HOMEWORK 3
Introducing Dopants by Diffusion AND
Thermal Oxidation
DUE: Thursday, Nov. 13, 2008

Homeworks may be submitted electronically to hu@ece.ucsb.edu

In order for you to collectively get the experience needed for your group labs, half of you will be carrying out *phosphorus diffusion* into silicon wafers and the other half will be doing an *oxidation procedure*. Within your lab groups, make the decision on who will be doing which process for this homework.

Obtain a piece of p-type <100> silicon. The resistivity of this sample is not important, but note the value of the starting resistivity. *Do this by etching off the native oxide, and carrying out a 4-point probe measurement of the wafer.*

The first goal of this homework is to give you experience in the two furnace-based processes of diffusion-doping and of oxidation. The second goal is for you to assess the process through measurement of the resulting resistivity of the wafer, or thickness of the oxide.

Read the 'Furnace Cleanliness Instructions'.

1. DIFFUSION: You will actually carry out the 'predeposition' process, rather than the full diffusion with the 'drive-in' in the oxidation furnace. This is to reduce the demand on the oxidation furnace. The key steps in this process are described in the 'Phosphorus Predeposition' document*.
    a. Clean the wafer using the *Piranha Clean*.
    b. Carry out the phosphorus predeposition for *15 minutes at 950 C*.
    c. Etch off the *phosphorus glass* that is formed on the wafer, and measure the resistivity of the n-type layer that has been formed.
    d. (You may wish to save these 'predep' samples, and carry out a drive-in step later on)

2. OXIDATION: Follow the process steps outlined in the document on 'Oxidation'*.
    a. Clean the wafers, and remove the native oxide by etching in buffered HF for 45 seconds. Rinse in DI water.
    b. The furnace temperature is set to 1000 C. Using the chart next to the furnace, determine the time needed to form an oxide *300 nm* thick.
    c. Verify the thickness of the oxide you have grown.

In your analysis of either the diffusion or oxidation process, discuss:
1. The changes in the material properties resulting from the process. How uniform is either the resistivity (for the diffusion process) or the oxide thickness (for the oxidation process).
2. Were the values of resistivity or oxide thickness that you obtained, the results you expected?
3. Were there any parts of the process that were more difficult to control?
4. Are there procedures that you would change, or concentrate on further, the next time you do these processes?
5. The write-up should be short (~ 2 pages)

[1]To save time for the training and the processing, please try to schedule your training in groups, and also arrange to do the predeposition and oxidation of several samples at one time.

*These documents are available in the Teaching Clean Room, and will be available on the class website.