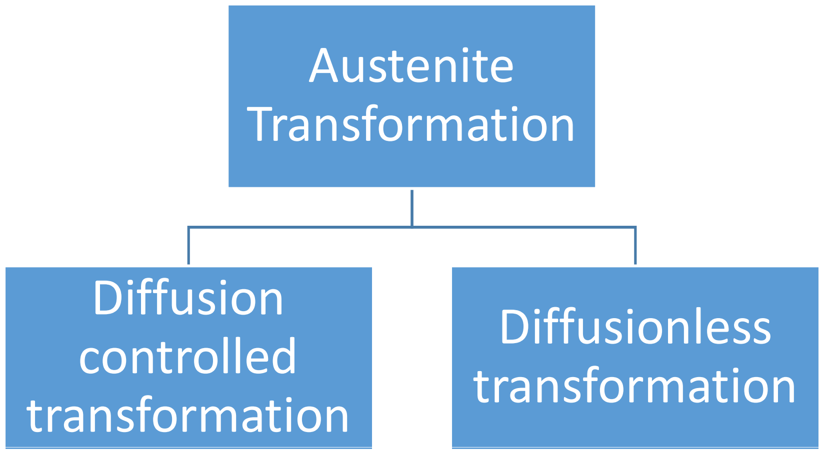
Diffusionless Transformations

- Characteristics of Martensitic Transformations
- Martensite Crystallography
- Martensite Nucleation
- Martensite Growth
- Tempering of Ferrous Martensite
- Strain induced transformation.

Introduction



Diffusionless transformation: Atomic movements are less than one interatomic spacing.

Recent development in martensite transformation

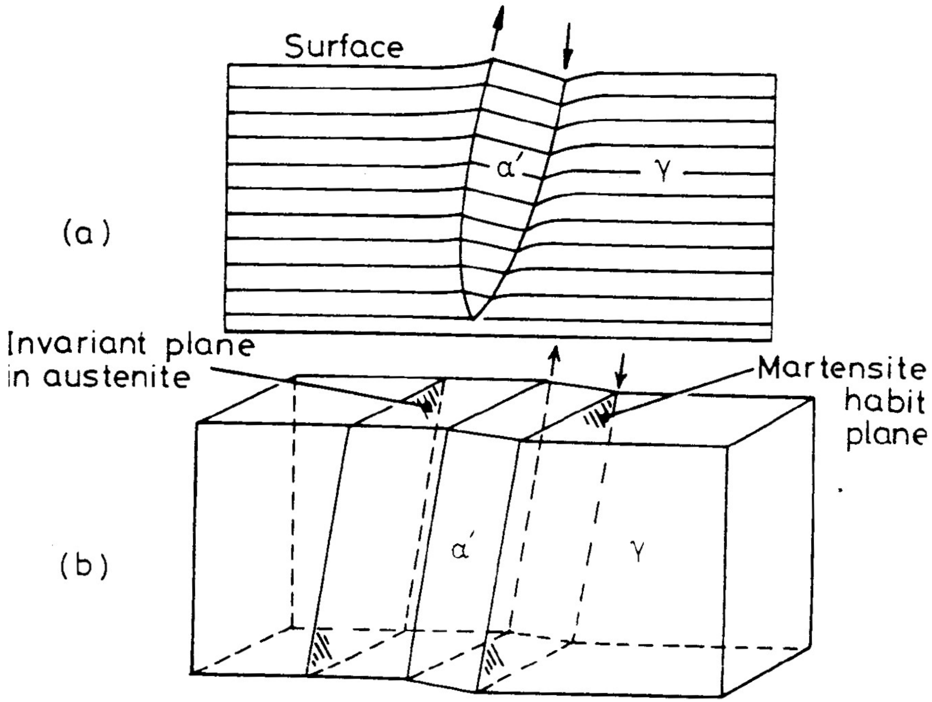
- Maraging steels (ppt. hardened martensite)
- TRIP steels(Transformation induced by plastic deformation)
- Ausforming steel (plastically deformed austenite prior to quenching)
- Dual phase steels (mixture of ferrite + martensite phasess)

Martensite: Supersaturated solid solution of C in α-Fe

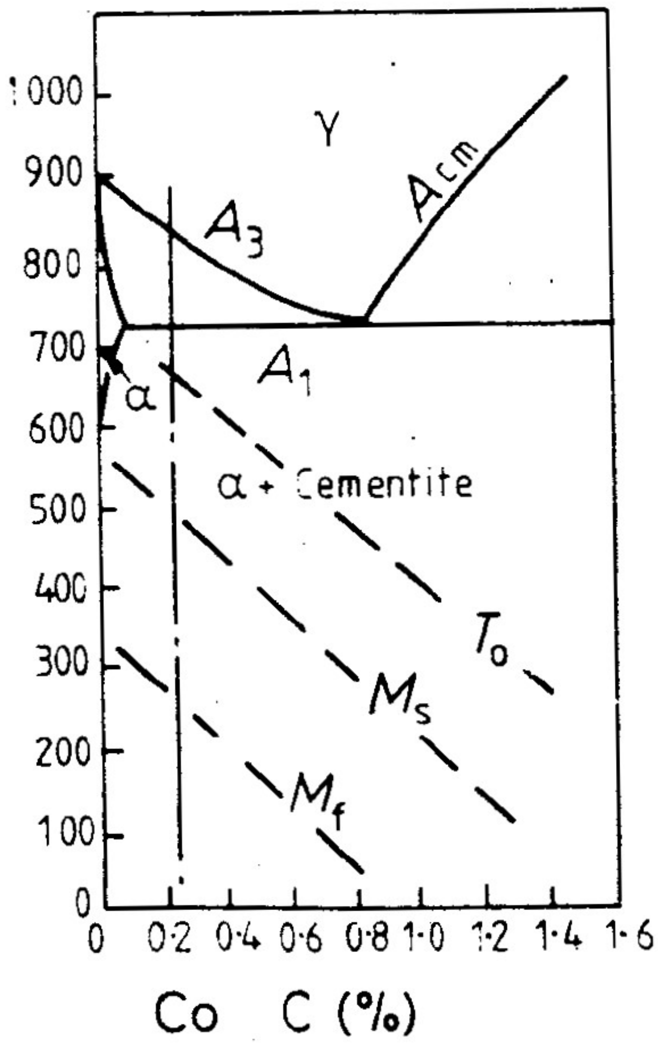
Characteristics of Diffusionless Transformations

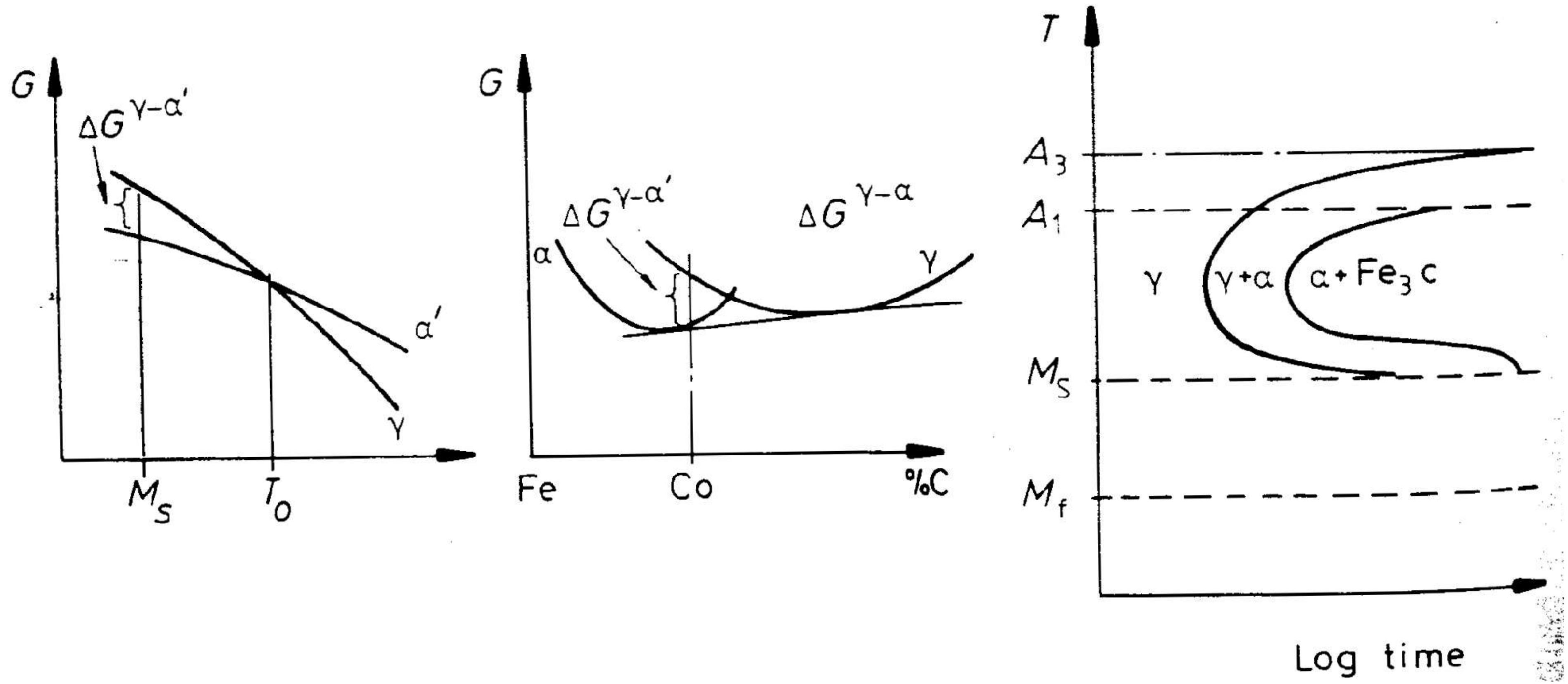
- Martensite phase is in the shape of a lens and span an entire grain diameter.
- Density of plates are independent of grain size of the austenite.
- The plates intersect the surface of a polished specimen tilting of the surface.
- The transformed regions appear coherent with the surrounding austenite. Indicates that there is no discontinuity due to formation of lenses in the austenite.

(a) (b)



- The interface of α′/γ interface is continuous after the transformation.
- The transformation is take place ~10^7 sec which is equal to the sound in the solid.
- M_s and M_f temperature decreases with increasing C content.
- Below M_f does not correspond to 100% martensite
- ~10-15% retained austenite is common especially in higher C content alloys.





- The driving force for the nucleation of martensite at M_s temperature is given by

$$\Delta G^{\gamma\rightarrow\alpha'} = \Delta H^{\gamma\rightarrow\alpha'} \frac{(T_o - M_s)}{T_o}$$

- The cooling rate for martnsite transformation is obtained from TTT diagram.

Table 6.1 Comparisons of Calorimetric Measurements of Enthalpy and Undercooling in some martensitic alloys

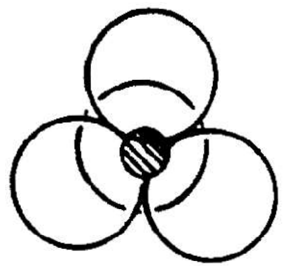
G. Guénin, Ph.D. thesis, Polytechnical Inst. of Lyon, 1979

Alloy	$\Delta H^{\gamma \to \alpha'}$ (J mol^{-1})	$T_0 - M_s$ (K)	$-\Delta G^{\gamma \to \alpha'}$ (J mol^{-1})
Ti–Ni	1550	20	92
Cu–Al	170–270	20–60	19.3 ± 7.6
Au–Cd	290	10	11.8
Fe–Ni 28%	1930	140	840
Fe–C			1260
Fe–Pt 24% ordered	340	10	17
Fe–Pt disordered	2390	~150	~1260

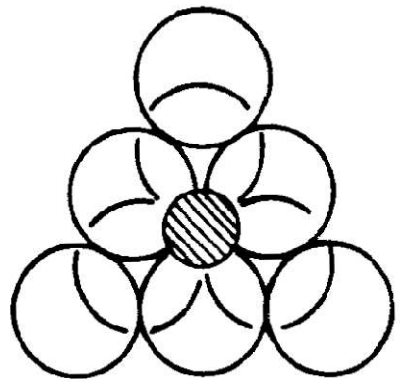
Solid solution of C in Fe

- Two possible position for C in γ-Fe
  - Tetrahedral
  - Octahedral
- The size of interstitial sites are
  - Tetrahedral interstice d_4=0.225D
  - Octahedral interstice d6=0.414D

  Where D is diameter of parent atom.
- D=2.52Å for γ-Fe. Therefore
  - Tetrahedral interstice d_4=0.568Å
  - Octahedral interstice d6=1.044Å
- Diameter of C is 1.54Å



(a) tetrahedral



(b) octahedral

- Two possible position for C in α-Fe
    - Tetrahedral
    - Octahedral
- The size of interstitial sites are
    - Tetrahedral interstice d_4=0.291D
    - Octahedral interstice d_6=0.155D

    Where D is diameter of parent atom.
- d_6<d_4 for bcc. Diameter of C is 1.54Å. Still C occupies octahedral site.
- X-ray diffraction at -100°C of martensite show that c/A ration of the bct lattice is given by

c/a=1.005+0.045(wt.%C)

- The distortion of the lattice in one direction (z) causes a contraction in the two directions normal to z (x,y).