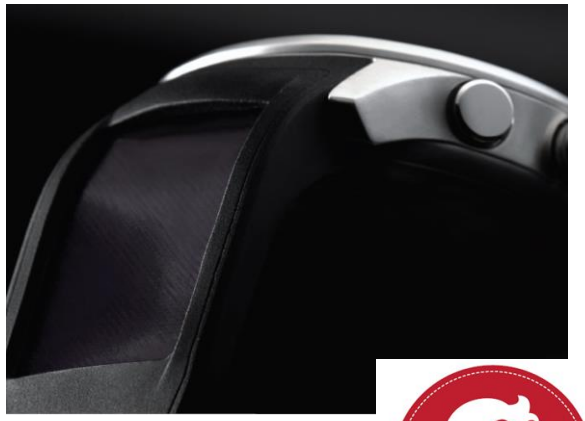
- High-couture modules for competition boats

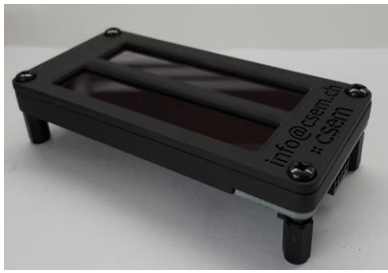


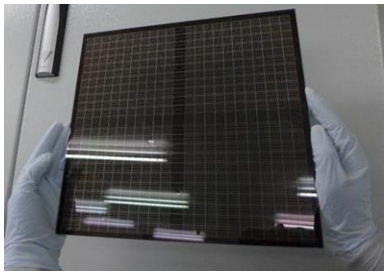

E-tonomy

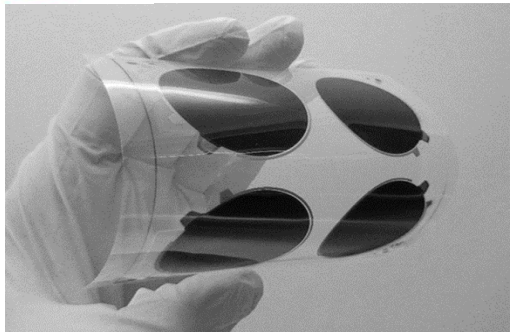
energy scavengers and ubiquitous power sources

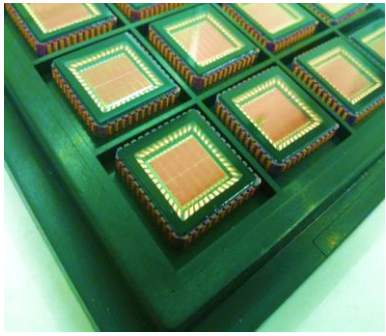












Coin cells
High performance
PV-devices

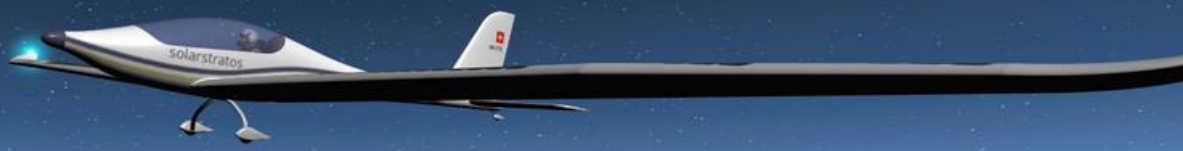
>> 40'000 pieces
Produced 2017

Solar electricity: just a start….

Jamais le soleil ne voit l'ombre

(The sun has never seen a shadow)

Léonard de Vinci



Merci pour votre attention !
Contact: christophe.ballif@epfl.ch

Solarstratos