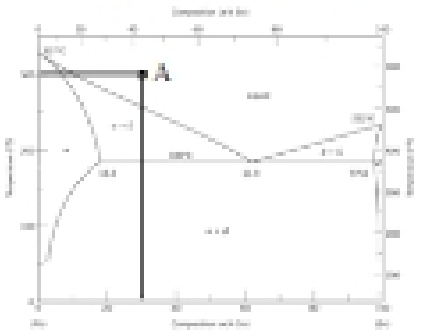
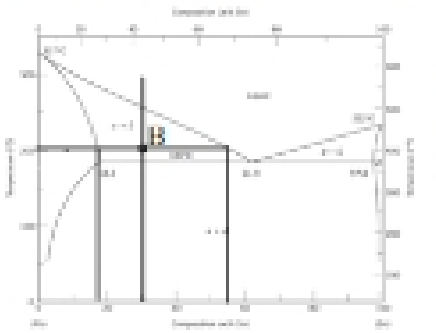
Cooling of a hypoeutectic alloy (30%Sn in Pb-Sn system)



Start cooling from
Point A
300 C
Liquid phase (L)
30% Sn, 70% Pb

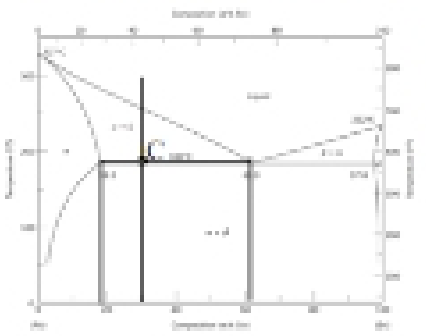
Cooling of a hypoeutectic alloy (30%Sn in Pb-Sn system)



Point B
200 C
L + α
L: 55% Sn, 45% Pb
α: 18% Sn, 82% Pb

W_L = (30-18)/(55-18) = 0.32
W_α = (55-30)/(55-18) = 0.68

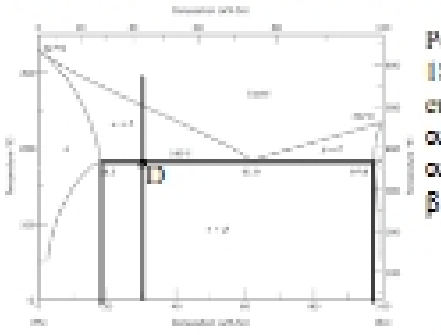
Cooling of a hypoeutectic alloy (30%Sn in Pb-Sn system)



Point C
184 C
L + α
L: 61.9% Sn, 38.1% Pb
α: 18.3% Sn, 81.7% Pb

W_L = (30-18.3)/(61.9-18.3) = 0.27
W_α = (61.9-30)/(61.9-18.3) = 0.73

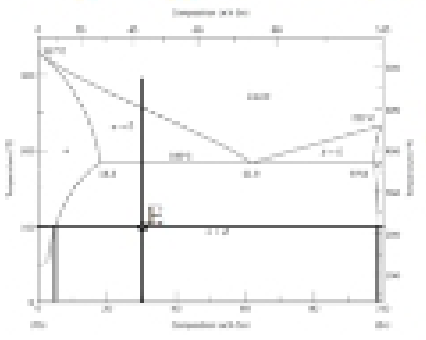
Cooling of a hypoeutectic alloy (30%Sn in Pb-Sn system)



Point D
182 C, which is just below eutectic temperature
α + β
α: 18.3% Sn, 81.7% Pb
β: 97.8% Sn, 2.2% Pb

W_α = (97.8-30)/(97.8-18.3) = 0.85
W_β = (30-18.3)/(97.8-18.3) = 0.15

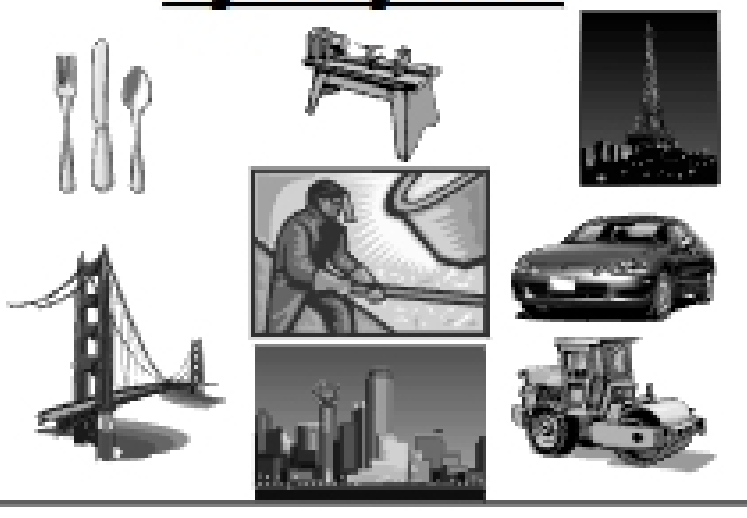
Cooling of a hypoeutectic alloy (30%Sn in Pb-Sn system)



Point E
100 C
α + β
α: 5% Sn, 95% Pb
β: 99% Sn, 1% Pb

W_α = (99-30)/(99-5) = 0.73
W_β = (30-5)/(99-5) = 0.27

Steel – the most important engineering material



Steel: iron-carbon system

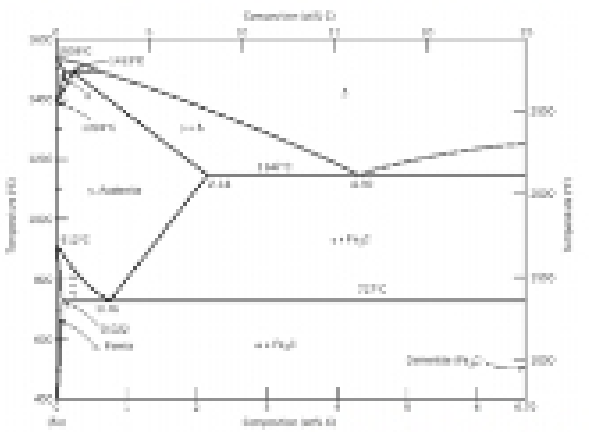
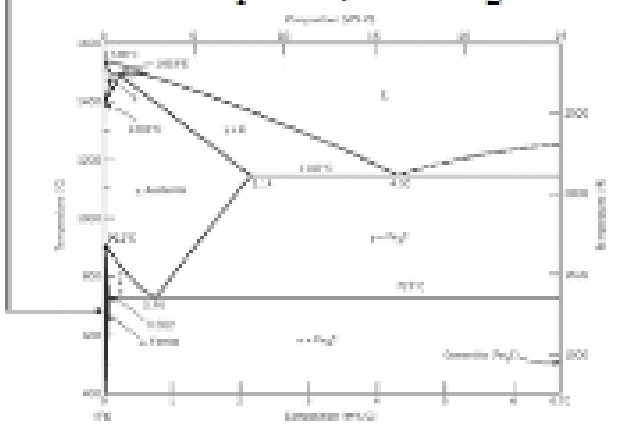


Fig. 9.22, Callister

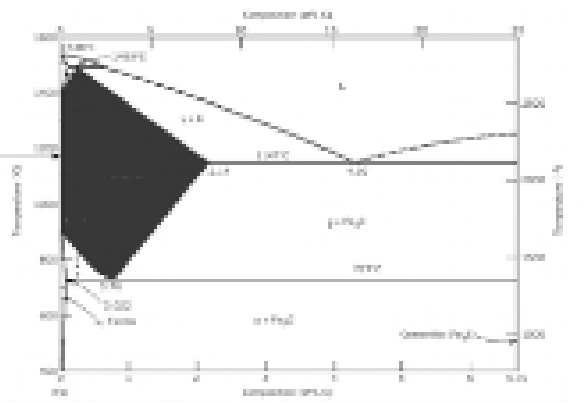
Phases in iron-carbon system

α ferrite: a iron-carbon solid solution, BCC, stable at room temperature, can be magnetic



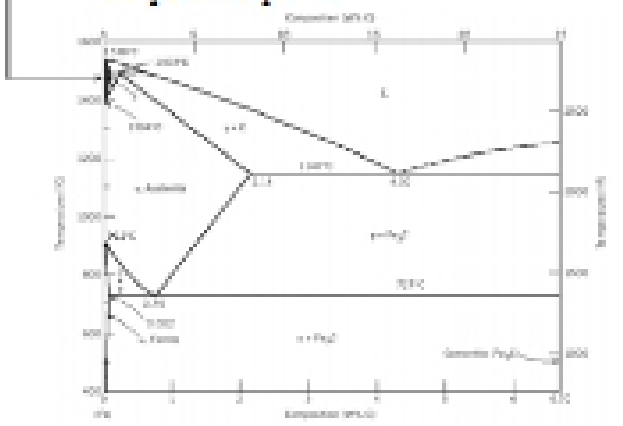
Phases in iron-carbon system

Austenite : a iron-carbon solid solution, FCC, (γ iron) nonmagnetic



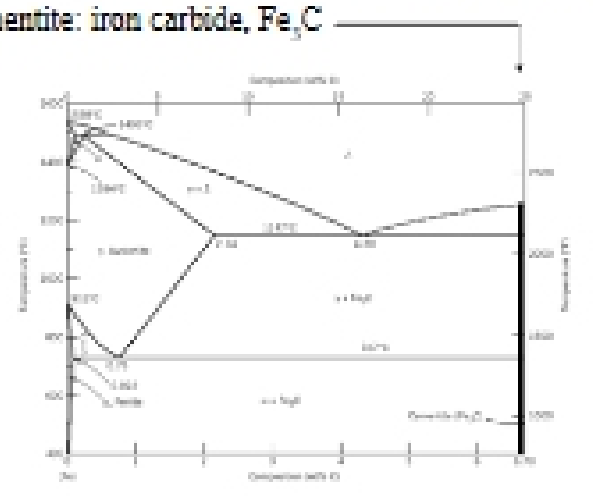
Phases in iron-carbon system

δ ferrite: a iron-carbon solid solution, BCC, a high temperature phase



Phases in iron-carbon system

Cementite: iron carbide, Fe_3C



Phases in iron-carbon system

α ferrite: a iron-carbon solid solution, BCC, stable at room temperature, can be magnetic

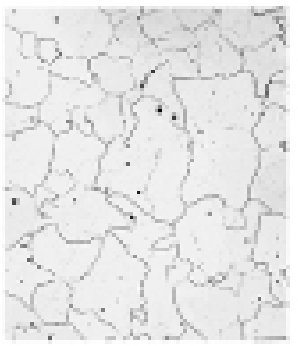
Austenite : a iron-carbon solid solution, FCC, (γ iron) nonmagnetic

δ ferrite: a iron-carbon solid solution, BCC, a high temperature phase

Cementite: iron carbide, Fe_3C

Phases in iron-carbon system

α ferrite



austenite

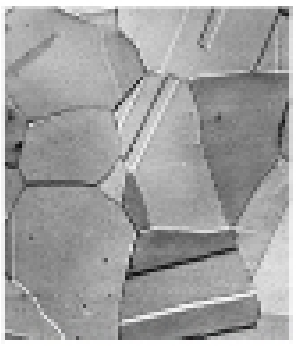
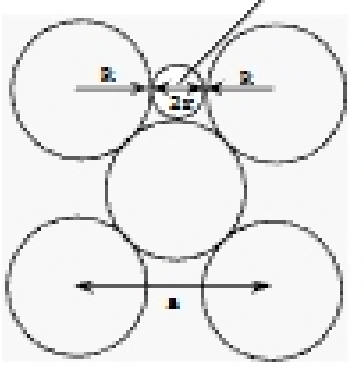


Fig. 9.23, Callister

Size of interstitial atoms in FCC cells

Interstitial site at the center of the edge



(100) face of an FCC unit cell

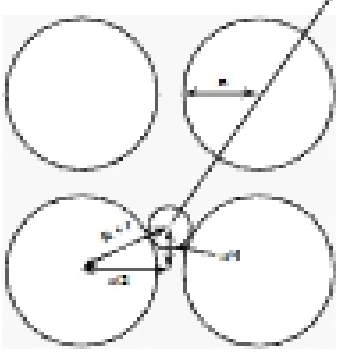
$a = 2R + 2r$

Also $a = 2\sqrt{2}R$

Solving the above equations we get: $r = 0.41R$

Size of interstitial atoms in BCC cells

Interstitial site at (0,1/2,1/4)



A (100) face of a BCC unit cell

$(a/2)^2 + (a/4)^2 = (R + r)^2$

However, $\sqrt{3}a = 4R$

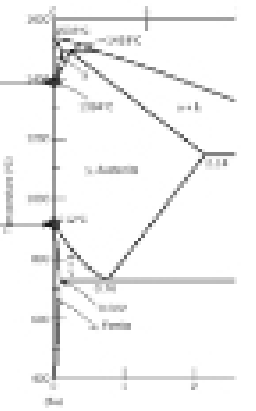
Solving the above two equations we get: $r = 0.29R$

Reactions in iron-carbon system

Polymorphic transformations of pure iron

At 1394 °C: $\gamma \underset{\text{cooling}}{\overset{\text{heating}}{\rightleftharpoons}} \delta$

At 912 °C: $\alpha \underset{\text{cooling}}{\overset{\text{heating}}{\rightleftharpoons}} \gamma$



Reactions in iron-carbon system

Reactions at invariant points

Peritectic reaction at 1493 °C:

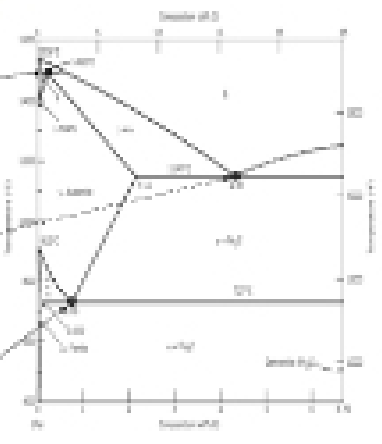
$\delta + L \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \gamma$

Eutectic reaction at 1147 °C:

$L \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \gamma + Fe_3C$

Eutectoid reaction at 727 °C:

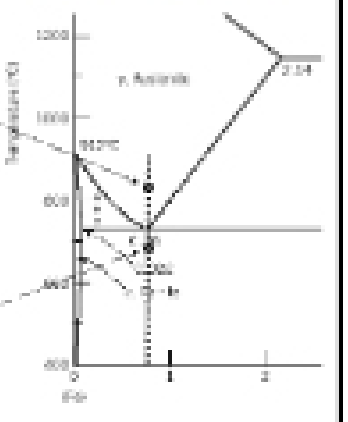
$\gamma \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \alpha + Fe_3C$



Development of microstructures

Alloy with eutectoid composition (0.76 wt% C)

At temperatures higher than 727 °C: austenite



At temperatures below 727 °C: pearlite