

# Semiconductor Process (EB68684)

## Report 3 Assignment

Nov. 2, 2019

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### ■ How & When to submit your report :

1. Electronic submission: Submit your report in PDF via E-mail to [leedevicelab@gmail.com](mailto:leedevicelab@gmail.com)

2. Deadline: Nov. 10, 2019

### ■ Answer the questions (problems) of the Chapter 4 with explanations and/or calculations:

#### Chapter 4: Diffusion (3rd elementary process)

**Problem 4-1:** Derive the time-space dependent differential equation (Fick's second law) of diffusion from the Fick's first law and the continuity equation.

**Problem 4-2:** Explain about the two independent mechanisms of diffusion.

**Problem 4-3:** Describe the constant-source diffusion and the limited-source diffusion showing respective mathematical expressions of dopant density as a function of time and space.

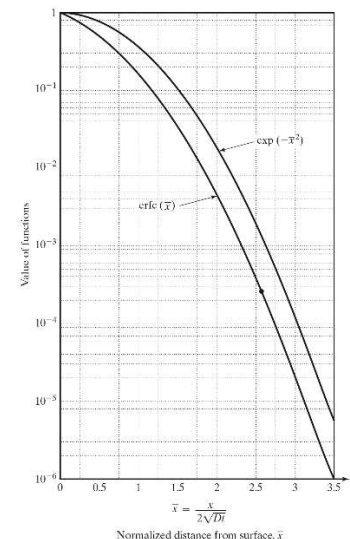
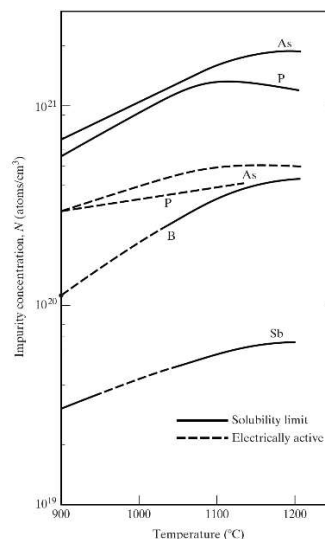
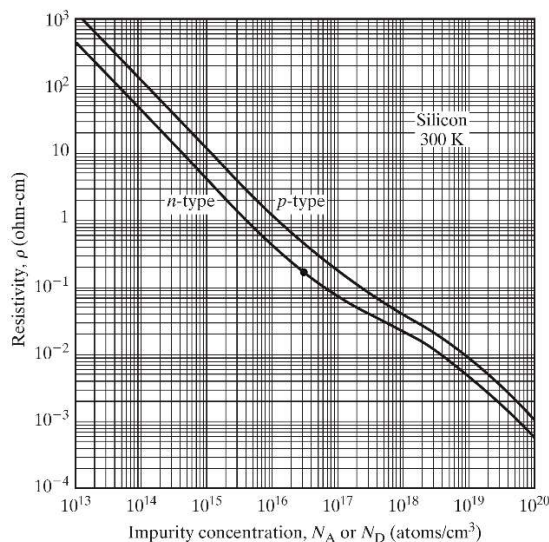
**Problem 4-4:** Explain the two step diffusion in terms of pre-deposition and drive-in processes.

**Problem 4-5:** Explain the background doping concentration-dependent diffusion in terms of relative dominance between the dopant concentration and the intrinsic concentration at diffusion temperature.

**Problem 4-6:** A phosphorus diffusion is used to form the base region of an NPN BJT in a 0.2 Ω-cm p-type silicon wafer. A solid-solubility-limited phosphorus pre-deposition is performed at 900 °C for 20 min followed by a 5-hr drive-in at 1100 °C. Find the surface concentration and junction depth (a) after the pre-deposition step and (b) after the drive-in step using the Table and Figures below:

TABLE 4.1 Typical Diffusion Coefficient Values for a Number of Impurities.

Element	$D_0$ (cm <sup>2</sup> /sec)	$E_a$ (eV)
B	10.5	3.69
Al	8.00	3.47
Ga	3.60	3.51
In	16.5	3.90
P	10.5	3.69
As	0.32	3.56
Sb	5.60	3.95



**Problem 4-7:** Explain the relationship between Sheet resistance and junction depth with calculating Sheet resistances of cases of (a) and (b) of **Problem 4-6**. Also, check graphically with the **Irvin's curves** shown in **Figures 4.16 (c) and (d)**.