Today's Schedule

- Test instructions
- REVIEW
- Questions, questions, questions
- Answers, answers, answers… hopefully the right ones.
- Quizzes

MID TERM TEST, Feb 26th, 2007 **DURATION: 75 mins**

CLOSED BOOK

McGill ID _____

Name _____

ALL Students must have one of the following calculators: *CASIO fx-115, CASIO fx-991, SHARP EL-520* or the *SHARP EL-546*. **NON-REGULATION CALCULATORS WILL BE REMOVED AND NO REPLACEMENT CALCULATORS WILL BE PROVIDED.**

Leave your calculator cover in your book-bag. You may take only your calculator, a ruler and writing utensils to your desk. NO equation sheets. *Rulers are subject to inspection.*

http://www.mcgill.ca/engineering/faq/#CALCULATOR

All students must have one of the following two calculators, exceptions will not be permitted: CASIO fx-991 with any extensions, or a SHARP EL-546L or R or V (VB) or G ONLY.

Statement of Academic Integrity (All students MUST read this)
McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see http://www.mcgill.ca/integrity/ for more information).

How this statement applies to this course:

1) By default, WebCT quizzes are open book and thus you can use the text and internet resources. However, they are designed to test your knowledge of the subject and are timed. It is recommended that you study prior to starting the quiz. Answers pasted in from an internet search or copied from a text will be considered plagiarism.
2) In class exams and quizzes will all be closed book. They will be monitored by the instructor and teaching assistants. Cheating will not be tolerated.

Instructions

1. Read the instructions *carefully.*
2. **Put your name and ID# on this page.**
3. Read **each** question **completely** before working on each part, (the parts may be **interrelated**).
4. Write your solutions in the space provided below the relevant question. **Anything written outside the provided space will be ignored.**
6. **You may use the blank sides of this examination paper for rough work.**
7. Draw any diagrams as large as possible in the space provided.
8. **Label** all diagrams, axes, curves etc.
9. Phase diagrams, a periodic table, a graph of erfc(z) and other useful information are attached at the end of this examination book.
10. The gas constant, R = 8.314 J/mol/K.
11. Boltzmann's constant, $k = 8.26 \times 10^{-5}$ eV/K = 1.38×10^{-23} J/K.
12. Avogadro's number is 6.022×10^{23}
13. e = 2.71828 and π = 3.14159

Callister

- The exam is on Ch. 1, 2, 3, 4, 5, and 9
- These sections were not covered
  - 4.9, 4.10, 4.11
  - 9.16, 9.17, 9.20, 9.6 single component phase diagrams

Questions?

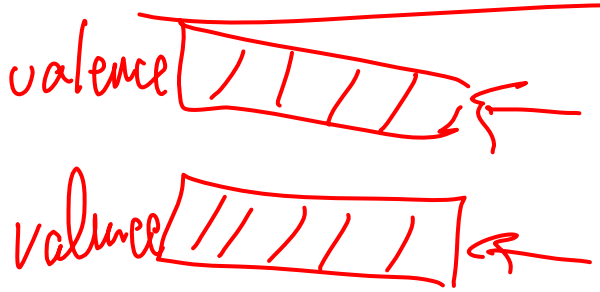
Chapter 1

- What is a metal?
- What is a ceramic?
- What is a polymer?
- What is a semiconductor?

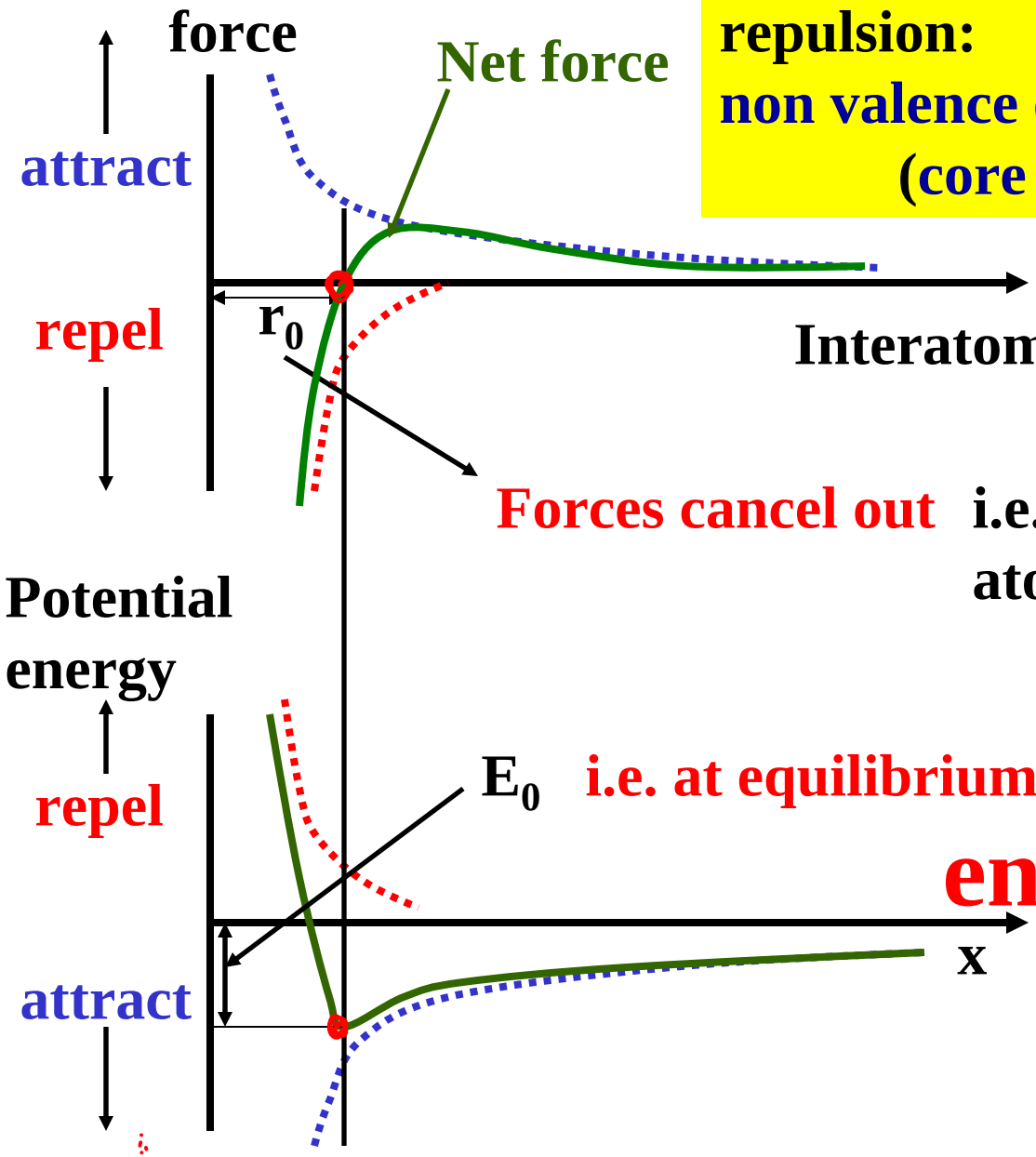
There are many right ways to answer these questions, you should have a version of your own.

Chapter 2

- Electronic structure
  - Order in which we fill the orbitals (up to Ar)
  - Given an electronic structure recognize the valence electrons
- Bonding
  - WebCT Quiz#1
  - Inter-atomic forces and minimization of energy



BONDING FORCES AND ENERGY



repulsion:
non valence electrons interact
(core electrons)

Forces cancel out **i.e. equilibrium atomic separation**

i.e. at equilibrium atomic separation

energy lowest

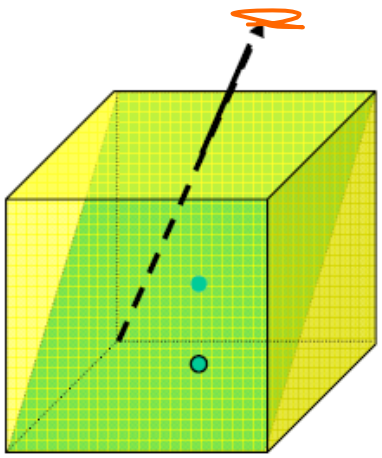
Chapter 3

- Crystal systems, crystal structures
  - Study the homework and tutorial quizzes
- Points, directions and planes
  - Know how to define the indices from a drawing
  - Know how to create a drawing from the indices
- APF and densities

$$\text{Planar atomic density} = \frac{\text{Area of plane intersected by atoms}}{\text{total plane area}}$$

SUMMARY OF MILLER INDICES

determining values from a drawing



Points

Right hand cartesian coords

('travel')

x, y, z

Directions **Define 2 co-ords; Subtract first one from second one**

Clear fractions; **[u v w]**

Planes **Define intercepts on the three axes**

d-spacing

Take reciprocals **Clear fractions;**

d_{hkl}

(h k l)

SUMMARY OF MILLER INDICES

making a drawing from given values

From given indices:

Points

Right hand cartesian coords **('travel')**

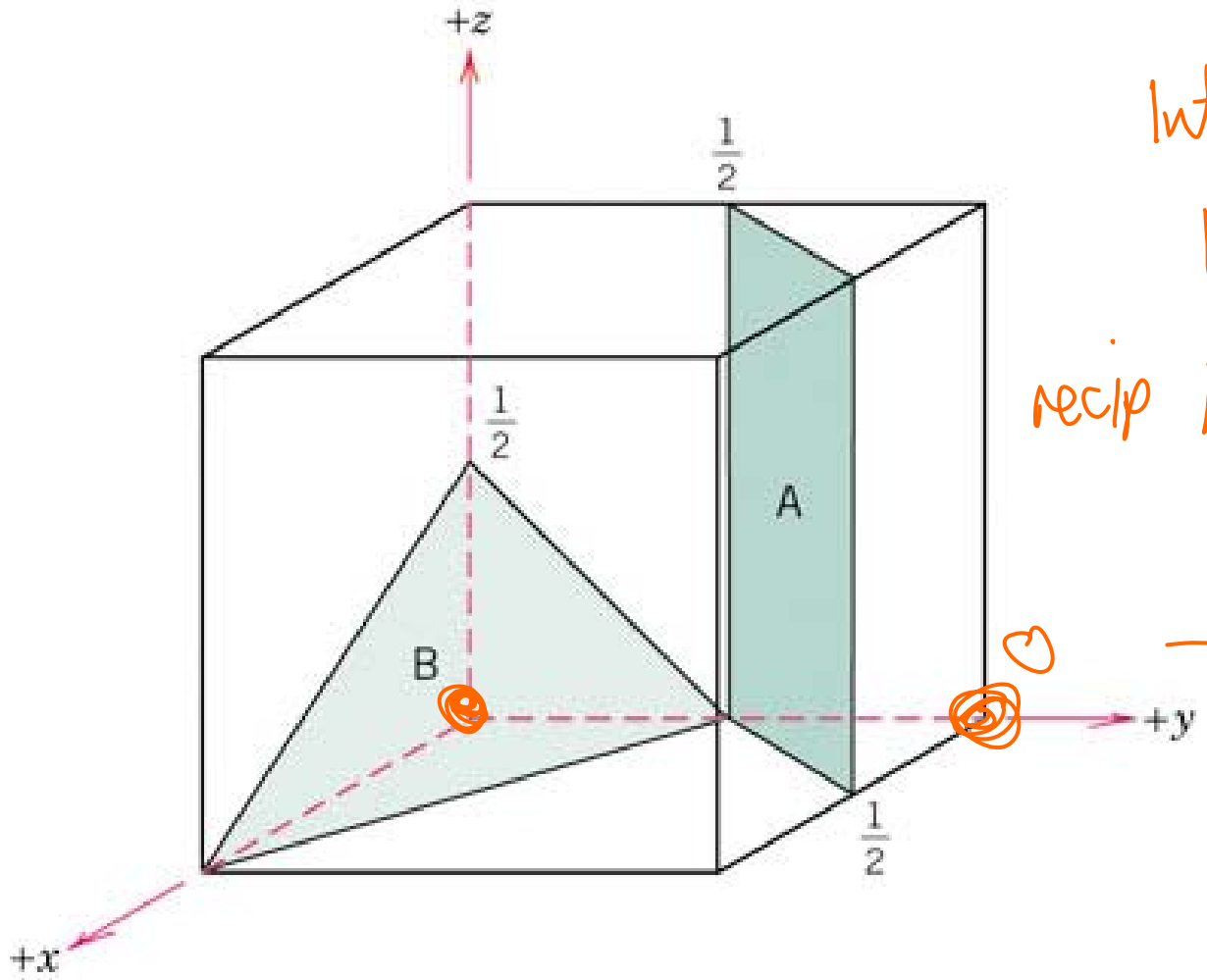
Directions **Divide throughout by highest index**

Plot corresponding point **connect origin to point**

Planes

Take reciprocals

Plot intercepts on the three axes



Intercepts A B

1 ½ ½

recip 1 2 2

(1 2 2)

Plane A

½ -½ 0

recip 2 -2 0

reduc 1 -1 0

(1 $\bar{1}$ 0)

Chapter 4

- Defects
- Dislocations
- Designation of at% and wt%
- Grains, texture, orientation
- Hume-Rothery rules

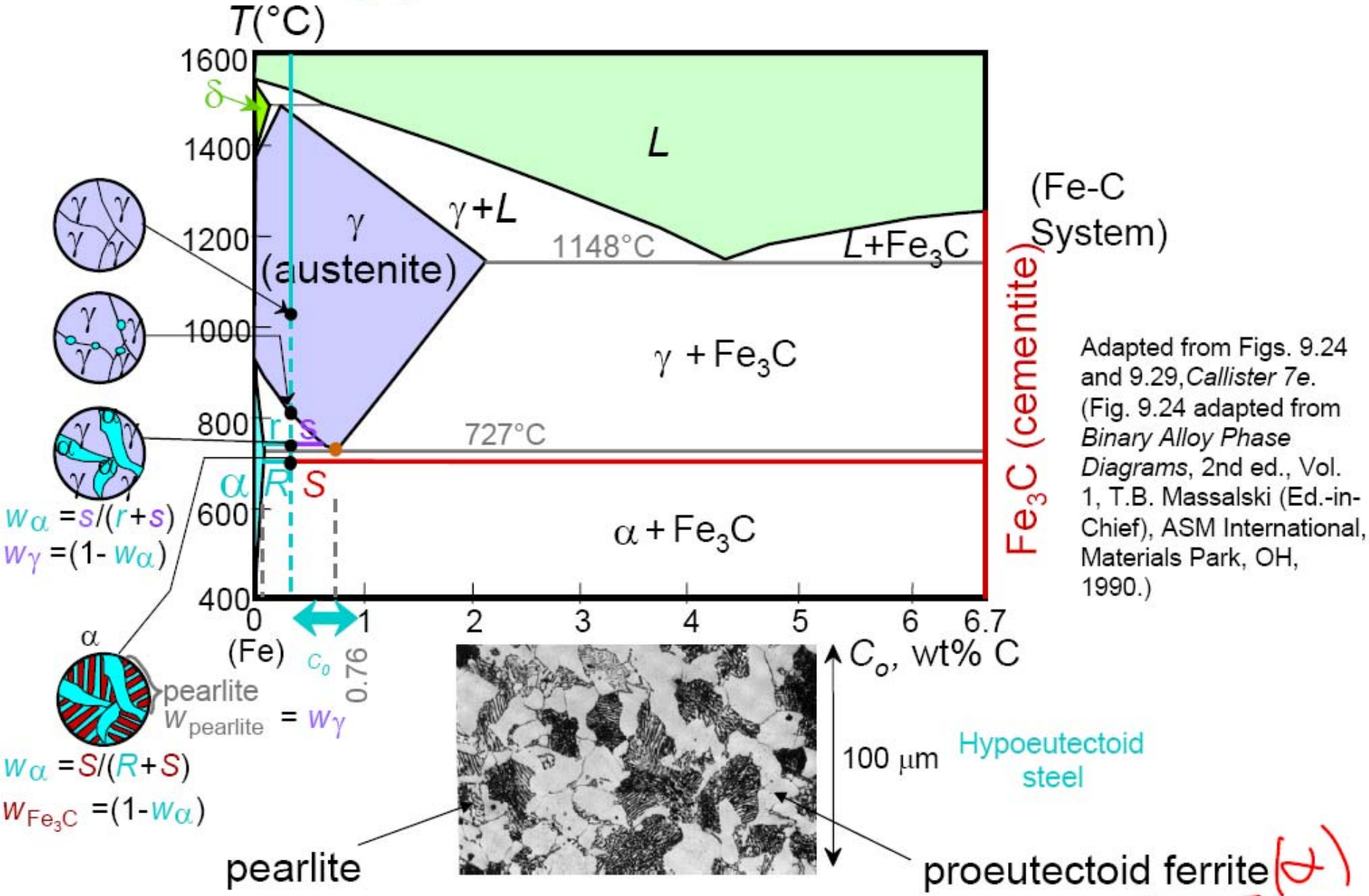
Chapter 5

- Diffusion mechanisms
- Random walk (Day07)
- Fick's 1st law
- Carburization solution to Fick's 2nd law

Chapter 9

- Recognize and label 2-phase fields
- Recognize and label invariant points
  - Congruent melting
  - Eutectic and eutectoid
  - Peritectic and peritectoid
- Lever rule
- Pictures of microstructures (Callister and lecture)

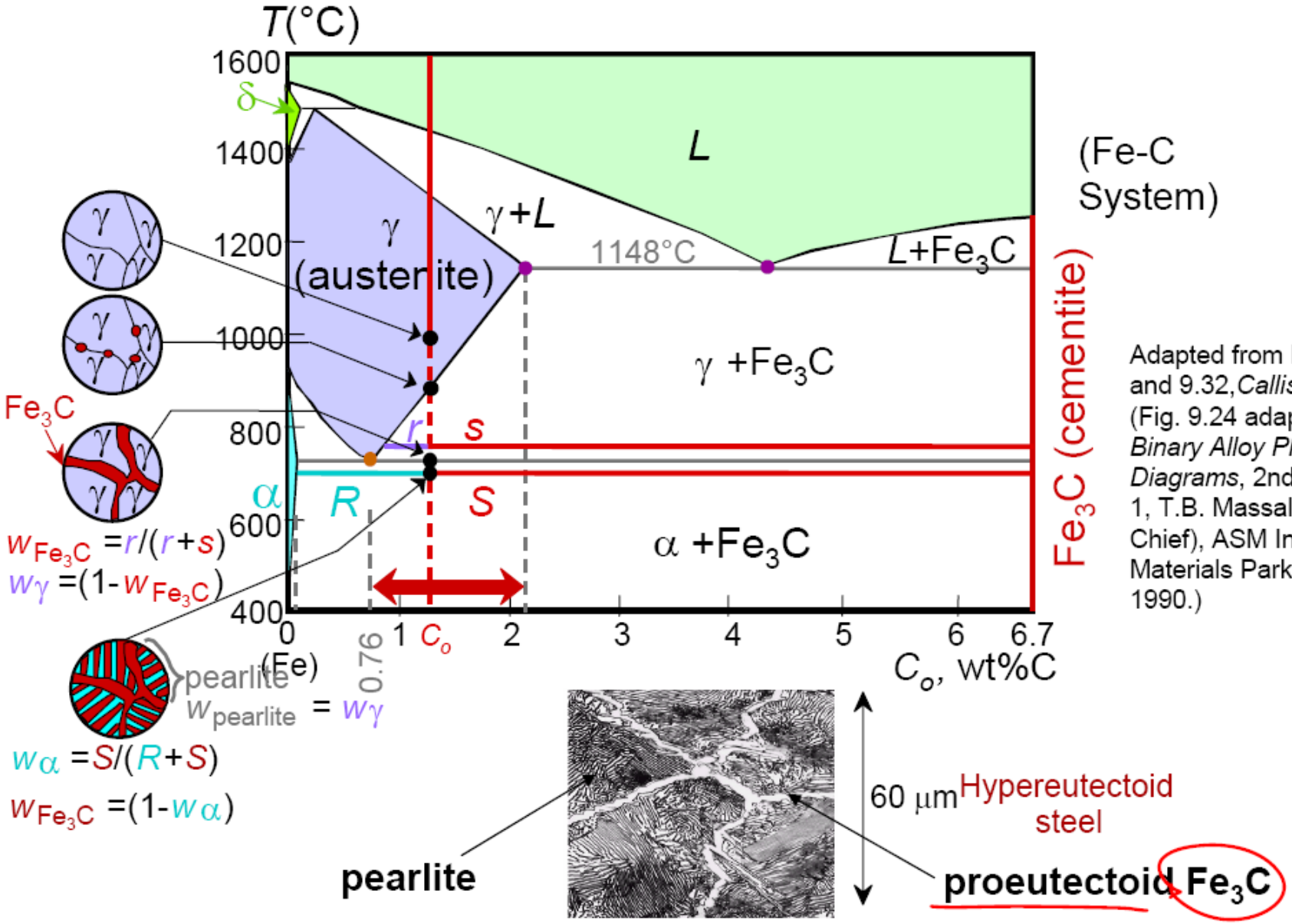
Hypoeutectoid Steel



Adapted from Figs. 9.24 and 9.29, *Callister 7e.* (Fig. 9.24 adapted from *Binary Alloy Phase Diagrams*, 2nd ed., Vol. 1, T.B. Massalski (Ed.-in-Chief), ASM International, Materials Park, OH, 1990.)

Adapted from Fig. 9.30, *Callister 7e.*

Hypereutectoid Steel



Adapted from Figs. 9.24 and 9.32, *Callister 7e.* (Fig. 9.24 adapted from *Binary Alloy Phase Diagrams*, 2nd ed., Vol. 1, T.B. Massalski (Ed.-in-Chief), ASM International, Materials Park, OH, 1990.)

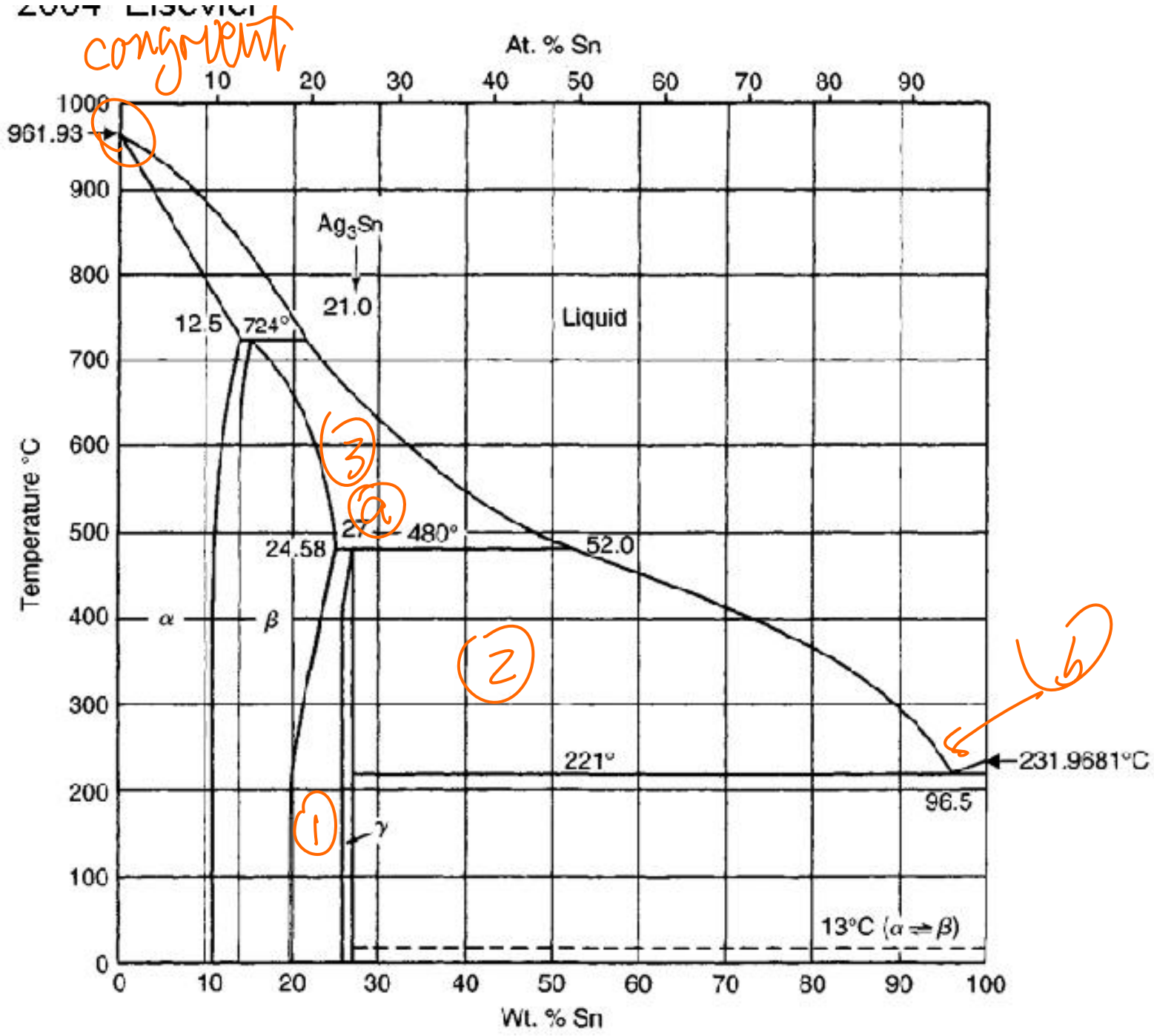
60 μm

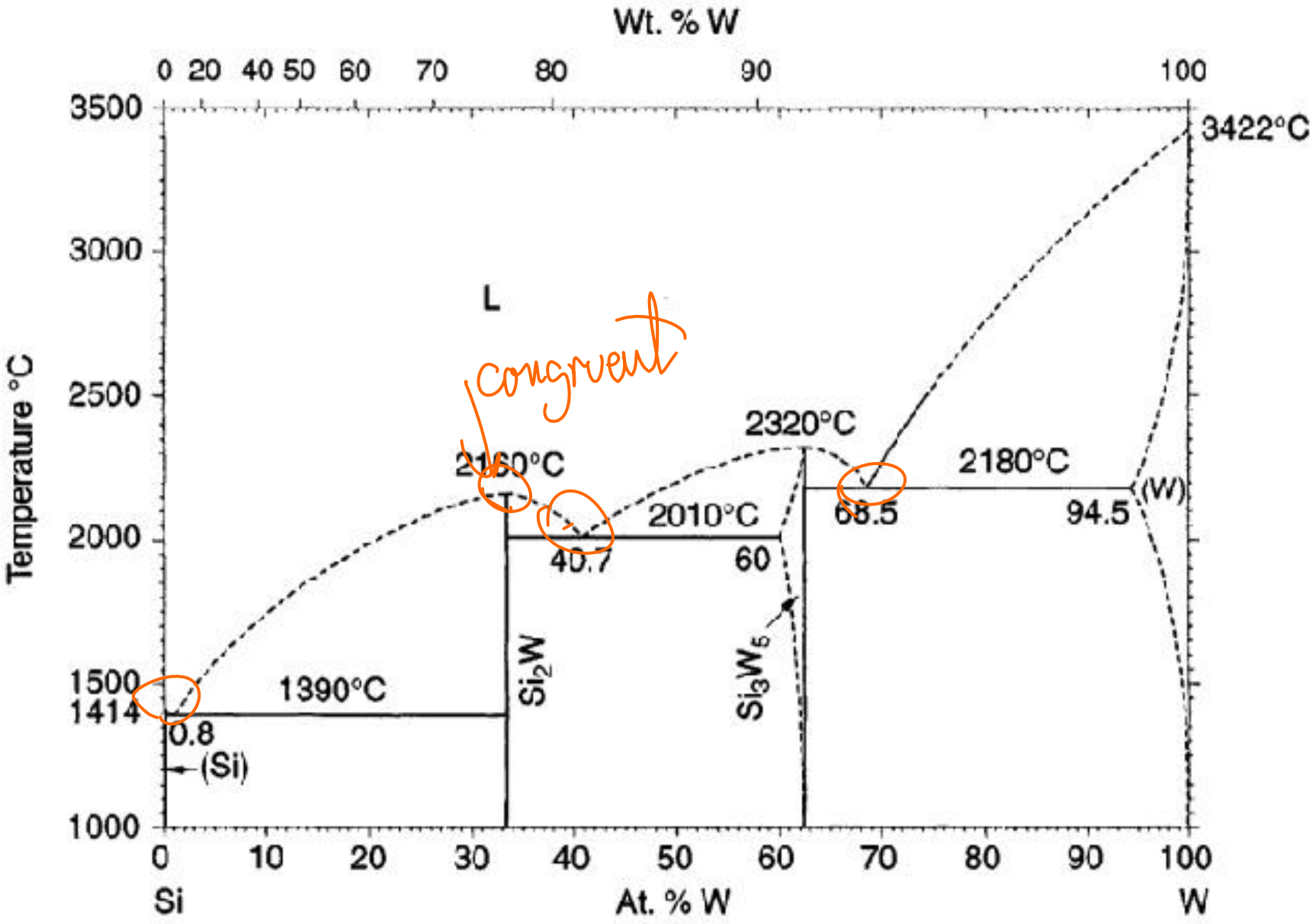
Hypereutectoid steel

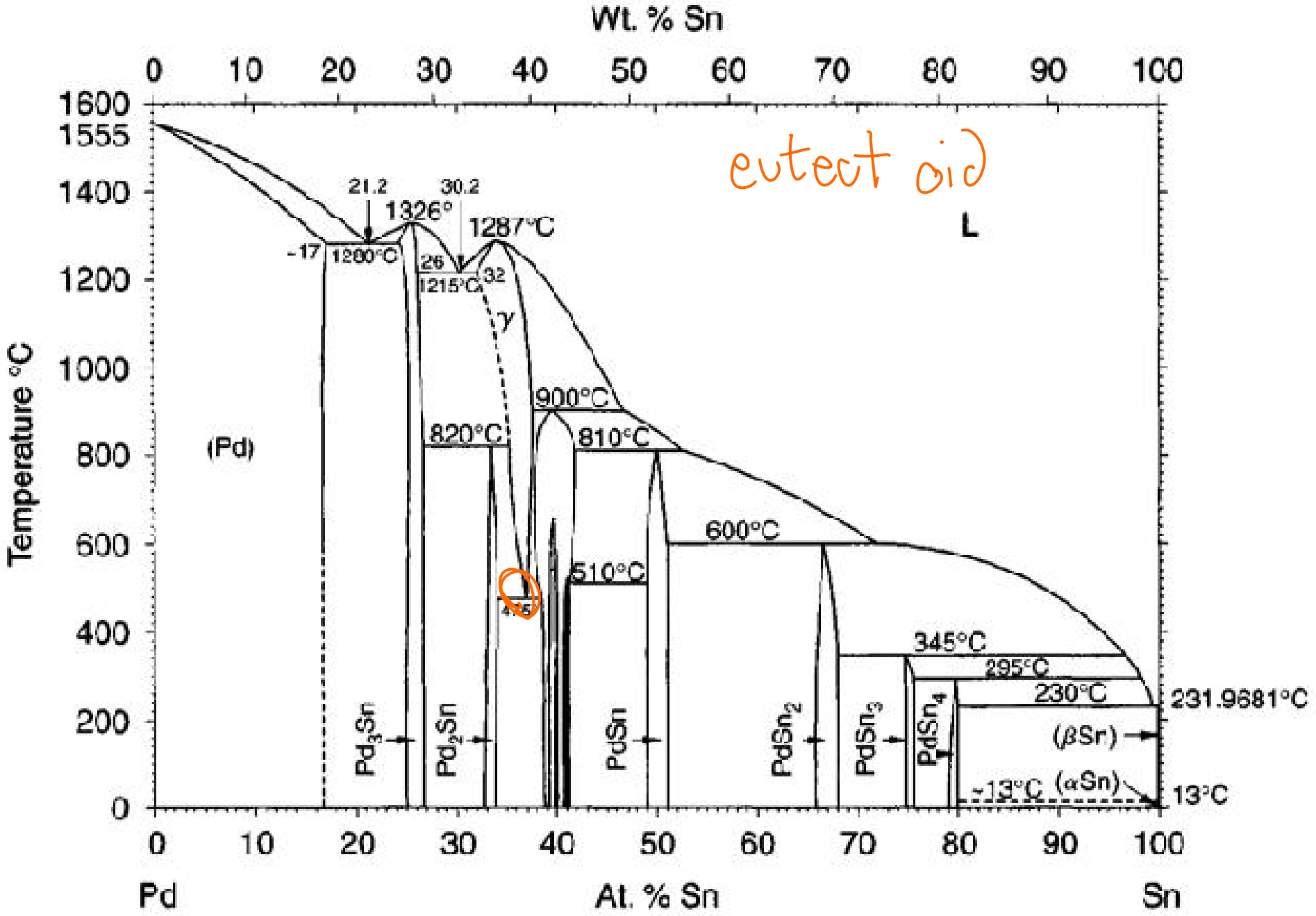
pearlite

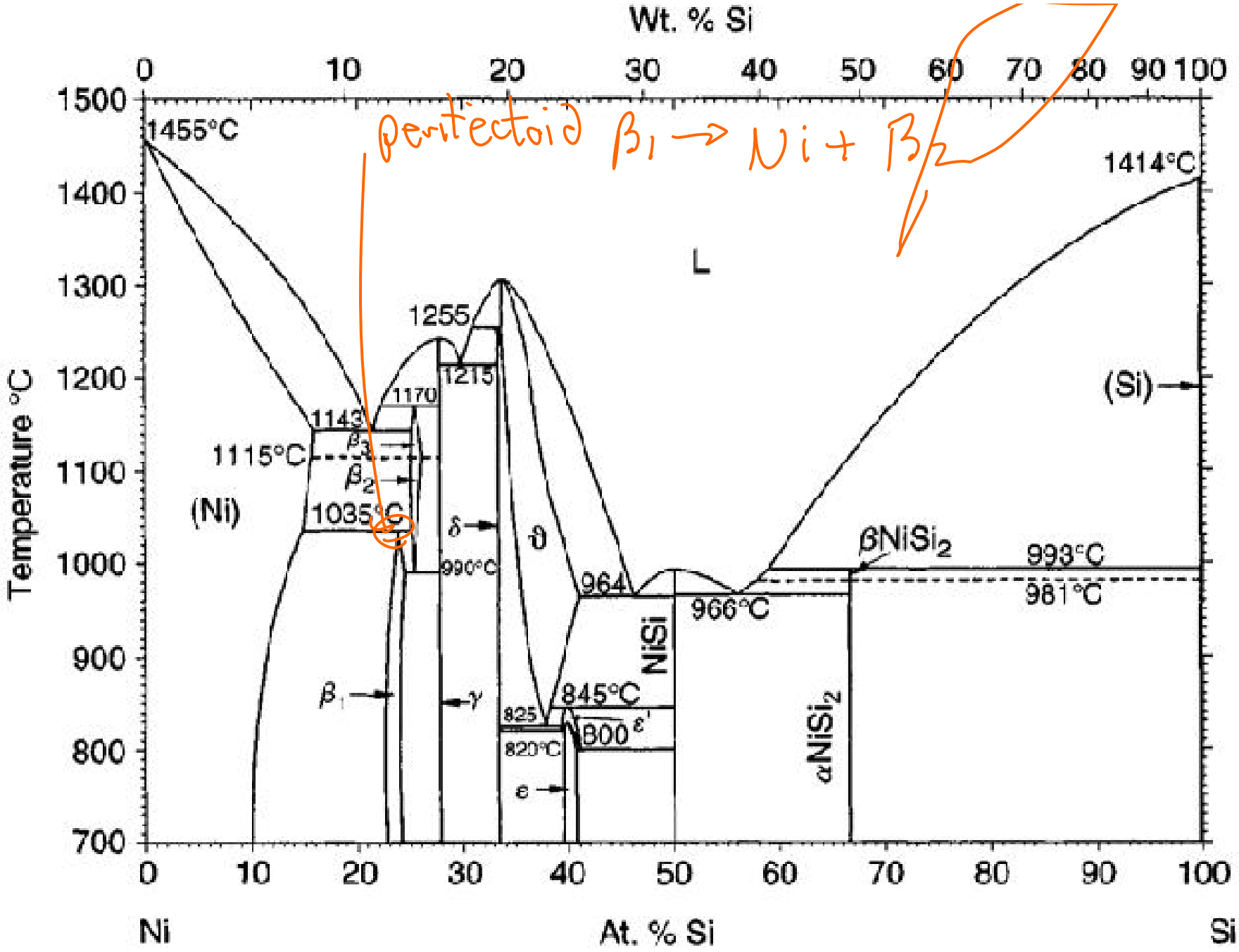
proeutectoid Fe_3C

Adapted from Fig. 9.33, *Callister 7e.*


congruent
At. % Sn
10
20
30
40
50
60
70
80
90
961.93
900
800
700
600
500
400
300
200
100
0
Ag3Sn
21.0
Liquid
12.5
724°
24.58
480°
52.0
α
β
γ
221°
96.5
231.9681°C
13°C (α ⇌ β)
Temperature °C
0
10
20
30
40
50
60
70
80
90
100
Wt. % Sn




Wt. % Sn
0
10
20
30
40
50
60
70
80
90
100
1600
1555
1400
1200
1000
800
600
400
200
0
Temperature °C
21.2
30.2
1326°
1287°C
-17
1260°C
26
1215°C
32
γ
900°C
820°C
810°C
600°C
510°C
475
345°C
295°C
230°C
231.9681°C
(Pd)
L
Pd_3Sn
Pd_2Sn
PdSn
$PdSn_2$
$PdSn_3$
$PdSn_4$
(βSr)
~13°C
(αSn)
13°C
Pd
At. % Sn
Sn
eutect oid


Wt. % Si
0
10
20
30
40
50
60
70
80
90
100
1500
1400
1300
1200
1100
1000
900
800
700
Temperature °C
1455°C
1414°C
L
1255
1215
1170
1143
1115°C
1035°C
(Ni)
(Si)
990°C
964
966°C
993°C
981°C
845°C
825
820°C
800
NiSi
$\alpha NiSi_2$
$\beta NiSi_2$
β_1
β_2
β_3
γ
δ
ϑ
ε
ε'
Ni
At. % Si
Si