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| Process flow title | | | Revision |
| Danchip GreenBelt Solar cell process | | | 2.5 |
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| | Labmanager group GreenBelt | Batch name Aug 2016 | Date of creation 23-May-16 |
| | | | Date of revision 23-May-16 |

Objective

Batch name: Aug 2016

This process is used in Danchips UV-litho Green Belt course.

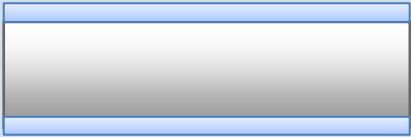

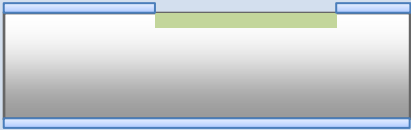



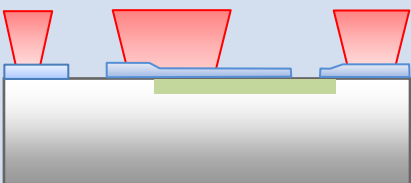
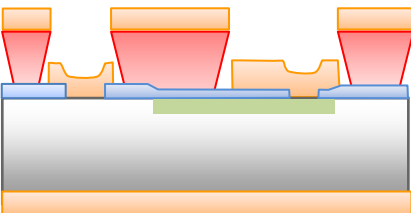
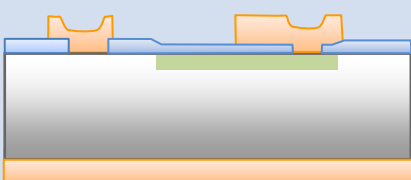
The purpose is to provide an example process flow and to educate Cleanroom users in general UV-lithographic techniques. The outcome is test-wafers with solar cells.

Substrates

| Substrate | Orient. | Size | Doping/type | Polish | thickness | Box | Purpose | # | Sample ID |
|-----------|---------|------|-------------|--------|-----------|-----|---------------------|----|-----------|
| Silicon | <100> | 4" | p(Boron) | SSP | 525±25µm | | Device wafers | 12 | S1-S6 |
| Silicon | <100> | 4" | p (Boron) | SSP | 525±25µm | | Test wafers | 2 | T1-T2 |
| Silicon | <100> | 4" | p (Boron) | SSP | 525±25µm | | Danchip test wafers | 3 | D1-D3 |

Comments:

Figures

| Figure | Caption | Step | Figure |
|--------|--|------|--|
| 1 | After SiO ₂ dep | 1.2 |  |
| 2 | After lithography and SiO ₂ etch in BHF | 3.3 |  |
| 3 | After Phosphor predep and SiO ₂ etch in BHF | 4.3 |  |
| 4 | After thermal oxidation of SiO ₂ | 4.4 |  |
| 5 | After lithography and BHF etch | 6.3 |  |
| 6 | After resist strip | 6.4 |  |
| 7 | After lithography | 7.5 |  |
| 8 | After metal deposition | 8.2 |  |
| 9 | After lift-off | 8.3 |  |

Comments:

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| Step Heading | Equipment | Procedure | Comments |
|-------------------------------------|-----------------------|--|---|
| 1 SiO₂ deposition | | | Wafer S1-S12, T1, D1 |
| 1.1 RCA clean | RCA bench | Follow standard procedure. | Wafer S1-S12,T1, D1 |
| 1.2 SiO ₂ dry oxidation | Boron Drive-in (A1) | Place a test wafer T1 and D1 in the center of the boat and place device wafers and eg. test wafers equally distributed on each side of the test wafer. No spacing between wafers. Recipe: Dry1050, time:180min Anneal: 20 min Target thickness: 150±10nm | Measure oxide thickness on D1 on the Filmtek and note the result in the furnace log and measurement sheet S1-S25 T1, D1 |
| 2 Lithography – 1.5µm resist | | | Wafer S1-S12 |
| 2.1 Surface treatment | Oven HMDS-2 | Load all wafers in oven for ~30 min Recipe: program 01 | Fill out the logbook |
| 2.2 Clean spinner | SSE spinner | Clean spinner nozzle and run the dummy wafers Recipe: _DCH_100mm_AZ5214E_1.5um_Prox bake (Temp: 95°C, time: 90 sec) | 1-3 dummies Fill out the logbook |
| 2.3 Coat wafers | SSE spinner | Coat back side of the device wafers with 1.5 µm AZ5214e Novolac resist Recipe: _DCH_100mm_AZ5214E_1.5um_Prox bake (Temp: 95°C, time: 90 sec) | Resist thickness not checked Fill out the logbook |
| 2.4 Coat wafers | SSE spinner | Coat front side of the device wafers with 1.5 µm AZ5214e Novolac resist Recipe: _DCH_100mm_AZ5214E_1.5um_Prox bake (Temp: 95°C, time: 90 sec) Remember to set hotplate temperature back to standby temperature (90°C) | Resist thickness not checked Fill out the logbook |
| 2.5 Exposure | KS-aligner | Hard contact Exposure time: 7 sec, Dose: 49 mJ/cm ² Mask: N+ (dark field) | Fill out the logbook |
| 2.6 Develop | Developer bench 6" | Develop in AZ 351B for 60±10 sec | Fill out the logbook |
| 2.7 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 2.8 Inspection | Optical microscope | Check pattern and alignment marks | Note in measurement sheet |
| 3 SiO₂ etch | | | Wafer S1-S12 |
| 3.1 SiO-etch | SiO-etch | Etching rate: 75-80 nm/min Time: 2-2½ min | SiO-etch is BHF with surfactant |
| 3.2 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 3.3 Inspection | Optical microscope | Check pattern and alignment marks | |
| 3.4 Strip resist | Acetone | First 2-3 min in rough followed by 5 min in fine strip bath with US | |
| 3.5 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 3.6 Inspection | Dektak | Measure step height Target: 150±10 nm | Note in measurement sheet |

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| 4 Phosphor Pre-deposition | | | |
| 4.1 | RCA clean | RCA bench | Follow standard procedure but without HF dip. No HF Wafer S1-S12,T1,T2,D2 |
| 4.2 | Phosphor pre-deposition | Phosphor pre-dep furnace (POCL) | Place a p-type test wafer D2 in the center of the boat and place device wafers equally distributed on each side of the test wafer. On each side of the wafers place two p-type test wafers T1 and T2. No spacing between wafers. Front-side to the left. Recipe: 900, time 15 min Anneal: 20 min Target doping : $R_{\square}=40 \Omega/\square$ |
| 4.3 | Etch of phosphor glass | BHF in RCA bench for doped wafers | Time: 30 sec, Exactly Removes all phosphor glass and only some of the dry oxide Wafer S1-S12, T1, T2, D2 Measure resistivity on D2 using four point probe and note resistivity for D2 in furnace logbook. |
| 4.4 | SiO2 dry oxidation | Phosphor Drive-in (A3) | Place a test wafer in the center of the boat and place device wafers and eg. test wafers equally distributed on each side of the test wafer. No spacing between wafers. Front-side to the left. Recipe: Dry1050, time: 70 min Target thickness: $90\pm 10\text{nm}$ Wafer S1-S2, T1, T2, D3 Measure oxide thickness on T1 (ca. 77+80nm), T2 (ca. 90 nm) and D3 (ca. 80 nm) on the Filmtek and note the result in the furnace log for D3 and in measurement sheet for T1, T2 and D3. |
| 4.5 | Etch oxide | BHF | Etch oxide on test wafer T1 (ca 150 nm) Etch oxide on test wafer T2 (N+) (ca 90 nm) Wafer T1, T2 Measure resistivity and on T1 and T2 using four point probe. Note resistivity in measurement sheet. Note the wafer becomes hydrophobic. |
| 4.6 | Inspection | Optical microscope | Check alignment marks on device wafers |
| 5 Lithography – 1.5μm standard | | | Wafer S1-S12 |
| 5.1 | Coat test wafers | Spin Coater: Gamma UV | Recipe: 3410 DCH100mm 5214E 1.5um 1-3 dummies Fill out the logbook |
| 5.2 | Coat wafers | Spin Coater: Gamma UV | Coat the wafers with a positive Novolac resist Recipe: 3411 DCH100mm 5214E 1.5um HMDS (Soft bake on hotplate Temp: 90°C, time:90 sec) Resist thickness not checked Fill out the logbook |
| 5.3 | Exposure | Aligner: 6inch | Align to alignment marks on wafer Target < 2 μm Hard contact Recipe: Greenbelt-1_5um_ Contacts Exposure time: 5 sec Mask: CONTACTS (dark field) Fill out the logbook |
| 5.4 | Develop | Developer: TMAH UV-Lithography | Process: DCH 100mm SP 60s Fill out the logbook |
| 5.5 | Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300 ± 30 sec). Spin dry |
| 5.6 | Inspection | Optical microscope | Check pattern and alignment Note in measurement sheet. |

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| 6 SiO₂ etch | | | Wafer S1-S12 |
| 6.1 SiO-etch | SiO-etch | Etching rate: 75-80 nm/min Time: 2-2½ min | Use etching time from step 4.5 on test wafer T1 (ca 150nm oxide). Note that the backside becomes hydrophobic |
| 6.2 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 6.3 Inspection | Optical microscope | Check pattern and alignment | |
| 6.4 Strip resist | Acetone | First 2-3 min in rough followed by 5 min in fine strip bath with US | |
| 6.5 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 6.6 Inspection | Dektak | Measure step height Target: 90±10 nm in N+ areas Target: 130±10 nm in un-doped areas | Note step heights in measurement sheet. |
| 7 Lithography – 2.0µm n-LOF2020 | | | Wafer S1-S12 |
| 7.1 n-LOF 2020 resist coating | Spin Track 1+2 | Coat device wafers with a negative Novolac resist Recipe: T2 nLOF 2020 2µm with HMDS (Bake at Temp: 110°C, time:60 sec) | Run 1-3 dummies first Resist thickness not checked Fill out the logbook |
| 7.2 Transport of wafers | transport box | Load wafers into the Black or blue transport box | To avoid unwanted exposure from the white light |
| 7.3 Exposure | Aligner: MA6-2 | Align to alignment marks on wafer. Hard contact, Align gap: 25 µm Exposure time: 9 sec Mask: METAL (clear field) | Fill out the logbook |
| 7.4 Post Exposure Bake and Develop | Developer: TMAH UV- Lithography | Sequence number: 3001 Recipe: DCH 100mm PEB60s@110C+SP60s | Fill out the logbook |
| 7.5 Inspection | Optical microscope | Alignment check | Note in measurement sheet. |
| 8 Aluminum pattern | | | Wafer S1-S12 |
| 8.1 Aluminum deposition on front side | Alcatel | Metal: Ti/Al Thickness: 50nm/300 nm | Fill out the logbook |
| 8.2 Aluminum deposition on back side | Alcatel | Metal: Al Thickness: 200 nm | Fill out the logbook |
| 8.3 Lift-off | Lift-off bench 6" | Leave wafers in Remover 1165 for 2-3 min. Temperature: 45 °C Start the US for 10 min. Rotate wafers and start US for another 10 min. | Fill out the logbook |
| 8.4 Annealing | Furnace: Al Anneal | Temp: 400 °C Time: 15min | |
| 8.5 Rinse/dry | Wet bench/ Spin dryer | Rinse in DI water for 5 min (300±30 sec). Spin dry | |
| 8.6 Inspection | Optical microscope | Check for completeness | |
| 8.7 Inspection | Dektak 4pp | Measure thicknesses (on front and back) Measure metal sheet resistance on backside | Note in measurement sheet Note in measurement sheet |

Contents

| | | |
|----------|--------------------------------------|----------|
| 1 | SiO₂ deposition | 3 |
| 1.1 | RCA clean | 3 |
| 1.2 | SiO ₂ dry oxidation | 3 |
| 2 | Lithography – 1.5µm resist | 3 |
| 2.1 | Surface treatment | 3 |
| 2.2 | Clean spinner | 3 |
| 2.3 | Coat wafers | 3 |
| 2.4 | Coat wafers | 3 |
| 2.5 | Exposure | 3 |
| 2.6 | Develop | 3 |
| 2.7 | Rinse/dry | 3 |
| 2.8 | Inspection | 3 |
| 3 | SiO₂ etch | 3 |
| 3.1 | SiO-etch | 3 |
| 3.2 | Rinse/dry | 3 |
| 3.3 | Inspection | 3 |
| 3.4 | Strip resist | 3 |
| 3.5 | Rinse/dry | 3 |
| 3.6 | Inspection | 3 |
| 4 | Phosphor Pre-deposition | 4 |
| 4.1 | RCA clean | 4 |
| 4.2 | Phosphor pre-deposition | 4 |
| 4.3 | Etch of phosphor glass | 4 |
| 4.4 | SiO ₂ dry oxidation | 4 |
| 4.5 | Etch oxide | 4 |
| 4.6 | Inspection | 4 |
| 5 | Lithography – 1.5µm standard | 4 |
| 5.1 | Coat test wafers | 4 |
| 5.2 | Coat wafers | 4 |
| 5.3 | Exposure | 4 |
| 5.4 | Develop | 4 |
| 5.5 | Rinse/dry | 4 |
| 5.6 | Inspection | 4 |
| 6 | SiO₂ etch | 5 |
| 6.1 | SiO-etch | 5 |
| 6.2 | Rinse/dry | 5 |
| 6.3 | Inspection | 5 |
| 6.4 | Strip resist | 5 |
| 6.5 | Rinse/dry | 5 |
| 6.6 | Inspection | 5 |
| 7 | Lithography – 2.0µm n-LOF2020 | 5 |
| 7.1 | n-LOF 2020 resist coating | 5 |
| 7.2 | Transport of wafers | 5 |
| 7.3 | Exposure | 5 |
| 7.4 | Post Exposure Bake and Develop | 5 |
| 7.5 | Inspection | 5 |
| 8 | Aluminum pattern | 5 |
| 8.1 | Aluminum deposition on front side | 5 |
| 8.2 | Aluminum deposition on back side | 5 |
| 8.3 | Lift-off | 5 |

| | | | |
|---|------------|------------------|----------------------|
| Process flow title | Rev. | Date of revision | Contact email |
| Danchip GreenBelt Solar cell process | 2.5 | 23-May-16 | jehan@danchip.dtu.dk |

| | | |
|-----|------------------|---|
| 8.4 | Annealing..... | 5 |
| 8.5 | Rinse/dry | 5 |
| 8.6 | Inspection | 5 |
| 8.7 | Inspection | 5 |