EE 432/532 — CyMOS process

PWELL diffusion

In this lab, we start the boron diffusion to form the p-wells — the regions where the NMOS transistors will be located. This will be a two-step diffusion, and we start with the deposition step, which sets the total dose. The lab supervisors will do the subsequent drive step. The key aspect of this diffusion is to have a relatively small total dose, which, combined with a long, high-temperature drive, will give a deep p-type region with a relatively low surface concentration, as needed for making NMOS transistors. Design the deposition to give a starting dose in the range

$$5\text{x}10^{13}\ \text{cm}^{-2} < Q_{boron} < 10^{14}\ \text{cm}^{-2}.$$

Read the boron source wafer data sheet to see the allowed temperature range of the boron wafers. Choose the deposition temperature and soak time to give the desired dose. (Note: Do not use temperatures over 900°C, even though that is allowed according to the data sheet.)

Before lab

1. Class notes: diffusion, diffusion details, diffusion example problems
2. Read through the *Boron Deposition* SOP.
3. Read through the boron source wafer manufacture's data sheets:
   BN975 source data, BN975 hydrogen injection process, and *low-temperature oxidation*.
4. Read through the PWELL boron diffusion pages of the *CyMOS Process Traveler*.
5. Calculate the required deposition soak time to give the desired boron dose for the p-well.

Activities

1. If needed, take pictures of the patterns formed during lithography last week. (Suggested photos subjects: alignment marks, a few PWELL rectangles, vdP, and TLM patterns, anything unusual.)
2. Perform standard clean on all wafers. (To save time, part of the group can begin the standard clean while the rest are taking pictures.)
3. Perform the boron deposition using the chosen temperature and soak time on the prescribed wafers. (Check the process traveler for the test wafers that should be included).
4. Remove the boron glass from wafers.
5. The lab instructors will perform the boron drive before the next time that the lab group meets. (See boron SOPs for details) Before the drive, the wafers will undergo a low-temperature oxidation step to remove the boron skin, as described in the boron source wafer data sheet. The drive will last for a total of 18 hours at a temperature of 1125°C. The first 10 minutes of the drive will consist of a wet oxidation, which should grow about 0.25 μm of oxide in the bare regions. The remainder of the drive will be done with a dry nitrogen ambient.
6. After the drive is complete, measure the oxide thickness on all test wafers. (Done at the beginning of the PMOS litho lab.)

Reporting

Prepare a report that covers the p-well lithography and the p-well diffusion (both deposition and drive). Use the Field Oxidation Report provided by Prof. Tuttle as a guide. The report is due by Mar 6, and should be submitted to Canvas.

At a minimum, the report should include:

- a description of the PWELL in terms of the overall CyMOS process
- a summary of the lithography process
- details of the lithography process (photoresist type, spin speed, exposure time, etc.)
- photos of the etched patterns
- a summary of the the boron diffusion deposition and drive steps. (including information from the boron source wafer data sheets)
- calculations of diffusion details (dose, surface concentration, junction depth, oxide thickness, etc.)
- measured oxide thicknesses after the diffusion.

As an appendix, attach copies of the completed sheets from the relevant portion of the process traveler.