Properties of Materials

Metal Processing

Microstructures

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2.7 Queens Building

Formative Feedback

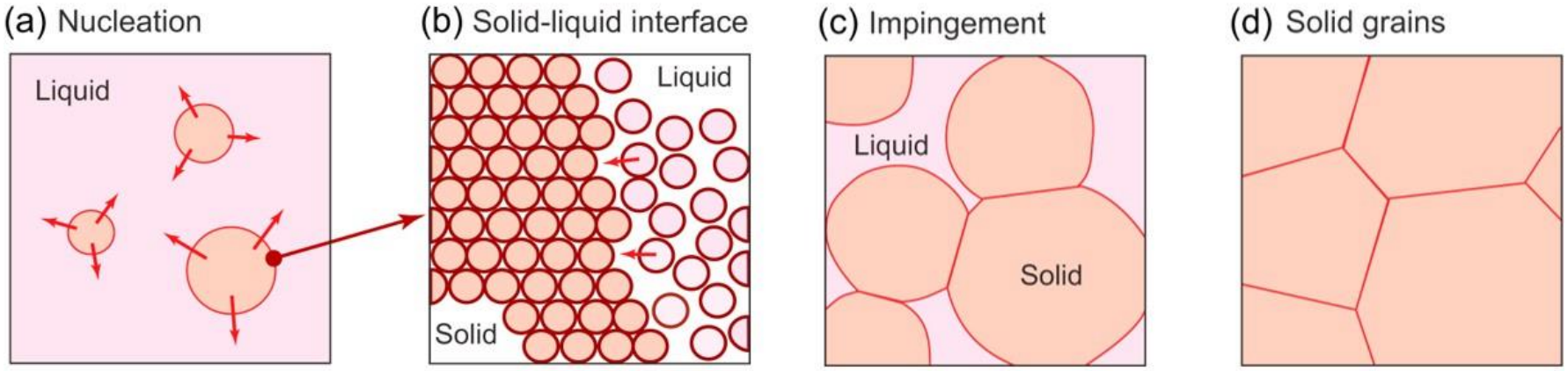
- Top 3 Questions
  - "How to choose correct side of the lever"
  - "If there is liquid present, is it always composed of both metals"
  - "Is there a visual example of partially mixed solid"
- Response
  - I'll show/reinforce this during this lecture
  - No (for you: YES). Also 90% if our interest is solid-solid transformations
  - I will show videos of solidification (solid+liquid) and deal with solid-solid mixtures in this lecture.

Preview

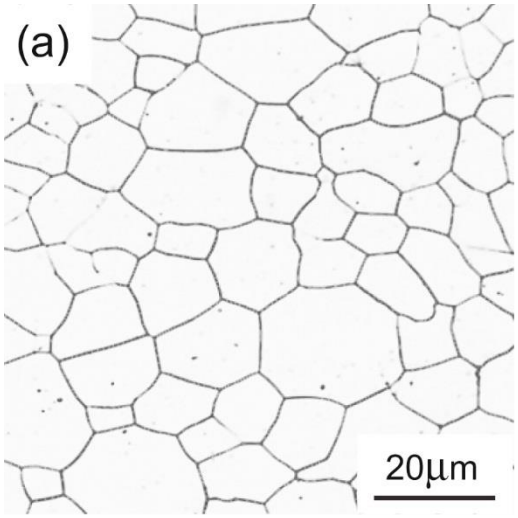
Intended Learning Outcomes	
Understanding	How the phases predicted by phase diagrams tend to manifest.
Skills	Able to make qualitative predictions of microstructure from phase diagrams.
Values	Appreciate the link between microstructure and subsequent properties.

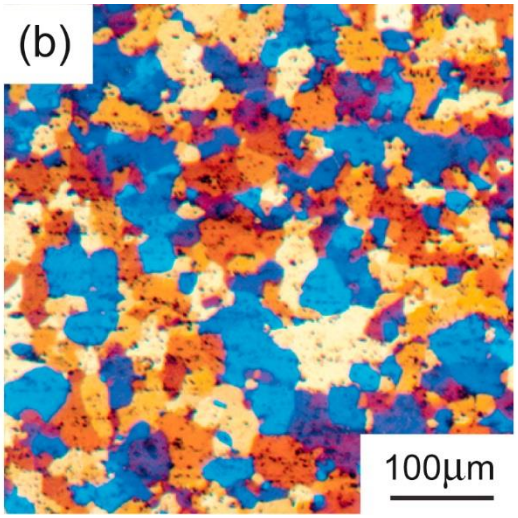
- Interpreting phase diagrams wrt common microstructures
- Predict likely changes in properties
- Look at Fe-C phase diagram

Microstructures



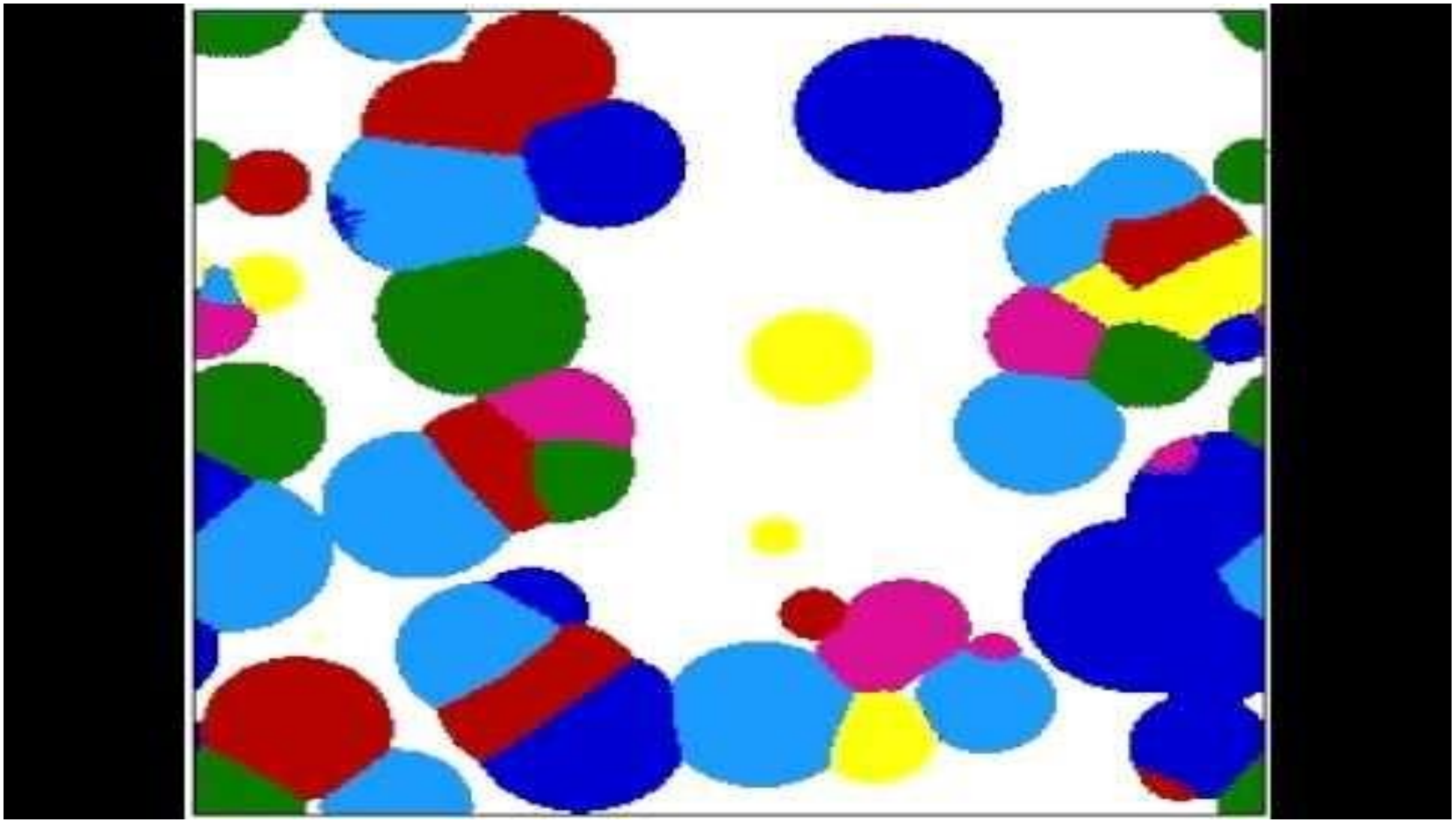
Pure Fe



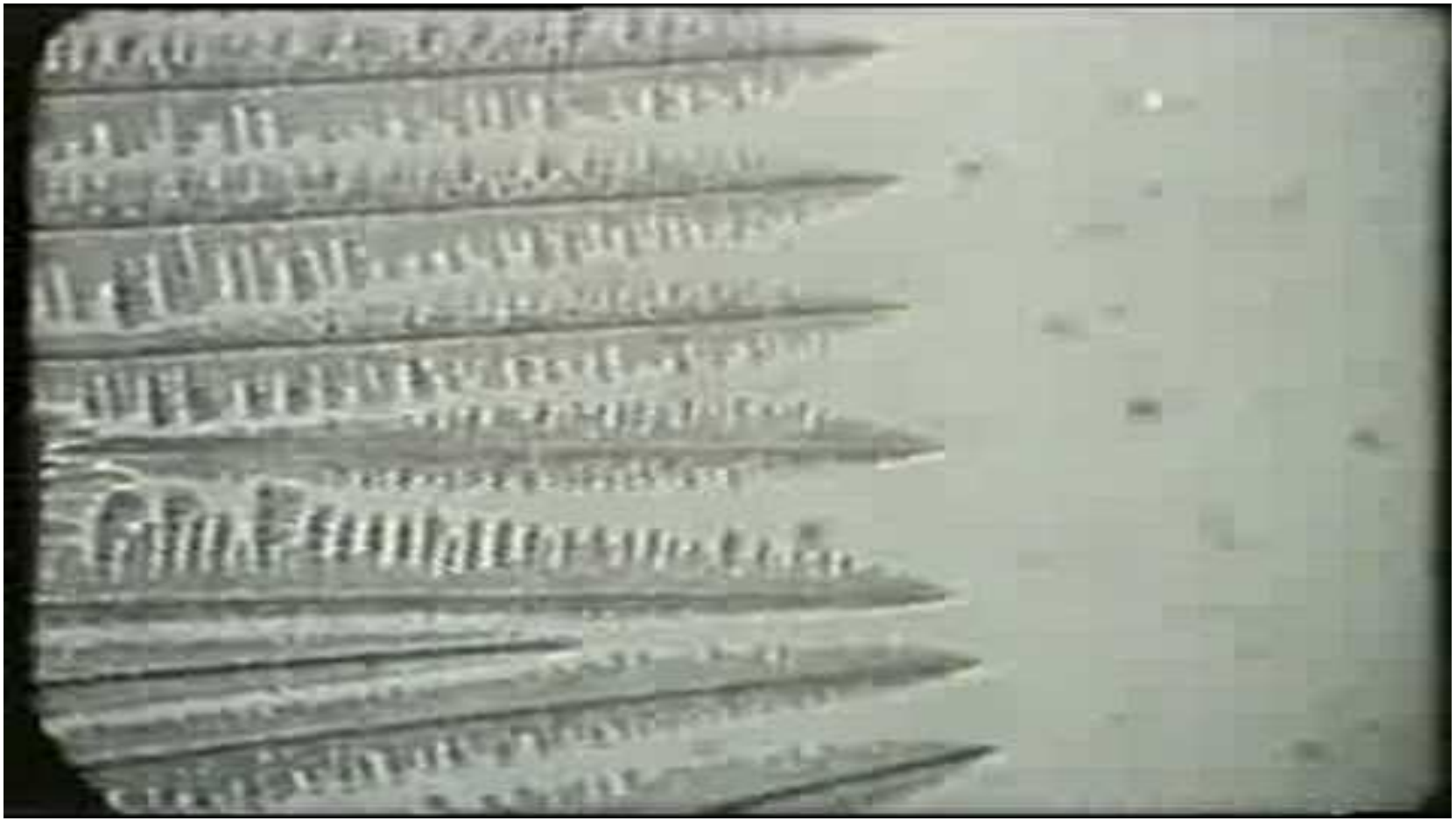


Pure Al

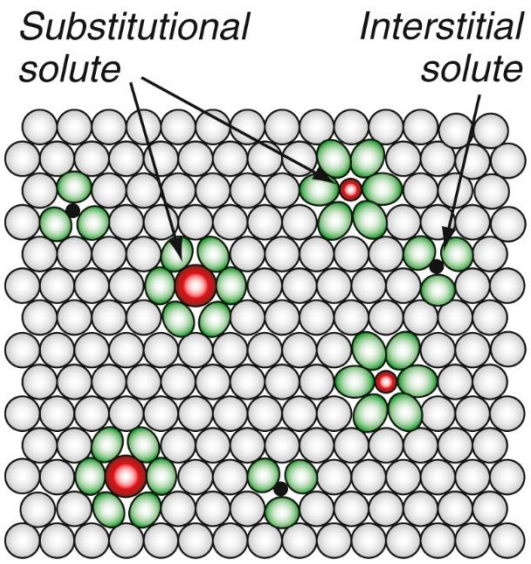
Solidification

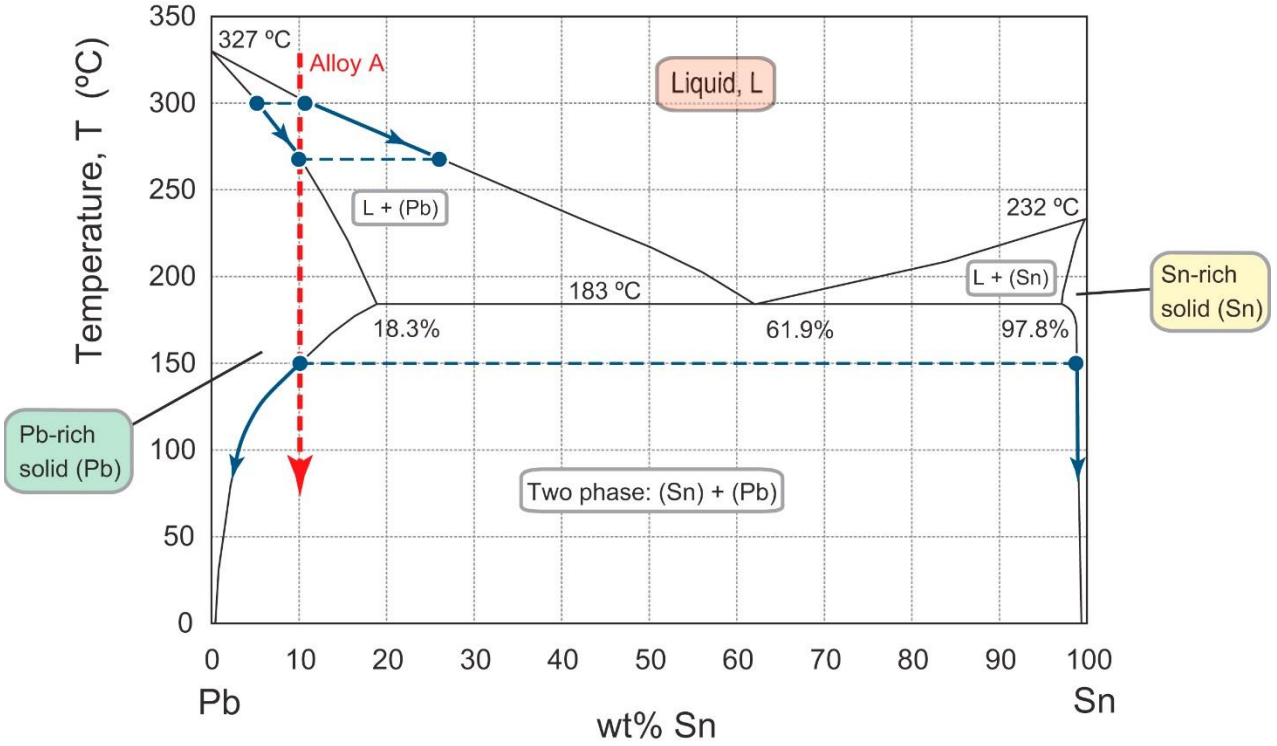


Solidification

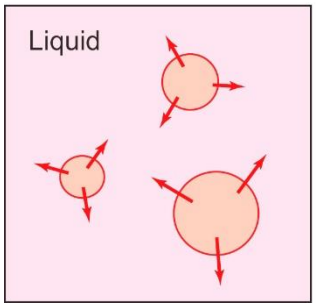


Microstructures

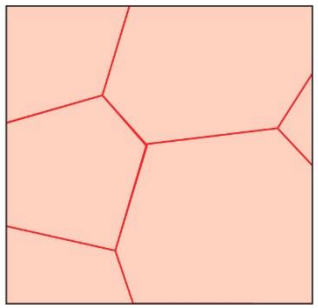




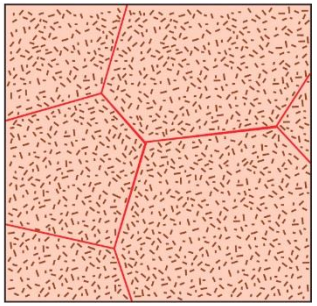
Nucleation of (Pb), below 305 °C



Grains of (Pb), 270 °C to 150 °C



Precipitation of (Sn) within (Pb) grains, below 150 °C



If precipitates are **hard** in **soft** matrix we get a strengthened material

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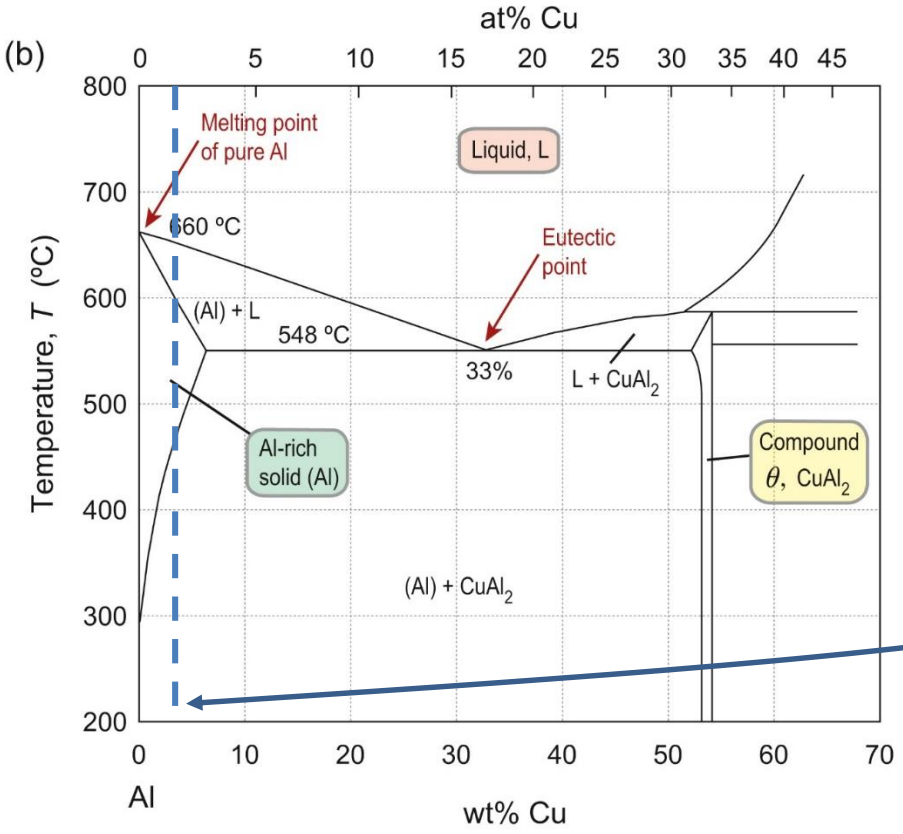
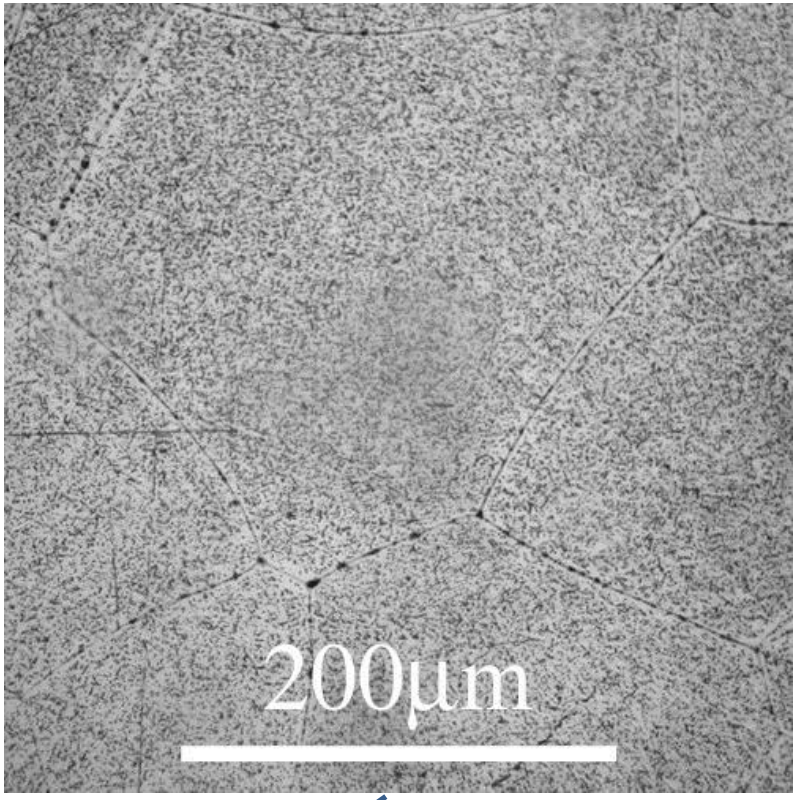
Al-Cu (2xxx)


(b)
at% Cu
0
5
10
15
20
25
30
35
40
45
800
700
600
500
400
300
200
Temperature, T (°C)
Melting point of pure Al
660 °C
Liquid, L
Eutectic point
(Al) + L
548 °C
33%
L + CuAl2
Al-rich solid (Al)
Compound θ, CuAl2
(Al) + CuAl2
0
10
20
30
40
50
60
70
Al
wt% Cu


200μm

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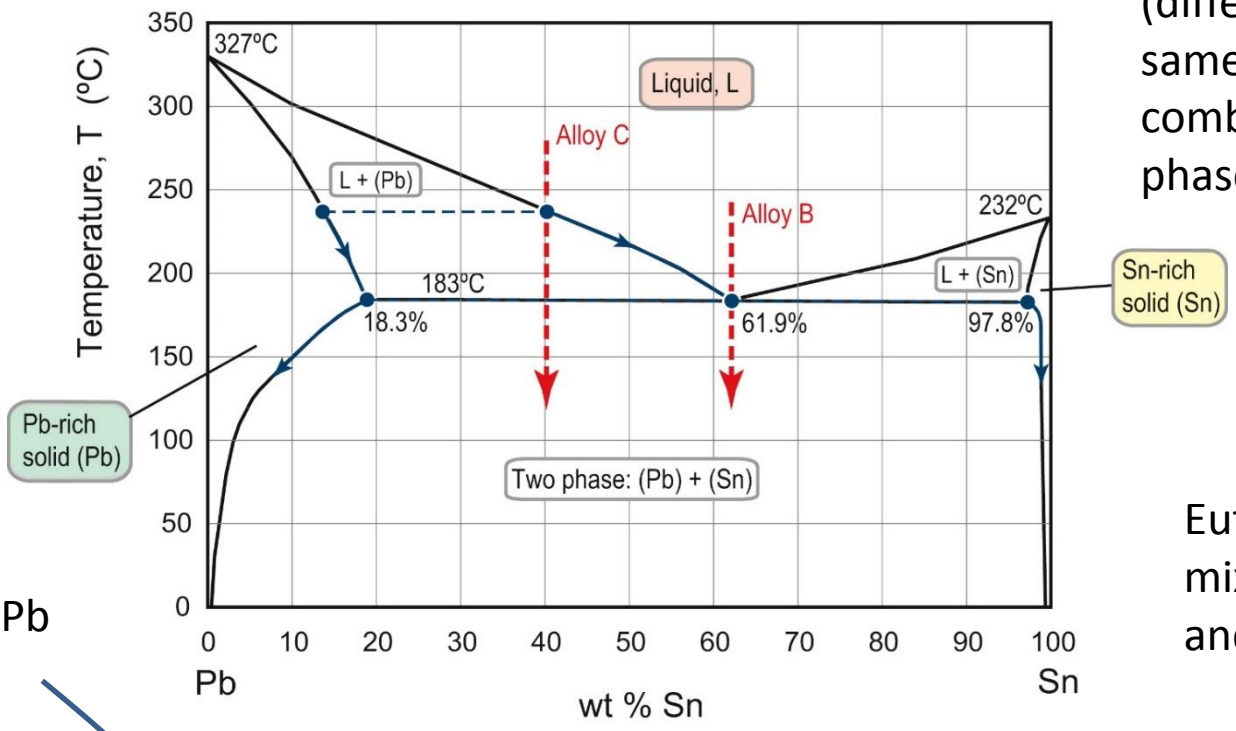
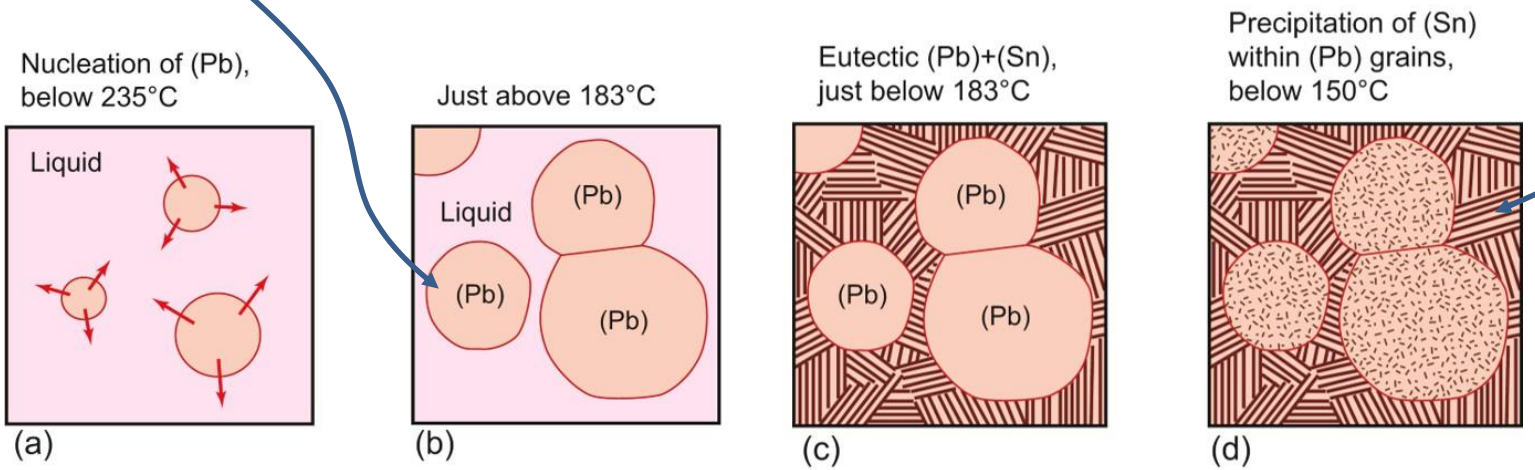
Eutectics

MICROCONSTITUENT (different form of same phase or combination of phases)

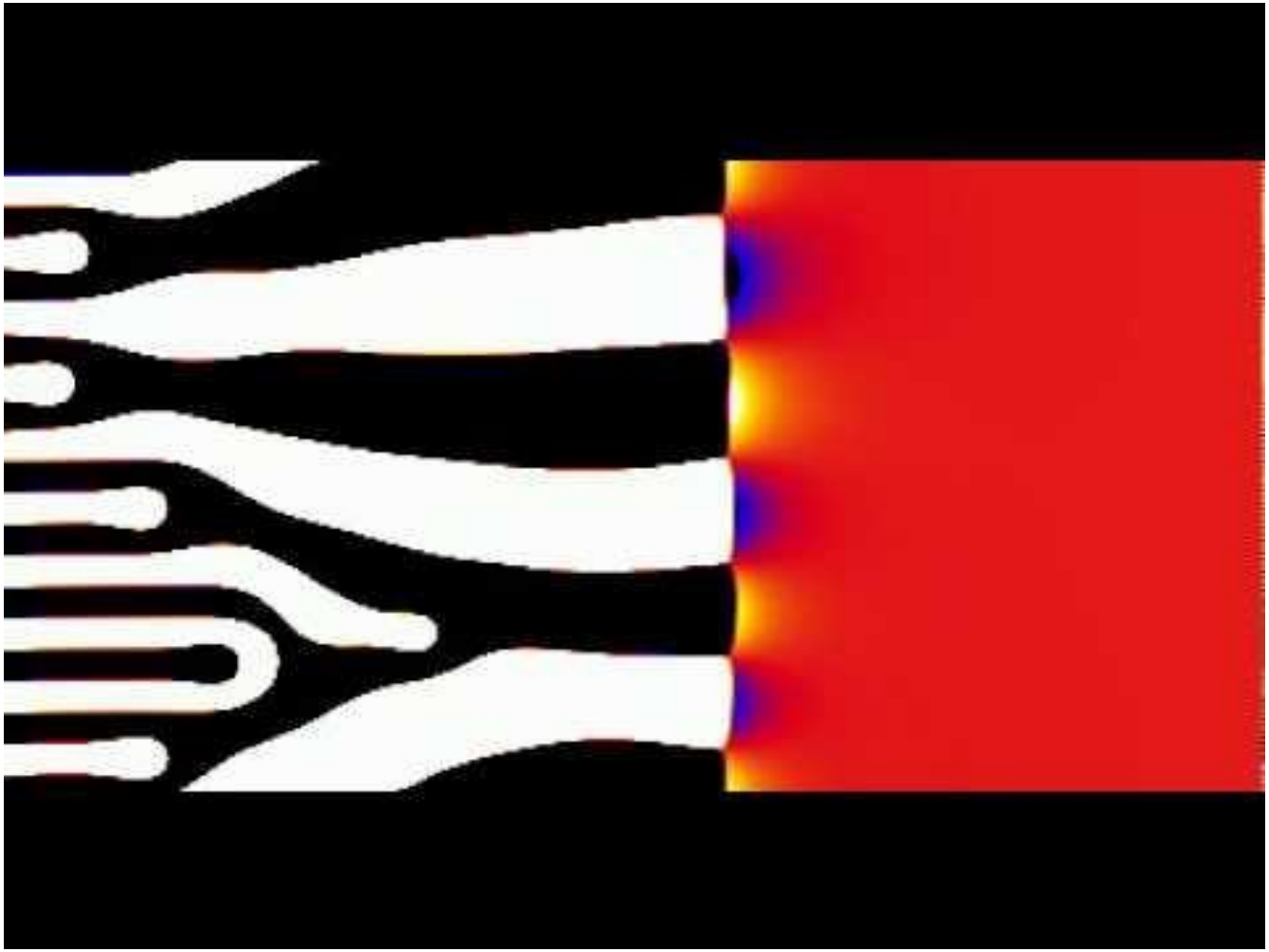


Primary Pb

Eutectic mixture of Pb and Sn



Eutectic growth



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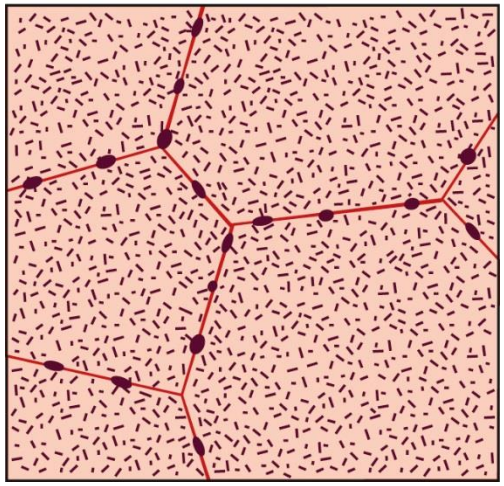
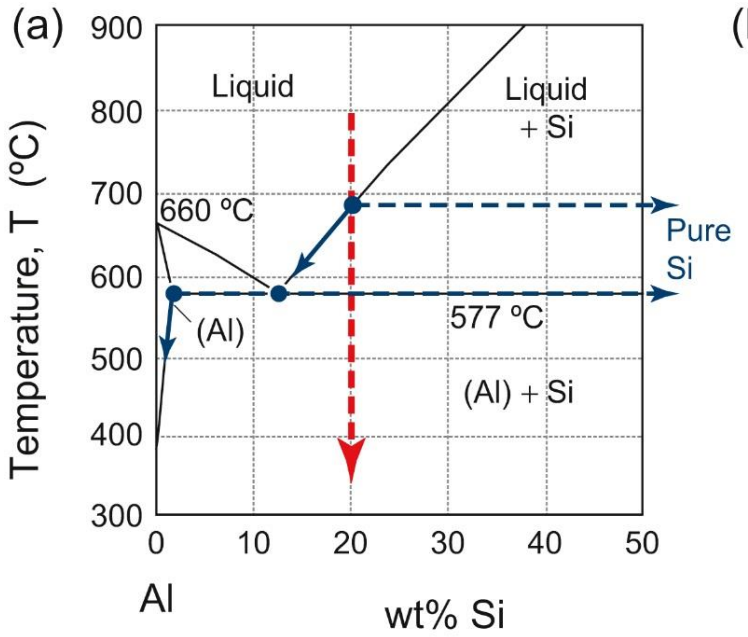
Aluminium

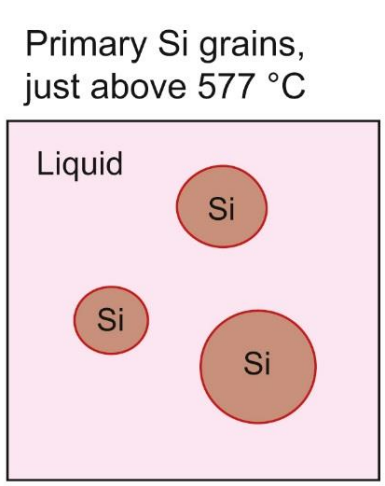
Precipitates of $CuAl_2$ in (Al)

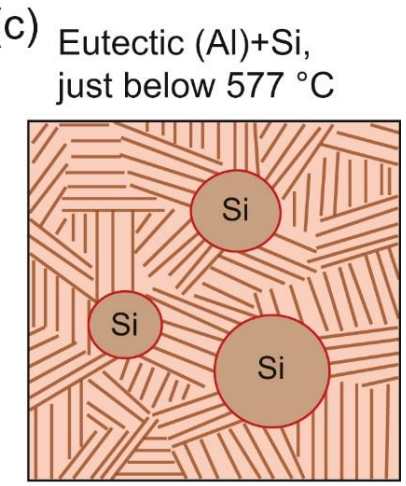
Precipitation strengthened wrought Aluminium (2xxx Al-Cu)



Cast Al-Si alloy

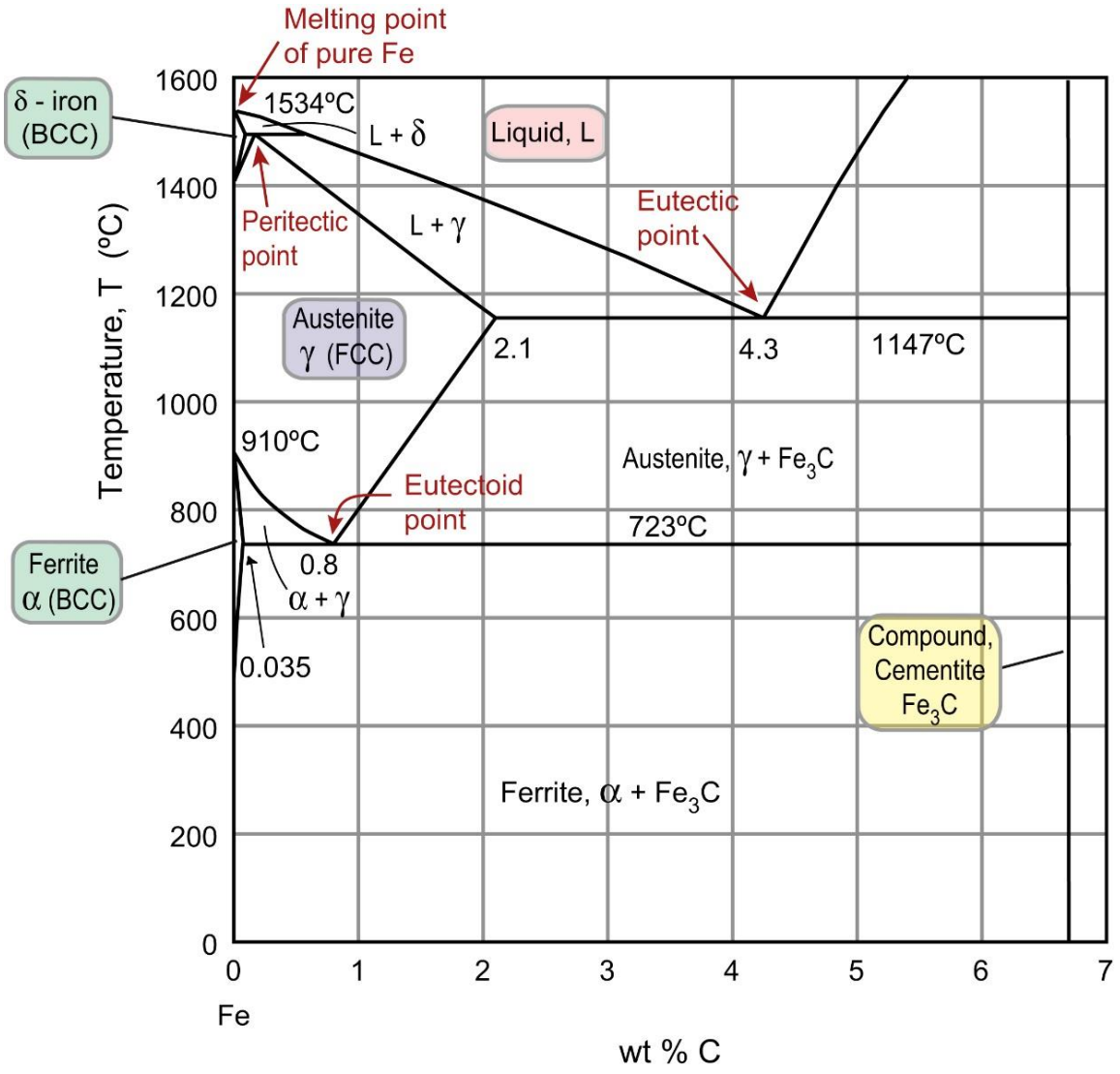






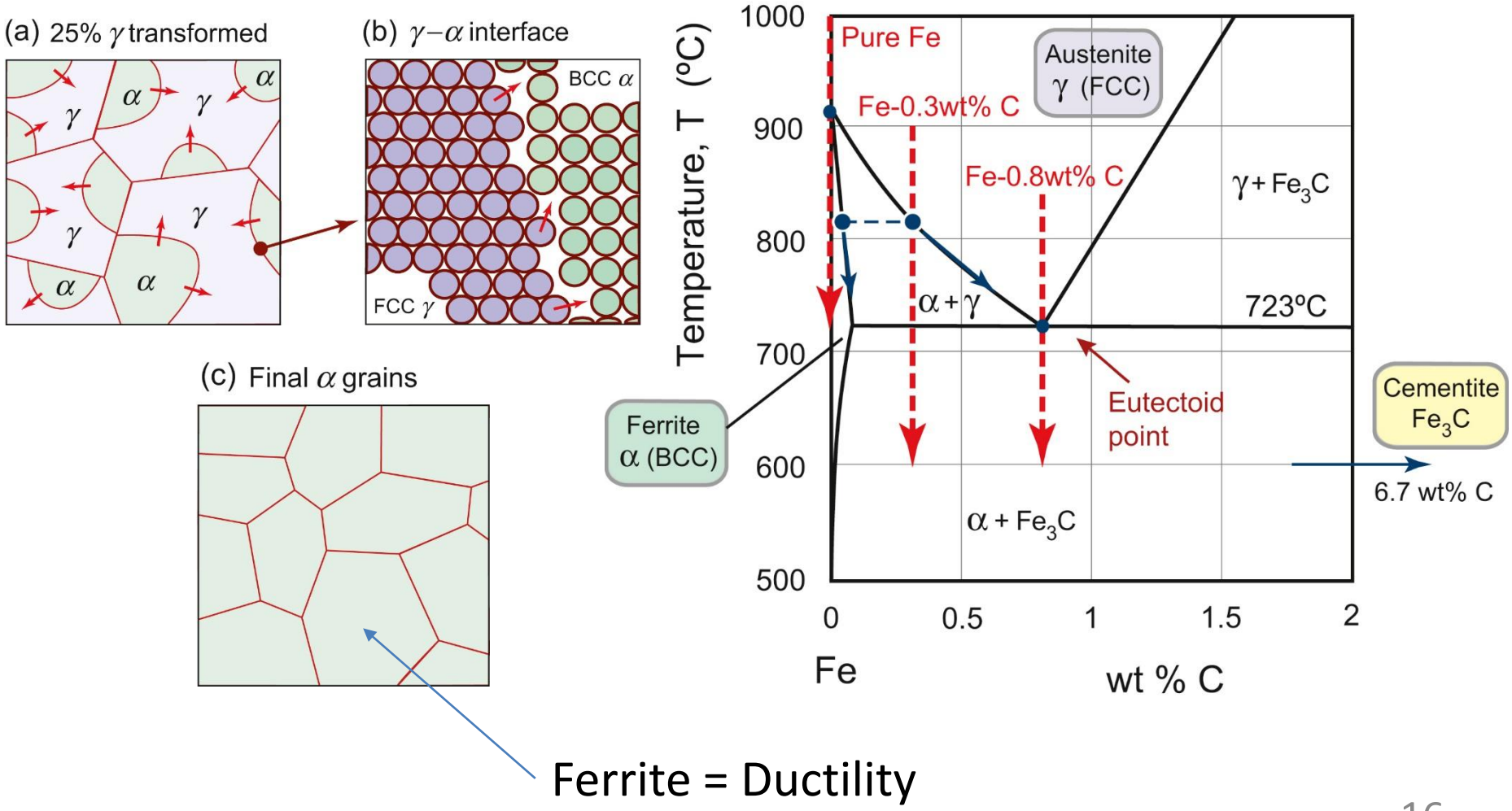
Much bigger scale
Si 100-200um

Fe-C Phase Diagram



Steel Microstructures

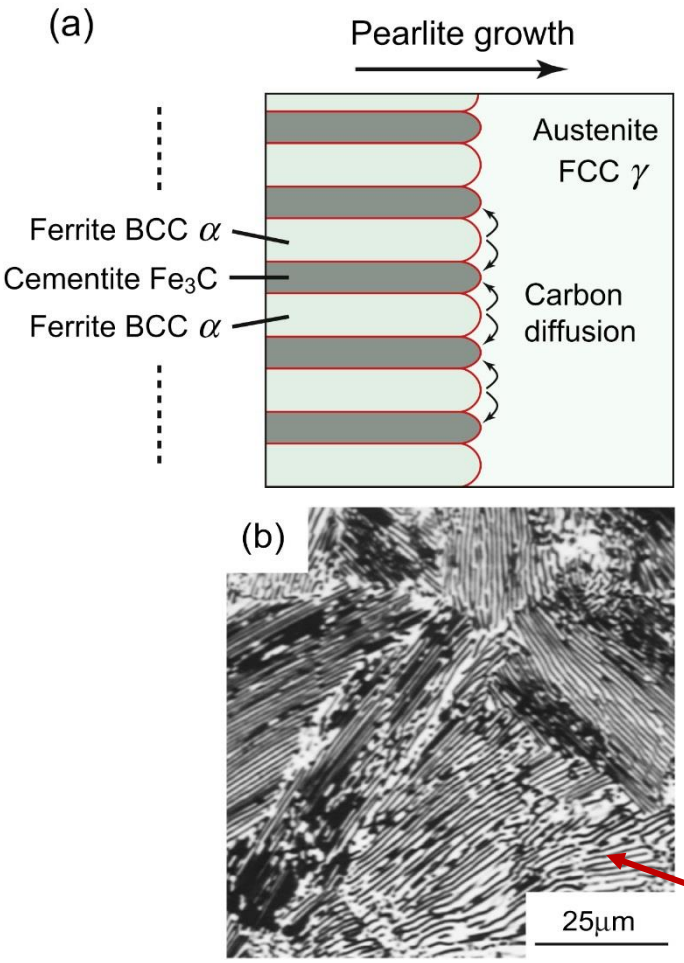
Pure Fe (C<0.02%)

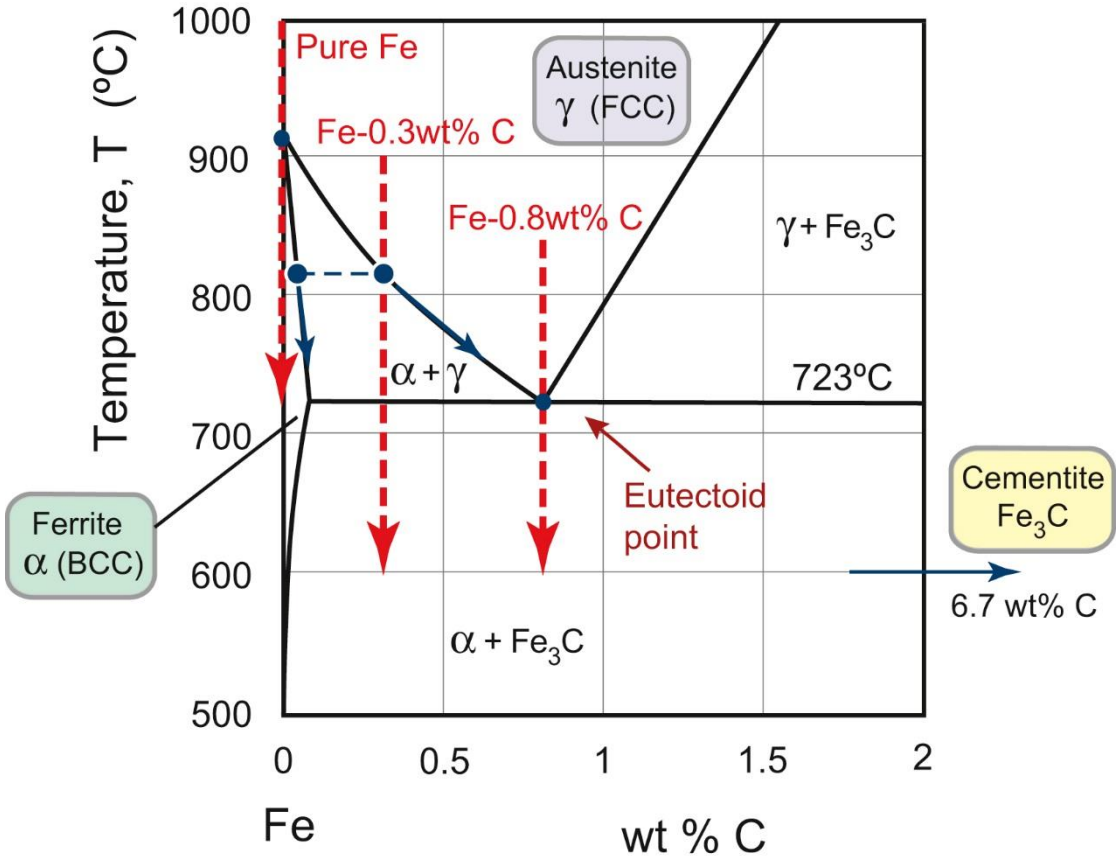


Ferrite = Ductility

Steel Microstructures

Eutectoid Fe (C=0.8%)



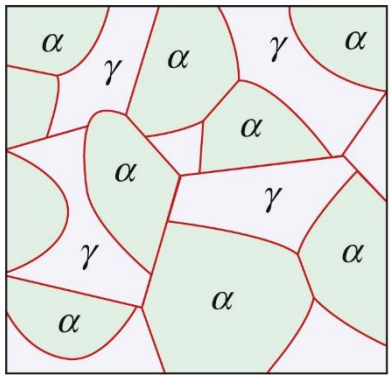


Pearlite (eutectoid) = Strength

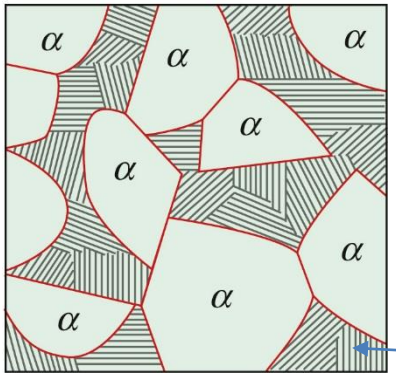
Steel Microstructures

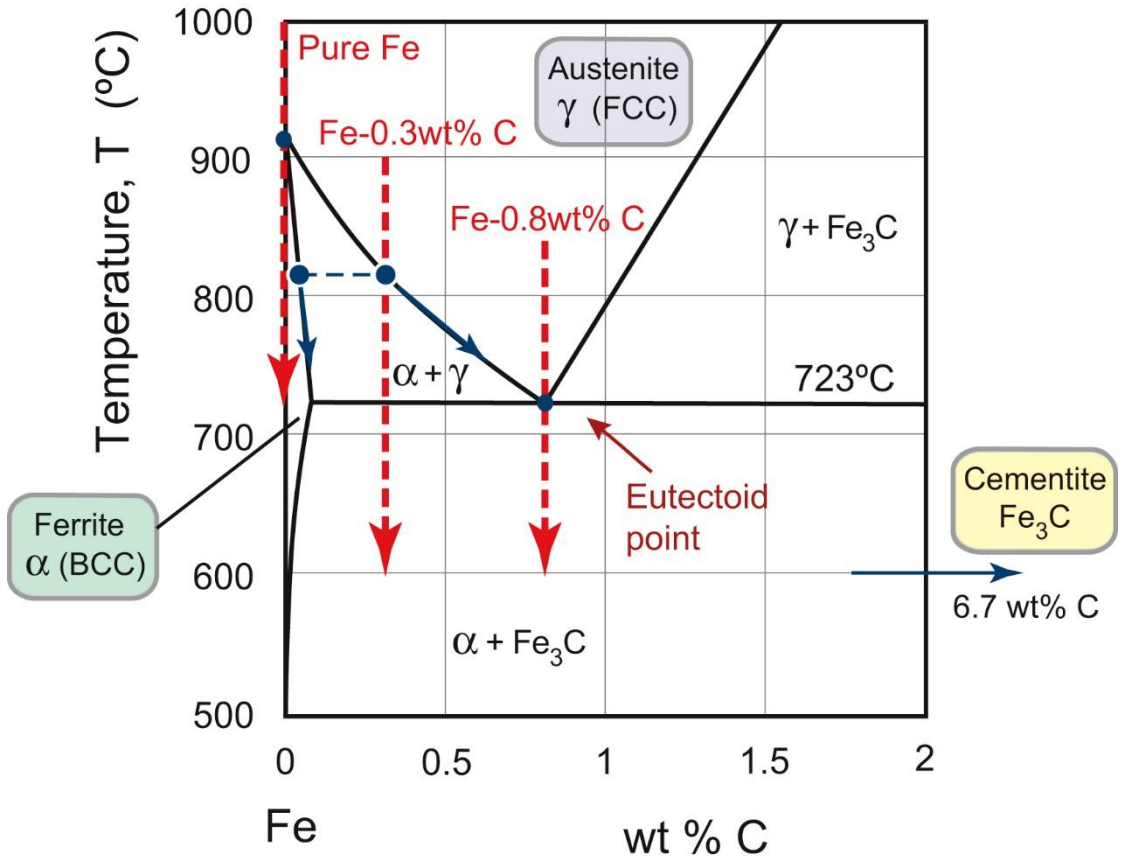
Hypoeutectoid Fe (C=0.3%)

Just above 723 °C



Just below 723 °C:
ferrite + pearlite





More pearlite (more C) = more strength, less ductility

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Summary

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Skills	Able to make qualitative predictions of microstructure from phase diagrams.
Values	Appreciate the link between microstructure and subsequent properties.

- **COMPLETE QUESTIONS 4-7 BY NEXT WEEK**