3.14/3.40/22.71 Lecture Summary: Introduction to Steel Case Study

November 25, 2009

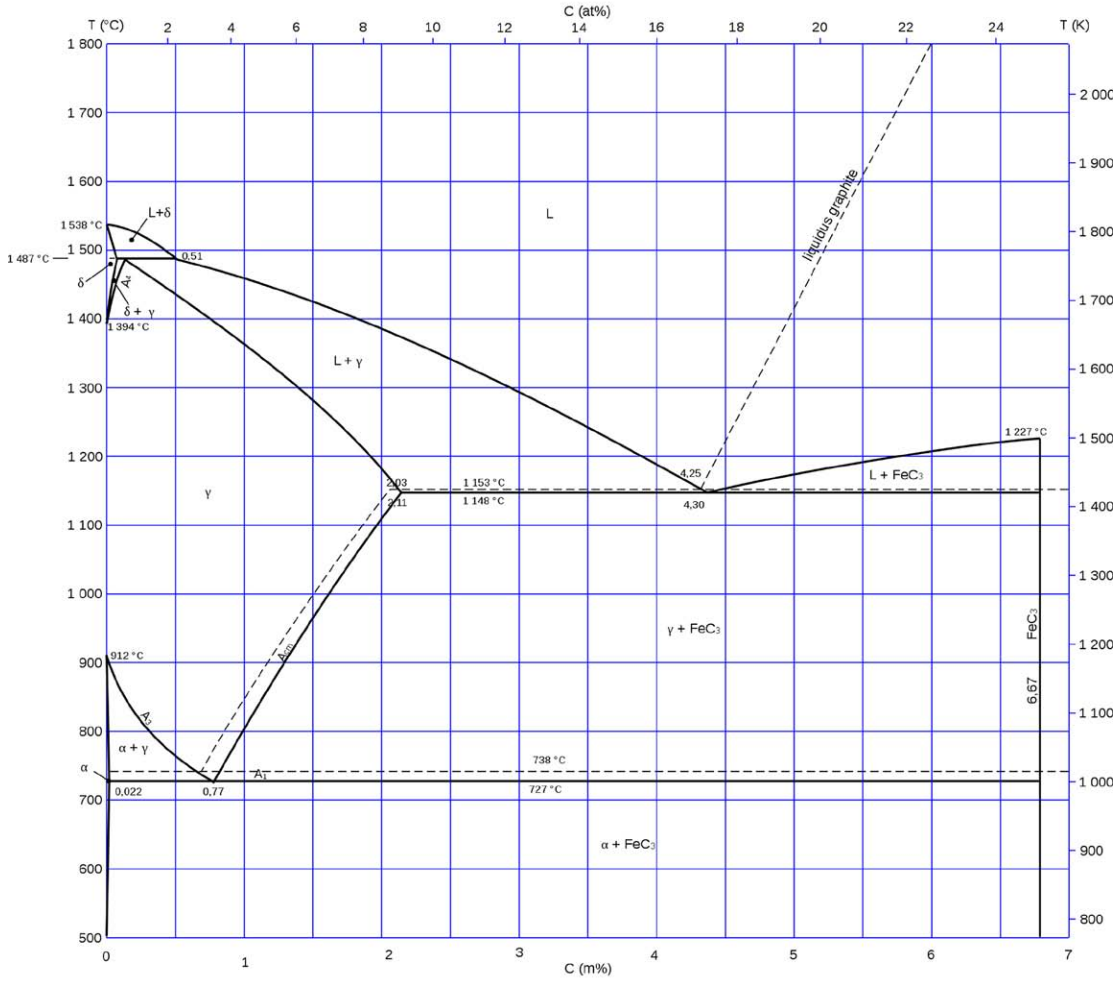
Fe-C System Definitions

- **Steel: 0.005 to 2 wt% C in Fe**
  - **Most carbon steel is less than 1 wt% C**
  - **Greatest tonnage produced in the 0.2 to 0.3 wt% C, used for structural steel in buildings, bridges, ships, etc.**
  - **Greater than 1 wt% C is rare, used for razor blades, cutlery, etc.**
- **Cast iron: >2 wt% C in Fe**
  - **Usually has other elements added, such as Si**

Steel Phases

Phase	*Term*	*Structure*	*Temperature Conditions*	*Notes*
α-Fe	Ferrite	BCC	T<911.5 °C	Solubility is very low
δ-Fe	δ-Ferrite	BCC	1396 °C<T<1538 °C	Only seen in transient when melting
γ-Fe	Austenite	FCC	911.5 °C<T<1396 °C	C is an "Austenite stabilizer": add C, γ field widens
C	Graphite	Hexagonal		Rarely observed, competes with Fe_3C, hard to nucleate except in the presence of Si
Fe_3C	Cementite	Orthorhombic		Hard ceramic, lower nucleation barrier than for graphite
Fe-C solid solution	Martensite	BCT		Metastable, formed by quenching

Phase Diagram



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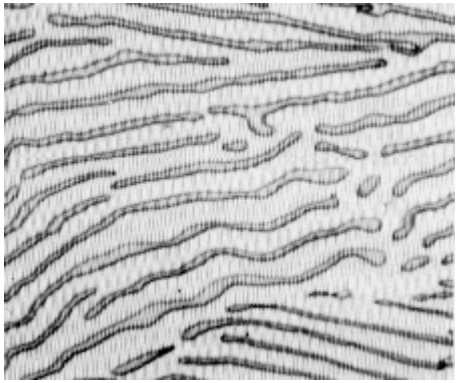
Materials Science and Engineering: An Introduction.
Hoboken, NJ: Wiley & Sons, 2007.

Eutectoid Reaction

Pearlite

- α and Fe3C with a lamellar structure
- Grows into the grains from the grain boundaries
- Lamellae promoted by crystallography; close-packed planes line up before and after the eutectoid transition



Pearlite microstructure forms below the eutectoid point

$\gamma\ (0.77\%) \rightarrow \alpha\ (0.22\%) + Fe_3C\ (6.7\%)$

Eutectoid Kinetics

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Please see Fig. 10.14 in Callister, William D.
Materials Science and Engineering: An Introduction. Hoboken, NJ: Wiley & Sons, 2007.

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