



HAL
open science

Technological realization of a hybrid photovoltaic-thermoelectric system

Léopold Boudier, Sébastien Hanauer, Jean Baptiste Doucet, Rodolphe
Vaillon, Guilhem Almuneau, Inès Revol

► **To cite this version:**

Léopold Boudier, Sébastien Hanauer, Jean Baptiste Doucet, Rodolphe Vaillon, Guilhem Almuneau, et al.. Technological realization of a hybrid photovoltaic-thermoelectric system. Physics of Solar Cells: from basic principles to high performance, May 2024, Les Houches School of Physics, France. hal-04743829

HAL Id: hal-04743829

<https://hal.science/hal-04743829v1>

Submitted on 18 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Technological realization of a hybrid photovoltaic-thermoelectric system

Léopold BOUDIER, Sébastien HANAUER, Jean-Baptiste DOUCET, Rodolphe VAILLON, Guilhem ALMUNEAU, Inès REVOL

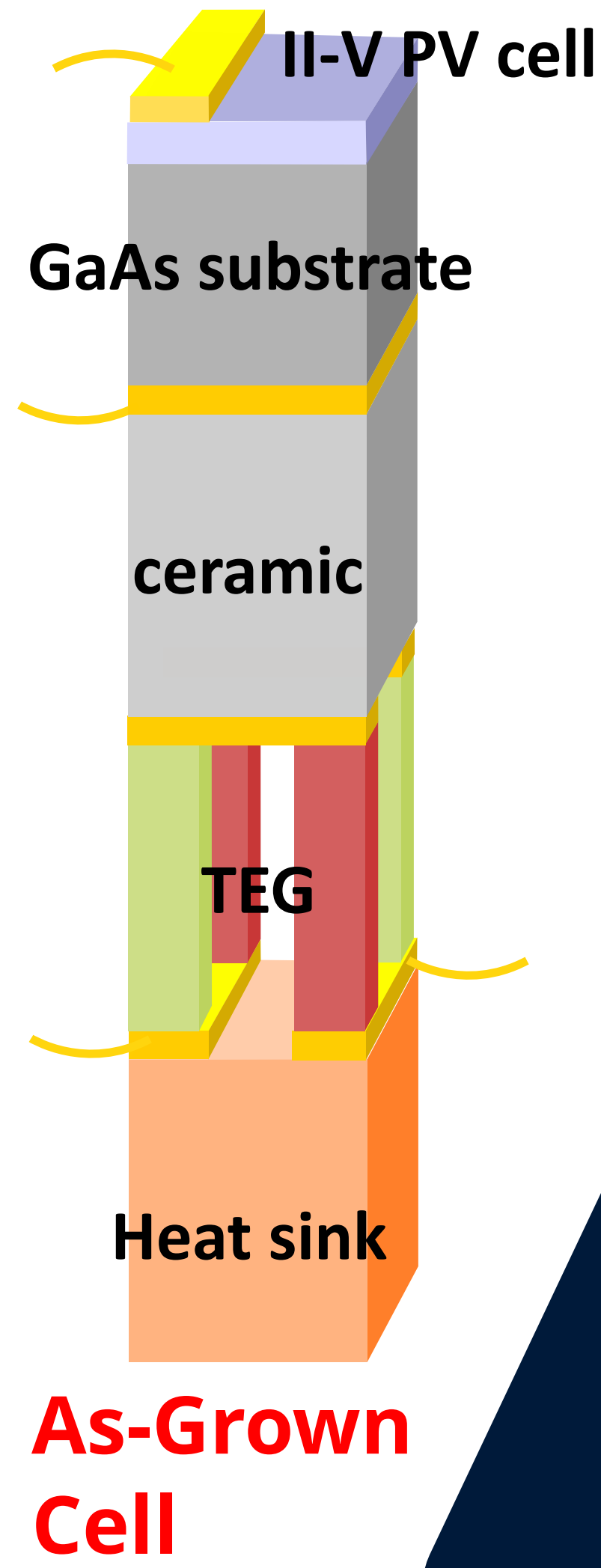
LAAS – CNRS, Toulouse, France
Contact: leopold.boudier@laas.fr

Context

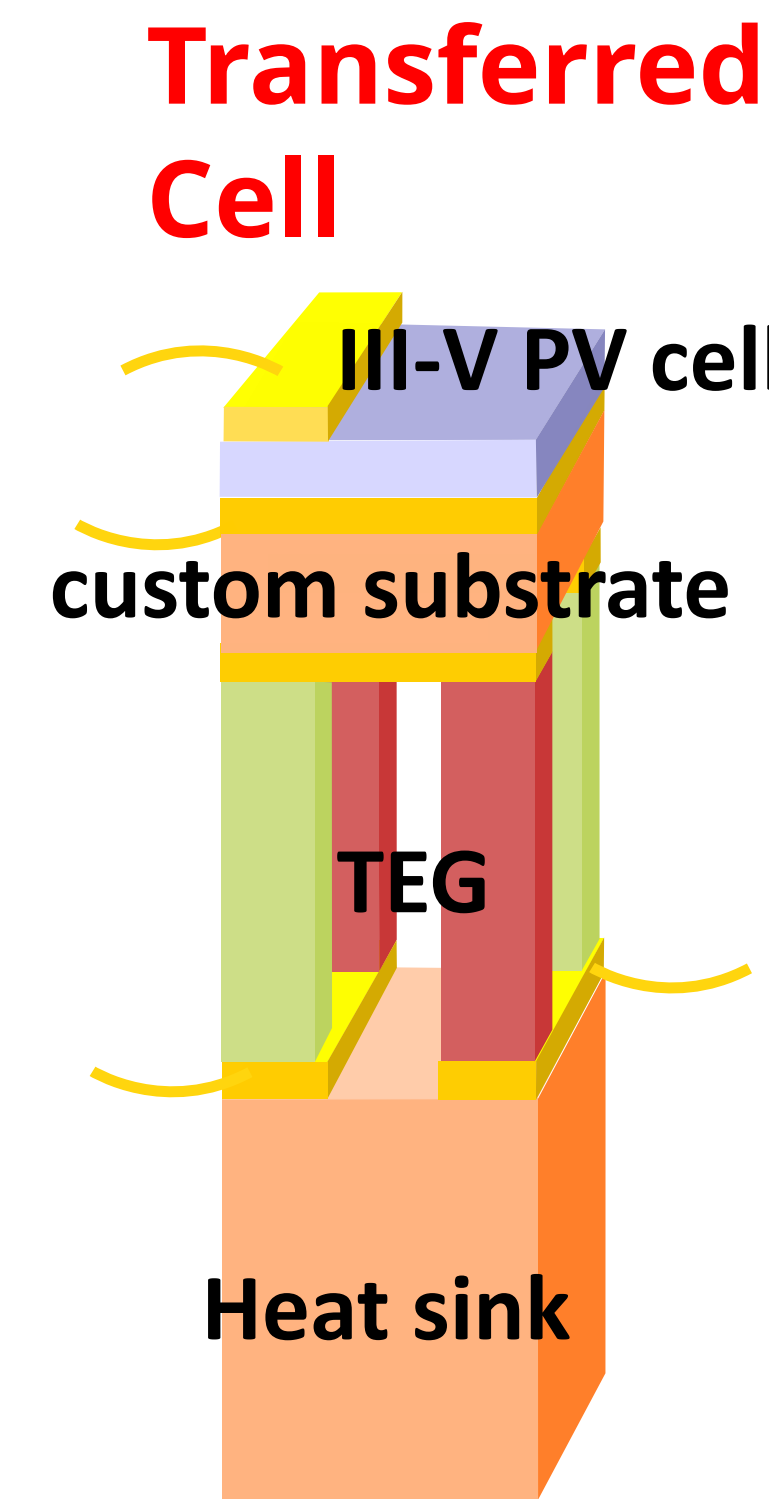
- One way of harvesting heat dissipated in a photovoltaic (PV) cell is by combination with a thermoelectric generator (TEG) in a hybrid energy device

How to fabricate such a system?

- We compare here a standard solar cell fabrication process with one that allows us to reduce thermal resistance between the PV cell and the heat sink.



VS.

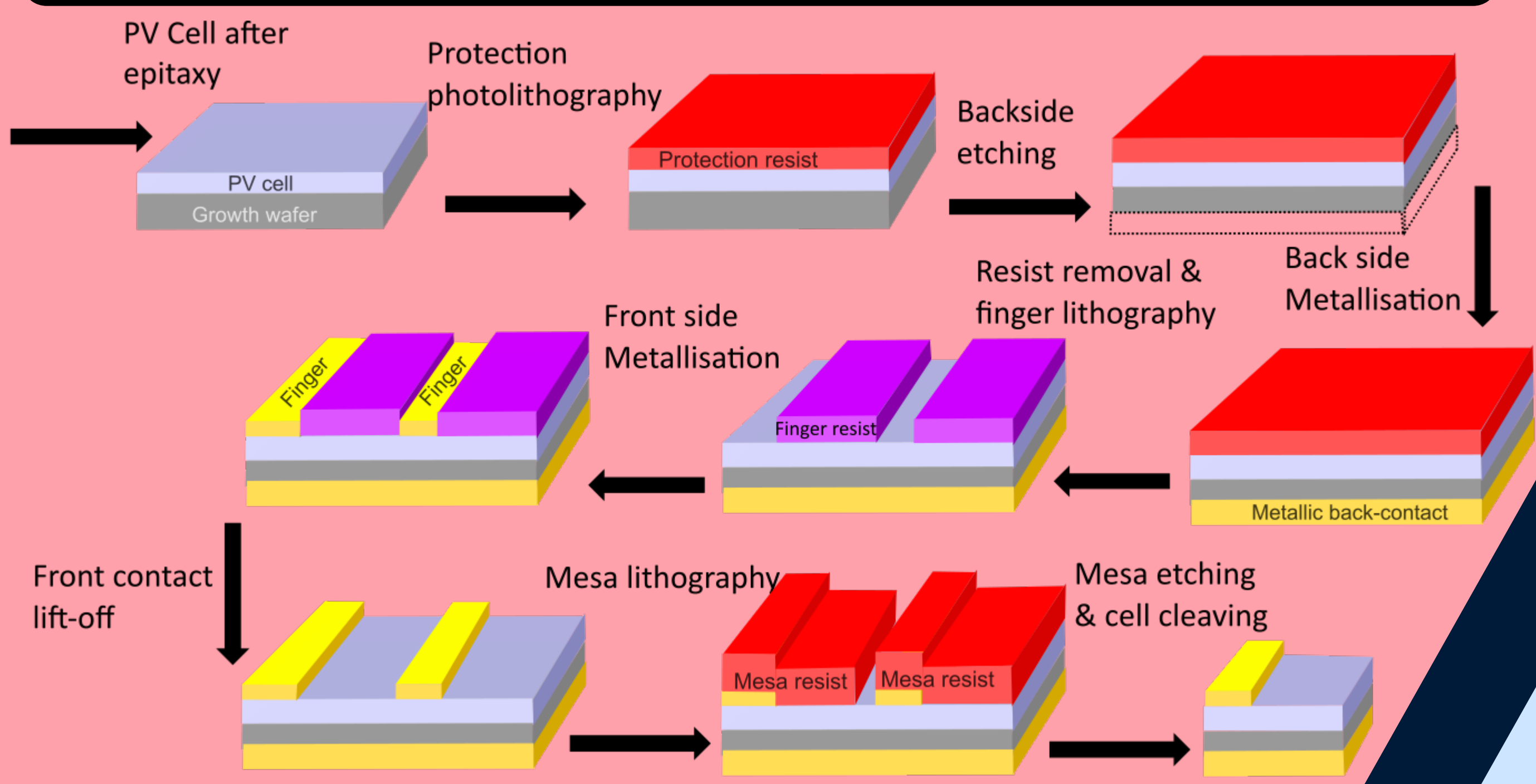


Challenges

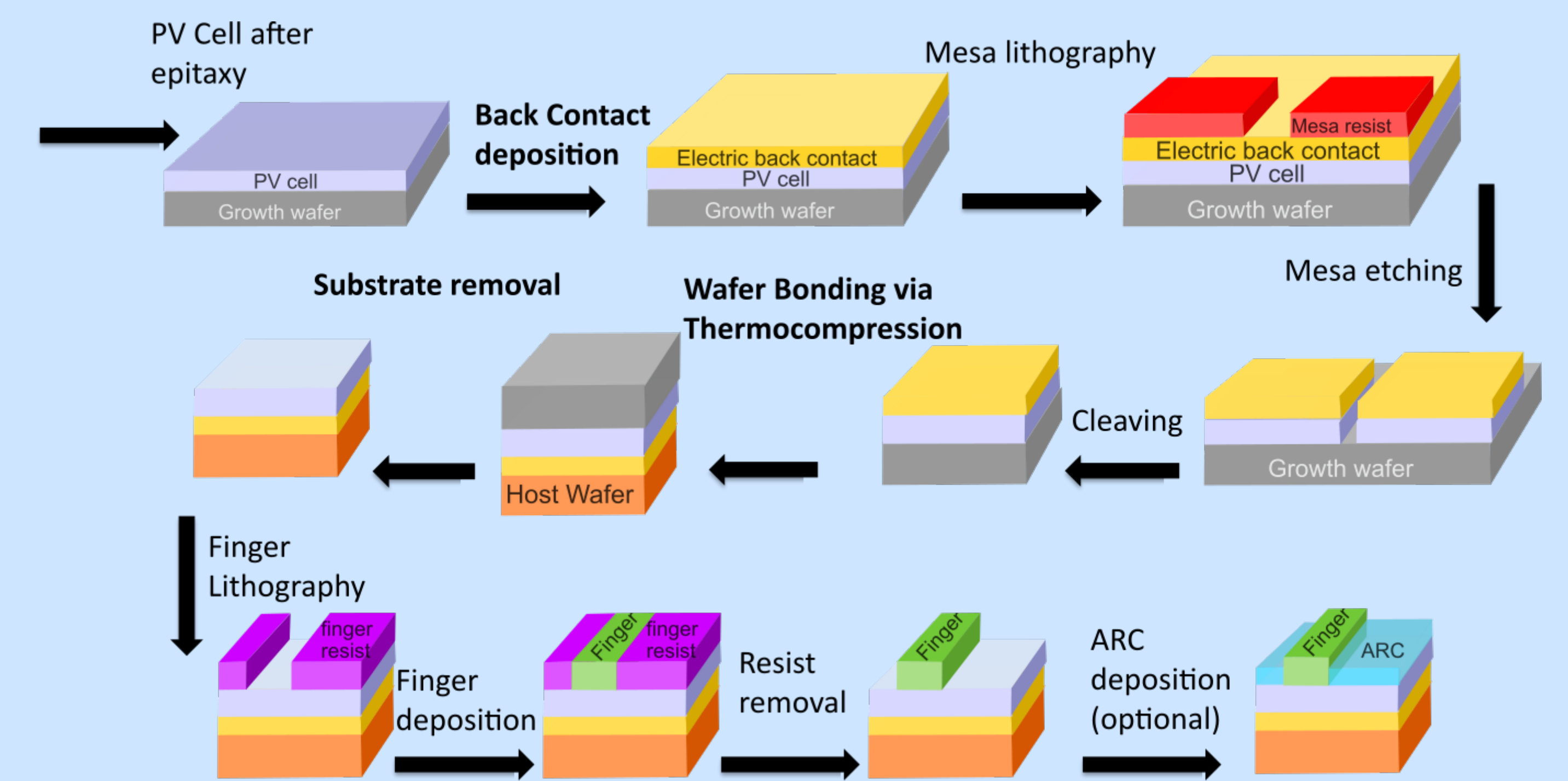
The process allowing us to transfer the III-V PV cell on a thinner copper substrate includes 3 main challenges:

- The full removal of the GaAs substrate via selective wet etching $\text{NH}_4\text{OH} : \text{H}_2\text{O}_2$
- A bonding method that can hold above 300°C for further bonding steps.
- Annealing of the contact at higher temperature than usual.

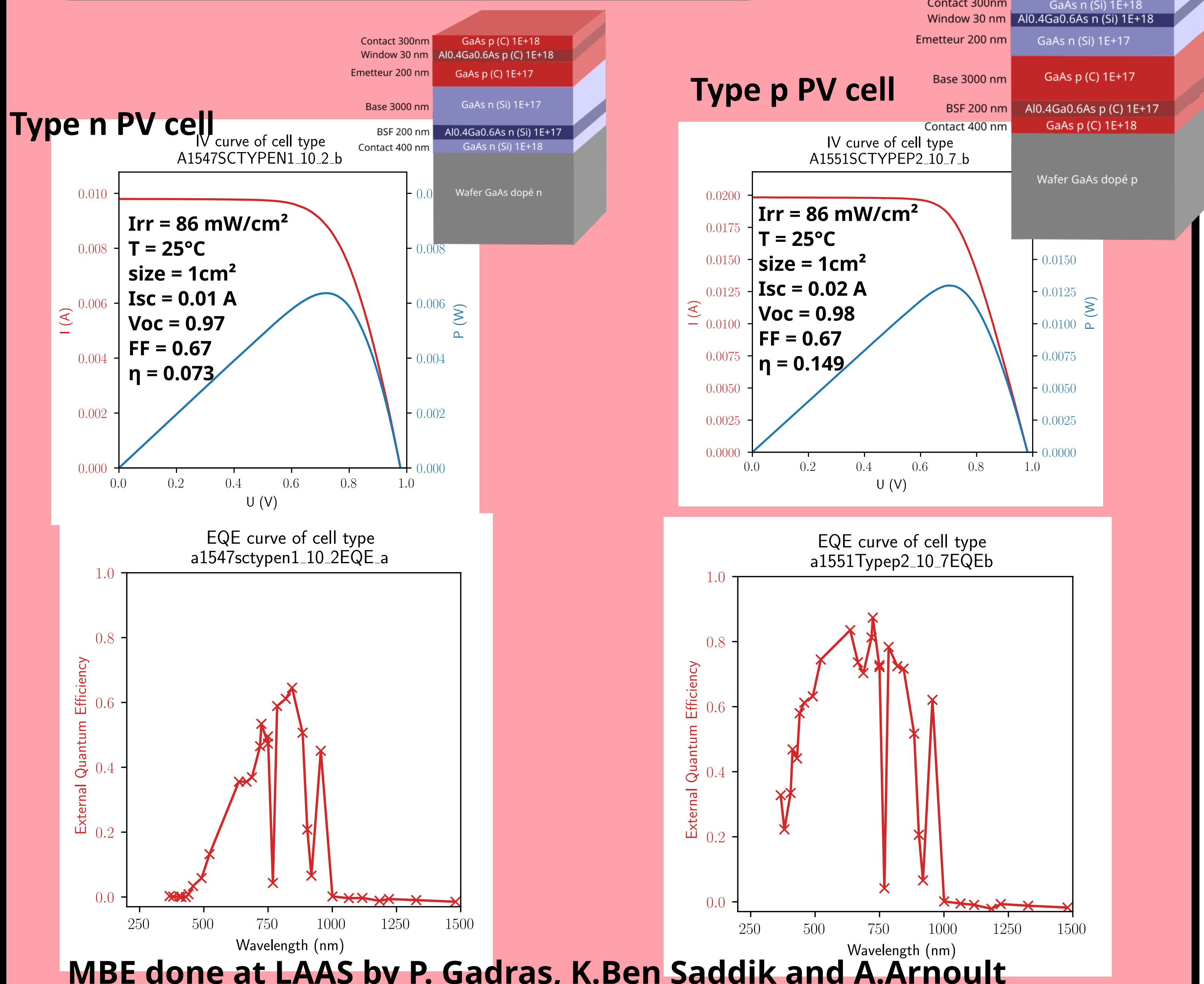
Standard process for solar cell fabrication



Process for transferring on custom substrate

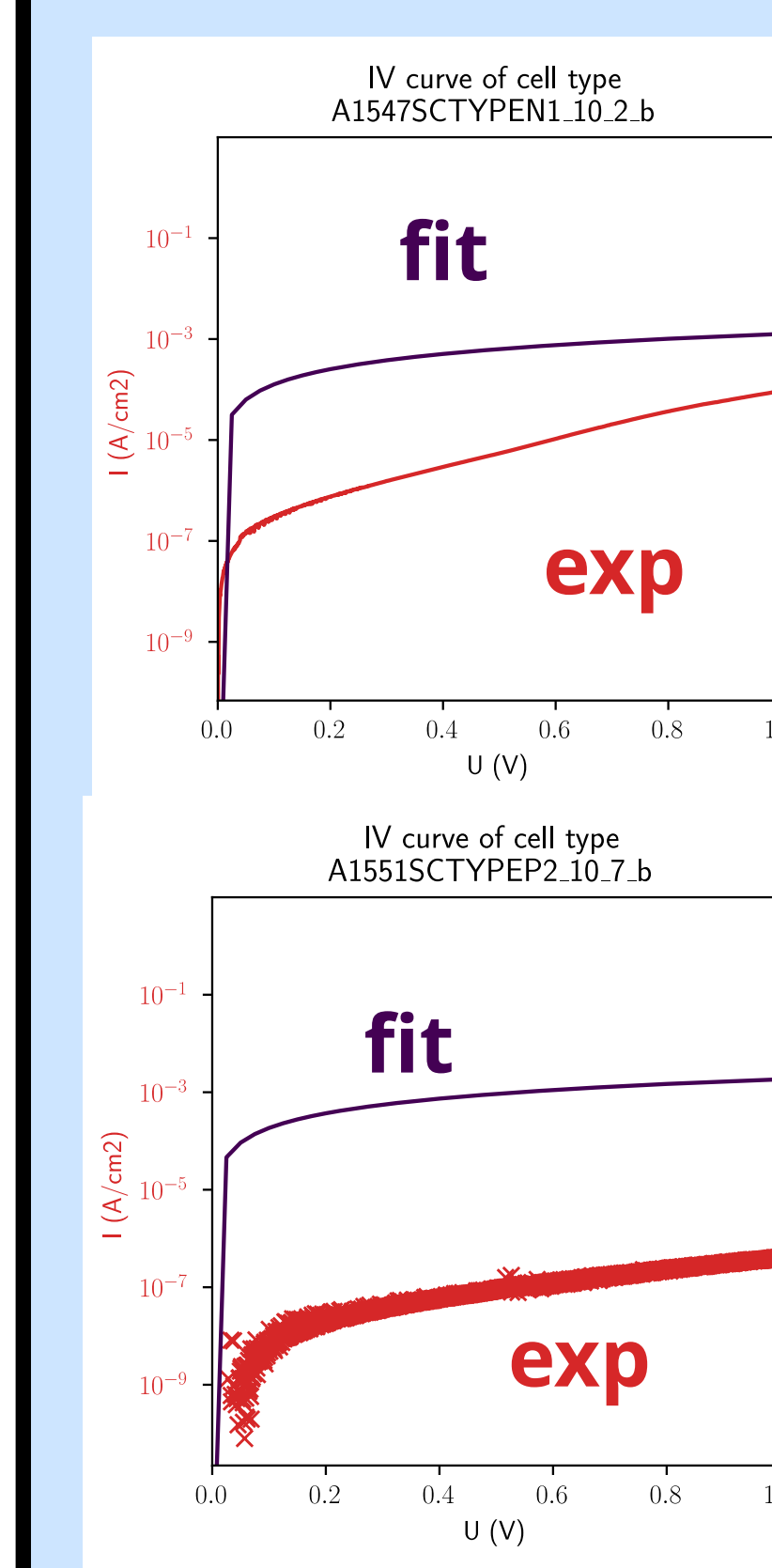


Fabrication of the reference cell



MBE done at LAAS by P. Gavras, K. Ben Saddik and A. Arnoult

Double diode model



In our case, solar cells efficiency is limited by series resistances. => Caused by metal-semiconductor contacts

Use of the double diode model on dark IV curves to determine the origin of power losses

Question: How to fit properly transcendental equation for this model?

$$J = J_{01} \exp\left[\frac{q(V - J R_s)}{kT}\right] + J_{02} \exp\left[\frac{q(V - J R_s)}{2kT}\right] + \frac{V - J R_s}{R_{shunt}}$$

Conclusion

- Comparison between custom and as-grown substrate process
- Electrical characterisation of cells with as-grown substrate
- Modelling of the cell to identify limiting factors for efficiency

All these aspects could pave the way toward a better understanding of PV-TE devices and the design of a fully optimized system