ECE6450 Homework #4 Dr. Alan Doolittle

1.) In an RTP system similar to the one our Microelectronics Research Center has, the lamps heat a graphite susceptor (emissivity ~ 0.9). The wafer to be processed (emissivity ~ 0.7 for silicon) is heated by radiation from the susceptor (convection and conduction are small). The temperature is monitored by a thermocouple in contact with the susceptor. If the thermocouple measures 1000 degrees C, what is the wafer temperature? You may assume all radiation heating the wafer come from the susceptor, all radiation is emitted perpendicular to the susceptor and wafer (a good assumption for wafer in such close contact with the susceptor), and neglect all edge effects. Hint: This problem can be solved with only equation 6.4 in your book.

2.) Arsenic is to be ion implanted into silicon in four steps at multiple energies. Using a math package or spreadsheet, design an implant that has as close to a flat 1e17 cm^{-3} profile between 250 angstroms to 1000 angstroms deep. The profile must have a concentration less than 1e15 at depths less than 100 angstroms and deeper than 1700 angstroms. The projected range can be approximated as,

$$R_p = \left(\frac{1025\ \dot{A}}{200\ KeV}\right)\ Energy\ in\ KeV$$

and the straggle is described as,

$$\sigma_p = \left(\frac{215\ \dot{A}}{200\ KeV}\right)\ Energy\ in\ KeV$$

Using a simple gaussian approximation, determine the best combination of peak concentrations and implant energies to achieve this profile. Plot the resulting profile. Your answer may not be unique.

3.) During a subsequent anneal, the profile is changed. If the wafer surfaces are assumed to be at infinity relative to the peak, a simple approximation to the new profile is given by replacing the straggle according to,

$$\Delta R_p \Rightarrow \sqrt{\Delta R_p^2 + 2Dt}$$

where D is the diffusion coefficient and t is time. Using neutral vacancy controlled diffusion data from table 3.2 in your book, plot the new profile after (A) a 1000 degree C, 45 minute furnace anneal and (B) after a RTP anneal at 1100 degrees C for 10 seconds. (C) Given the profiles that result, is the surface at infinity assumption valid for the two cases?