Fabrication Log of Al-Si and Ni-Si chips for Baseline Testing

Metal Contacts Project

Process: FabuBlox

Goal: Fabricating 2 Aluminum chips and 2 Nickel chips. Within those, one will be p-doped and one will be n-doped.

Observations: The 4 chips are fabricated side by side

Day 1: Dopant Diffusion

Cut and labeled four chips sequentially: 633, 634, 635, and 636. The initial labeling on the Si wafer was incorrect, so new chips were cut from the correct wafer.

Spin coated the dopants. The chips keep flying off. This was solved by using double sided tape.

Diffusion:

- n-doped chips are baked for 10min after spin coated at 100C
- p-doped chips go straight to the tube furnace
- n-doped chips are put in the tube furnace for 30min at 1100C
- p-doped chips are put in the tube furnace for 60min at 1200C

Day 2: SiO_2 Deposition and Baking

Started with the chips after diffusion and proceeded with wet etching using HF.

Applied 700B. I was told the spin coater is now fully operational. It was not the case, as the chip still flew off. I went back to the double sided tape.

The chips were baked at 350°C for 30 minutes.

Day 3: SiO_2 Patterning and Wet Etching

Patterned SiO_2 successfully. I noticed the image on the stepper software appears with some shadows like it is duplicating the mask (or the exposure). The pattern came out good despite this.

Followed with the wet etching of SiO_2 and resist strip. I made a mistake and etched chip 635 for 10 minutes instead of 10 seconds. I did not make the same mistake on the other chips and surprisingly I can't spot any difference between them in the microscope.

Day 4: Patterning and Nickel Deposition

I noticed that the patterns were inverted - rather than patterning the holes for aluminum deposition, the reverse pattern was created. This required re-patterning to correct the issue.

Another issue I encountered was in the developing stage. I was using the same developer that was already in the beaker and it was not working. I learned that I should always pour new developer and not use it for too many chips.

Nickel deposition was attempted but didn't proceed as expected. It appears that the Nickel got deposited on the whole surface of the chip and with a sheet resistance of 0.1 ohm/sq. According to Jay this has never happened before and the cause is still unclear, but the two chips (635 and 636) were successfully coated with Ni and are now ready for patterning the contacts.

Something else happened after Nickel deposition where the chips have a shifted pattern now. It is like only the metal contacts got shifted and all in the same angle and direction. We decide the patterning of the contacts will be on these shifted ones as they appear to be the original ones.

Day 5: Aluminum Deposition and Nickel Etching

I proceeded with Aluminum deposition on the 2 chips (633 and 634) at the same time:

- **Pressure:** 5.4e-5 hPa
- **Deposition Rate:** 150-170 Å/s
- **Thickness Achieved:** 6.67 kÅ

After some research, I confirmed that HMDS cannot be applied over aluminum and/or nickel, as it introduces organic residues that can contaminate the metal and affect photoresist adhesion.

Patterned all four chips. Several patterns failed. It looks like the photoresist is not being correctly exposed. We are not exactly sure what failed but I repattern it anyway.

The initial nickel etching process failed because the etchant was not at the required 40°C, although the hotplate was set to 40°C. The etch rate is 50 Å/s @40C according to the datasheet and we electroplated for 5 min, so that means our thickness is 1um (deposition rate is 2000 Å/min). So we should etch for 200 seconds, and we end up etching for 4min just to be sure. A thermistor was added to monitor the temperature and we end up having to set the hotplate to 95-100C in order for the etchant to reach 40C, but the etching process still didn't work.

Day 6: Testing

Performed IV testing on chips 633 and 634:

- **Chip 633 (n-type):** Exhibited ohmic behavior.
- **Chip 634 (p-type):** Showed rectifying behavior.

Day 7: Annealing and Final Testing

Annealed both chips at 250°C for 15 minutes.

Probed the chips again:

- **Chip 633 (n-type):** The ohmic contacts were improved after annealing.
- **Chip 634 (p-type):** The rectifying behavior is not present anymore. Instead it appears to show something similar to an ohmic behavior.