

Tutorial problems and questions

1. Consider a carbon steel which is kept at 950° for about 8 hours. The diffusivity of carbon in steel at this temperature is about $10^{-11} \text{ m}^2/\text{s}$. What is the depth to which considerable decarburization would have taken place?

Answer

From the given data, the characteristic time associated with diffusion is found to be $(100 \times 10^{-6})^2 / 10^{-11} = 10^5$ seconds; this roughly corresponds to about 28 hours or so of homogenisation.

2. If it takes about an hour to achieve the required boron doping concentration at a depth of 2 microns in silicon, at the same temperature, how long will it take to achieve the same boron concentration at a depth of 4 microns?

Answer

Given the diffusivity and time; hence, the depth is given by $\sqrt{(Dt)} = 0.54 \text{ mm}$;

3. Consider a cast specimen with an dendritic arm spacing of about 100 microns. The spaces between these dendritic arms are enriched in solutes while the dendrite itself is nearly pure. This type of chemical segregation is known as coring. If at high temperatures, the typical diffusivities are of the order $10^{-13} \text{ m}^2\text{s}^{-1}$, what is the time required for the homogenisation heat treatment?

Answer

The ratios of time will be proportional to the ratios of the squares of distances. Hence, it will take about 4 hours.