MSE-S304

Phase Transformation in Metals

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Heterogeneous Nucleation

Introduction to Heterogeneous Nucleation

- Nucleation is generally a random process.
- In fact, in two identical systems nucleation will occur at different times.
- In Heterogeneous Nucleation, Nucleation with the nucleus at the surface is much more common and faster process than homogeneous nucleation.
- Heterogeneous nucleation needs the presence of a foreign substance to initiate the nucleation.

Introduction to Heterogeneous Nucleation

- **Heterogeneous nucleation applies to the *phase transformation* between any two phases of *gas, liquid, or solid.***

Example

- **Condensation of gas and or vapor.**
- **Solidification from liquid.**
- **Bubble formation from liquid, etc.**

The wetting angle determines the ease of nucleation by *reducing the energy needed.*

Homogeneous Nucleation / Heterogeneous Nucleation

Homogeneous Nucleation	Heterogeneous Nucleation
Nucleation takes place away from the surface of the system.	*Nucleation takes place at the surface of the system.*
Nucleation Site: NIL.	*Nucleus grows at the Nucleation site.*
Nucleation Rate: Slow.	*Nucleation Rate: Fast.*
Nucleation Type: Less Common.	*Nucleation Type: Most Common.*
Free Energy Barrier: High.	*Free Energy Barrier: Low.*

Introduction to Heterogeneous Nucleation

- **Nucleation of the *product phase* during *solid state transformation***

Lattice Imperfections in the parent phase

(Grain Boundaries, Free Surfaces, Inclusions/Matrix interfaces and Dislocations)

Introduction to Heterogeneous Nucleation

Nucleation of the *product phase* during *solidification*

Container/Liquid interfaces and Inclusion/Liquid interfaces