Bottom-up Module Reliability Studies at ASU

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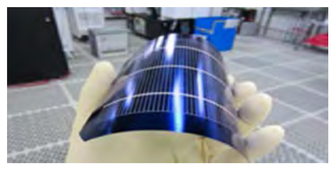
Introduction

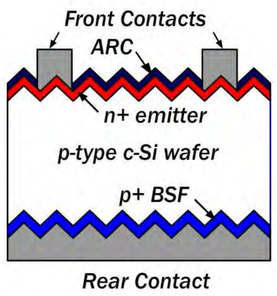
- 6" Silicon process line for diffused and heterojunction cells
- Bottom-up Evaluation of:
  - Materials
  - Processing steps
  - Encapsulants
  - Lamination

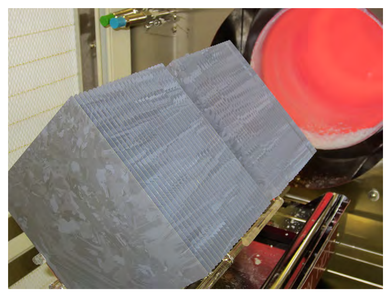


Pilot Lines

- Diffused Junction Cell Line

Saw Damage Removal and texturing
↓
Acid cleaning and backside oxide dep
↓
Phosphorus diffusion
↓
ARC deposition
↓
BSF and Ag tabbing
↓
Finger printing and Fire metal contacts
↓
Characterization

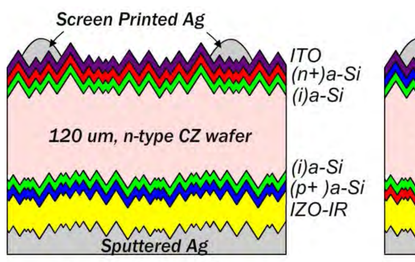


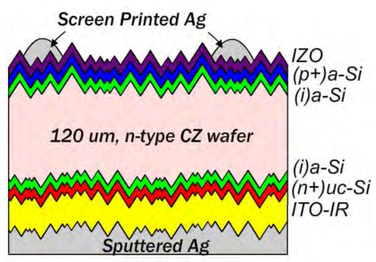


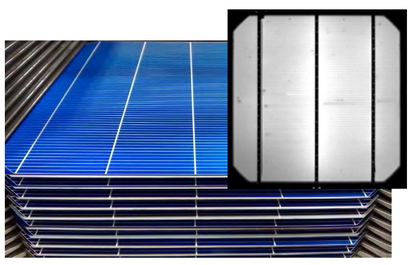
V_{oc} (mV)	J_{sc}(mA/cm^2)	FF(%)	Eff. (%)	Area (in)
362	36.7	79.8	18.6	6x6

- HIT Cell Line

SHJ Solar Cell Process Flow
↓
Damage removal and texturing
↓
Clean and HF dip
↓
a-Si deposition on both sides (PECVD)
↓
TCO deposition on both sides (sputtering, shadow mask)
↓
Rear metal contact (Ag, sputtering)
↓
Front metal contact (Ag, screen printing)
↓
Thermal curing



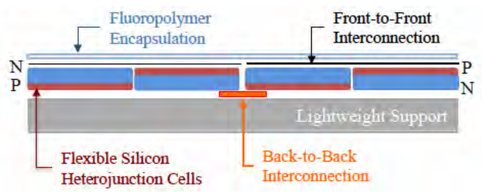


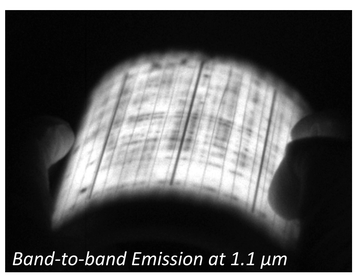


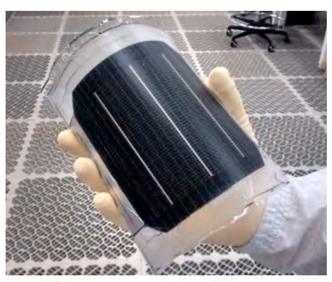
V_{oc} (mV)	J_{sc}(mA/cm^2)	FF(%)	Eff. (%)	Area (cm^2)
727	38.7	78.2	22.0	239

- Flexible Silicon Cells

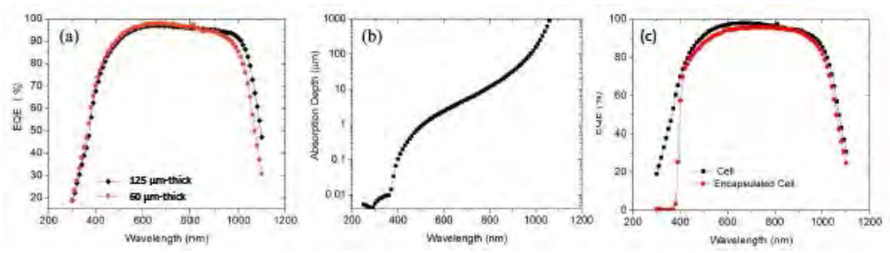
Encapsulated using Fluoropolymer foil
Front-to-front and front-to-back intercon.





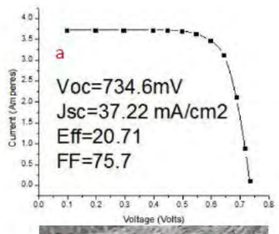


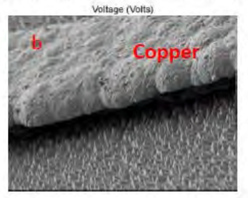
(a) EQE 125um and 60um cell
(b) Absorption depth in Si
(c) 60 um-thick cell before and after encapsulation

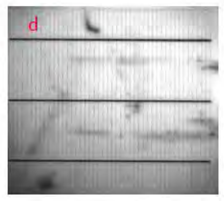


Advanced Processing

- Copper, Nickel and Tin plating





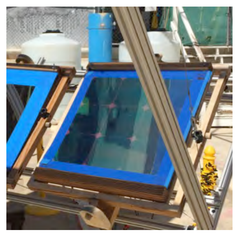


(a) IV Bifacial Electroplated Cell, (b) SEM, (c) EL, (d) PL

Lamination

- Standard and Unconventional Modules

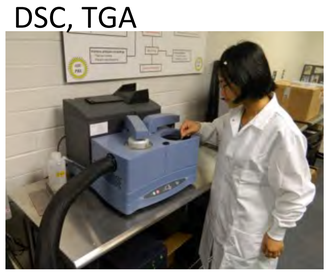
- 20% Cells
- 18% Modules
- SunsV_{oc} characterization



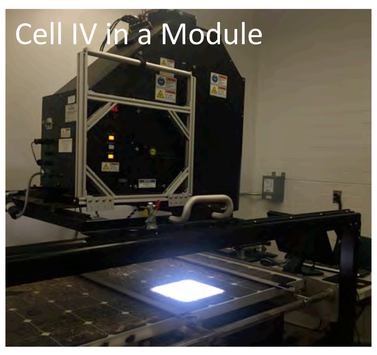
Characterization @ PRL

- Indoor Testing

DSC, TGA



Cell QE in a Module



- Outdoor Testing

- Accelerated Testing and Modeling

Walk-in UV chamber
Modeling: ReliaSoft, Pvsyst,Minitab, Tableau, SAS, JMP
PID Test station: Module and Cell

UV weathering

PRL Mission

Pre-characterization
↓
Field Testing | Accelerated Testing
↓
Post-characterization
↓
Modeling
↓
Lifetime Prediction

DuraMAT Durable Module Materials Consortium

QESST

ASU