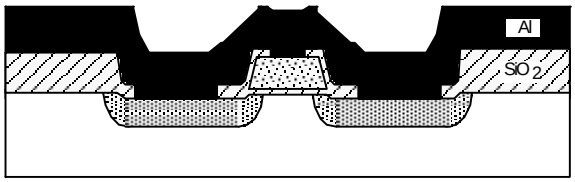
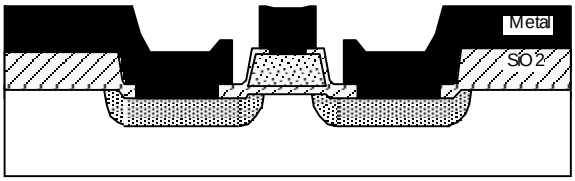
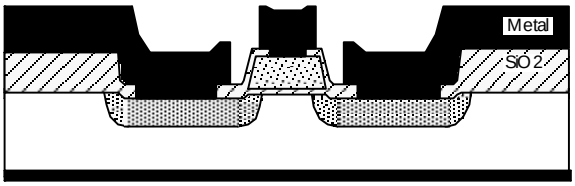
LAB #8
Lithography IV for Metal Pads, Al Etching, and Backside Poly-Si Etching



Al Deposited Over Entire Wafer
In Lab 7



Photolithography for Metal Contacts
and Wet Etching of Al



Strip Backside of Poly-Si and SiO_2
Deposit Backside Al
Sinter

- **Measure Al Step Height and Sheet Resistance**
- **Discuss Lithography for this Lab**
- **Discuss Metal Resistance**
- **Discuss how much Oxide and Poly-Si are left on Backside**
- **Explain the Effects of Annealing conditions on Device Performance**

LAB #8
Lithography IV for Metal Pads, Al Etching, and Backside Poly-Si Etching

Purpose:

The last photolithography step will be used to define Al contact pads. Al will be etched using wet chemical solution. Poly-Si at the back of the wafer will be removed by plasma etching.

Process Steps:

1. Photolithography steps for Al contact pad openings (on device wafer only).
   Coat wafers with resist and pre-bake following the procedures used in Lab #3.

2. **Align and expose** fourth mask (metal contact definition):
   [Metal MASK]
   POSITIVE PROCESS
   The exposure time may need to be adjusted. Photoresist is now on top of reflective Al surface instead of oxide or Si.

3. Develop and post-bake resist. Record the development time and alignment accuracy.
   Inspect under the microscope with the photoresist filter in to see if the patterns are fully developed. If not, continue to develop as advised by lab instructor. Inspect carefully for error in alignment across the wafer, and have your wafer checked by lab instructor. There is Al underneath the developed photoresist.

4. Etch Al in Transene Al etch at 40 °C until pattern clears; rinse, spin dry and inspect. The etch time is ~1.5 min.

5. Strip the resist from the device wafer using PRS 2000 at 100 °C for 2 min, followed by organic solvent clean of 1 min in Acetone, 1 min in IPA, and 3 min in DI H_2O.

6. Dektak Al step on device wafer.

7. Measure sheet resistance of Al using monitor wafer #10.

8. Coat front of wafer with photoresist to protect the devices. To get a thicker resist film, spin at half speed and post-bake for 30 min.

9. Plasma etch Poly-Si from the backside of the wafer.

Gas Flow:	25.0 sccm of pre-mixed gas with 10% O_2 in SF_6/O_2
Pressure:	200 mTorr
rf power:	75 W
Etch Time:	8 min

INFORMATION TO BE INCLUDED IN THE LAB REPORT

1. What are the exposure, development times, and alignment accuracy (include sketch of alignment marks)? Compare the lithography step used for the Metal mask (#4) to the one in Lab #3. What are the 2 major differences? List 2 steps that can be changed (compared to conditions used in Lab #3) to improve resolution for Metal mask patterning?

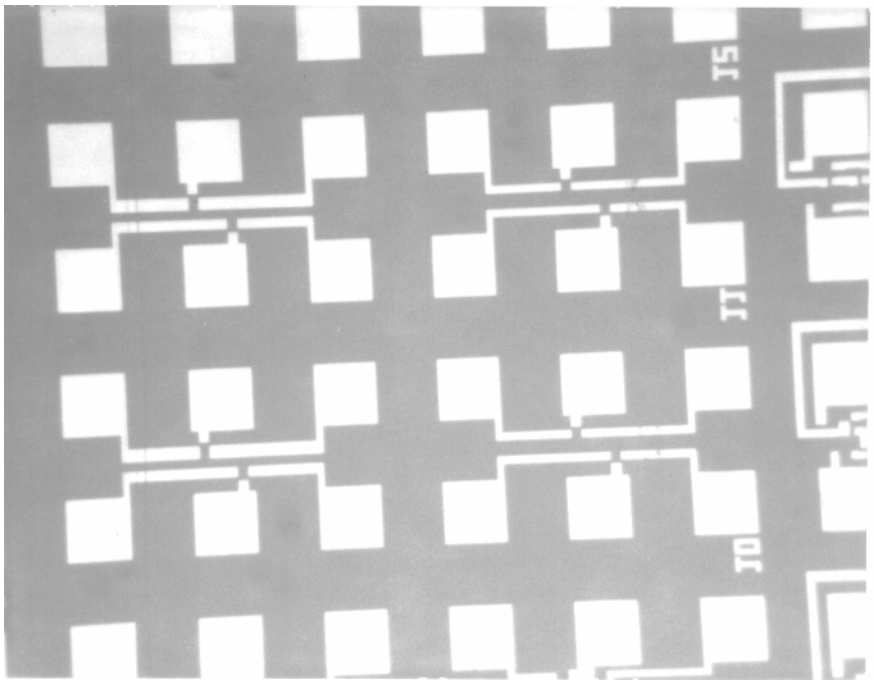
2. What are the Al step height, the resistivity of Al, and the Al etch time? What is the expected resistivity of Al? List 2 techniques to reduce metal resistivity. Discuss 2 common problems of using Al in ICs and techniques to overcome the problems.

3. How much oxide and Poly-Si do you expect at the backside of the wafer? What happens to the device performance if the etch times for Poly-Si is too long or too short?

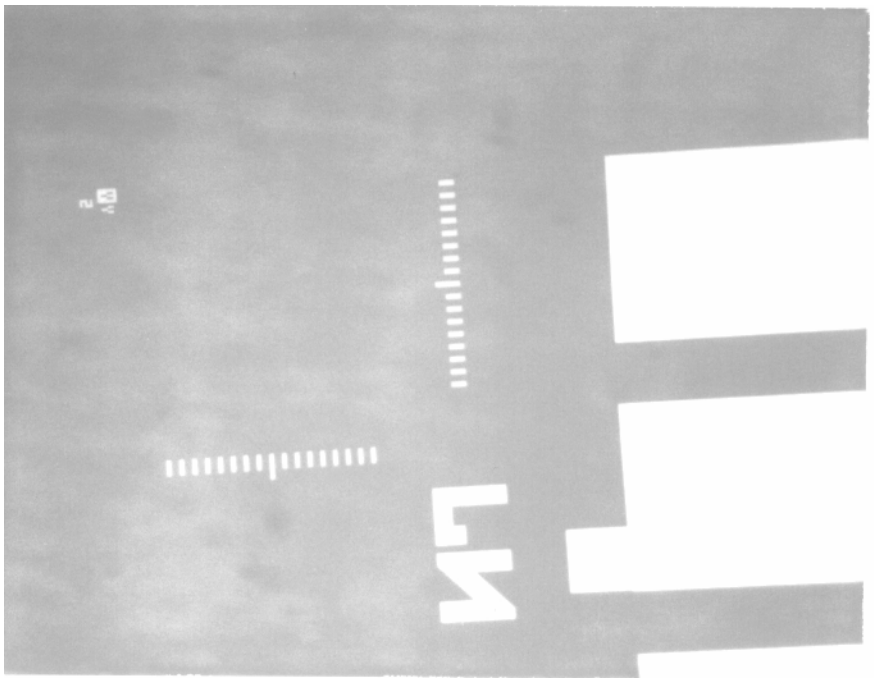
4. Which defects are removed by thermal annealing? What effects do the sintering gas ambient and temperature have on device performance?

5. Sketch the cross sections of a MOSFET after step #5 and at the end of Lab #9 (different sketches across gate contact and S/D contact). Sketch a top view of a MOSFET after step #5. Label all layers and dimensions.

Metal Mask to Define Patterns in Al Pads



Contact Pads for Source, Gate, and Drain



Alignment Marks for Metal Mask

EECS 423
LAB #9
Backside Al Contact and Annealing

Purpose:

The backside Al Contact will be prepared. Al will be deposited on the backside of the wafer, followed by thermal annealing.

Process Steps:

1. Remove any residual oxide from the backside of the wafer using BHF.

2. Deposit 0.3 μm Al on backside of the wafer by sputter deposition.

3. Strip resist on the frontside of the wafer and solvent clean wafer.

Anneal (sinter) wafer at 450 °C for 20 minutes in forming gas (94.98% N_2 - 5.02% H_2) with a total flow rate of 3 slpm.

4. Ready for device testing.

Your wafer will be ready for testing at the end of this lab. Testing details will be discussed later.