ECE 686 Semiconductor Process and Device Fabrication

Term Project

2023-2024 Spring

In this project, you will develop a numerical simulation tool in regards to a dopant diffusion process. The tool will have GUI. It should accept inputs from the user and display the dopant profiles in two conditions, i.e. (1) after predep and (2) after drive-in. It should also present the junction depths after those two steps.

This is a solo project.

IMPORTANT. It is required that you *numerically* solve the differential equation (diffusion equation, slide 9). It is not acceptable if you use the closed form expressions directly.

Evaluation. On **30 May**, you will **demonstrate** the tool you developed during the class hour.

- Input parameters
  - Dopants: boron (B), arsenic (As), antimony (Sb), and phosphorus (P)
  - Predep temperature range: 900–1200°C
  - Drive-in temperature range: 900–1200°C
  - Predep duration in seconds
  - Drive-in duration in seconds
  - Background (substrate) doping level (atoms/cm^3)
  - Depth range for simulation (limit of depth, measured from surface, in μm or in nm)
- Outputs
  - Dopant concentration profiles (semi-log scale and linear scale)
    - After predep
    - After drive-in
  - Junction depth (in μm or in nm)
    - After predep
    - After drive-in
- Surface concentration (C_0) during predep can be obtained from a lookup table. Refer to slide 6.
- Diffusivities must be calculated. Refer to slide 20.
- Field enhanced impurity diffusion can be ignored.
- Delta doping approximation should not be used. The concentration profile obtained at the end of predep process must be used as the initial condition for the drive-in process.
- Tips about numerical simulation
  - Convert the diffusion equation to a difference equation [1].
  - Be careful with the initial conditions and the boundary conditions for each process.
  - The depth step (δx) and the time step (δt) have to be carefully chosen in order to obtain converged results [1] as well as smooth curves.

[1] https://sites.me.ucsb.edu/~moehlis/APC591/tutorials/tutorial5/node3.html