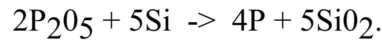
OP-E: Phosphorus Pre-Deposition

filename: PPREDP

Unlike the p-type dopants, there are several n-type dopants (column V elements) suitable for use in silicon device fabrication. The three most commonly used n-type dopants are phosphorus, antimony, and arsenic. Of these, phosphorus diffuses at about the same rate as boron, and ten times faster than arsenic and antimony. For these reasons, we use phosphorus as our n-type dopant. As with boron, there are many ways to supply the phosphorus during pre-dep, but the final chemical reaction is



$$2P_20_5 + 5Si \rightarrow 4P + 5Si0_2.$$

The solid source wafers we use are more complex in composition than the simple boron nitride wafers used for boron pre-dep. They consist of silicon pyrophosphate, SiP_20_7, in a porous, inert ceramic binder. These wafers do not require any activation process, but the extremely hydroscopic nature of P_20_5 requires that they be kept very dry at all times. At pre-dep temperatures (950^oC) the SiP_20_7 decomposes to P_20_5 and $Si0_2$, which provides the concentration gradient induced diffusion of P_20_5 to the silicon. Figure 19 shows the sheet resistance vs. time curve for our phosphorus pre-dep system.

REFERENCES

"A Solid Planar Source for Phosphorus Diffusion," N. Jones, D. M. Metz, J. Stach, and R. E. Tressler, J. Electrochem. Soc., Vol. 123, pp. 1565-1569, 1976.

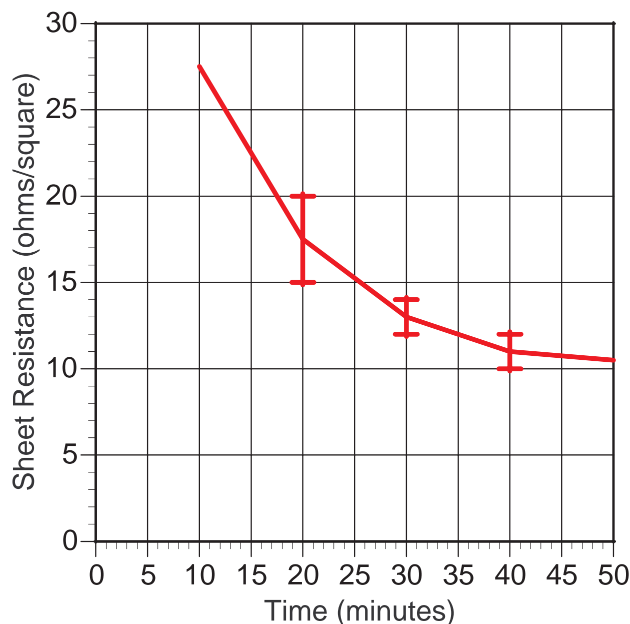


Figure 19: Sheet resistance vs. phosphorus pre-dep time.

PHOSPHORUS PRE-DEP PROCEDURE

1. Set gas flow rate N_2 @ 70, Steel ball.

2. Set furnace temperature controller: 929. Allow at least 30 min. for temperature to stabilize. This should normally be done by the lab TA before lab starts.

3. Remove furnace cap and place it in the beaker on the table. Carefully remove the pull-rod from its storage tube and pull the wafer boat from the neck of the furnace. ALLOW 1 min. TO COOL.

NOTE: NEVER USE ANY PULL-ROD OTHER THAN THE ONE SPECIFICALLY FOR THE FURNACE YOU ARE USING!

4. LOAD WAFERS: Place CLEAN Si wafers in slots immediately adjacent to the P source wafers. Note in your lab notebook the location of your samples in the boat. DO NOT TOUCH THE P WAFERS OR QUARTZ BOAT WITH TWEEZERS!

5. Using the pull-rod, push the boat into the neck of the furnace. Allow to temperature condition for 2 min.

6. Slowly push boat into center zone of furnace: 1 min. push. The center zone is reached when the end of the pull-rod reaches the mark on the furnace tray. Replace pull-rod in its storage tube, and replace furnace end cap.

THE PULL-ROD WILL BE VERY HOT: DO NOT TOUCH ANY PORTION WHICH WAS INSIDE THE FURNACE.

7. Allow boat to remain in flat zone for desired pre-dep time.

8. At the end of the pre-dep time slowly pull the boat from the flat zone to the furnace neck: 1 min. pull. Allow boat to cool in the neck for 2 min.

9. Pull boat out onto furnace rack, allow to cool for 2 min. Remove samples.

10. Store boat in furnace neck, replace cap and pull-rod.

Stand-by:
-Boat should be in the furnace neck.
-N_2 flow-rate: 10, glass ball.
-Controller setting: 650.