Alexandria University
Faculty of Engineering
Electrical Engineering Department

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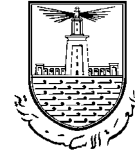

Sheet (2) : Semiconductor Devices
IC_Fabrication

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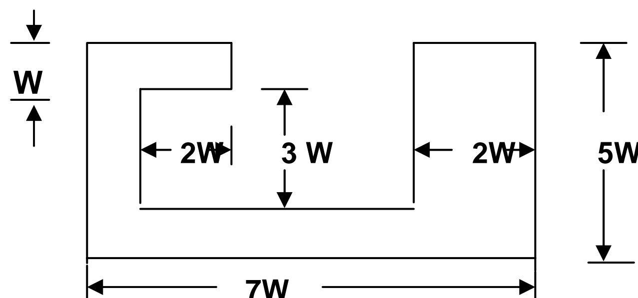
1. **Assume that Boron is diffused into an n-type Si single-crystal substrate with a doping concentration of 10^{15} atoms/cm^{-3}, and also that the diffusion profile can be described by a Gaussian function. Using a diffusion time of 60 minutes, one obtains a measured junction depth of 2 microns and a surface concentration of $1\times10^{18}cm^{-3}$. (This is close to the surface concentration of a diffused base). From the known given profile, determine the diffusivity of Boron into silicon and the temperature at which this diffusion process has been carried out.**
2. **A p-n junction is made by diffusing Boron into an n-type substrate with $C_{SUB}=10^{16}$ cm^{-3}. A constant surface concentration $C_s=10^{20}$cm^{-3} is maintained during the diffusion process. Calculate the time required to form the junction at a depth of 1 μm, if the diffusion temperature is 1050 °C. Repeat for a temperature of 950°C.**
3. **A uniformly doped n-type Si substrate of 0.1 Ωcm resistivity is subjected to a Boron diffusion with constant surface concentration of $4.8\times10^{18}cm^{-3}$. The desired junction depth is 2.7 μm.**
   - **a- Calculate the impurity concentration for the Boron diffusion as a function of the distance form the surface.**
   - **b- How long will it take if the temperature at which the diffusion is conducted at 1100°C?**
   - **c- An n-p-n transistor is formed by diffusing Phosphorous at a surface concentration of 10^{21}cm^{-3}. If the new junction is to be set at a depth of 2 μm, calculate the concentration of the phosphorous diffusion as a function of distance from the surface.**
   - **d- If the phosphorous diffusion takes 30 minutes, at what temperature is the apparatus operated?**
4. **a- Determine the percentage chip surface area of a 5.0-mm^2 chip occupied by a monolithic integrated capacitor whose value is 500 pF. Assume that the active dielectric material is an SiO_2 layer of thickness 0.10 μm.**
   b- Calculate the breakdown voltage for this capacitor. The breakdown voltage for SiO_2 is $6\times10^{6}V/cm$.
5. **Calculate the nominal value of the shown thick film resistor whose sheet resistance is 1.0kΩ/ . If the t□mperature of the above resistance is elevated to 60°C above room temperature, what will the new resistance value be. The TCR is 1000ppm/°C.**



6. **A slice silicon has a 5000-$\overset{o}{A}$ thick oxide on its surface. A window is cut in the oxide, and a diffusion is made through it by two-step process. The resulting oxide over this window is 1500- $\overset{o}{A}$ thick. Determine the time taken to grow the oxide film and sketch the cross section of the silicon, indicating clearly the location of the oxide relative to the substrate. Assume (111) silicon and a 1100^0C process in wet oxygen.**
7. **Calculate the oxide thickness which would be obtained by the following sequence: 20 minutes in dry O_2 followed by 20 minutes in wet O_2, both at 1100^oC. Assume (100) silicon.**