ChE 333 Transport Phenomena III, fundamentals of Mass Transfer
Studio Worksheet #10 Unsteady state diffusion in semi-infinite media

NAME____

Studio Section	**Studio 12:00-12:50**	**Studio 13:00-13:50**	**Studio 14:00-14:50**	**Studio 15:00-15:50**

Instructions: Open book, notes, and homework. Make sure to write your name and studio on any additional sheet of paper with your solution. Show your calculation, algebraic setup, and make sure to include units. Please turn in your studio at the end of class.

A silicon wafer of 10 cm diameter and 1.0 mm thickness is coated with a thin film of elemental arsenic metal (*As*), which is a semiconductor dopant. The As-coated silicon wafer is "baked" in a diffusion furnace at 1050 ^oC to allow the As molecules to diffuse into the silicon. At this high temperature, the solubility of *As* in silicon is $2.3 \cdot 10^{21}$ atoms As/cm^3, and the diffusion coefficient of As in solid silicon is still an incredibly small value of $5.0 \cdot 10^{-13}$ cm^2/sec. There is a uniform background impurity of As initially in the silicon of uniform $2.3 \cdot 10^{17}$ atoms As/cm^3 concentration. To obtain a desired semiconductor property and microelectronic device structure, the target concentration of As atoms in the silicon must be least $2.065 \cdot 10^{20}$ atoms As/cm^3 at a junction depth of 0.5 μm ($1.0 \cdot 10^4$ μm = 1.0 cm).

How long would you need to run this process to reach the desired semiconductor properties, and how much As has been loaded into the silicon at that time?

How does the required time needed to run the process change with junction depth(z), sketch it? How much longer would it take if the junction depth (*z*) is increased from 0.5 μm to 1.0 μm?

Would the flux of As from the surface changed from the time it took to reach required concentration at 0.5 μm and 1.0 μm and if so why ?

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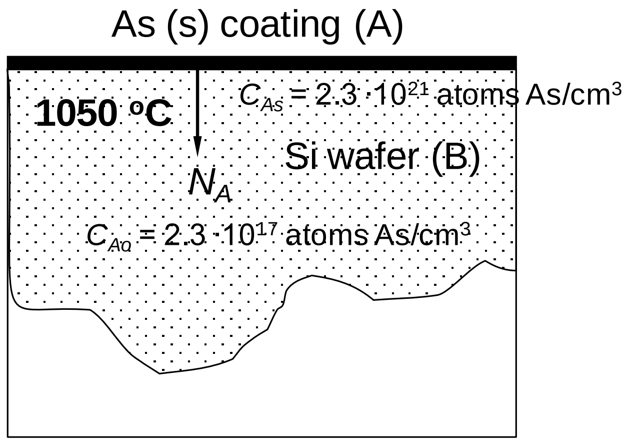

Recall that:

$$\frac{d}{dx}(erf(a \cdot x)) = \frac{2a \cdot e^{-(ax)^2}}{\sqrt{\pi}}$$