BOBTandem
Band Offset selective Barrier Three Terminal perovskite on silicon high efficiency Tandem Solar Cell

Project duration: from 09.2019 to 08.2022
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Publishable Summary

In the field of solar cells, now increasingly competitive, increased efficiency is the strongest imperative. The most effective route to higher efficiencies is that of multijunction solar cells. They consist of two (tandem solar cells) or more solar cells of increasing bandgap which, combined in one device, can reach efficiencies well beyond 29%. These multijunction cells achieve such high efficiencies by reducing, in essence, heating losses. This is termed “reducing thermalization losses”.

These MJ solar cells come in a range of configurations in terms of connectivity. Briefly, these traditionally include two terminal (2T) and four terminal (4T) designs have yielded the best results but suffer technological bottlenecks due to tunnel junctions (2T) which impose current continuity and grid alignment (4T).

The BOBTANDEM project proposed a new three terminal (3T) concept which we call the “3T-SBOB” which eliminates the 2T and 4T technological bottlenecks. The 3T-SBOB device, patented in 2018, uses an internal barrier (the Selective Band Offset Barrier or SBOB) to allow this reduction in thermalization by isolating charged current carriers in different regions of the cell.

The result is that the two cells making up 3T-SBOB device operate independently without series limitations, and with a single contact grid on the front surface, together with interdigitated back contacts on the back surface.

The project was coordinated by researchers at the origin of the 3T-SBOB concept (GeePs CentraleSupelec / CNRS / EDF). The perovskite cell is integrated by perovskite solar cell researchers (EPFL) active since the start of the field of perovskites. The interdigitated back contact silicon expertise and fabrication was assured by solar cell industrial partners managing mass production of the ZEBRA IBC cell in 2019. Theoretical modelling and analysis was provided by researchers at the PVMD group of TU Delft deploying accurate optical modelling and comprehensive energy yield modelling of the 3T SBOB device. Finally, materials modelling from first principles for device material optimization was provided by the EDF partner.

These researchers were brought together with the recently patented concept, which has been independently demonstrated in the field of infra-red detectors. These strong industrially validated IBC and SBOB concepts can yield a novel 35% efficient tandem device without the limitation of tunnel junctions, and without the complex optical interconnection issues of 4T designs.

The BOBTandem has demonstrated this concept experimentally, using the exciting emerging perovskite solar cell technology and integrating it with a silicon back-contact solar cell which is in industrial mass production by the project partner ISC-Konstanz.

In the first phase of the project the integration has progressed rapidly and fully functioning devices have been delivered ahead of schedule. This has enabled the optimization phase of the project to start half a year ahead of schedule on target to deliver efficient three terminal tandem solar cells at low cost and with efficiencies above 30% in the framework of the BOBTandem project.

In the second phase of the project issues related to the COVID-19 pandemic, compounded by a complete perovskite and 3T integration laboratory move in the last year of the project prevented finalization of complete devices. The theoretical activities progressed according to the workplan. Avenues explored to circumvent the fabrication issues following risk management plans have led to ongoing activities resulting from the project.

Future exploitation routes develop knowledge gained by BOBTandem via projects and industrial development. A French ANR project ORGANIST (financed, 2023-2026) replaces the PSC perovskite top cell with organic materials. A French PEPR-TASE project IOTA (financed, 2023-2027) is investigating a number of tandem structures including perovskites and organics. Both use BOBTandem architecture and expertise. The third is a confidential industrial development of 3T tandem cells as developed by BOBTandem for module interconnection for which patent and industrial studies are underway with the SATT Paris-Saclay (société d'accéleration du transfert de technologies). There is therefore strong development on both research and industrial implementation fronts.

For more information we refer you to the project website: https://bobtandem.wordpress.com/

Project consortium

Coordinator and all contact details:

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
France	2	739 344	340 378
Germany	1	352 816	282 253
The Netherlands	1	290 377	232 302
Switzerland	1	360 734	206 271
Total	*5*	*1 743 271*	*1 061 204*

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
ANR	ANR-19-SOL2-0001 “BOBTandem“
SFOE	S/501919-01, "Research contract (grant)"
ANR	ANR-19-SOL2-0001 “BOBTandem“
PtJ	FKZ 03EE1030, title: "Band Offset selektive Barriere von hoch effizienten Drei-Terminal
RVO	SOL18003 “ Band Offset selective Barrier Three Terminal perovskite on silicon high efficiency Tandem Solar Cell” (BOBTANDEM)“