10 - 5 - 2012,

Concentration Gradi
implies how the composition of the material varies with distance.

~~EXAMPLE~~

One way to manufacture transistors, which simplify

COMPOSITION PROFILE (FICK'S SECOND LAW)

Dynamic, or ~~non-~~ un-steady state diffusion of atoms, in the differential equation

$$\frac{dc}{dt} = D \frac{d^2c}{dx^2}$$

Diffusivity (m^2/sec)

Solution

$$\frac{C_S - C_X}{C_S - C_0} = \operatorname{erf}\left(\frac{x}{2\sqrt{Dt}}\right)$$

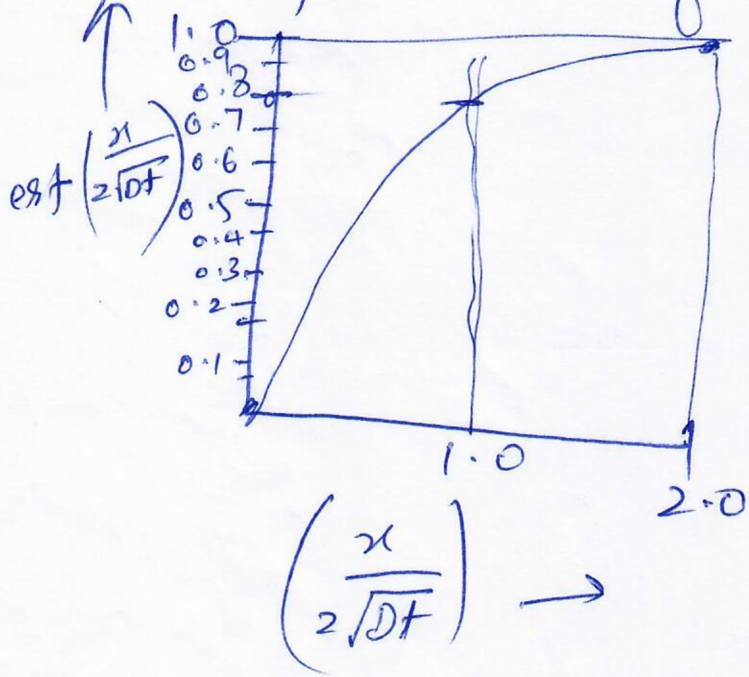
%age of one material in another

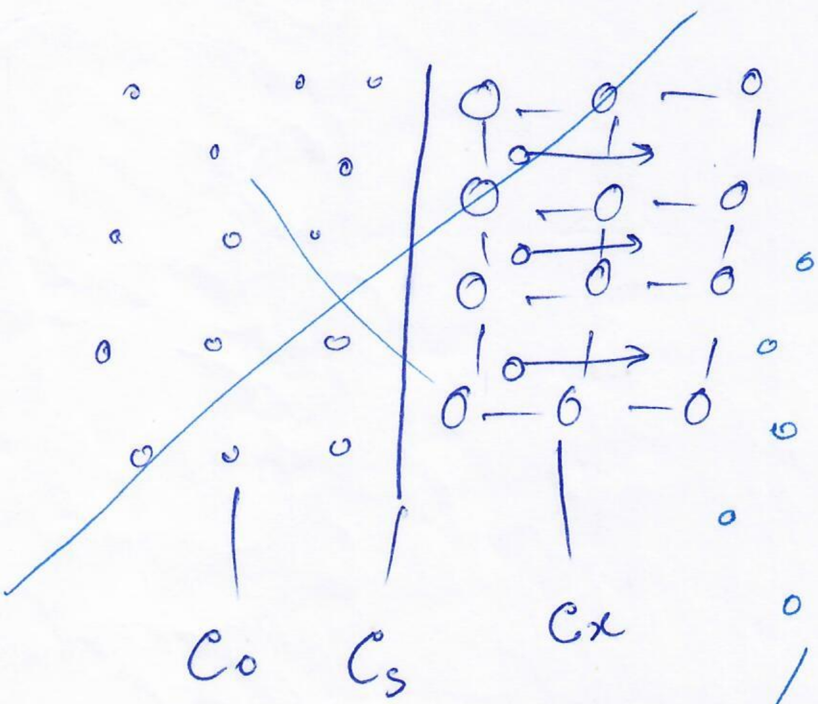
C_S → Constant concentration of the diffusing atoms at the surface of the material

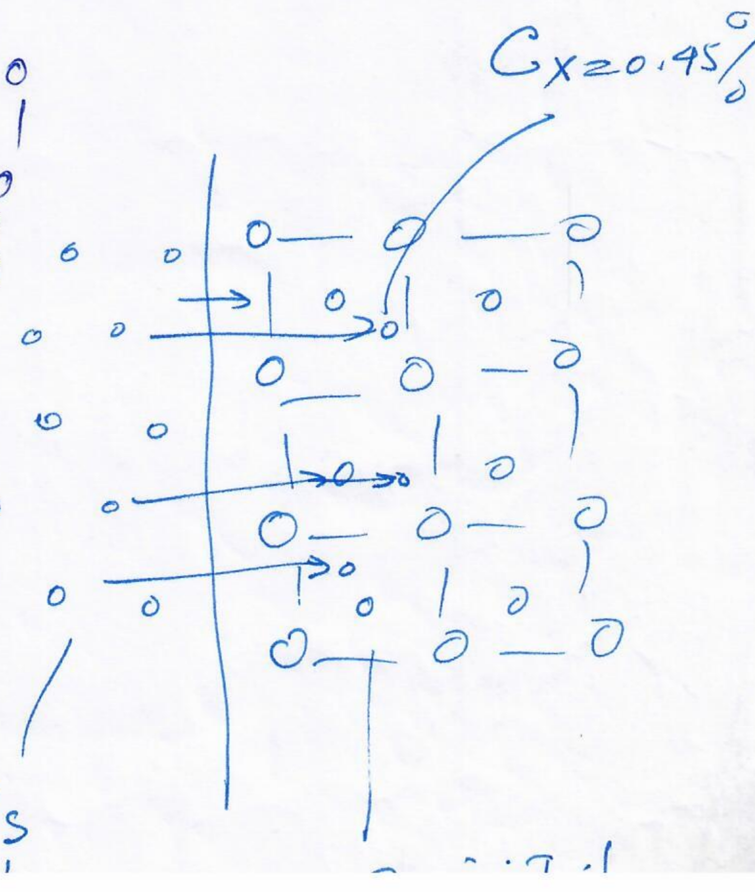
C_0 → Initial uniform concentration of the diffusing atoms in the

$C_x \rightarrow$ Concentration of the diffusing atom at x-location below the surface after time 't'?

erf $\rightarrow$ error function from from







EXAMPLE

The surface of a 0.1% C steel is to be strengthened by carburizing. In carburising the steel is placed in an atmosphere that provides a maximum of 1.2% C at the surface of the steel at a high temperature. Carbon then diffuses into the surface of the steel. For optimum properties, the steel must contain 0.45% C at a depth of 2 mm below the surface. How long will carburising take if the diffusion coefficient is 2×10^{-11} m²/sec

$C_s = 1.2\%\,C$, $C_0 = 0.1\%\,C$

$C_x = 0.45\%\,C$ $\quad x = 2mm = 0.002m$

From Fick's Second Law

$$\frac{C_s - C_x}{C_s - C_0} = \frac{1.2 - 0.45}{1.2 - 0.1} = 0.68$$

$x \quad = \text{erf}\left(\frac{224}{\ldots}\right)$