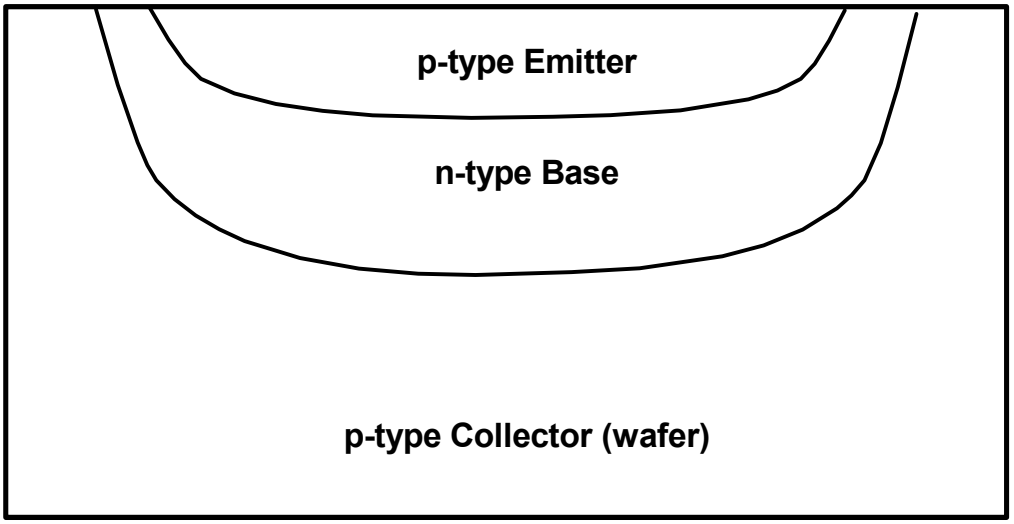
ECE 6450 Homework 2

NOTE: Some reference materials including tables, figures etc... handed out in class or in your text may be needed to solve these problems.

Analog Devices has asked you to fabricate a pnp Bipolar Junction Transistor (BJT) in a p-type, Silicon wafer, uniformly doped to a level of 10^{15} cm^{-3}. The device designer has specified a pnp structure as illustrated with the fabrication to begin with the base diffusion first followed by the emitter diffusion. For good BJT performance, the designer has specified that the Base-Collector junction be 3 um from the wafer surface, while the Base-Emitter junction (10^{16} cm^{-3} doped at the junction) is to be 1 um from the surface. Ignore all edge diffusion effects (i.e. consider all diffusions to be planar resulting in a 1D diffusion and assume $n<<n_i$ and $p<<n_i$ due to very high temperatures resulting in very high n_i).
Base:



1.) The base is to be done first (before the emitter-see step 2) by a predeposition and drive in (not a "2 step diffusion" but 2 individual steps. This means use solutions to the diffusion equation 1 and 2 not 3 from the notes). A.) Which is better, As or P, for the Base to prevent base diffusion during the subsequent emitter diffusion? Why? B.) What dose and characteristic diffusion length are required (this IS a unique answer)? C.) If the temperature of the drive in is limited to 1150 C, what drive in time is required? D.) If the predeposition is done at 900 C, where the surface concentration is $2x10^{20}$ cm^{-3} (limited by the solid solubility of your dopant at 900 C), what is the diffusivity (assume the diffusivity is independent of concentration and is equal to the intrinsic vacancy controlled diffusion)? E.) What time is required to achieve the desired dose? F.) Compare the characteristic diffusion lengths for the predeposition and drive in to verify the validity of the model. G.) What is the surface concentration after the drive in?

Emitter:
2.) A.) If a high surface concentration is desired, what type of diffusion is best for the emitter? B.) If the emitter diffusion is done at 1200 C, what time is required (same assumptions as above, i.e. 1D, high n_i for the diffusivity and the impurity solubility figure in your text may be needed to extract a surface concentration)? C.) What dose is supplied? D.) Using the characteristic diffusion length as an estimate, how far did the base-collector junction move during the emitter diffusion?