Reducing Shading Effects in CPV Solar Cells with Advanced Contact Finger Design

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Introduction
- Motivation: Reducing finger shading losses in III-V solar cells [1]
- Goal: Reflecting light from dedicatedly shaped fingers into active cell area

Two approaches:
1. Optimized contact fingers:
   - With trapezoidal finger cross section
2. Cloaked metal fingers:
   - Polymeric scaffold with Ag coating to cloak the finger

Summary
- Two approaches to reduce shading caused by contact fingers in solar cells:
  1. Optimizing finger cross section to a trapezoidal form to partially redirect incident light. **Shading reduction of 23 %**
  2. Introducing cloaked metal fingers (CMF) with a triangular cross section for efficient light redirection. **Shading reduction of 60 %**
- These approaches are promising pathways to increase the performance of high efficiency multi-junction concentrator cells.

1. Optimized Contact Fingers

Concept
- Light redirections depend on geometrical shape of the finger
- Most suitable cross section geometries:
  - **Trapezoidal** (top width): Realizable by photolithography (PL) masking and physical vapor deposition (PVD) metallization
  - **C-frame**: Ideal, yet technically hard to implement

Process Sequence

Characterization: Scanning Electron Microscope (SEM) and Simulation

Results
- Simulations reveal optimal finger conditions for highest conversion efficiency: top width < 1.5 µm and cross-sectional area > 10 µm².
- Iterative experimental optimization achieves superior finger geometries surpassing target parameters.
- Microscopic images provide quantitative proof of incident light redirection to active cell areas.
- At the cell level, the optimized fingers reduce shading by 23 % compared to reference fingers (3 µm top width, 6 µm bottom width).

2. Cloaked Metal Fingers (CMF)

Process Sequence

Characterization: Scanning Electron Microscope (SEM)

Results
- Proof of concept: Complex microstructures built with a polymeric scaffold, coated with silver for redirecting light onto the active cell area.
- Resulting cross-sections: Triangular with steep angles, optimizing reflection properties.
- μLBIC measurement shows CMF reduce shading by 60 % compared to reference fingers (3 µm top width, 6 µm bottom width)


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