

## CHEER-UP

### Low Cost High Efficient and Reliable UMG PV cells

*Project duration: from 02.2020 to 01.2023*

*Report submitted: 05.2023*

#### **Publishable Summary**

Upgraded Metallurgical Silicon (UMG) is an ecological alternative to solar-grade silicon in terms of energy payback time and CO<sub>2</sub> emissions (over 60 % less). It also has the potential to reduce the cost of raw material (around 25%). For all this, making UMG a commercial product is an opportunity to re-build European technological leadership in the photovoltaic sector by innovating upstream in the value chain.

CHEER-UP has demonstrated that UMG multicrystalline silicon is a competitive alternative for polysilicon to produce high efficiency solar cells, in terms of economics and environmental impact.

The project's approach has been the following:

- Defect engineering techniques based on phosphorus diffusion gettering have been explored to improve the bulk quality of UMG.
- Black silicon has been implemented to help increase the solar cell efficiency, designing this texturing process so that the gettering and surface passivation effects are maximized.
- PERC has been the cell architecture used to assess the efficiency of UMG, conveniently adapting and tailoring an industrial manufacturing process to the specificities of the material.
- Degradation mechanisms have been assessed to evaluate how apparent they are in UMG solar cells, proposing degradation recovery techniques if needed.
- TOPCon solar cell architectures have been tested on UMG wafers to further evaluate the potential of the material beyond PERC.

The project has resulted in the achievement of 20,1% UMG multicrystalline PERC solar cells, an efficiency target that is accompanied by a reduction in the cost of silicon and a reduction in the environmental impact of silicon technology.

The project started in February 2020, and has lasted three and a half years, conducted by a consortium of four partners. It is coordinated by the Solar Energy Institute at Universidad Politécnica de Madrid (Spain), which brought to the project its expertise in defect engineering approaches for silicon and in solar cell process development. Valencia Nanotechnology Centre at Universidad Politécnica de Valencia (Spain) lead the research in advanced texturing coordinated

with the cell development and studied the degradation mechanisms. ODTÜ-GÜNAM (Turkey) run its Photovoltaic Line, which is devoted to full size PERC processing in pilot scale, adapting the processing sequence to the UMG specificities. Aurinka PV, a Spanish company with large experience in the whole chain of PV, from feedstock to installations, contributed in key aspects of this project as the refinement of UMG and the characterization of the material, together with the economic and environmental assessment.

## Project consortium

Coordinator and all contact details:

Full name of organisation	Universidad Politécnica de Madrid
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Participating countries and financing:

Country	Number of organisations involved	Project costs in EUR	Public funding in EUR
Spain	3	376 687	266 742
Turkey	1	104 158	158 792
<b>Total</b>	<b>4</b>	<b>480 845</b>	<b>425 534</b>

## Funding agencies involved and contracts

Funding Agency	Contract N° and Title
AEI	PCI2019-111834-2, CELULAS FOTOVOLTAICAS CON SILICIO UMG DE BAJO COSTE, ALTA EFICIENCIA Y FIABILIDAD PCI2019-111903-2, LOW COST HIGH EFFICIENT AND RELIABLE UMG PV CELLS
CDTI	EXP 00128093/ SERA-20201003 CÉLULAS FOTOVOLTAICAS UMG FIABLES DE BAJO COSTE Y ALTA EFICIENCIA
TUBITAK	219M029, 'CHEER-UP' DÜSÜK MALİYETLİ, YÜKSEK VERİMLİ VE UZUN ÖMÜRLÜ UMG FV HÜCRELER