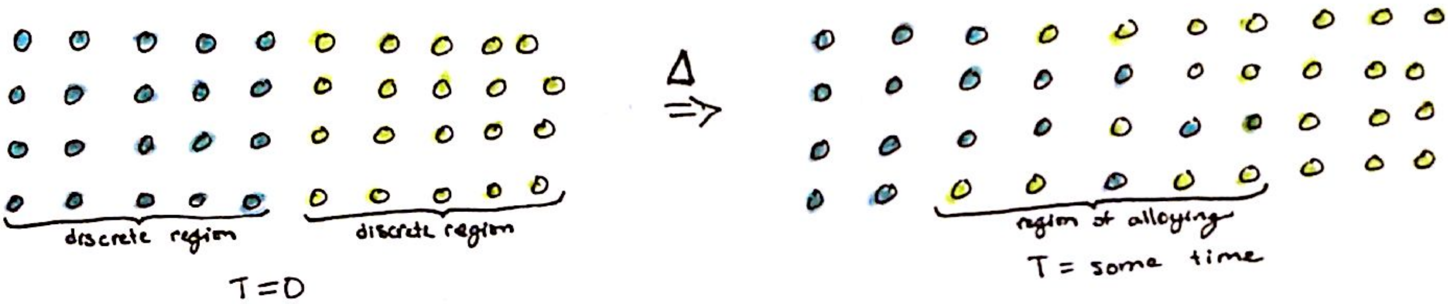
LECTURE 29: DIFFUSION

FRI, 12/2/15

DIFFUSION

- Lowering of the Energy due to Entropy Effects
  - Configurational Entropy (or Entropy of Mixing)
  - Alloying
    - Cu mixed into Ni
    - Ni mixed into Cu
  - Transport of Chemical Species
    - Diffusion

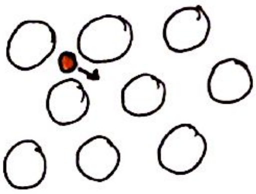
⇒ At time 0, all the Ni is one side and all the Cu is one side. This is not entropically favorable. In time, there is a region where the Cu and Ni are alloyed.



- Vacancy diffusion mechanism

There is a temperature at which the lattice opens up to allow diffusion

- Interstitial Diffusion mechanism



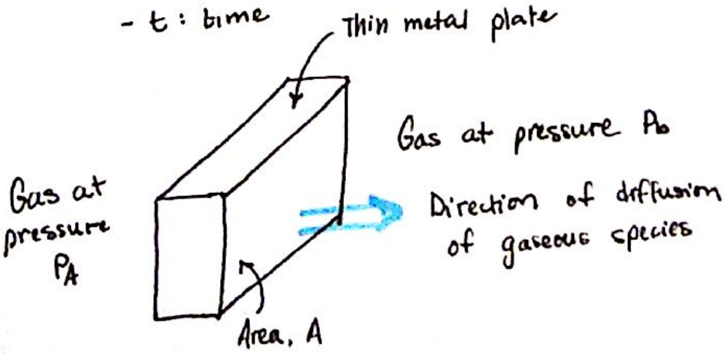
What governs diffusion?

- Diffusion Flux – J : consider a gas flowing through a membrane
  - M: mass
  - A: area
  - t: time

$$J = \frac{M}{At}$$

$$\boxed{J = -D\frac{dC}{dx}}$$

Steady state: flux is constant in time



Fick's First Law
D = Diffusion Coefficient
C = concentration
$\frac{dC}{dx}$ = gradient

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- Non-steady State Diffusion
  - Conservation of Mass

★ Problem: $\frac{dC}{dx}$ changes with time and it makes everything weird

Fick's second law ↗ help us deal with this

$$\boxed{\frac{\partial C}{\partial t} = \frac{\partial}{\partial x}\left(D \frac{\partial C}{\partial x}\right)}$$ Fick's Second Law

How does Fick's second law differ from Fick's first law?
↳ Fick's second law helps take into accont the changing concentration gradient

- Distance of diffusion depends on Distance and time

Atoms → Molecules → Materials → Properties

Happy Holidays!