

Versatile Lightweight Photovoltaic Module Line with Customized Module Stacks to Meet Application Oriented Reliability and Aesthetic Targets

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Introduction

The photovoltaic market is rapidly diversifying from mainstream modules and entering the application-integrated domain. Each targeted application, such as vehicle-integration or building-integration, comes with its own set of requirements for optimum weight, aesthetics, color, mechanical strength, and structure in addition to its photovoltaic performance and reliability. A strong emphasis is set in CSEM on development of materials, processes, concepts and cost-effective production means for the realization of such lightweight photovoltaic modules.

SolarStratos plane demonstrator: Ultra light-weight down to 700 g/m²



PERFORMANCE & RELIABILITY

CSEM developed new generations of special adhesives and encapsulant materials, as well as Pb-free interconnect, together with advanced module design and lay-up, enabling to demonstrate:

High performance with **>21% efficiency**, **ultralight weight of 700g/m²**

High durability with all accelerated aging tests passed with modules implemented on wing element: mechanical stability & performance conserved after **10'000 cycles at 25 N/cell peel force**, after **200 thermal cycles between -40 °C and +80 °C**, after bending fatigue tests simulating a maximum bending of the full wing of 3 meters, high UV resistance, ready for stratosphere.

High integration quality on wing, **surface roughness < 0.2 mm** enabling for no impact on flight conditions, durable fixation technology and innovative inter-module connections.



RESULTS

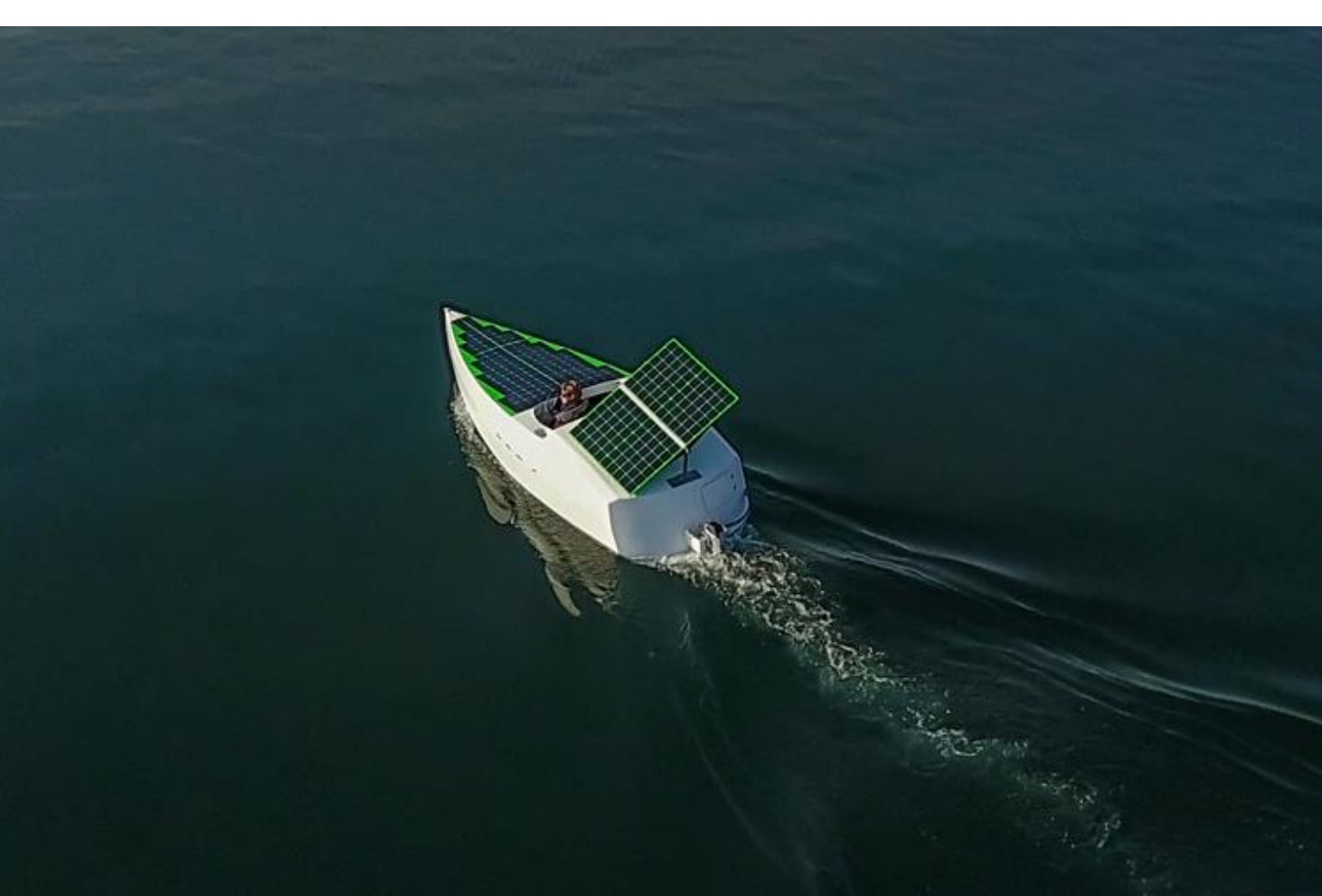
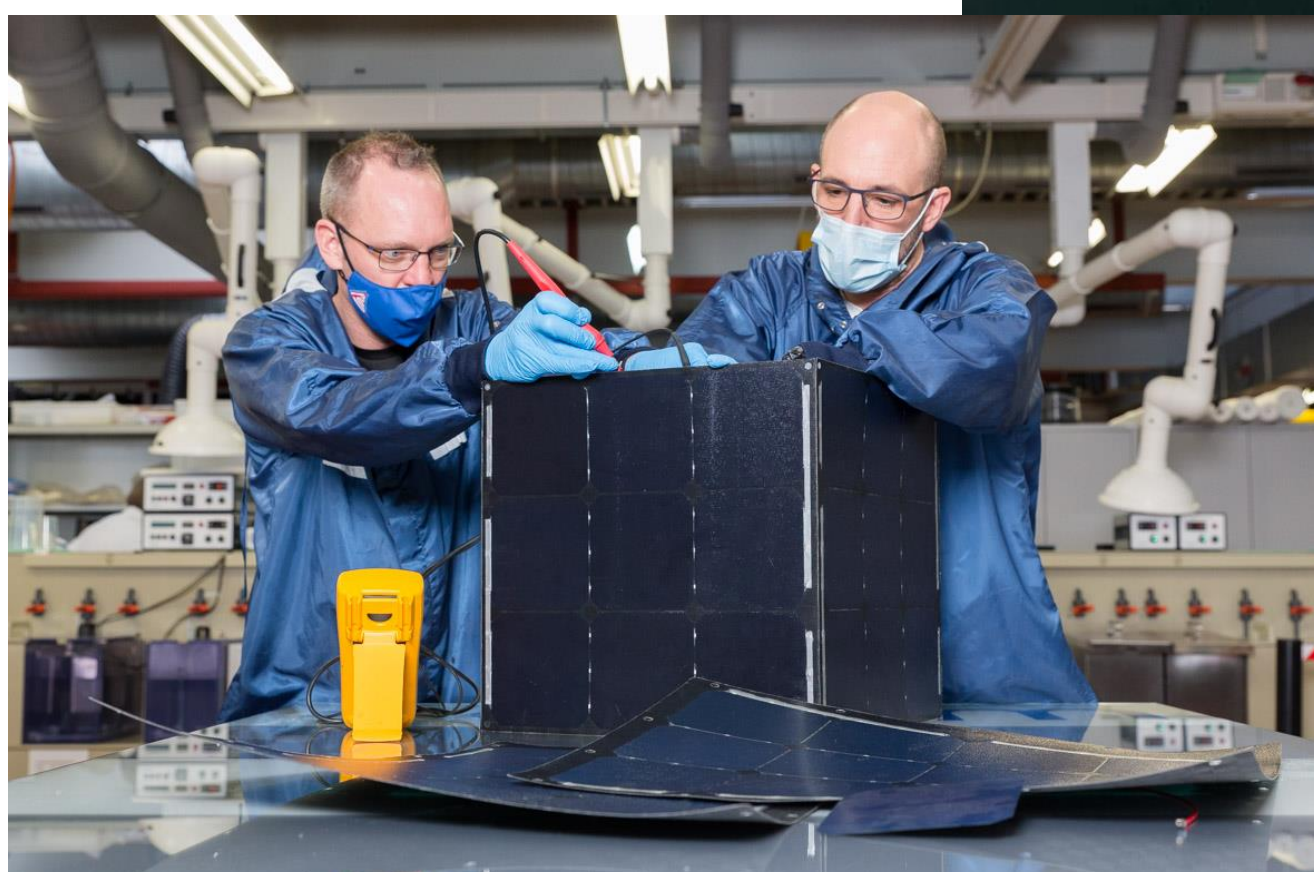
Successful integration of CSEM PV on the 2 wings of Solarstratos completed in 2020, qualification of performance of installed PV system.

Successful flights in 2020 with two world records set: First solar free-fall without any CO₂ emissions, First jump in history from an electric plane

Qualified for extreme environments

Lightweight PV modules stacks developed for varying backsheets providing adapted mechanical rigidity depending on PV module dimensions and application. Self-standing modules with 2 to 4 kg/m².

CSEM nautic solutions with 2-3 kg/m³ were qualified in arctic extreme conditions / offshore corrosive environment / project Arctic Solar

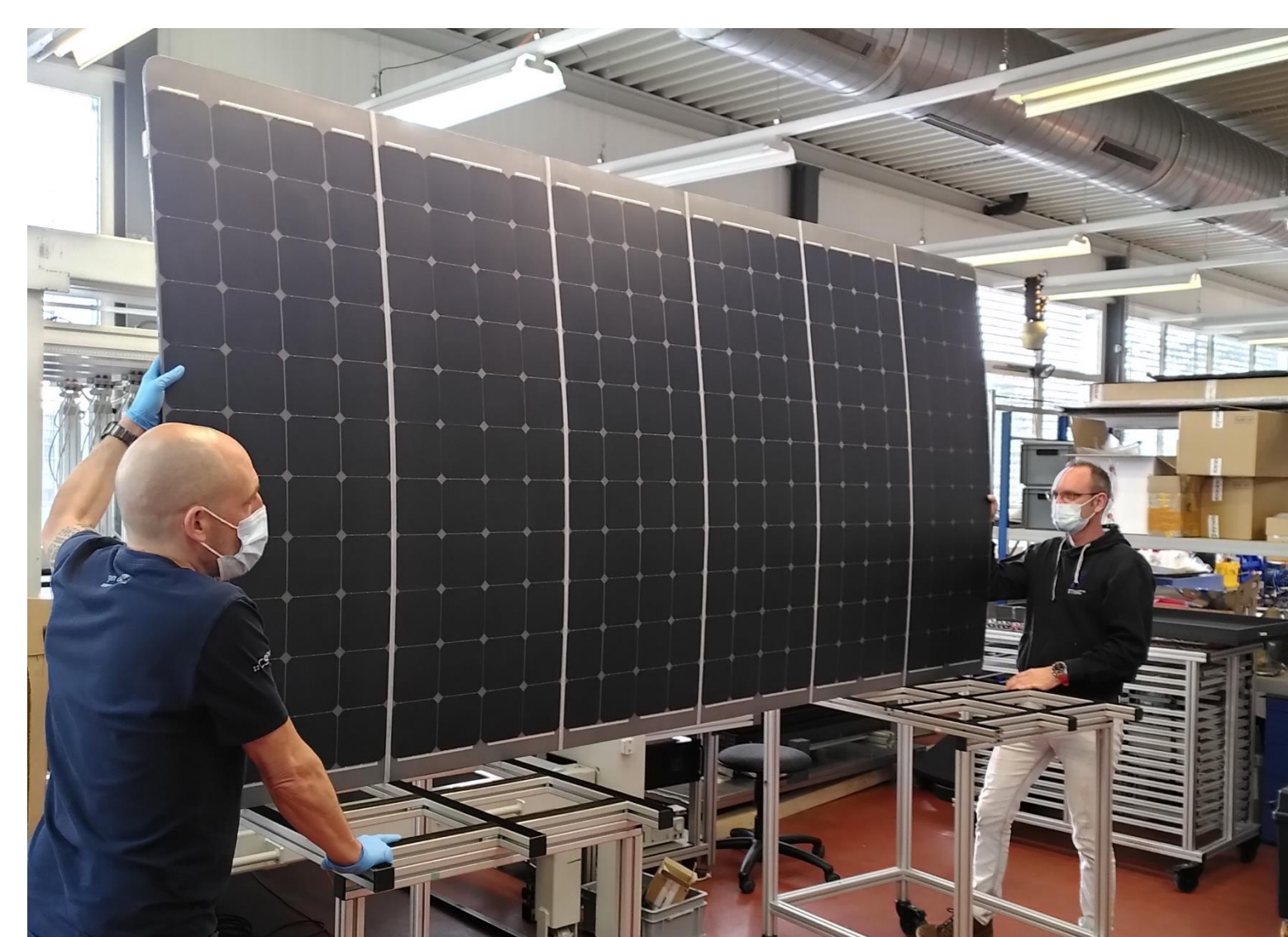


Ultralightweight modules developed to power 40 stratospheric balloons for a meteorological expedition in the Indian Ocean as part of International Project Strateole-2 project with CNES, France.

CSEM lightweight PV Modules were qualified according to stratosphere required standards, and successfully validated in test flights in 2020

Custom-made for optimum integration

New possibilities developed: integration of CSEM colouring technologies, curved devices, large area systems



Conclusions

This work demonstrates the implementation of new materials and processes developed in CSEM for the realization of lightweight photovoltaic modules. In contrast to typical glass-based PV modules which exhibit a weight superior to 15 kg/m², the products developed can go from **as low as 700 g/m² for a module integrated** into an existing structure to **4 kg/m² for a self-standing module**. The exact module weight and stack depend on the mechanical rigidity the PV module must provide. In addition to high performance and reliability, CSEM solutions demonstrate high level of adaptation to custom-demand, including colouring technologies.