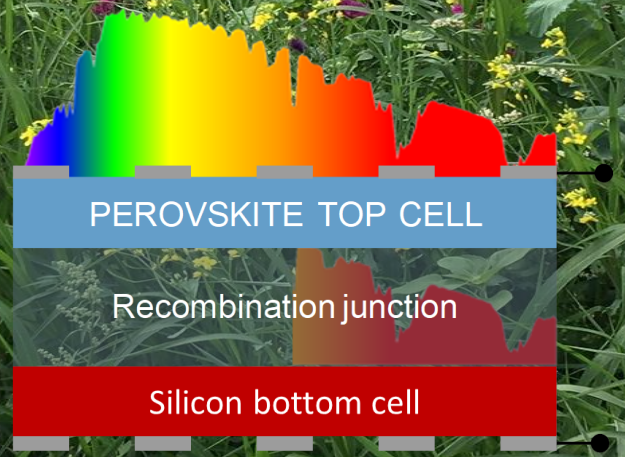
TANDEM project



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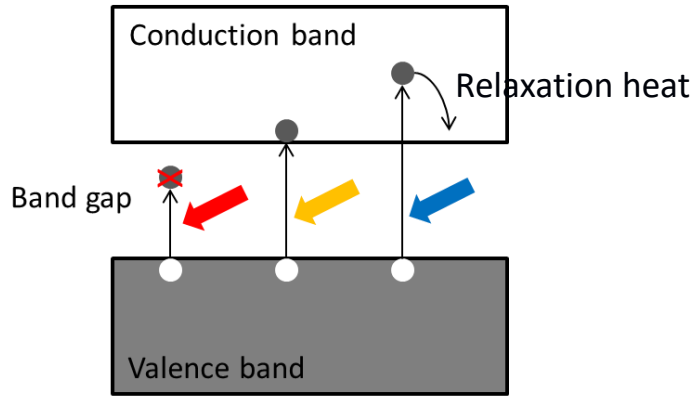
Low-cost sustainable high efficiency tandem solar cells

- Perovskite on silicon tandem solar cells
- Tandem solar cell technology reduces thermalization losses
  - High energy photons converted more efficiently to output power



Conventional solar cell (e.g., silicon)

Low-cost sustainable high efficiency tandem solar cells

- Perovskite on silicon tandem solar cells
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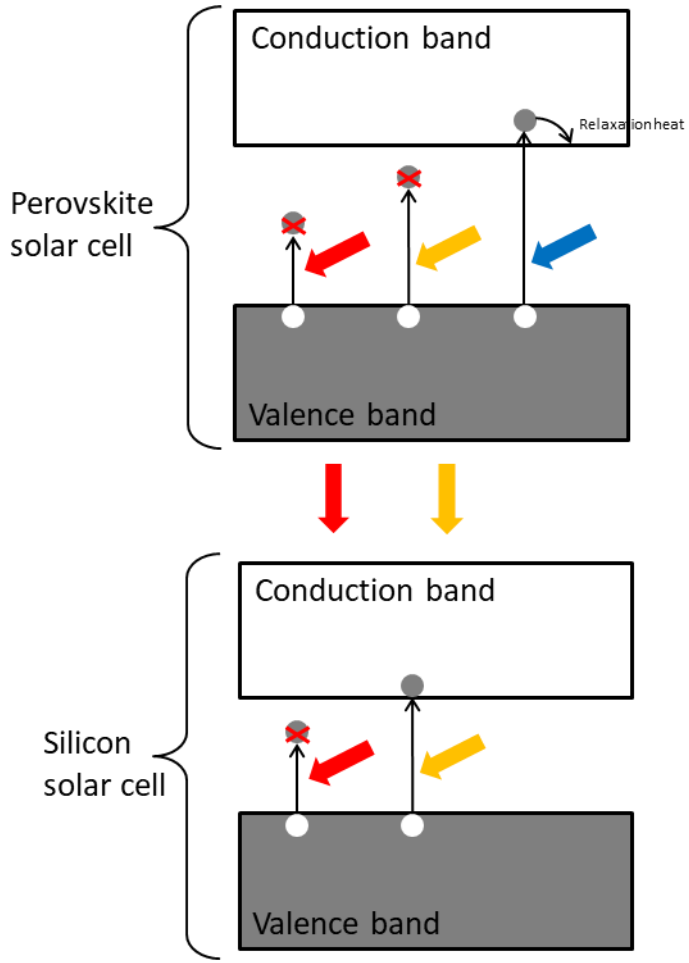
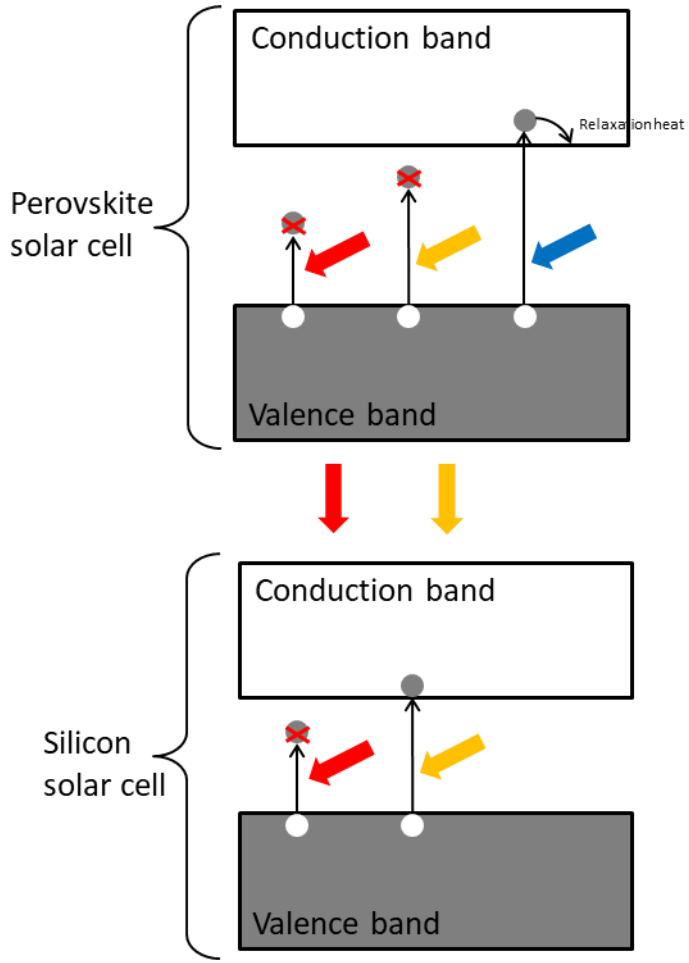
  - High energy photons converted more efficiently to output power



Low-cost sustainable high efficiency tandem solar cells

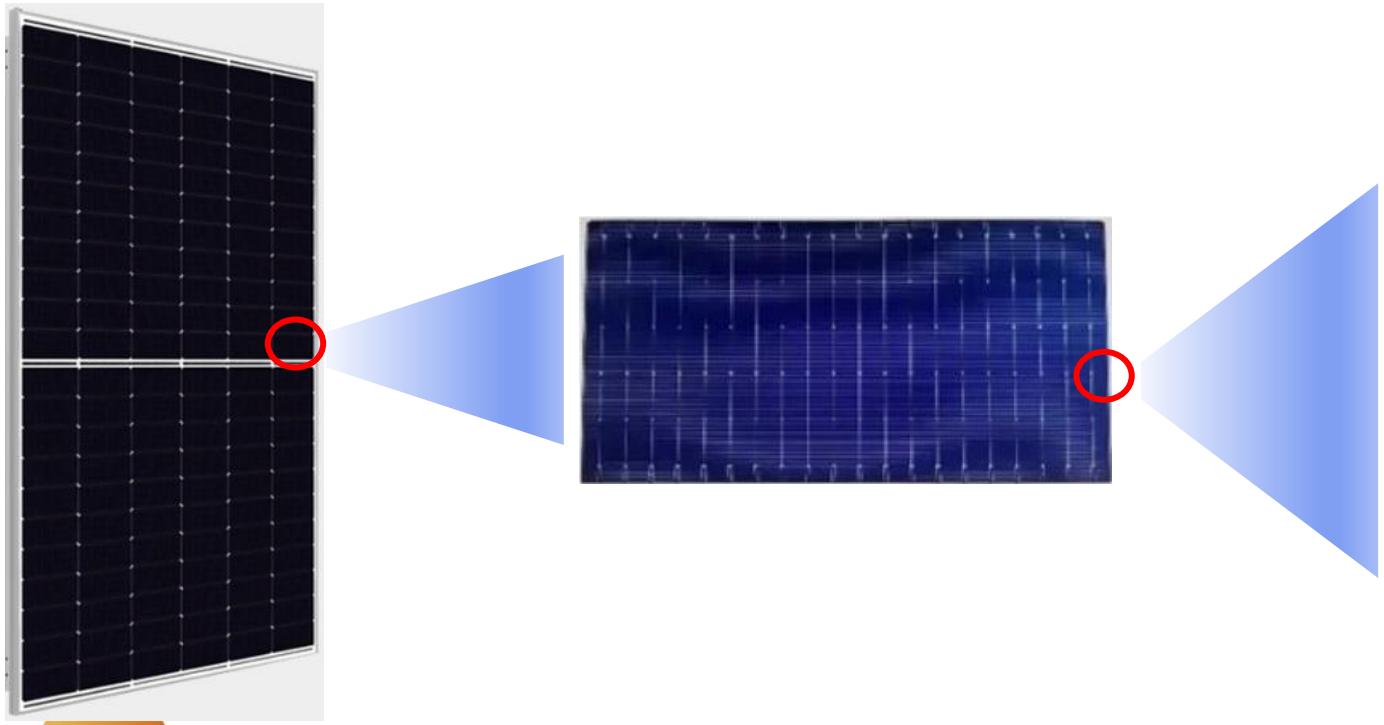
- Perovskite on silicon tandem solar cells
- Tandem solar cell technology reduces thermalization losses
  - High energy photons converted more efficiently to output power
- Project aims for **14% power increase over c-Si technology**

- Low-cost:
  - **Lowest cost bottom cell** technology (modified PERC)
  - **High-throughput large area** solution processing of perovskite
- Sustainable:
  - **Green solvents** for perovskite processing
  - Reduction of **silver and indium** usage



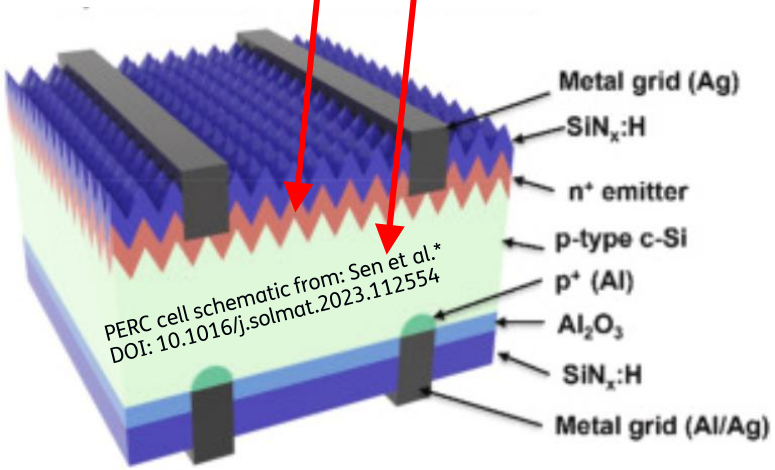
Silicon technology

- Kalyon PV (Ankara): Europe's only integrated ingot, cell, module manufacturer
- ÖDTU-GUNAM (Ankara): Türkiye's national solar research center
- IES-UPM (Madrid): Silicon material engineering and science



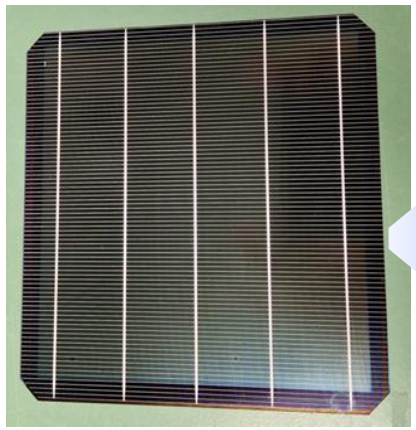
Replace emitter by higher performance ("TOPCon") type

Silicon ingot and wafer quality engineering

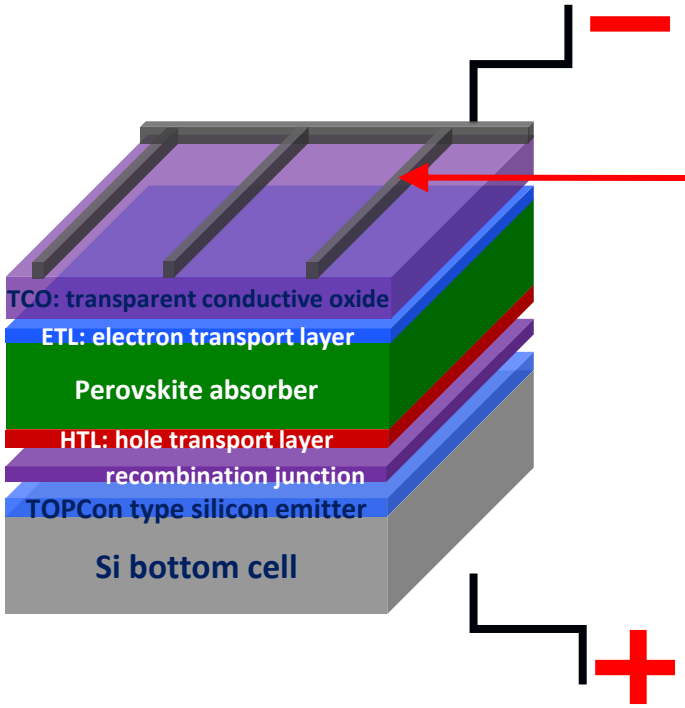


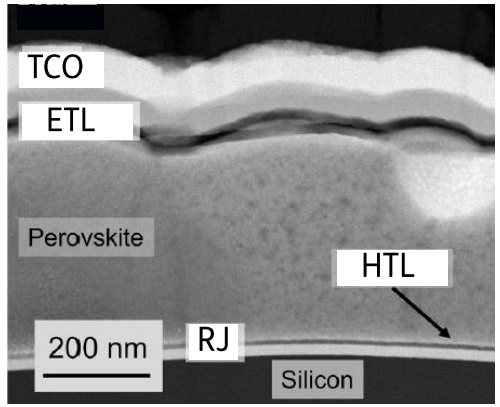
Perovskite technology

- SALD B.V. (Eindhoven): pioneer and specialist in spatial atomic layer deposition (ALD) equipment and processes
- TNO (Eindhoven, Petten): Netherlands applied research institute with specialist know-how and background in solar energy (ECN, Solliance)



Full wafer size tandem solar cell

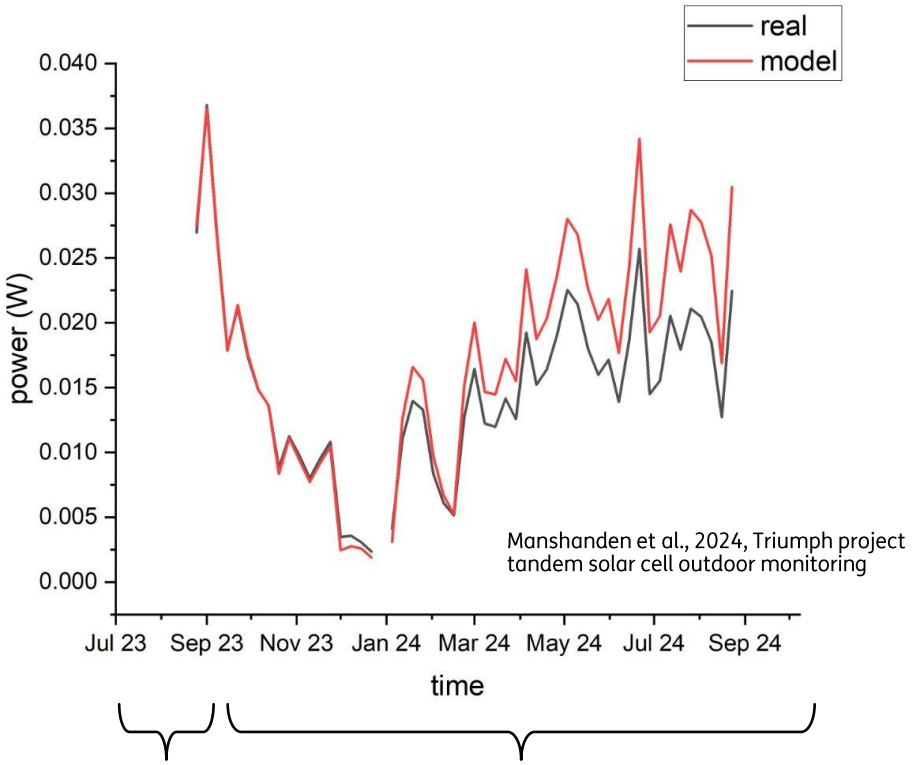




Silver reduction
Indium reduction
ALD developm.
Green solvents
ALD developm.

SEM image: Phung et al.*, DOI: 10.1016/j.solmat.2023.112498

Monitoring and digital twinning



1 month model training

Real power production vs model twin shows gradual degradation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TÜBİTAK
Partnership
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