Chapter 10 Phase transformation in metals

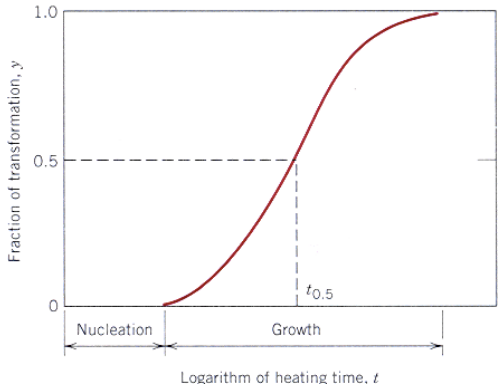
- Basic concepts
- The kinetics of solid-state reactions
- Isothermal transformation diagrams
- Mechanical behavior of iron-carbon alloys

Basic concepts

- Phase transformation takes time to occur
- Types of phase transformation

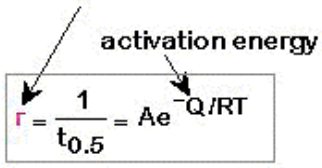
The kinetics of solid-state reactions

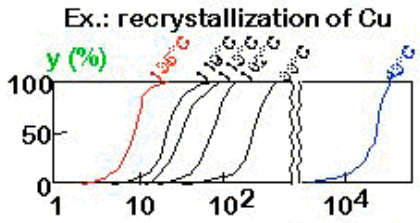
- Fraction of transformation depends on T



The kinetics of solid-state reactions (*continue*)

- Transformation rate depends on T



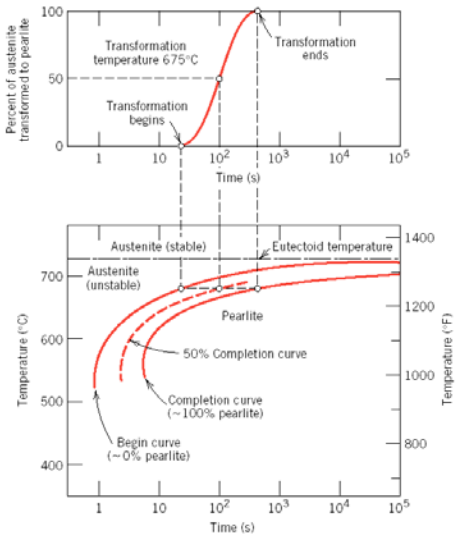


- r often small: equil. not possible!

Callister, Fig. 10.2

Isothermal transformation diagrams

- Iron-iron carbide eutectoid reaction



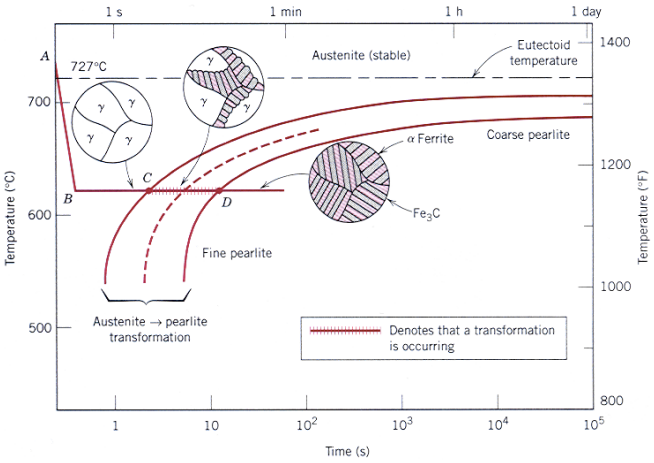
Pearlite morphology

Coarser

Finer

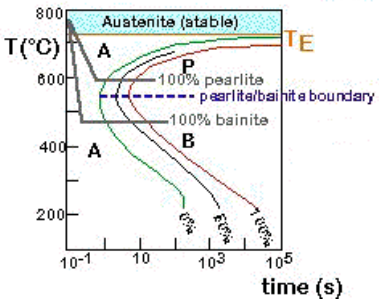
Isothermal transformation diagrams (*continue*)

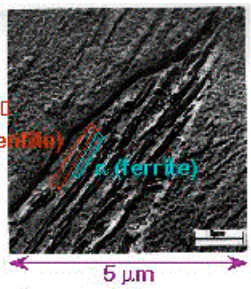
- Heat treatment & microstructures



Nonequil transformation products: bainite

Bainite

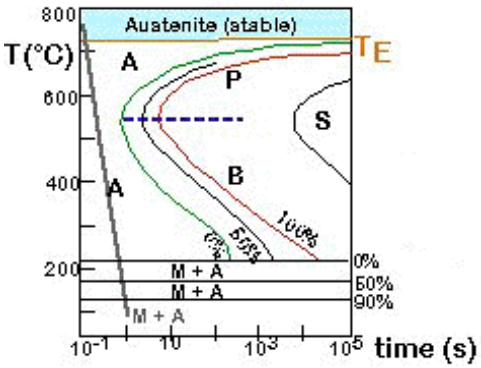


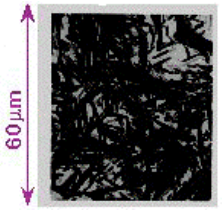


Bainite reaction rate:

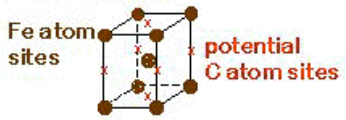
$$r_{bainite} = e^{-Q/RT}$$

Nonequil transformation products: martensitic

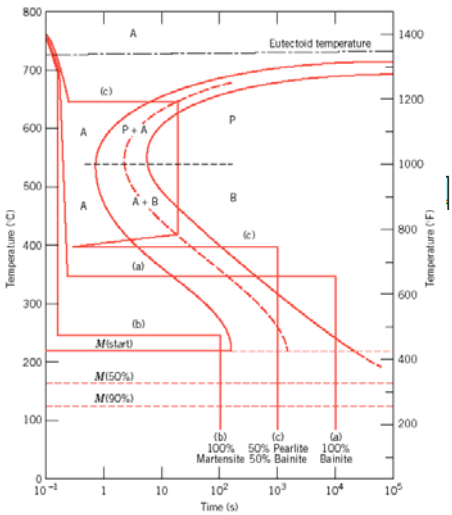




Martensite:
-γ(FCC) → M(BCT)



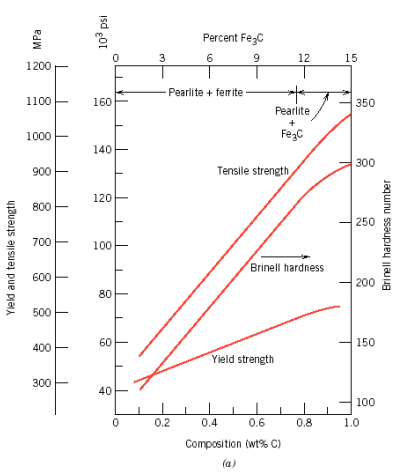
Example

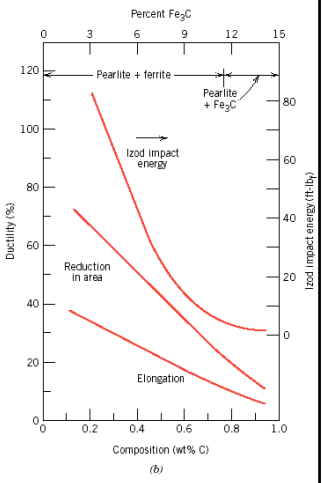


Rapidly cool to:	Hold for:	Rapidly cool to:	Hold for:	Rapidly cool to:
350°C	10^4s	T_{room}		
250°C	10^2s	T_{room}		
650°C	20s	400°C	10^3s	T_{room}

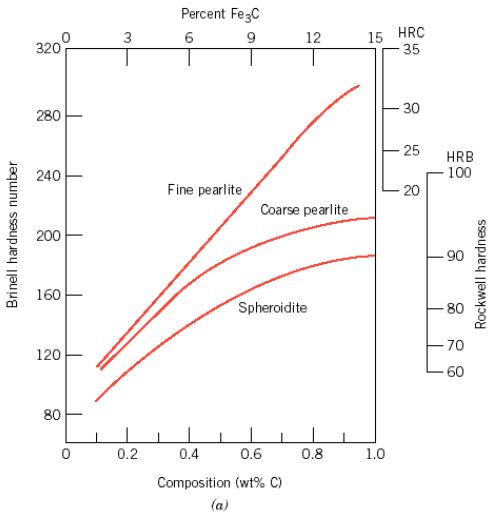
Mechanical behavior of iron-carbon alloys

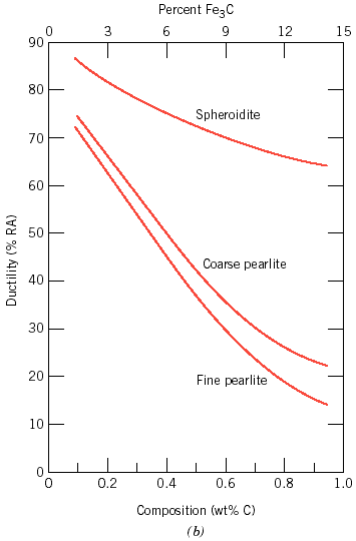
- Yield strength and hardness increase with wt%C
- Ductility decreases with wt%C



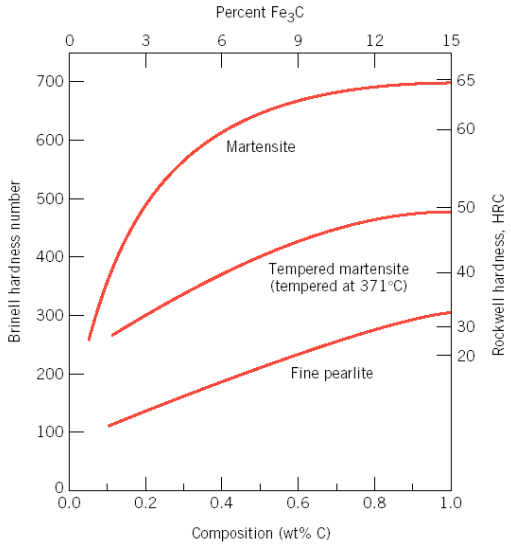


Mechanical properties of grain sizes





Mechanical properties of Fe-C system



Mechanical properties of Fe-C system