آزمایشگاه متالوگرافی

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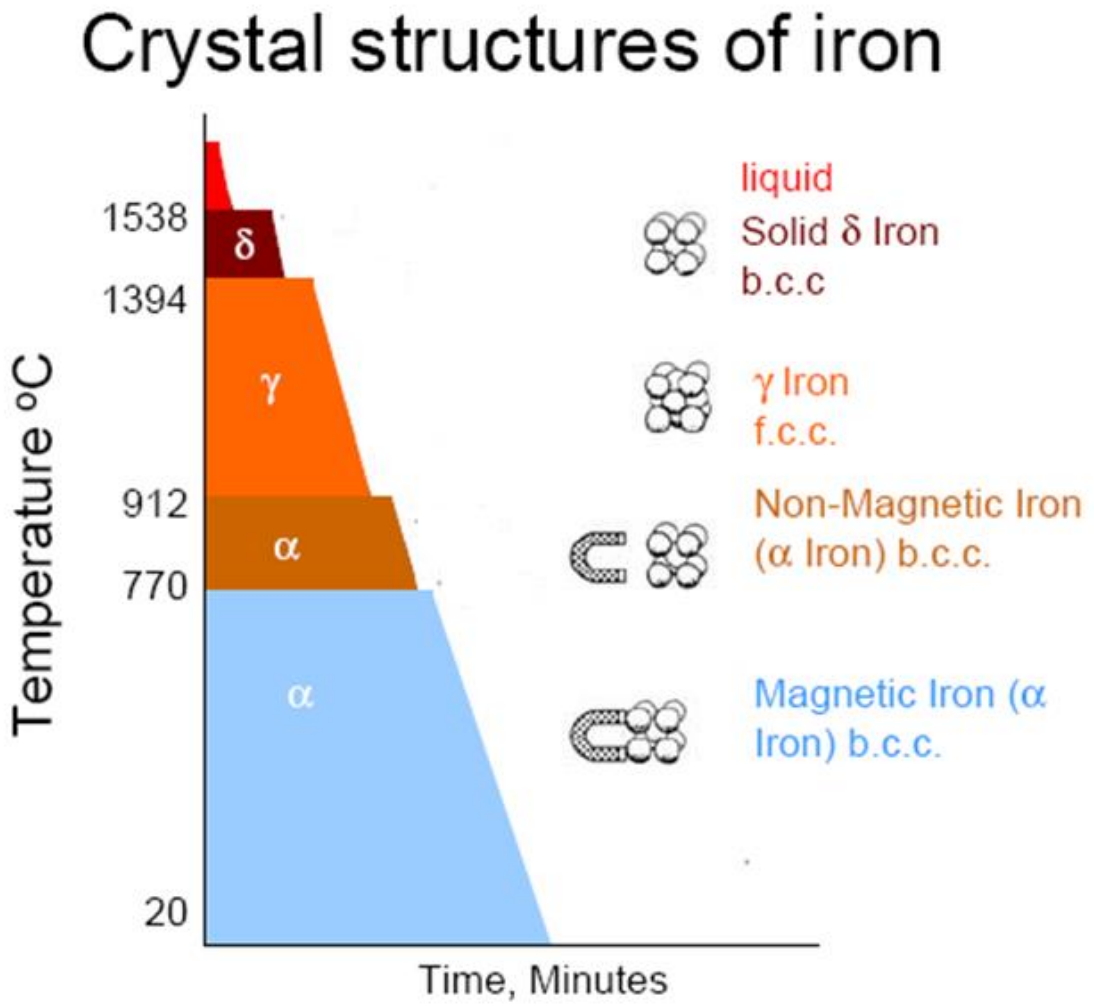
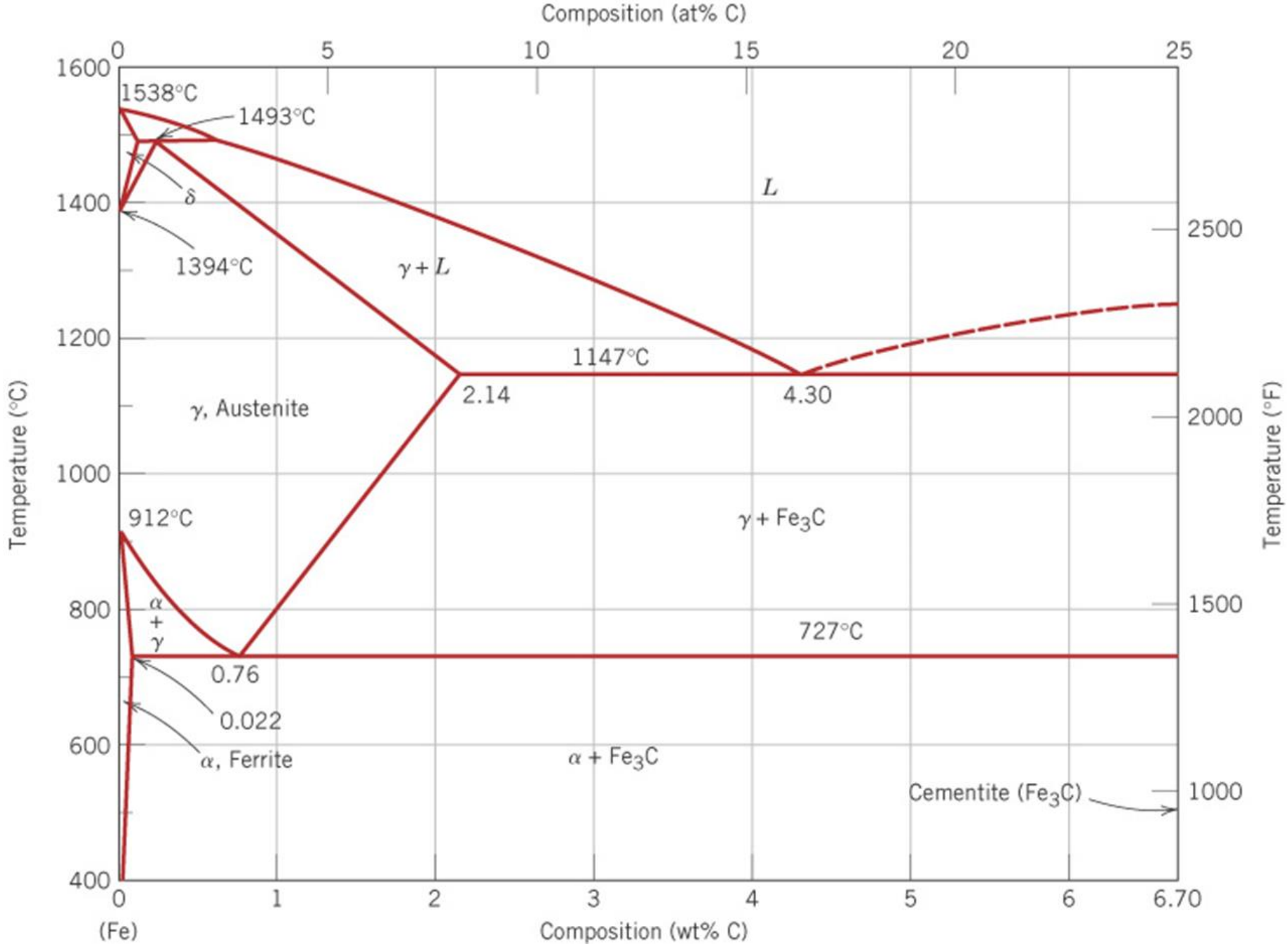
Metallography متالوگرافی

- Pure iron when heated experiences 2 changes in crystal structure before it melts.
- At room temperature the stable form, ferrite (α iron) has a BCC crystal structure.
- Ferrite experiences a polymorphic transformation to FCC austenite (γ iron) at 912 ˚C (1674 ˚F).
- At 1394˚C (2541˚F) austenite reverts back to BCC phase δ ferrite and melts at 1538 ˚C (2800 ˚F).
- Iron carbide (cementite or Fe_3C) an intermediate compound is formed at 6.7 wt% C.
- Typically, all steels and cast irons have carbon contents less than 6.7 wt% C.
- Carbon is an interstitial impurity in iron and forms a solid solution with the α, γ, δ phases.




Composition (at% C)
0
5
10
15
20
25
1600
1400
1200
1000
800
600
400
1538°C
1493°C
δ
1394°C
L
γ + L
1147°C
2.14
4.30
γ, Austenite
912°C
γ + Fe3C
α
+
γ
727°C
0.76
0.022
α, Ferrite
α + Fe3C
Cementite (Fe3C)
Temperature (°C)
Temperature (°F)
2500
2000
1500
1000
0
1
2
3
4
5
6
6.70
(Fe)
Composition (wt% C)

4 Solid Phases

- **α-ferrite**
  - solid solution of carbon in a iron,
  - BCC structure
  - carbon only slightly soluble in the matrix
    - maximum solubility of 0.02%C at 723°C to about 0.008%C at room temperature.
- **Austenite (γ)**
  - solid solution of carbon in γ–iron
  - FCC structure: can accommodate more carbon than ferrite
    - maximum of 2.08%C at 1148°C, decreases to 0.8%C at 723°C
    - difference in C solid solubility between γ and α is the basis for **hardening** of most steels.

δ-ferrite

- solid solution of carbon in δ–iron
- BCC crystal structure
  - maximum solubility of ferrite being 0.09%C at 1495°C

- **Cementite (Fe_3C)**
  - intermetallic Fe-C compound
    - Fe_3C : 6.67%C and 93.3%Fe.
  - orthorhombic crystal structure: hard and brittle

Iron carbide (Cementite or Fe_3C)

- Forms when the solubility limit of carbon in α ferrite is exceeded at temperatures below 727 ˚C.
- Mechanically, cementite is very hard and brittle.
- For ferrous alloys there are 3 basic types, based on carbon content:
  - Iron (ferrite phase): <0.008 wt% C room temp
  - Steel (α + Fe_3C phase): 0.008 to 2.14 wt% C
  - Cast iron: 2.14 to 6.70 wt% C