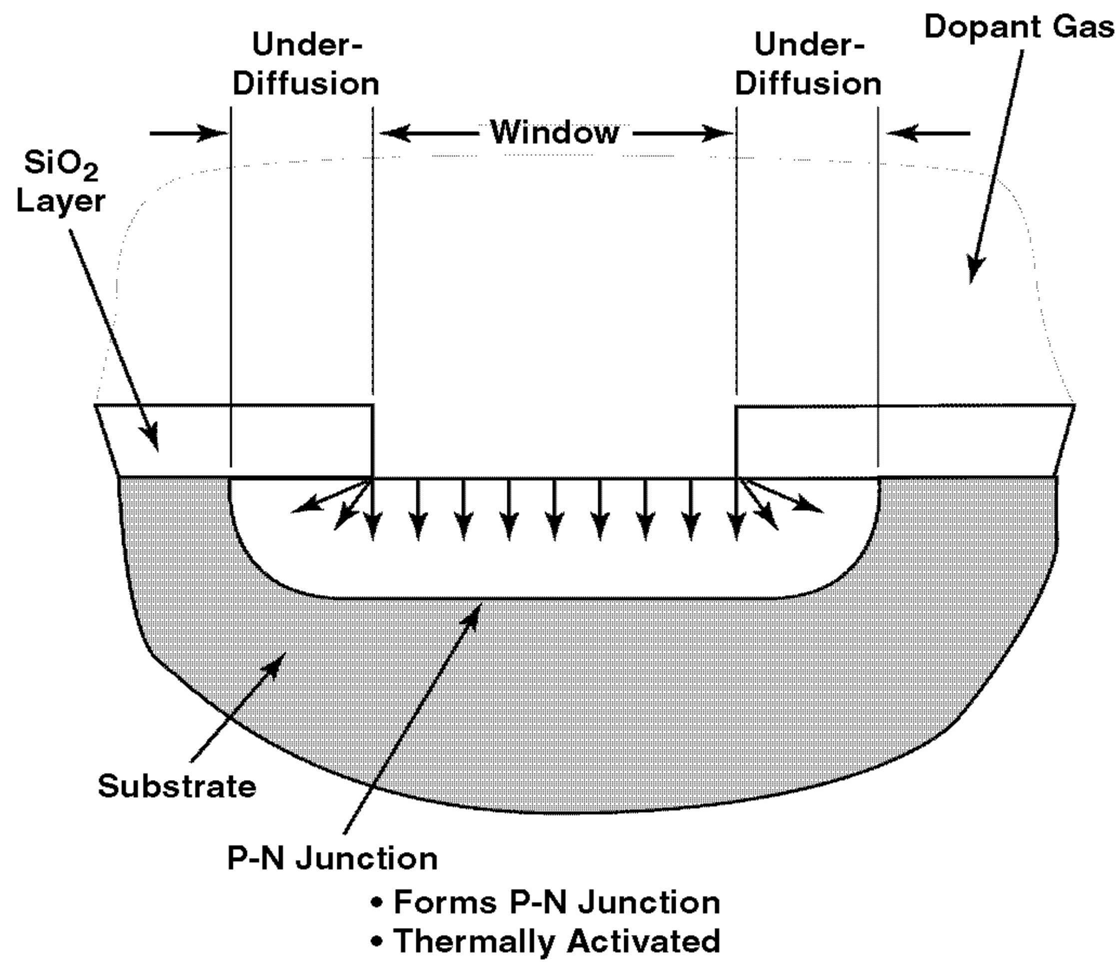
Drogaggio per diffusione



Source: ICE 8244C

$$F(x) = -D \, \partial N / \partial x$$

Where:

- D = the constant of proportionality and is the diffusion coefficient;
- N = the dopant atom concentration in atoms per unit volume; and
- x = the distance from the silicon surface from which dopant diffuses inward.

$$\frac{\partial N}{\partial t} = D\frac{\partial^2 N}{\partial x^2}$$

Where:

N = the concentration of the diffusant species,

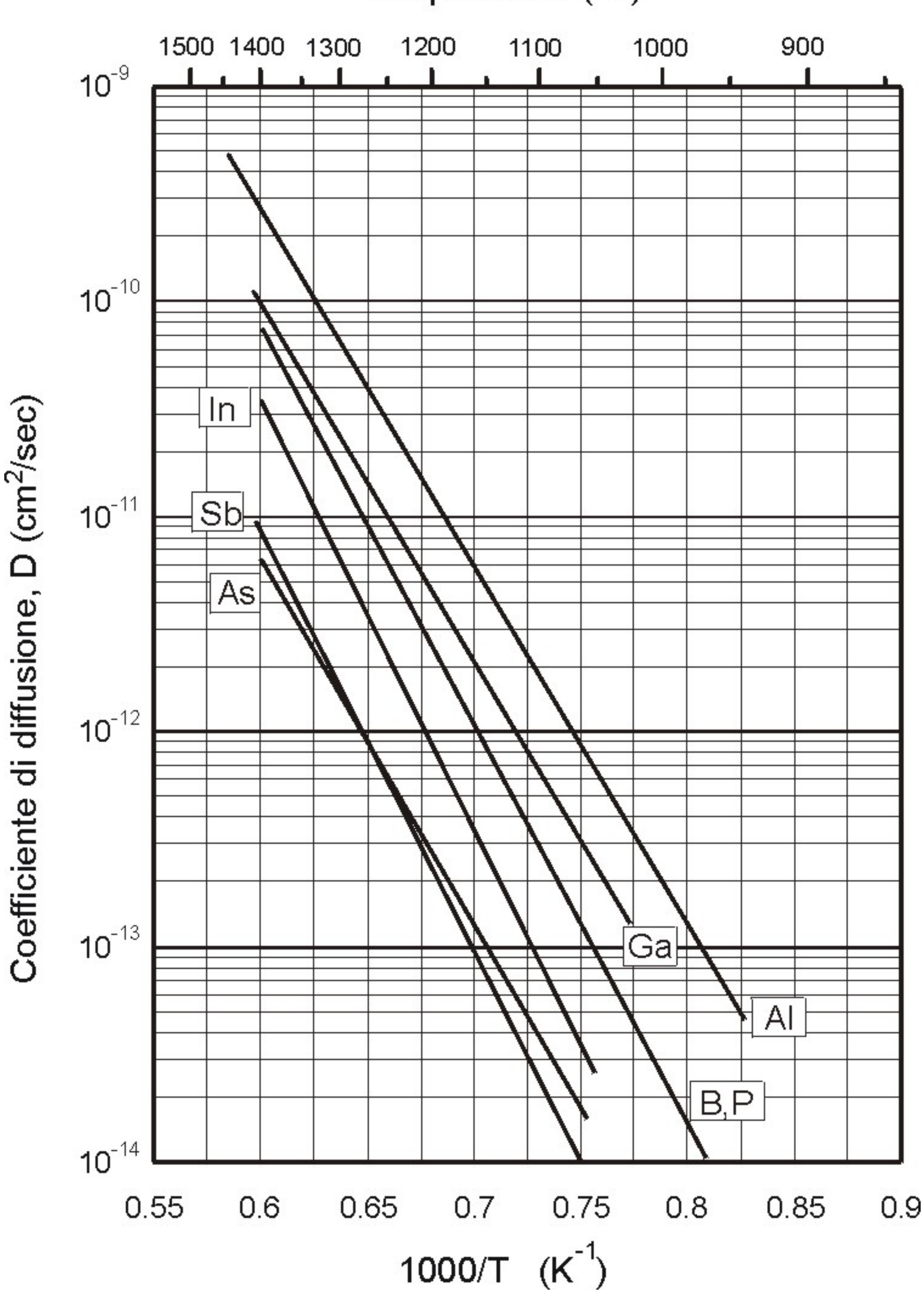
t = time,

x = distance measured in the direction of the one-dimensional diffusion, and

D = the diffusion coefficient, which has been assumed to be independent of x or N.*

$$D = D_0 \exp\left(-\frac{Ea}{kT}\right)$$

Elemento	D_0 [cm^2/s]	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


1500 1400 1300 1200 1100 1000 900
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
Coefficiente di diffusione, D (cm^2/sec)
In
Sb
As
Ga
Al
B,P
0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9
1000/T (K^{-1})

Diffusione con Concentrazione di drogante (Gas) costante alla superficie del Solido

Condizioni al contorno:

$$C(x, t_0) = 0$$

$$C(0, t) = C_S$$

$$C(\infty, t) = 0$$

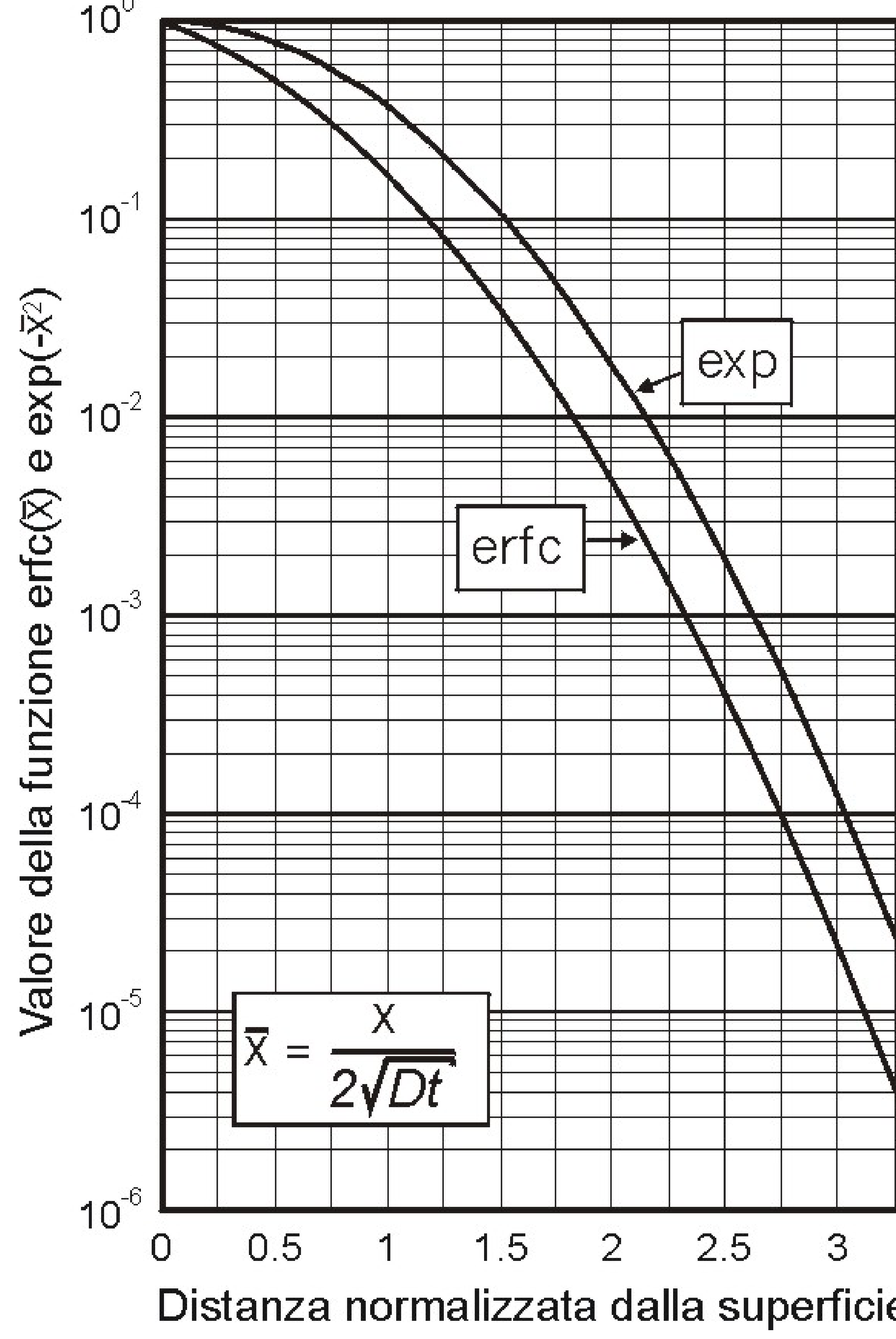
Cs e' la solubilita' ed e' il Limite di concentazione che un drogante puo' raggiungere alla superficie del solido.

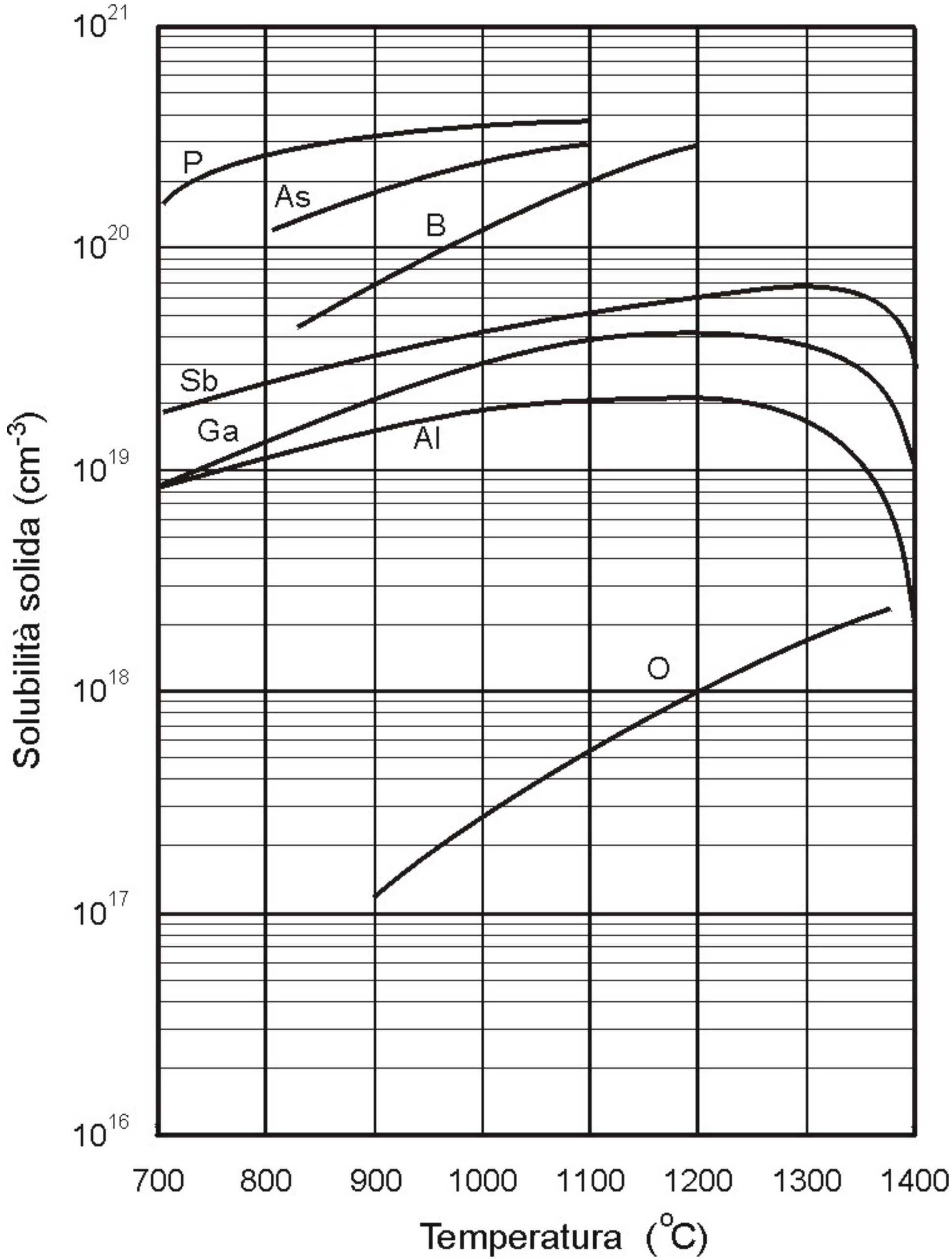
$$C(x,t) = C_s \operatorname{erfc}\left(\frac{x}{2\sqrt{Dt}}\right) = \frac{2C_s}{\pi} \int_{x/2\sqrt{Dt}}^{\infty} e^{-v^2} dv$$

$$\operatorname{erfc}(\eta) = 1 - \operatorname{erf}(\eta) = 1 - \frac{2}{\sqrt{\pi}} \int_0^{\eta} e^{-v^2} dv$$

$$N' = \int_0^{\infty} C(x,t)\,dx = 2\sqrt{Dt/\pi} \times C_s$$

$$C(x,t) = C_S\, erfc\left(\frac{x}{\sqrt{4Dt}}\right)$$



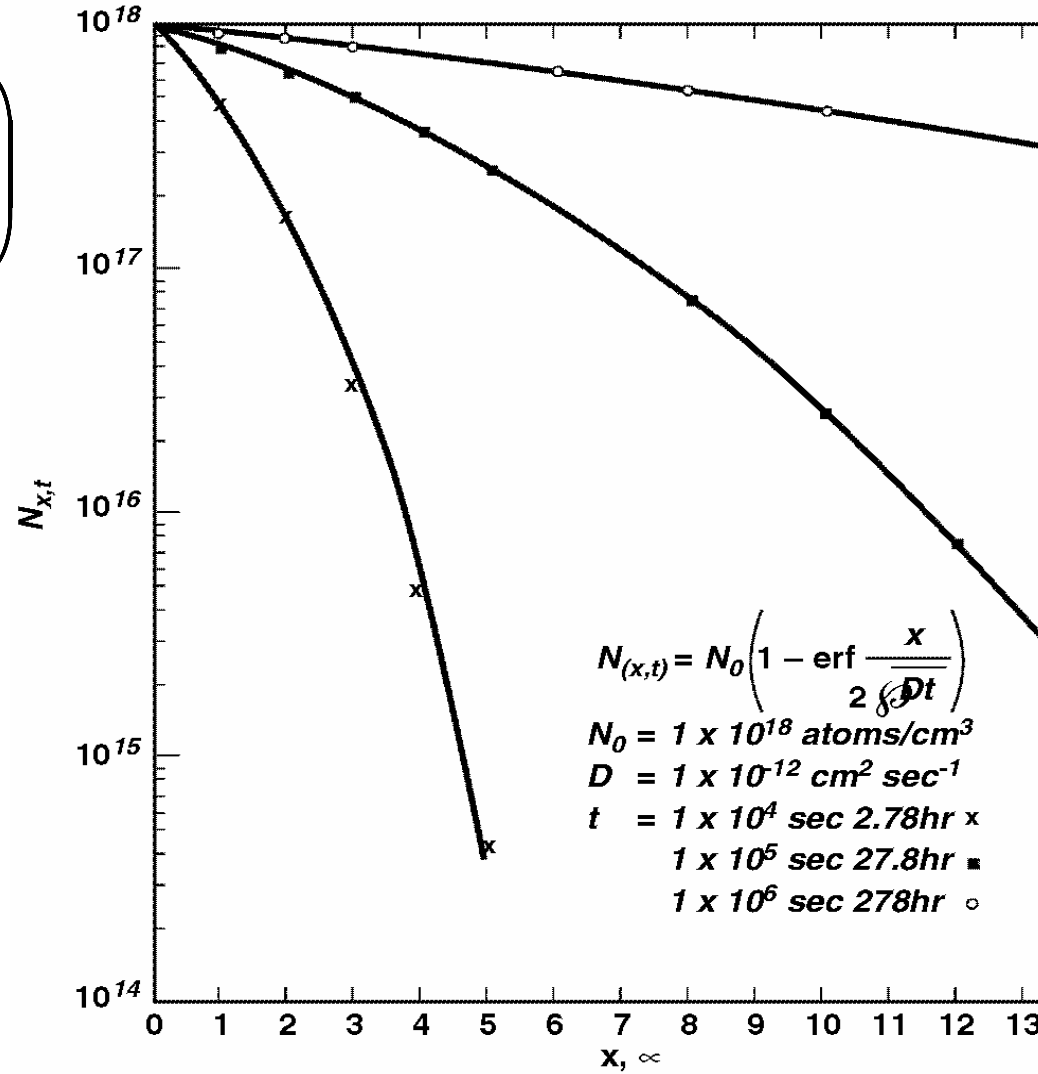


10^{21}
10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
Solubilità solida (cm^{-3})
P
As
B
Sb
Ga
Al
O
700
800
900
1000
1100
1200
1300
1400
Temperatura (^{o}C)

$$N(x,t)=C_S\,erfc\left(\frac{x}{\sqrt{4Dt}}\right)$$

Drogante che entra sel solido al tempo t:

$$N'=Q=2C_S\sqrt{\frac{Dt}{\pi}}$$



Diffusion from an infinite source showing the effect of diffusion time.

Diffusione con Q costante nel Solido (Limited-source diffusion)

$$\int_0^{\infty} C(x,t)\,dx = Q = COST.$$

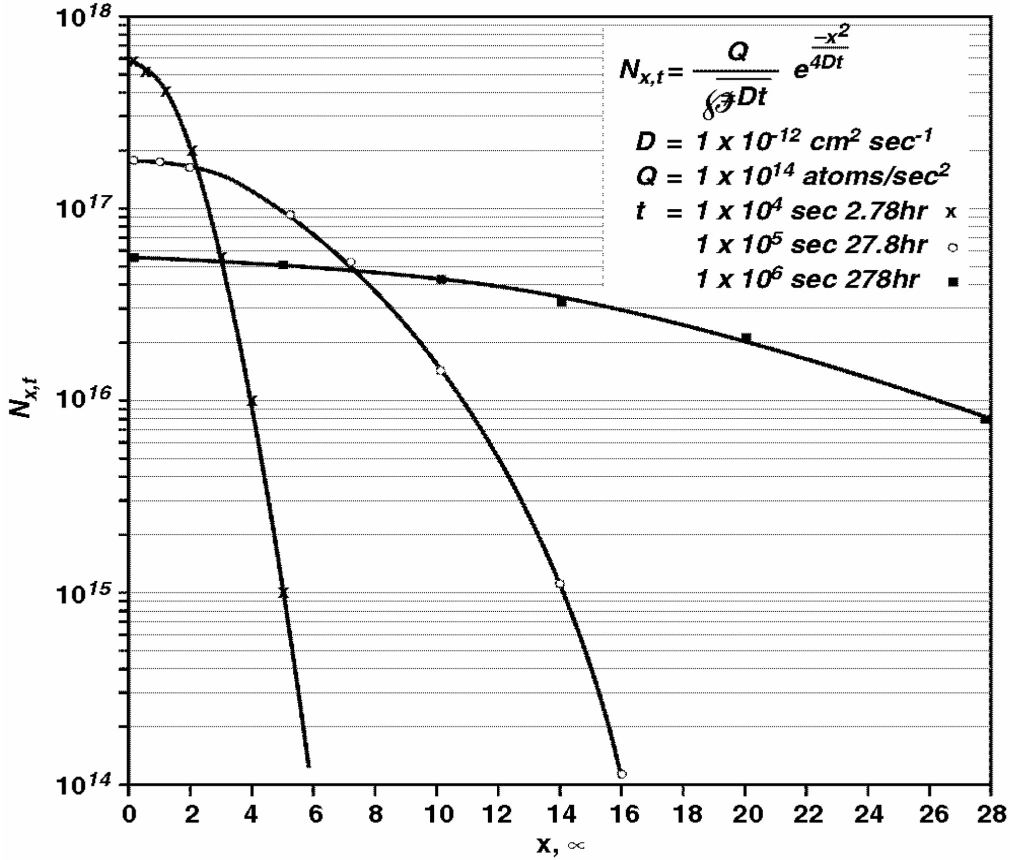
$$C_S(x,t) = \frac{Q}{\sqrt{\pi D t}} \exp\left(-\frac{x^2}{4Dt}\right)$$

$$C_S(0,t) = \frac{Q}{\sqrt{\pi D t}}$$

$$N_B = \left(\frac{Q}{\sqrt{\pi D_2 t_2}} \right) e^{-(x_j^2)/(4D_2t_2)}$$

or

$$\frac{N_B \sqrt{\pi D_2 t_2}}{Q} = e^{-(x_j^2)/(4D_2t_2)}$$



Diffusion from a limited source into a semi-infinite body, illustrating the effect of diffusion.

8778C

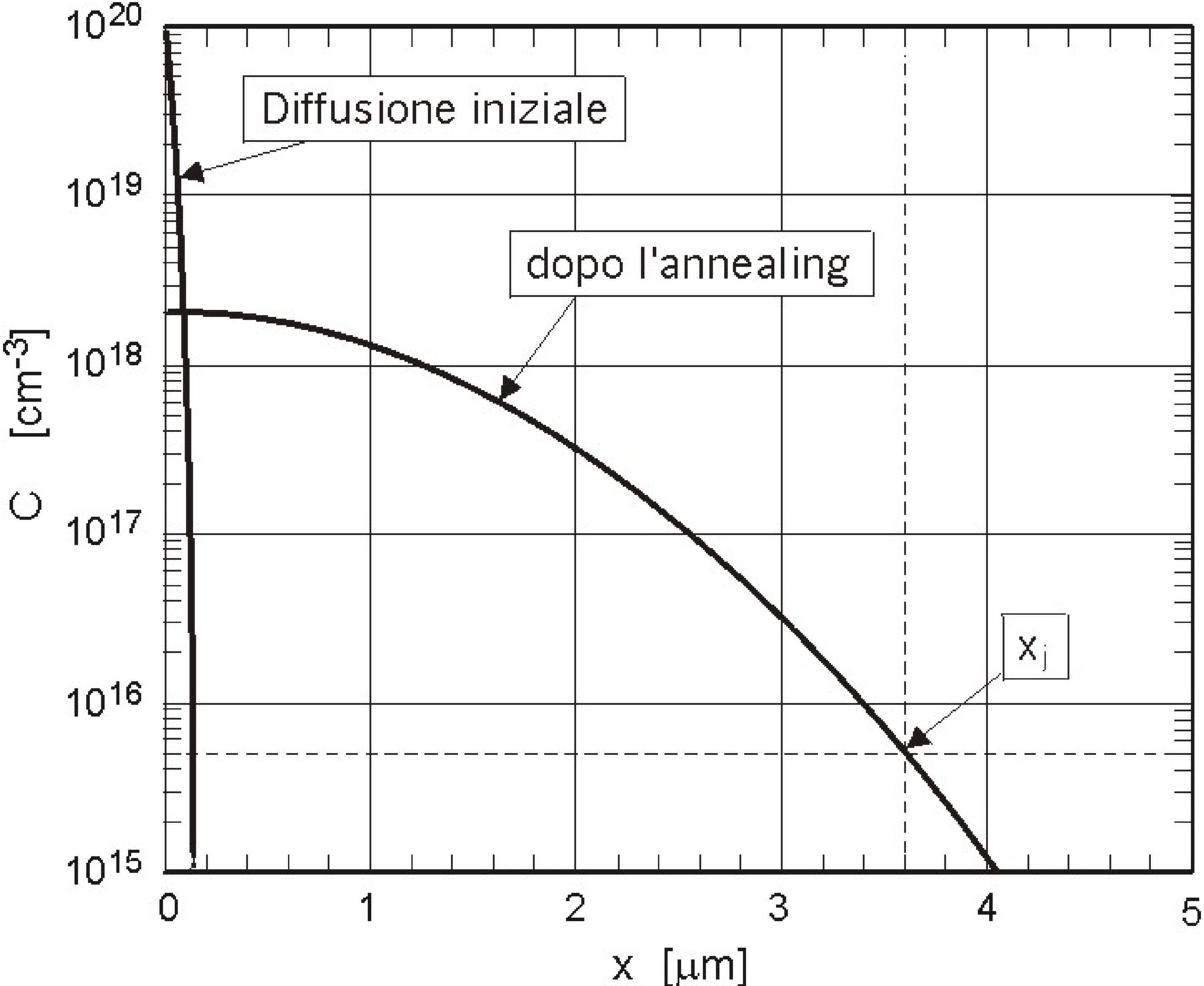
In genere il drogaggio per diffusione avviene in due fasi:

1) Fase di predeposizione (C_S cost.)
2) Fase di "Drive-in" (Q=cost)

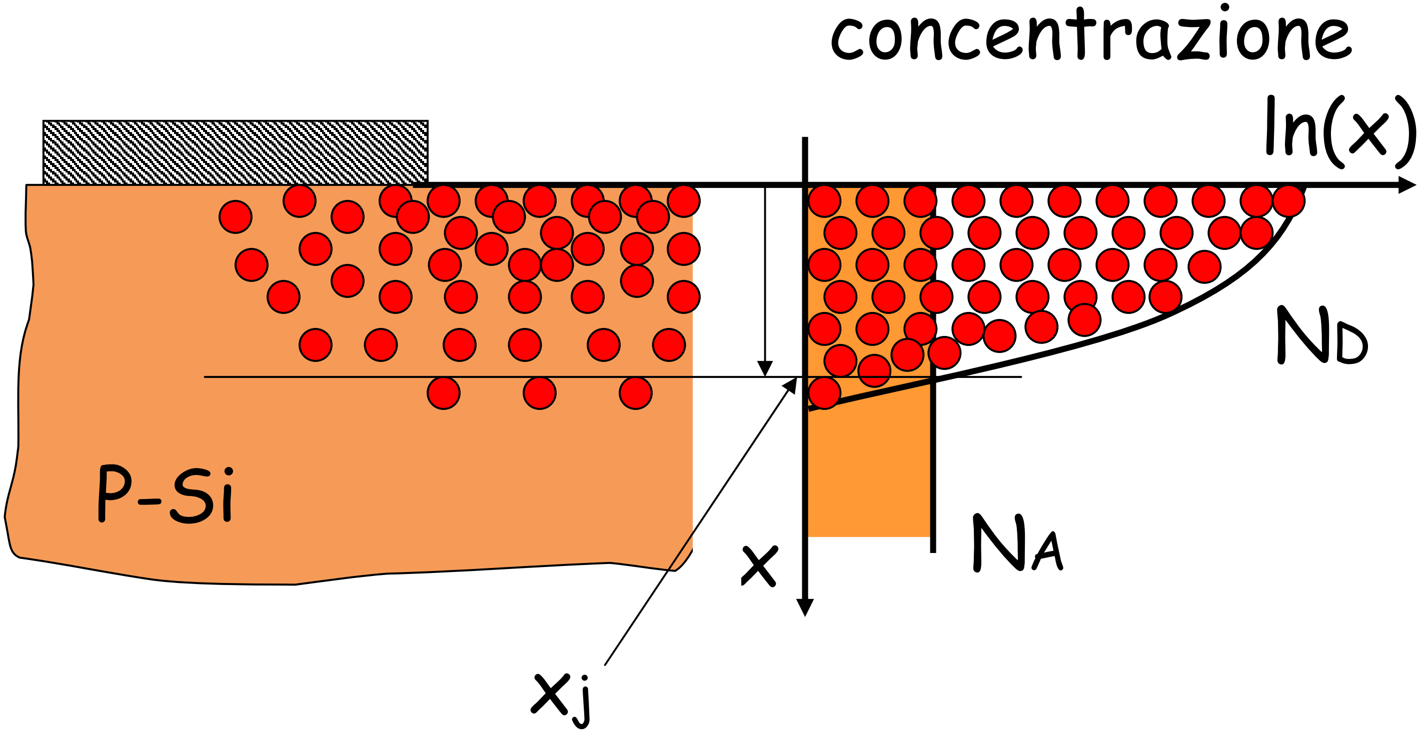
Per applicare le due relazioni viste in questo caso deve essere

$$\lambda_{DRIVE\text{-}IN} >> \lambda_{PRED}$$

Fase di predeposizione + “Drive-in”



Profondità di giunzione



x_j= profondità di giunzione