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# Technological realization of a hybrid photovoltaic-thermoelectric system

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

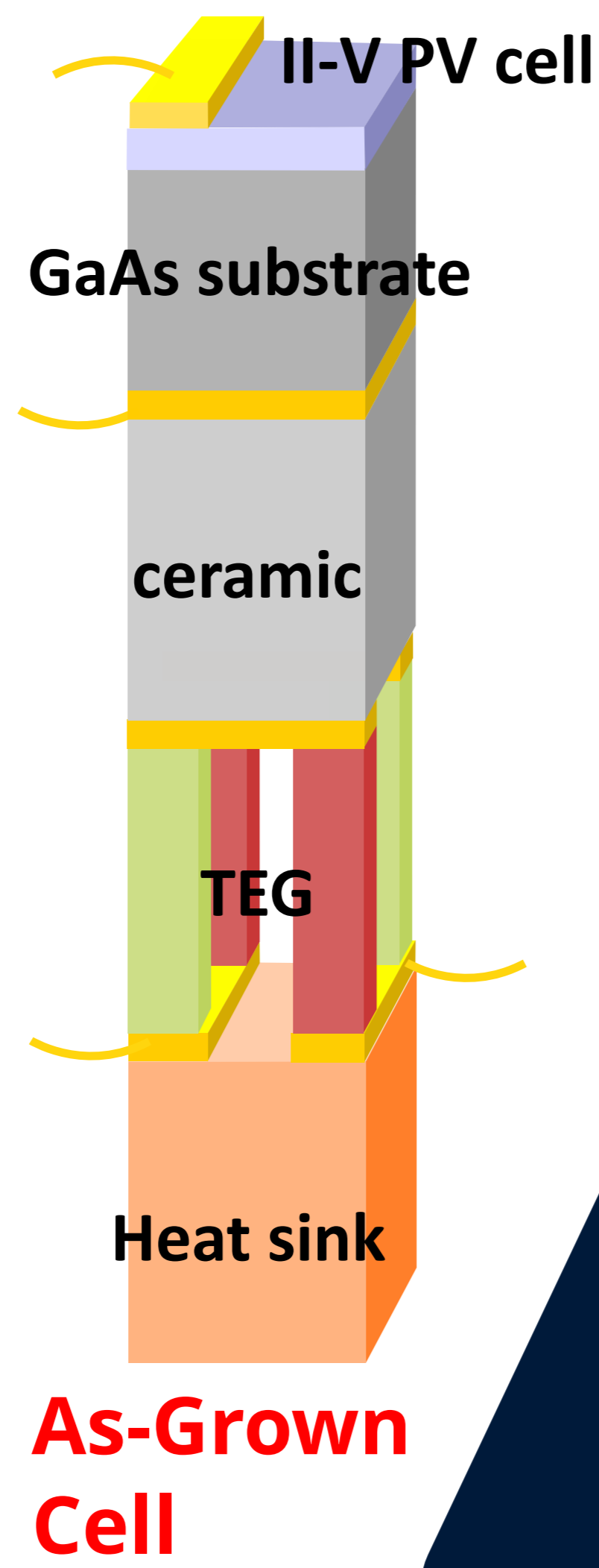
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## Context

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

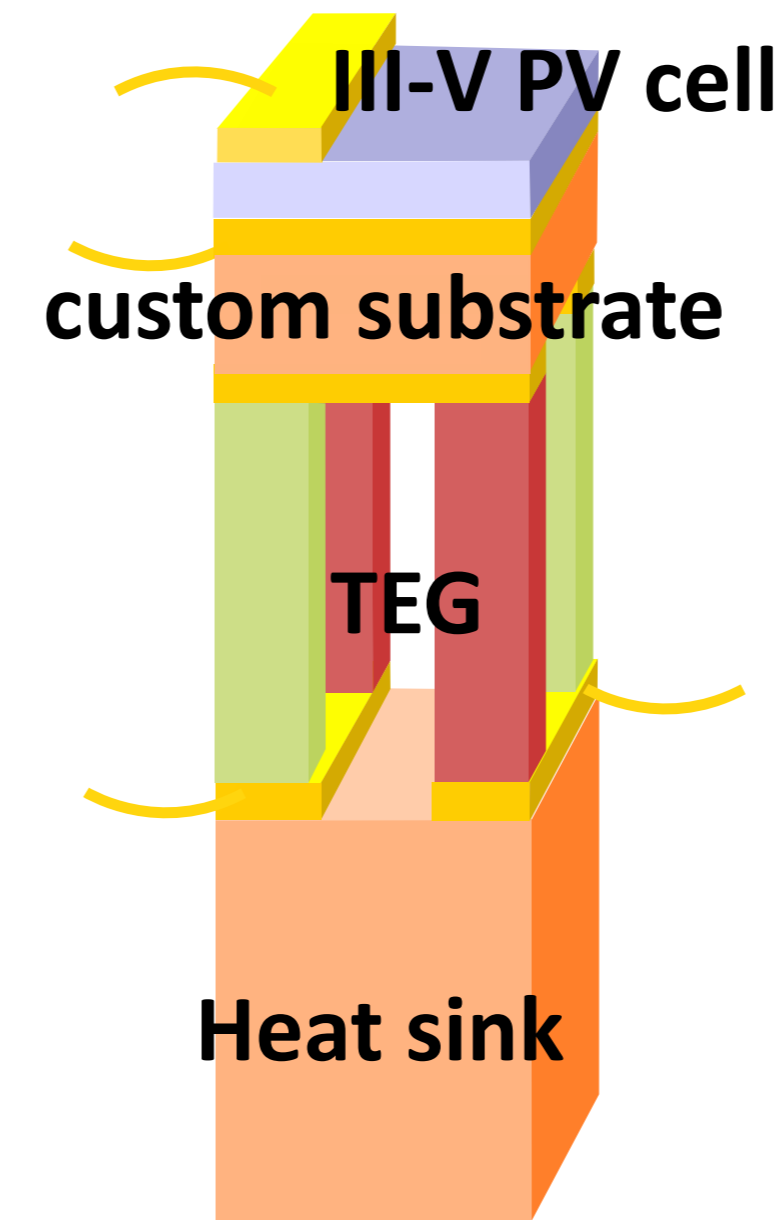
How to fabricate such a system?

- 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.

## Transferred Cell

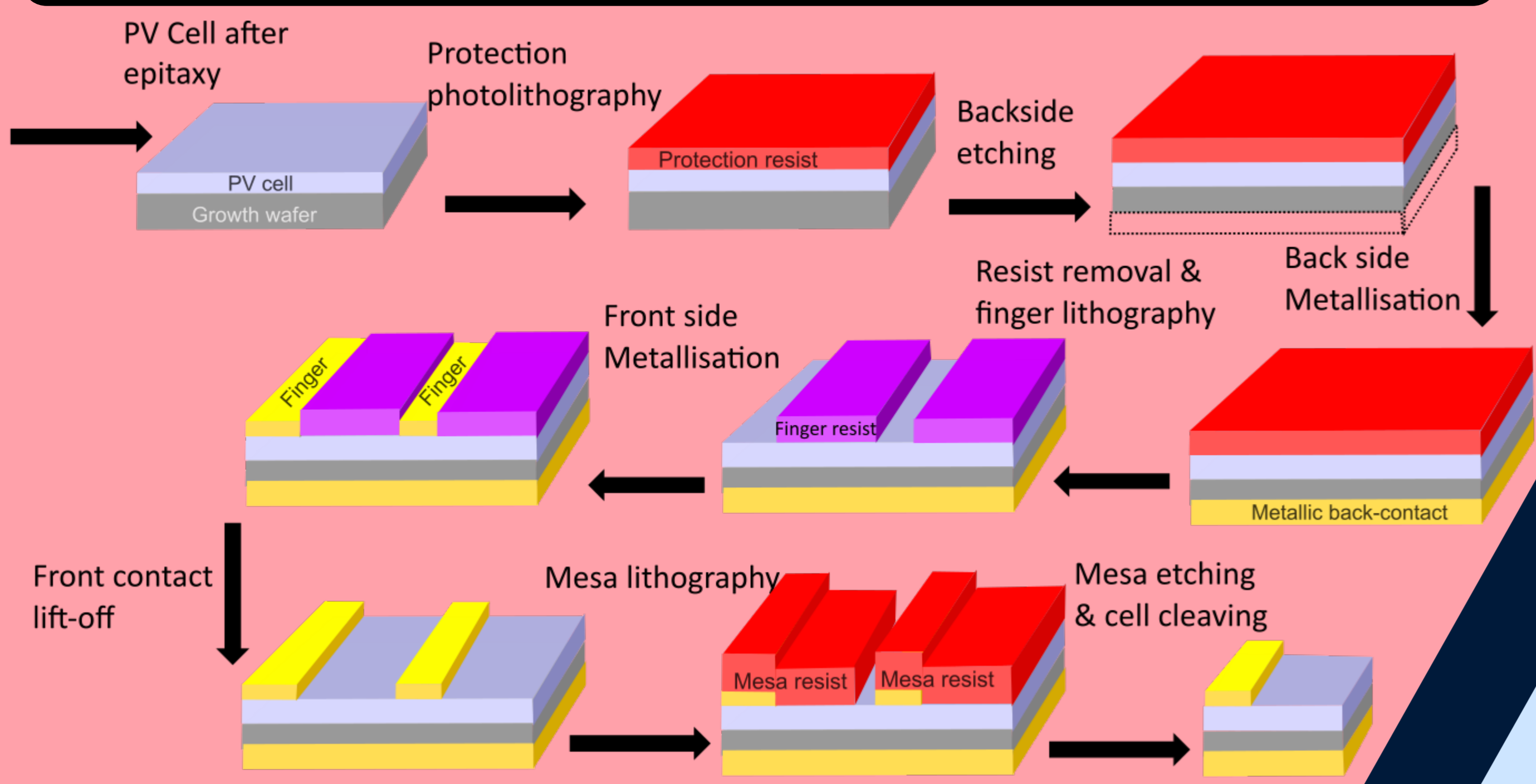


## Challenges

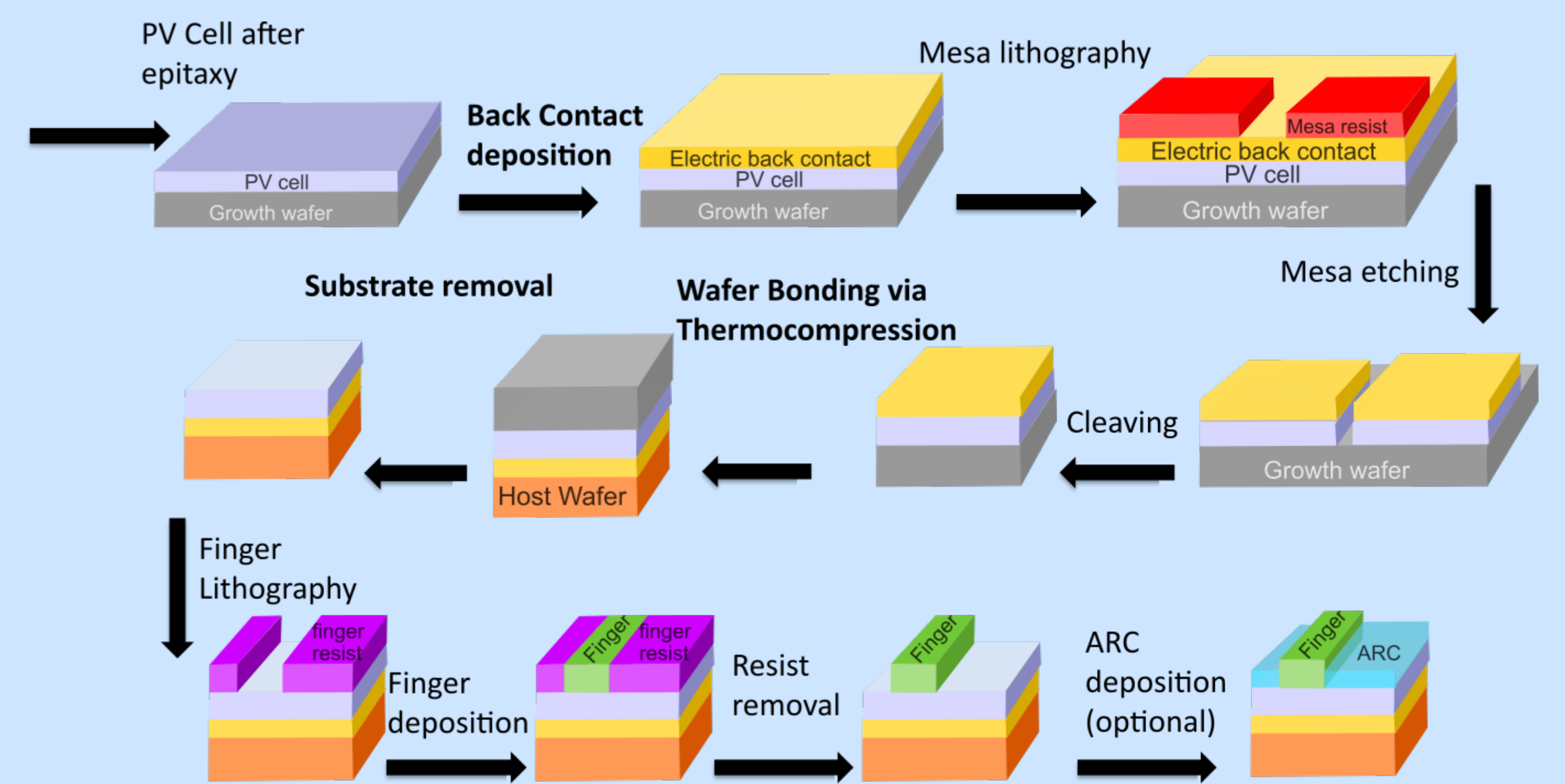
The process allowing us to transfer the III-V PV cell on a thinner copper substrate includes 3 main challenges:

- 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  $300^\circ\text{C}$  for further bonding steps.
- Annealing of the contact at higher temperature than usual.

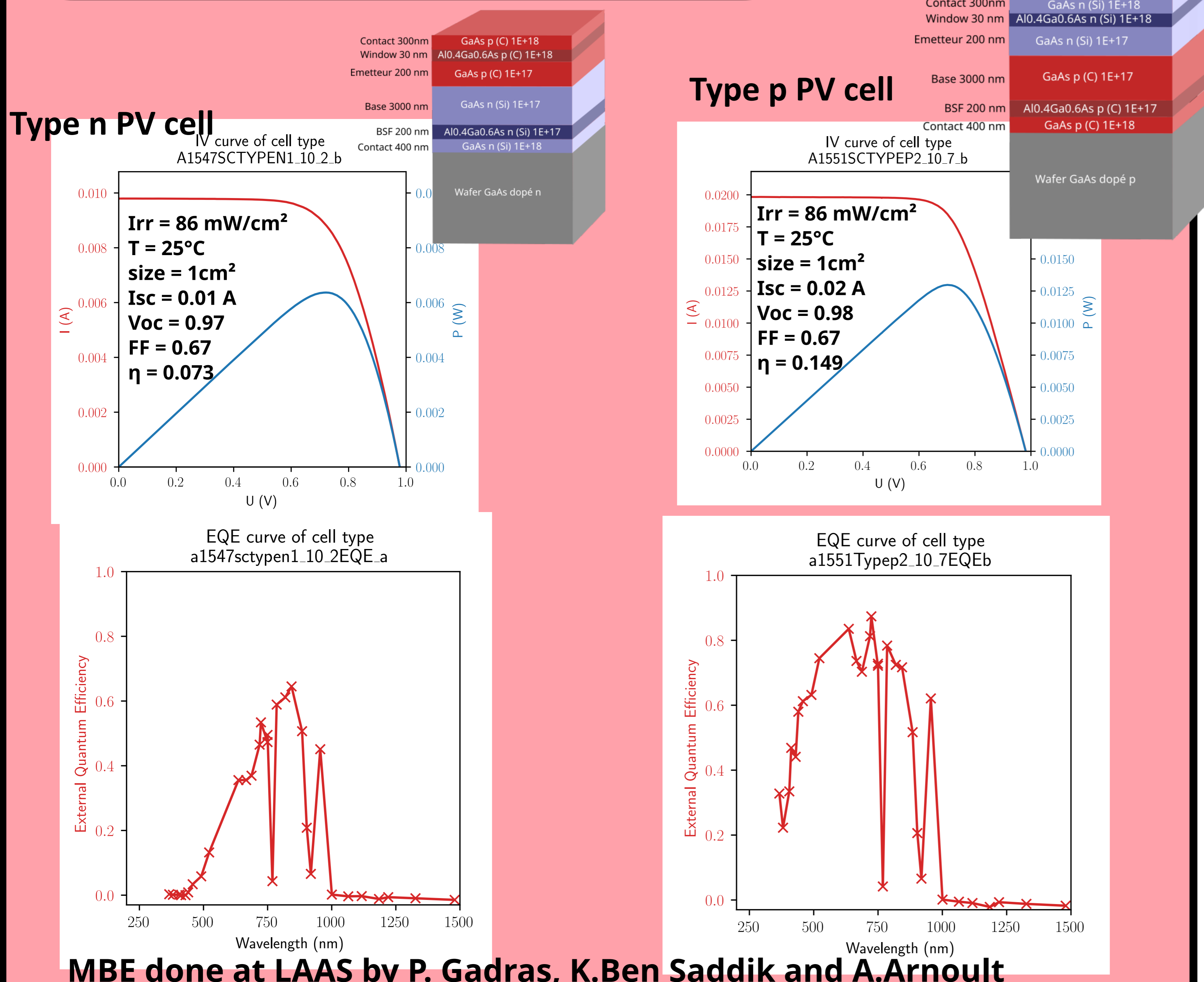
## Standard process for solar cell fabrication



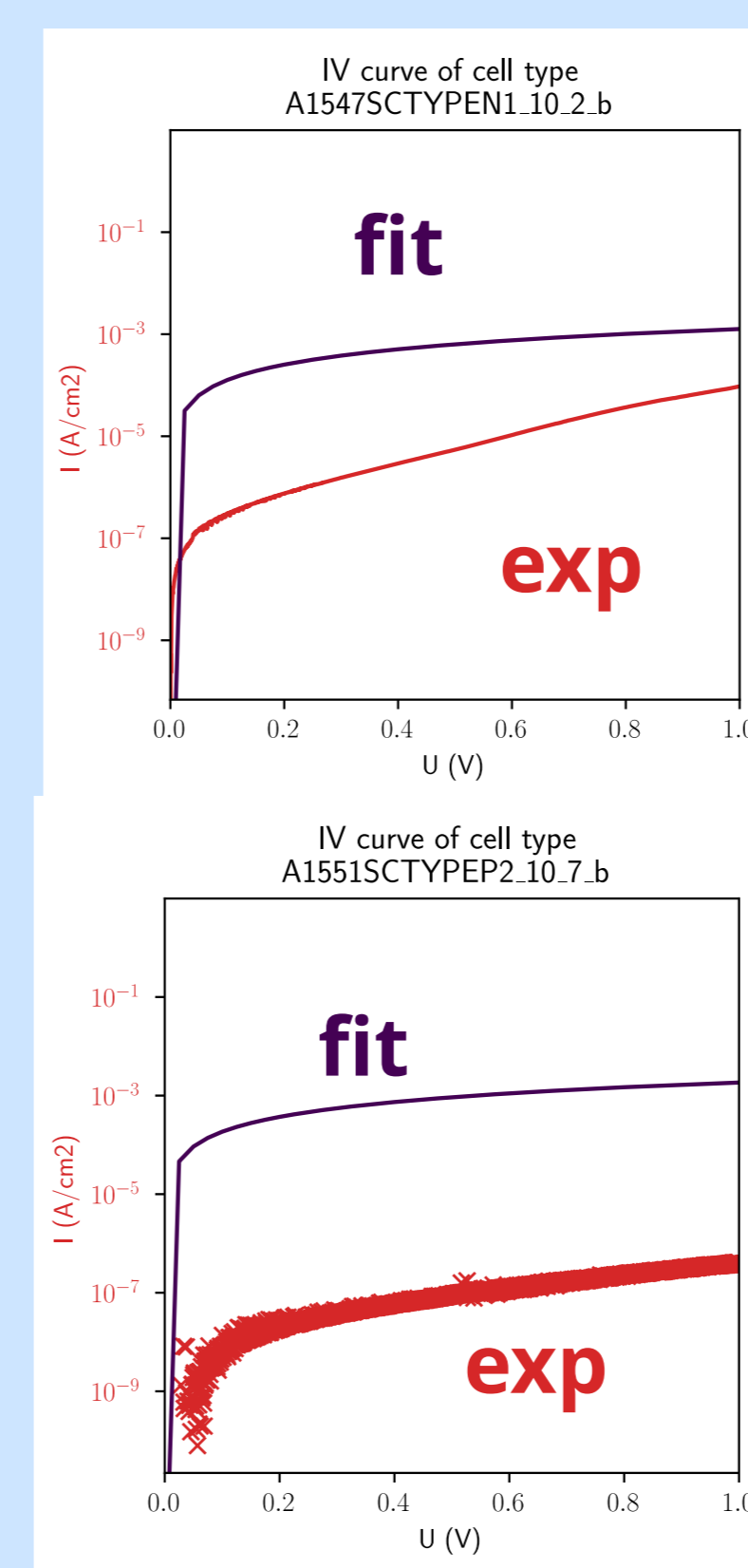
## Process for transferring on custom substrate



## Fabrication of the reference cell



## 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