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Synergy RTD 2013

FNSNF

Tandem solar cells based on a-Si/c-Si heterojunction cells

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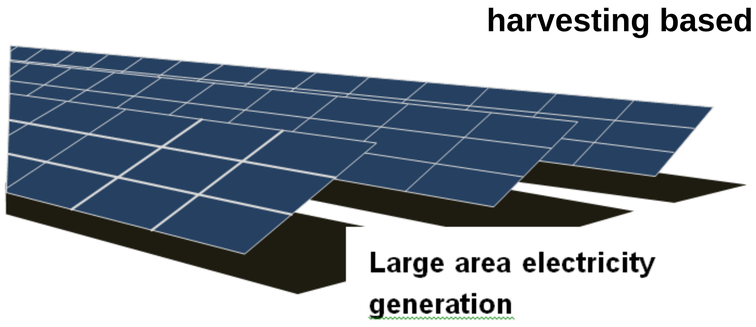
Synergy project

Systems for ultra-high performance photovoltaic energy harvesting based on tandem solar cells



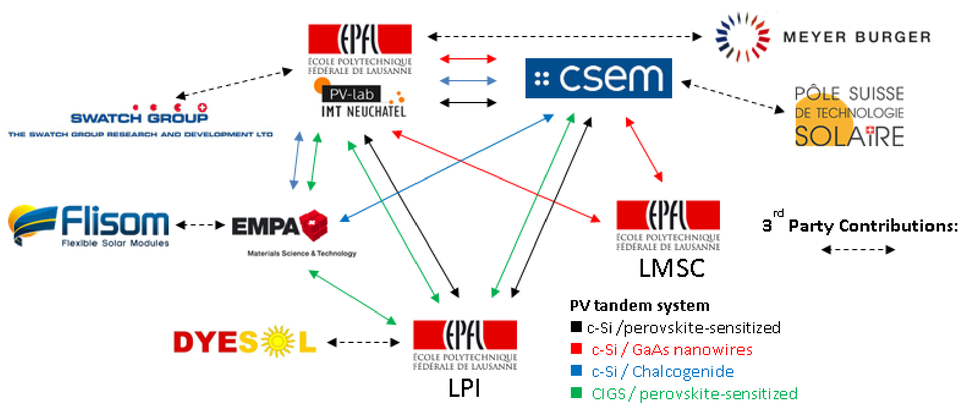
Large area electricity generation

- Ultra-high efficiency, low-cost PV
- Very large area
- High reliability and life time

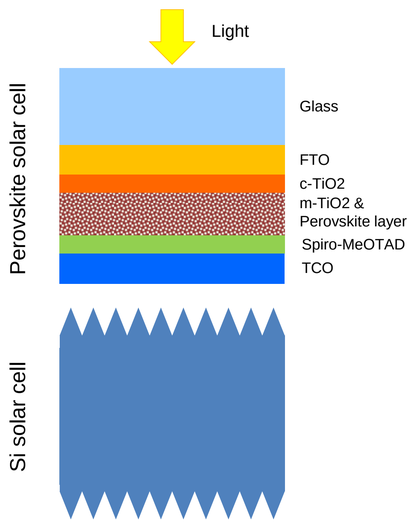
Ubiquitous energy scavenging

- Ultra-high efficiency
- Instant adaptation to environment
- Intermediate life time

Consortium

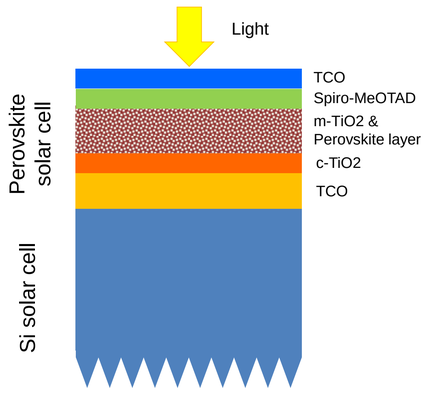


Perovskite / crystalline silicon tandem cells



4-Terminal tandem cell

- A perovskite cell is mechanically stacked on a crystalline Si cell to form a 4-terminal tandem device
- The perovskite cell absorbs visible light, the crystalline Si cell near-infrared light
- Optically, the perovskite absorber layer acts as a long-pass filter (coherence is lost)
- The Si bottom cell can be textured to enhance light trapping
- 4 transparent conducting electrode layers are needed

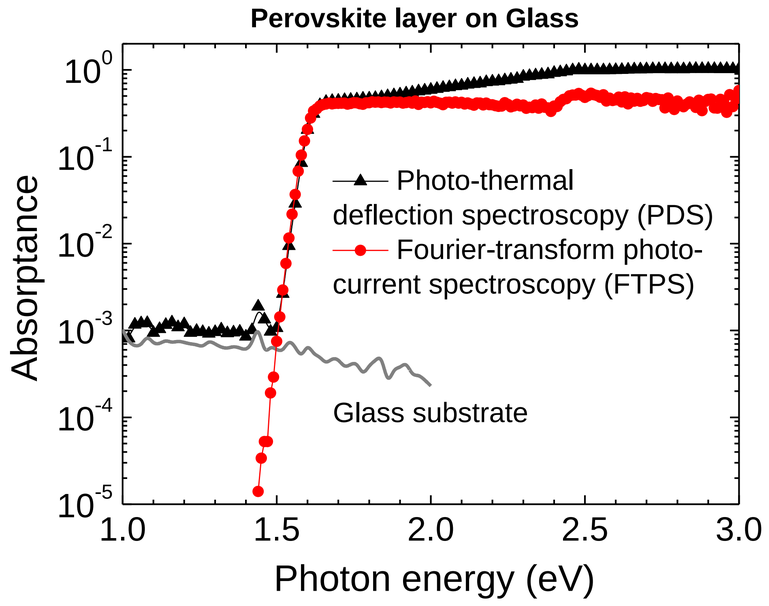


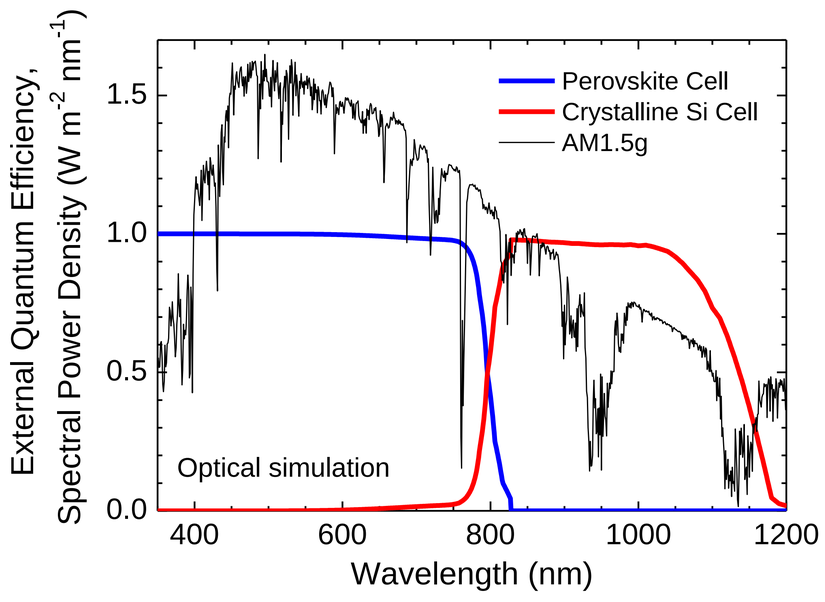
Monolithic tandem cell

- A perovskite cell is directly processed on a crystalline Si cell to form a monolithic tandem device
- The perovskite cell absorbs visible light, the crystalline Si cell near-infrared light
- Optically, the perovskite cell acts as an active anti-reflective coating
- Texturing of the Si bottom cell is problematic
- Low-temperature top cell processing or temperature-stable bottom cell is required
- Only 2-3 transparent electrodes are needed

Preliminary results

Perovskite layer on Glass





Optical characterization and assessment of efficiency potential

- Perovskite thin films show a steep absorption edge, indicating a high crystal quality
- Near-infrared light is not absorbed by the perovskite layer due to the negligibly small sub-bandgap absorption
- For a mechanically stacked 4-terminal perovskite / crystalline Si tandem cell, the maximal J_{sc} of the top cell is 25.53 mAcm^{-2} and that of the bottom cell 17.93 mAcm^{-2} for a 220-nm-thick perovskite cell

Summary

- The Synergy project aims to realize systems for ultra-high performance photovoltaic energy harvesting, based on tandem solar cells with efficiencies beyond the single-junction limit, i.e. > 30%
- Tandem cells consisting of a perovskite-based top cell and a crystalline Si bottom cell are developed. The perovskite cell absorbs the visible part of the solar spectrum, the Si cell the near infrared part
- Perovskite / crystalline Si tandem devices can be made either in the 4-terminal or in the monolithic configuration
- The absence of sub-bandgap absorption makes perovskites ideally suitable as absorber layers for high-bandgap component cells in tandem devices