2019. 3. 5.

Condensed matter physics ≈ solid state physics.

~ systems composed of many particles (atoms, electrons, molecules..)

~ emergence ~ 'whole more than the sum of the parts'

Solid

- long range order → crystalline solid (looks identical at each lattice points)
- holds its shape
- has the volume
- supports a stress (mechanical properties)
- types of solids – crystals | glass ∴ liquid (few Å) gas (100 Å distance)

→ mechanical P. (K, G, E, ν) 머리카락 100 μm.

electrical P. (metal, insulator, semiconductor)

optical P.

∴ 아보가드로수 ; 1몰에 해당하는 원자의 갯수 $6.02 \cdot 10^{23}\ mol^{-1}$

Crystal

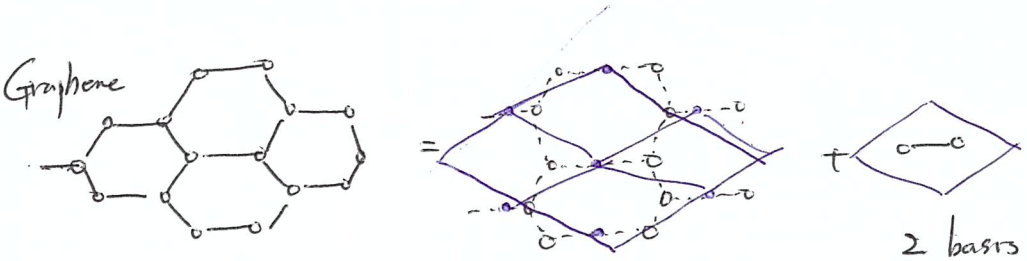
- Periodic arrangement of units (atoms, molecules..)
- crystal = Bravais lattice + basis

infinite collection of points

(looks identical about any points)

Eg.) Ice.

Graphene



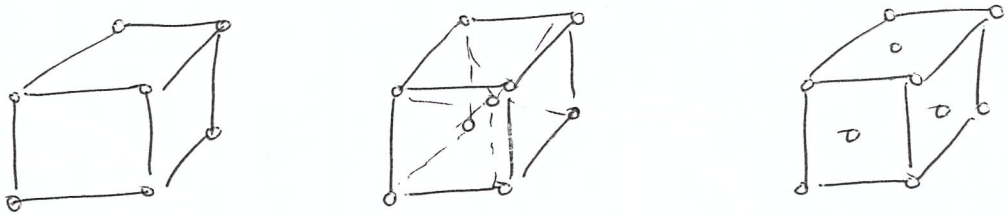
2 basis atoms in a unit cell

Symmetry

- operation that leaves lattice unchanged.
- classification into lattice types that preserves various symmetries
- symmetry transformation → displacements
  → point group operations (rotation about a site)
  → displacement + point group

$$\vec{r} = n_1\vec{a}_1 + n_2\vec{a}_2 + n_3\vec{a}_3$$

Eg.) integer. SC BCC FCC



Bravais lattice.

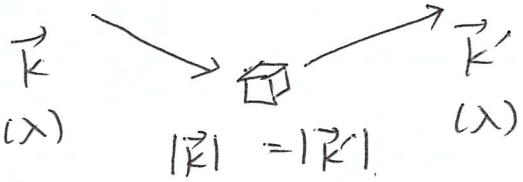
	SC	BCC	FCC
$\vec{a}_1 =$	$a\hat{x}$	$a\hat{x}$	$\frac{a}{2}(\hat{y}+\hat{z})$
$\vec{a}_2 =$	$a\hat{y}$	$a\hat{y}$	$\frac{a}{2}(\hat{x}+\hat{z})$
$\vec{a}_3 =$	$a\hat{z}$	$\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})$	$\frac{a}{2}(\hat{x}+\hat{y})$
	↳ unit vector	or	
		$\frac{a}{2}(-\hat{x}+\hat{y}+\hat{z})$	
		$\frac{a}{2}(\hat{x}-\hat{y}+\hat{z})$	
		$\frac{a}{2}(\hat{x}+\hat{y}-\hat{z})$	

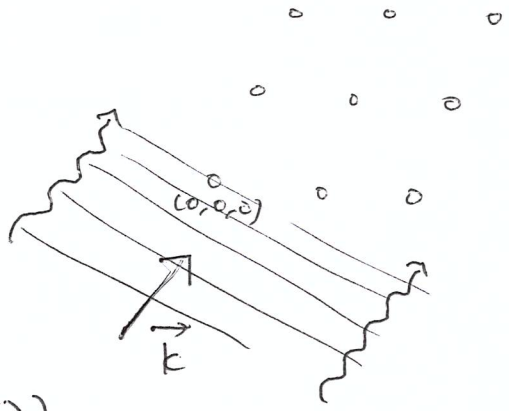
vol. of primitive cell $= |\vec{a}_1 \cdot (\vec{a}_2 \times \vec{a}_3)|$ $= a^3$ $\frac{1}{2}a^3$

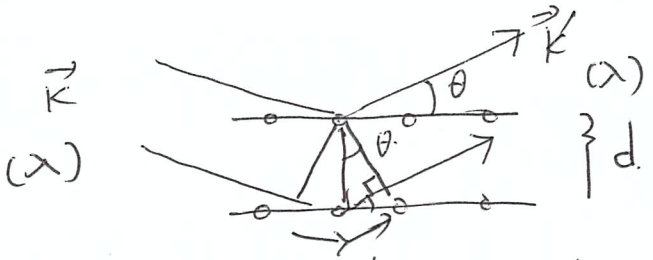
Scattering of waves by a crystal

1. Reciprocal lattice. ∝ wave in crystal (electron propagation, phonon propagation)
2. Crystal Scattering
   - Bragg's condition
   - Laue condition)
3. Fourier Series.

Scattering by a crystal







additional length = $2d\sin\theta = n\lambda$.

→ constructive interference 강화 간섭.

OPC.

$C_3S \rightarrow 2C_3S + 6H \rightarrow C_3S_2H_3 + 3CH$

$C_2S \rightarrow 2C_2S + 4H \rightarrow C_3S_2H_3 + CH$

? C_4AF

$C_3A \rightarrow$ { $C_3A + 3C\bar{S} + 32H \rightarrow C_6A\bar{S}H_{32}$ Ettringite

less Gypsum $C_4A\bar{S}H_{12}$ Monosulfate.

$C_3A + H \rightarrow C_4AH_{13}, C_2AH_8.$

pozzolan $+ CH + H \rightarrow$ C-S-H.

CSA

$C_4A_3\bar{S} + 18H \rightarrow C_4A\bar{S}H_{12} + 2AH_3$

$C_4A_3\bar{S} + 2C\bar{S}H_2 + 32H \rightarrow C_6A\bar{S}H_{32} + 2AH_3$

$C_2S + AH_3 + 5H \rightarrow C_2ASH_8$