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Léopold Boudier, Jean Baptiste Doucet, Guilhem Almuneau, Inès Revol. Integration of a GaAs solar cell in a hybrid photovoltaic-thermoelectric system. ELaboration of NANOMaterials for the recovery, conversion, transport and storage of energy, Jun 2023, Aussois, France. 2023. hal-04743680

HAL Id: hal-04743680

<https://hal.science/hal-04743680v1>

Submitted on 18 Oct 2024

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Integration of a GaAs solar cell in a hybrid photovoltaic-thermoelectric system

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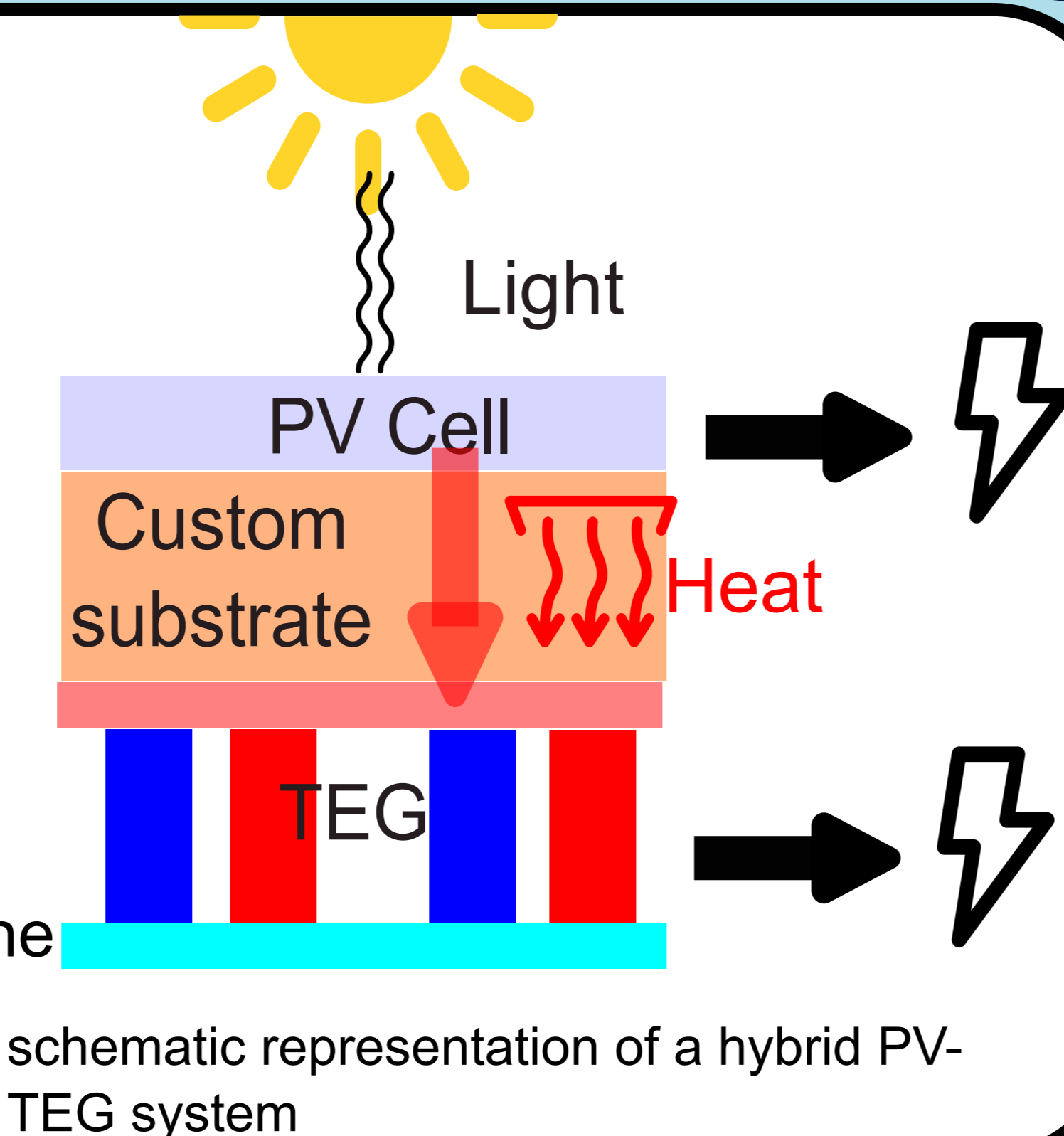
Context

Photovoltaic cell (PV) converts only partially energy above the bandgap into electricity.

The rest is either not absorbed or converted into heat.

Infrared part of the spectrum is not absorbed.

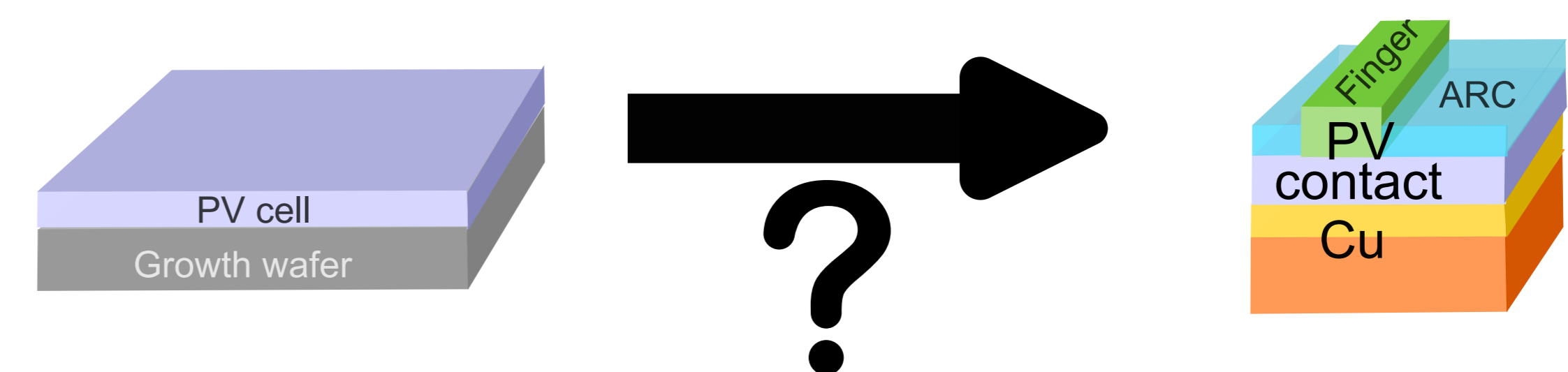
Excess heat loss is converted with the thermoelectric generator (TEG) via Seebeck effect [1].



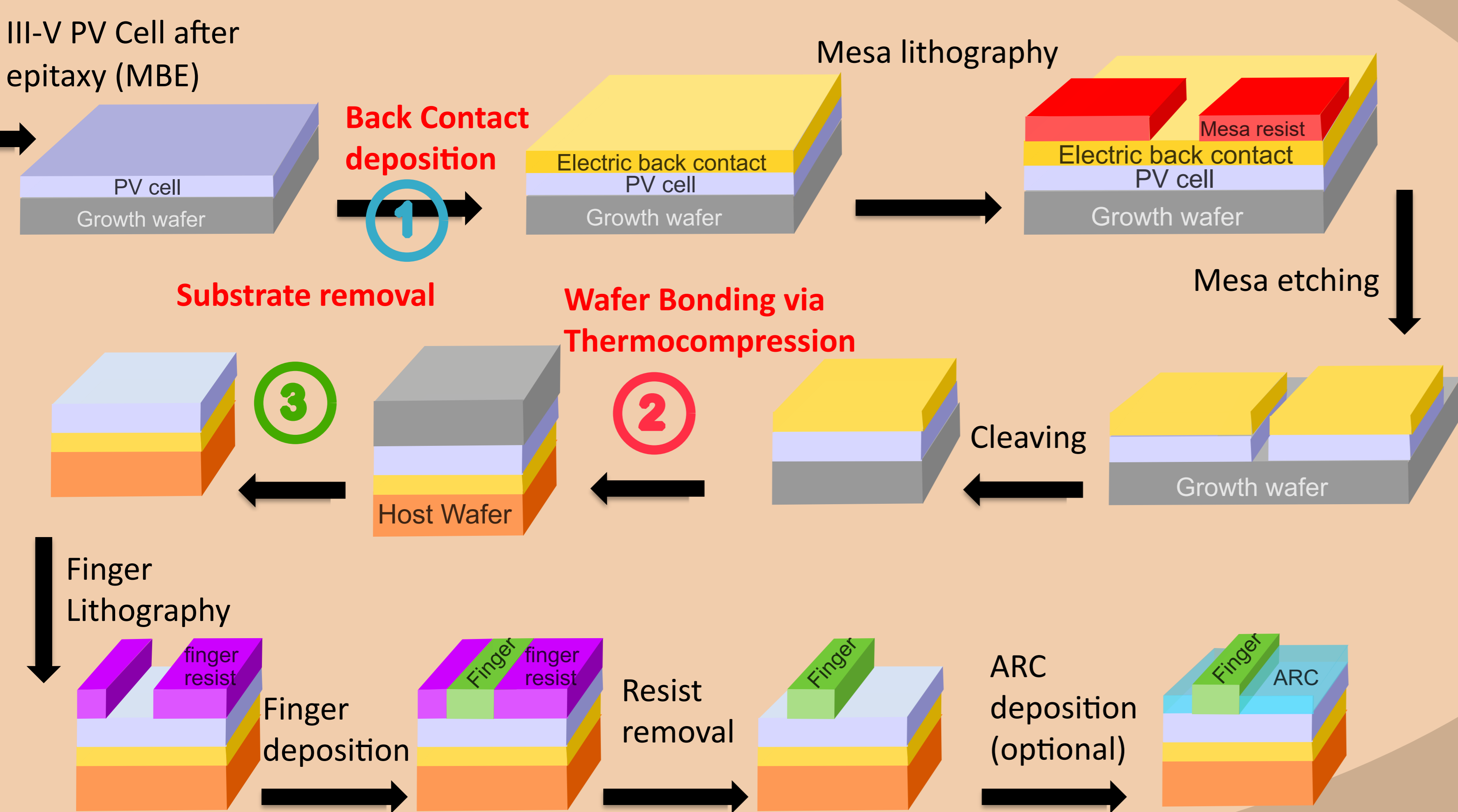
Objectives

Create a PV cell optimised for integration in hybrid PV-TEG system

- Use of a thermally conductive substrate
- Reduce thermal resistivity at the PV-TEG interface



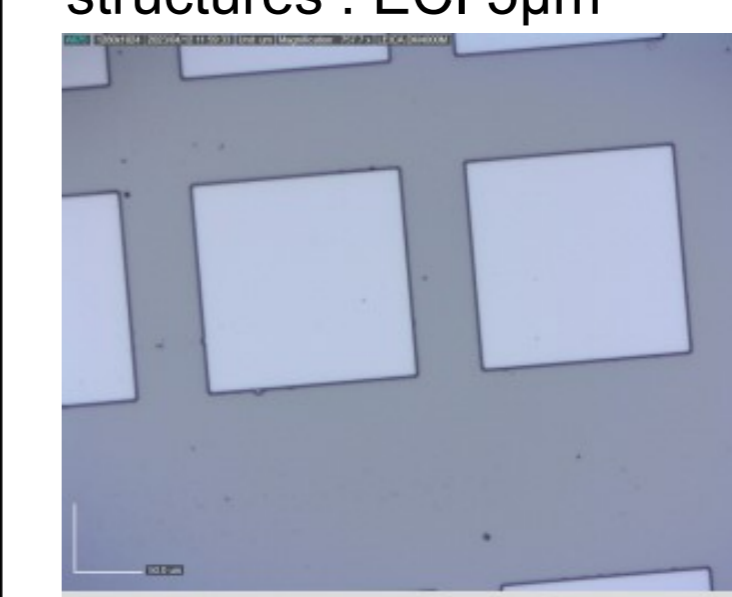
Process for design and transfer of a PV cell onto a host substrate



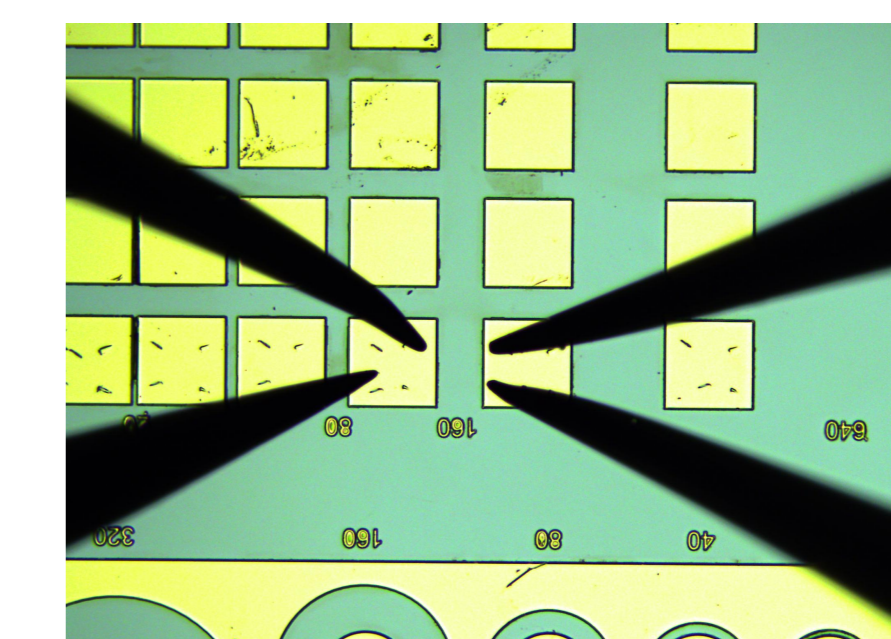
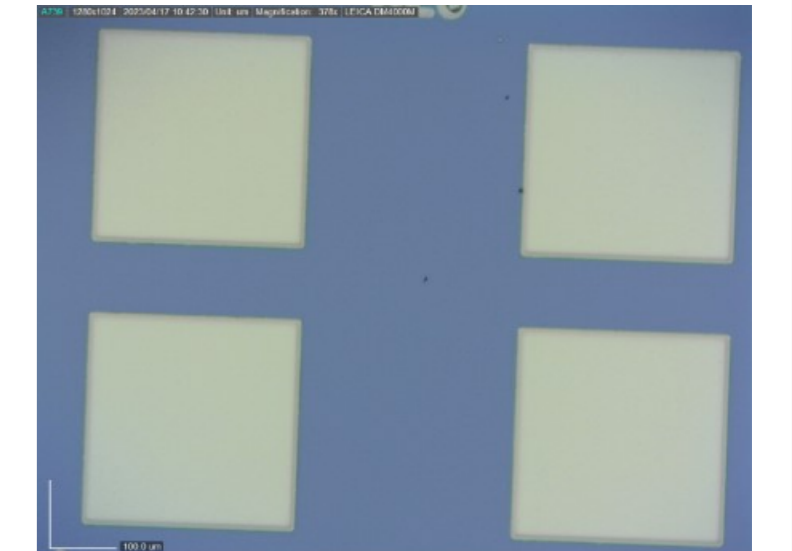
Back contact deposition

- Metal deposition via sputtering
- Contact resistivity checked via transfer length method (TLM)

Pad lithography for TLM structures : ECI 5µm



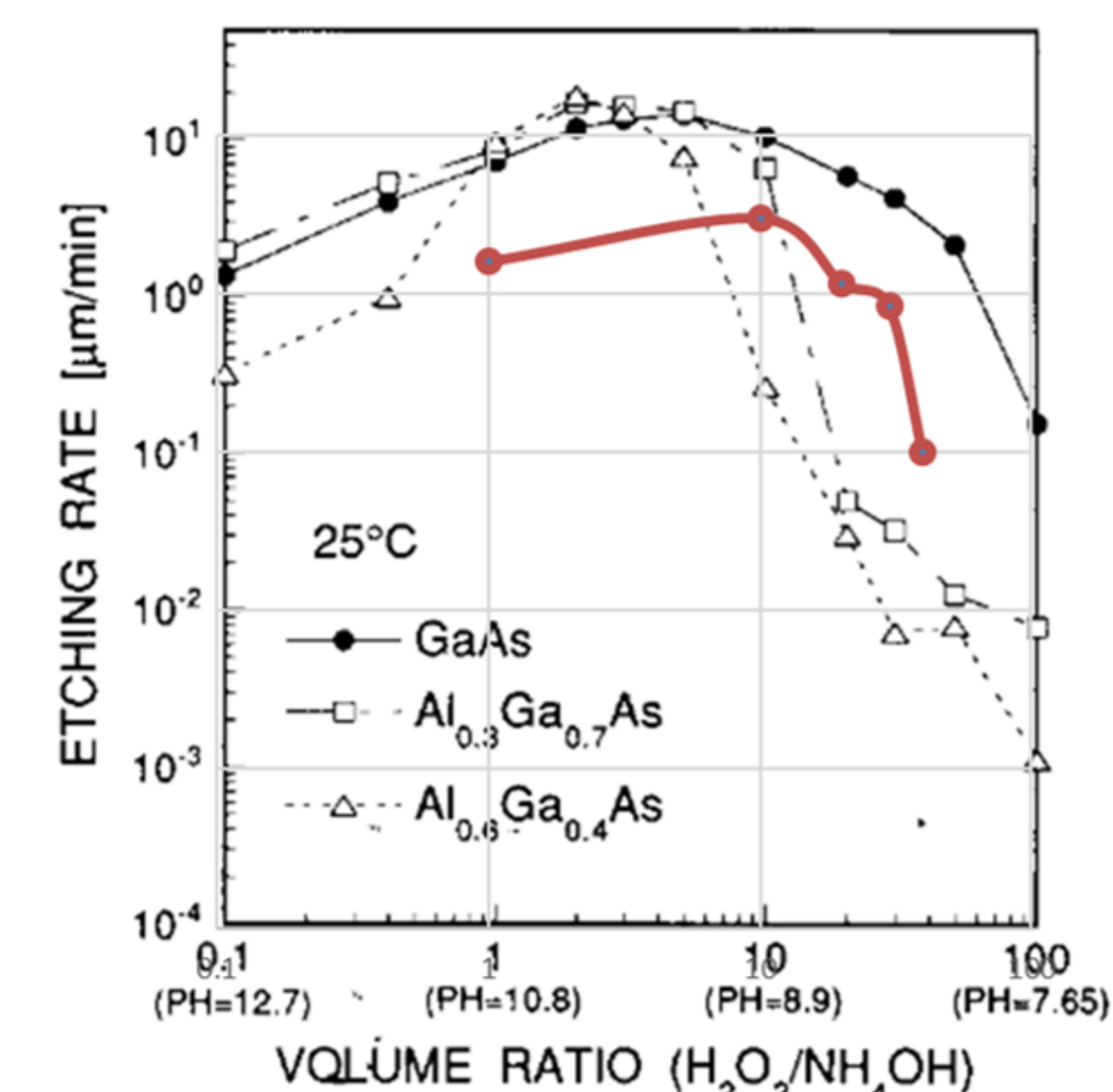
Pad structure after Ti-Au deposition via sputtering



TLM measurement on probing bench

Wafer etching

Selective etching of GaAs/AlGaAs using $\text{NH}_4\text{OH}(30\%):\text{H}_2\text{O}_2(\text{xx}\%)$



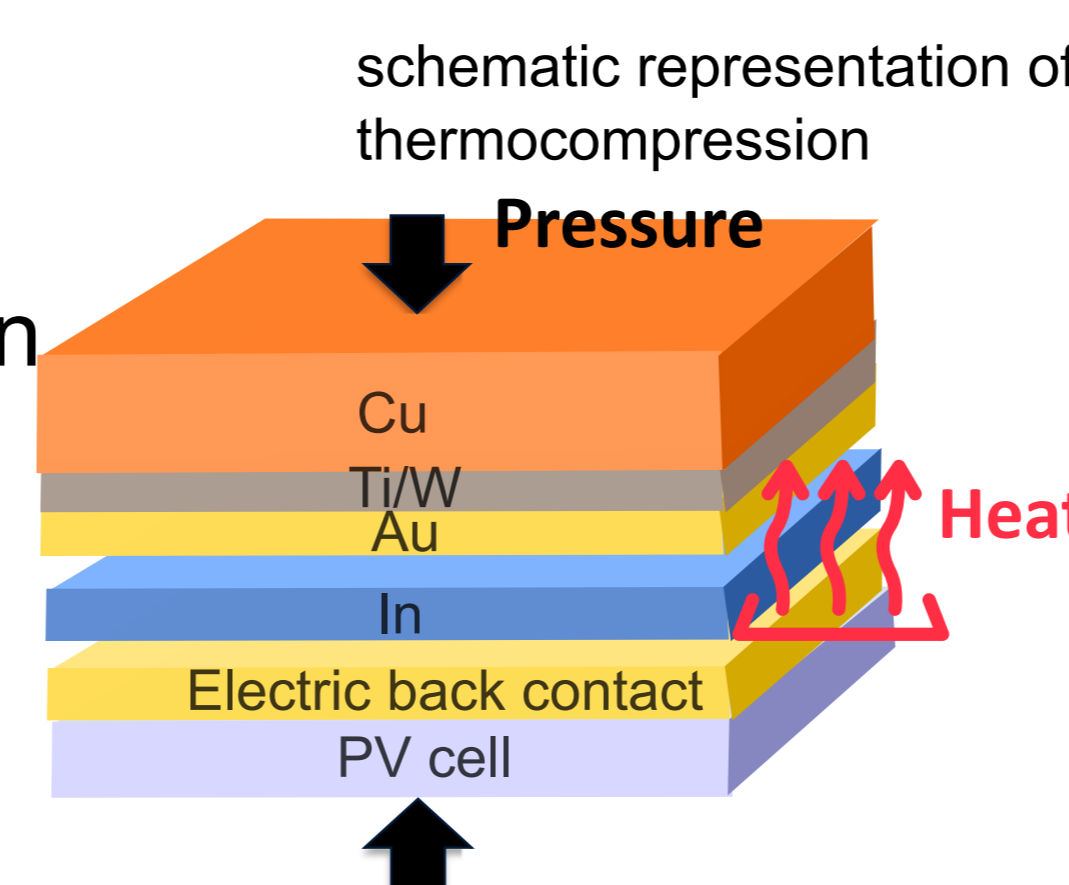
(black) values obtained by Uenishi et. al [3]

(red) GaAs etching rate for etching time up to 4h

Thermocompression

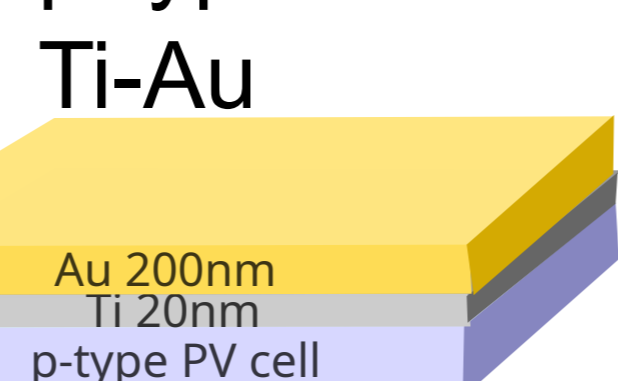
We use thermocompression as both a wafer bonding step and an annealing step for the electric back contact.

Bonding done via interdiffusion Au -Au

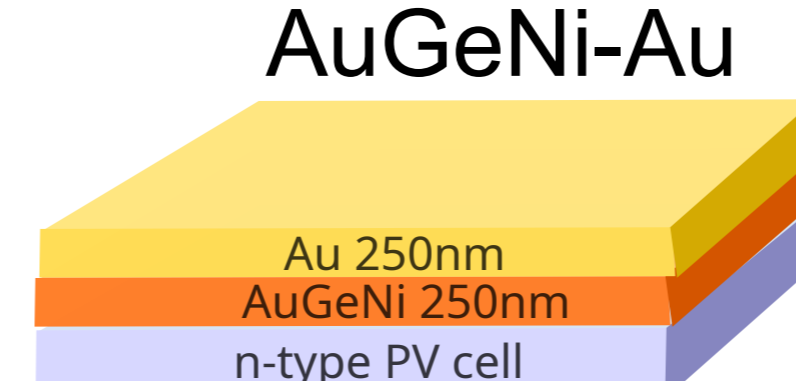


2 types of contact

p-type cell:



n-type cell:



Conclusion & Perspectives

- Original process to integrate a PV cell into a hybrid PV-TEG system
- Multiple technological challenges: wafer etching, wafer bonding, metallic contact deposition
- Multiphysics approach needed to quantify the improvement compared to classic PV-TEG system

References

1. Narducci, D., Bermel, P., Lorenzi, B., Wang, N. & Yazawa, K. vol. 268 (Springer International Publishing, 2018).
2. Pohl, U. W. . (Springer Berlin Heidelberg, 2013). doi:10.1007/978-3-642-32970-8.
3. Uenishi, Y., Tanaka, H. & Ukita, H. IEEE Trans. Electron Devices 41, 1778–1783 (1994).