EE 432/532 — CyMOS process

PMOS source/drain diffusion

In this lab, we finish the PMOS boron diffusion. The purpose of the PMOS diffusion is to form the source and drain regions of the PMOS transistors. In these regions, we want a high doping concentration (high dose) and relatively shallow junction depth. This is in contrast to the lightly doped and very deep PWELL diffusion done earlier. The high doping for the PMOS helps in making better contacts and reduces overall device resistance. Choosing the junction depth is a trade-off between minimizing lateral diffusion (shallower) and improving contact reliability (deeper). A junction depth of 1 µm is probably a reasonable value.

The deposition half of the two-step diffusion was done by Prof. Tuttle. The device wafers and test wafer 2 for each group receiving the same deposition process using the standard operating procedures with the process temperatures and times given below.

T_1 = 950°C, t_1 = 45 min.

In addition to driving the boron to the required depth, an oxide must be grown to cover the exposed region of the wafer surface. This is done as a wet oxidation at the beginning of the drive. Choose the oxidization time so that 0.25 µm of oxide will be grown. The oxidation time is included in the total drive time. Once the oxidation is completed, the water vapor flow is turned off and the tube is switched to a flowing nitrogen ambient for the remainder of the drive.

Before Lab

1. Review class notes: diffusion, diffusion details, diffusion example problems
2. Read through the *Boron Drive* SOP.
3. Review the boron source wafer manufacture's data sheets (links on web site): *BN975 source data, BN975 hydrogen injection process,* and *low-temperature oxidation*. Pay particular attention to the information on the LTO. The report will need to have a description of the LTO and the reason that it is needed in the process.
4. Read through the PMOS boron diffusion pages of the *CyMOS Process Traveler.* Make certain to identify which wafers are included in each step of the process.
5. Using the Q that was deposited during the first step, determine D_2t_2 for the drive to give a junction depth of about 1 µm.
6. Calculate the required oxidation time, using the temperature chosen for the drive.

EE 432/532 — CyMOS process

Activities

1. Photograph patterns formed during the previous lithography step. (Suggested photos subjects: alignment marks, a few PWELL rectangles with the added p-contact regions, a few PMOS regions, new vdP and TLM patterns, BJT regions, NAND and NOR gate regions, anything unusual.)
2. Perform a standard clean on the wafers. (To save time, part of the group can begin the standard clean while the rest are taking pictures.)
3. Load the wafers into the oxidation furnace and perform a *low-temperature oxidation* 800°C for 30 min.
4. After LTO, remove the wafers from the furnace and deglaze for 30 seconds. Rinse, dry, and ret turn wafers to the oxidation furnace.
5. Ramp to the desired drive temperature.
6. Use wet oxidation to grow the 0.25-µm thick oxide layer. Then stop the oxidation and continue the drive in nitrogen for the remaining prescribed drive time.
7. Remove wafers and measure oxide thicknesses on all test wafers. (May be put off until next time.)

Reporting

Prepare a report that covers the PMOS lithography and the PMOS diffusion (both deposition and drive). The report is due by Mar 27 and should be submitted to Canvas.

At a minimum, the report should include:

- a description of the PMOS steps 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. me.