EE / CprE / SE 492 - sddec24-21

CdSe Solar Cell

Week 3 Report

Sep 20 – Oct 3

Client: Vikram Dalal

Faculty Advisor: Vikram Dalal

Team Members:

Payton Bills – Team Lead | Client Interaction

Anders Peterson – Client Interaction | Component design

Michael Thomas – Individual Component Design | Testing

Drew Jensen – Individual Component Design | Testing

Jacob Steffens – Simulation research | Research aid discovery and distribution

Jonathan Timm – Simulation research | Simulation testing

Past Week Accomplishments

- Practice CdSe deposition
- Completed Silicon Cell fabrication process
- Completed Oxidation of Silicon solar cell.
- Meetings with Dr. Dalal to discuss tandem cell expectations

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Pending Issues

- Need to meet with Dr. Dalal to discuss amorphous silicon deposition on CdSe.

  This meeting is Saturday 10/5 at 10:00 AM.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Payton Bills	Began Silicon solar cell fabrication with Anders and completed cleaning and oxidation.	4	10
Anders Peterson	Performed a practice run depositing CdSe onto CdS. Developed a fabrication process and procedures for the Si-CdSe tandem cell (in appendices). Began fabrication of the Si-CdSe tandem cell with oxidation.	15	28
Michael Thomas	Began fabrication of Si-CdSe tandem cell with oxidation with Anders and Payton	4	9
Drew Jensen	I worked on developing economic analysis for a Si-CdSe tandem cell solar farm, and how that would compare for $/kWh to our current CdTe and Si solar farms. I also attended the team meetings.	2	5
Jacob Steffens			
Jonathan Timm	Attended and observed cell fab with rest of team. Began researching scale of economies analysis for solar farm cost breakdown. Met with rest of team to discuss group progress.	4	8

Plans for Coming Week

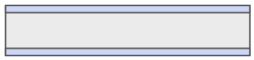
Friday, 10/2/2024 Anders, Michael, and Payton will finish the Silicon solar cell and take measurements, leaving only the CdSe solar cell to be fabricated. Anders and Payton will speak with Dr. Dalal Saturday morning to plan the fabrication of CdSe, which will hopefully begin next week. Drew and Johnathan will continue working towards a cost comparison between a CdSe:Si tandem solar panel farm and a Si solar farm in both total cost and cost/MWh. Jacob will continue research on resource availability and cost so that he and Drew can estimate production cost of CdSe towards the end of development.

Gitlab Activity Summary

Si-CdSe Tandem Cell Process Overview

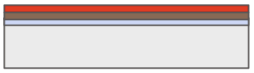
Si Cell

1. Clean Wafer

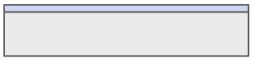


2. Grow SiO_2

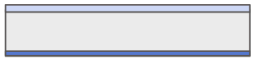
3. Spincoat HMDS & PR



4. Etch SiO_2 on rough side



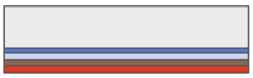
5. Remove HMDS & PR



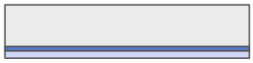
6. Phosphorus CSD

7. Grow oxide on Phos layer

8. Spincoat HMDS & PR



9. Etch SiO_2 on polished side



10. Remove HMDS & PR

11. Boron CSD

12. Grow oxide on boron layer

13. Drive in P & B 0.5 µm

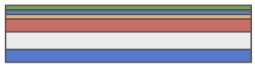
CdSe Cell

1. Clean Wafer

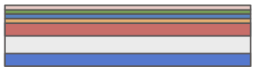
2. Remove Oxide

3. Deposit ZnO

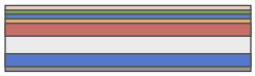
4. Deposit CdS



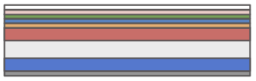
5. Deposit CdSe



6. Deposit a-Si



7. Deposit Aluminum



8. Deposit ITO

Si-CdSe Tandem Cell Detailed Process

Crystalline Silicon Cell

1. Silicon wafer
    a. One sided polished
    b. n-type
    c. 1-5 ohm-cm (N_B~1E15)
    d. Standard 400μm thickness
        i. End goal: dope polished side with boron and rough side with phosphorus
2. Clean wafer
    a. Standard RCA cleaning process
3. Oxidize both sides of wafer
    a. 400 nm thick of oxide growth
    b. Wet oxidation for 39 min at 1050 ℃
4. Place HMDS & Photoresist on polished side
    a. Protects polished side from being etched
5. Etch rough side's oxide
    a. Etch the oxide with HF chemical bath until all oxide is removed
6. Remove HMDS & photoresist
    a. Acetone and methanol baths
7. Dope n^+ region on rough side
    a. Constant source diffusion
        i. 850 ℃ for 15 min
    b. Doped with acceptor concentration ~1E19
    c. Final thickness of ~0.5μm after constant dose diffusion
8. Deglaze Si-P layer
    a. 30 second bath in etchant
9. Grow thick oxide to cover n^+
    a. 250 nm
    b. 120 min at 900 ℃
10. Place HMDS & photoresist on rough side
    a. Protects rough side from being etched
11. Etch polished side's oxide
    a. Etch the oxide with HF chemical bath until all oxide is removed
12. Remove HMDS & photoresist
    a. Acetone and methanol baths
13. Dope p^+ region on polished side
    a. Constant source diffusion
        i. 850 ℃ for 120 min
    b. Dope with acceptor concentration ~1E19

   c. Thickness of ~0.5μm after constant dose diffusion
14. Deglaze B_2O_3 layer
   a. 30 second bath in etchant
15. Low temperature oxidation on n^+
   a. 800 ℃ for 30 min
   b. Removes layer of defect heavy Si-B
16. Deglaze Si-B layer
   a. 30 second bath in etchant
17. Grow oxide layer
   a. Caps n^+ layer
18. Constant dose diffusion drive
   a. 1000 ℃ for 40 min

CdSe Cell

1. Deposit ZnO
   a. How thick
   b. Sputtering
2. Deposit CdS
   a. 10 nm through thermal evaporation
3. Deposit CdSe
   a. 300 nm through thermal evaporation
4. CdCl treatment
   a. Spincoat CdCl for 30 seconds
   b. Anneal at 150 ℃ for 1 minute
   c. Repeat once
5. Deposit amorphous silicon
   a. What process
   b. How thick
6. Deposit aluminum back contact
   a. How thick
   b. Thermal evaporation
7. Deposit ITO
   a. How thick
   b. Sputtering