1. Introduction

1.1 Why crystallization?

The constituent atoms, ions or molecules of a crystal are arranged in a regular infinite manner.

→ self-assembly

Crystals allow only similar molecular-scale growth units to attach themselves to the crystal lattice. → molecular recognition

Crystallization :

- purification technique
- separation process
- particle technology

Scale of crystals :

- nano-meter : catalyst, active metals
- submicro-meter : pigment, silver halide, pharmaceuticals
- millimeter : salt, sugar, diamond, quartz

Properties of crystals

- anisotropic : growth rate, refractive index, thermal expansion, electric conductivity etc.

Examples

- sugar, salt, cement, gypsum, ice, snow, quartz, diamond

1.2 What do we need to know?

1. Thermodynamics

- Phase equilibrium : solid-liquid, solid-solid, liquid

2. Kinetics

- Crystal nucleation
- Crystal growth
- Crystal agglomeration/breakage

3. Process

- Reaction
- Mass transfer
- Heat transfer
- Mixing
- Flow rate

1.3 What are crystals and how do we recognize them.

Crystalline : single crystal, poly-crystal

Long-range order + short-range order

Amorphous :

Short-range order

Space group : defining the three dimensional space of unit cell ($a, b, c, \alpha, \beta, \gamma$)

Crystal system (7 systems)

- Cubic ($a = b = c$) ($\alpha = \beta = \gamma = 90^o$)
- Hexagonal ($a = b \neq c$) ($\alpha = \beta = \gamma = 90^o$)
- Tetragonal ($a = b \neq c$) ($\alpha = \beta = 90^o, \gamma = 120^o$)
- Rhombohedral ($a = b = c$) ($\alpha = \beta = \gamma \neq 90^o$)

- Orthorhombic $(a \neq b \neq c)$ $(\alpha = \beta = \gamma = 90^o)$
- Monoclinic $(a \neq b \neq c)$ $(\alpha = \gamma = 90^o \neq \beta)$
- Triclinic $(a \neq b \neq c)$ $(\alpha \neq \beta \neq \gamma \neq 90^o)$