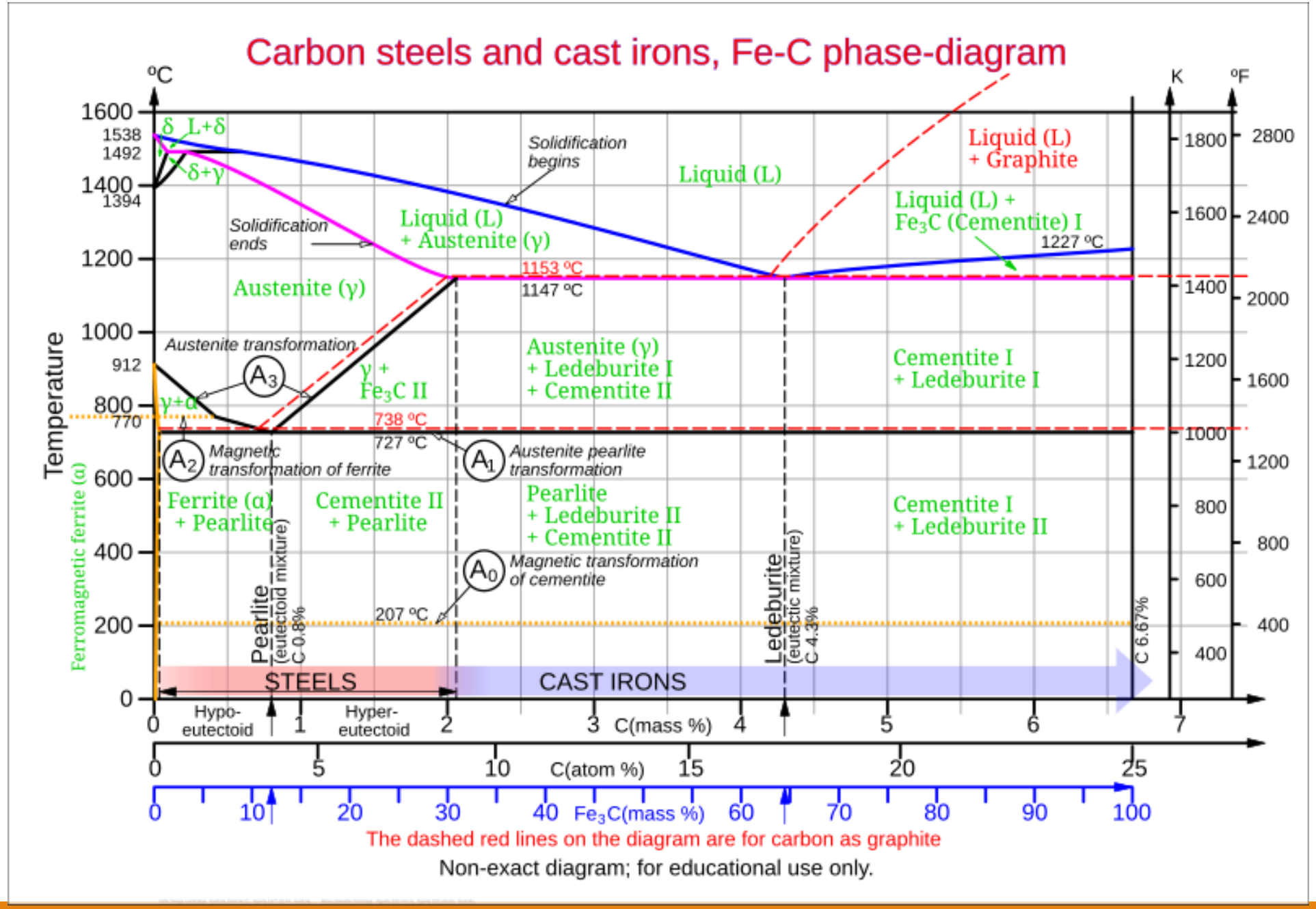
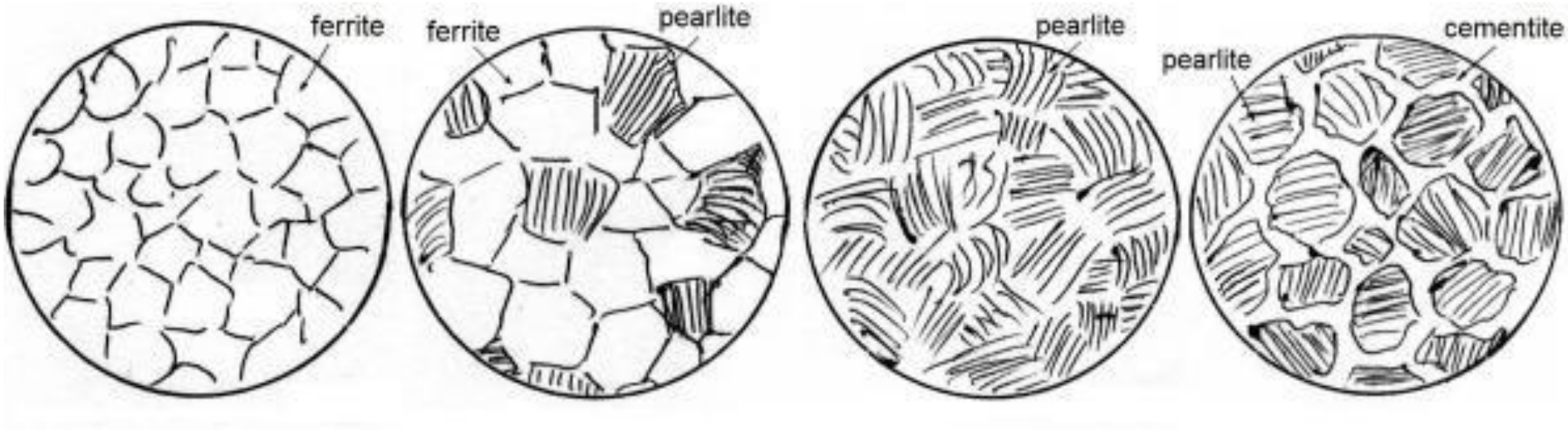
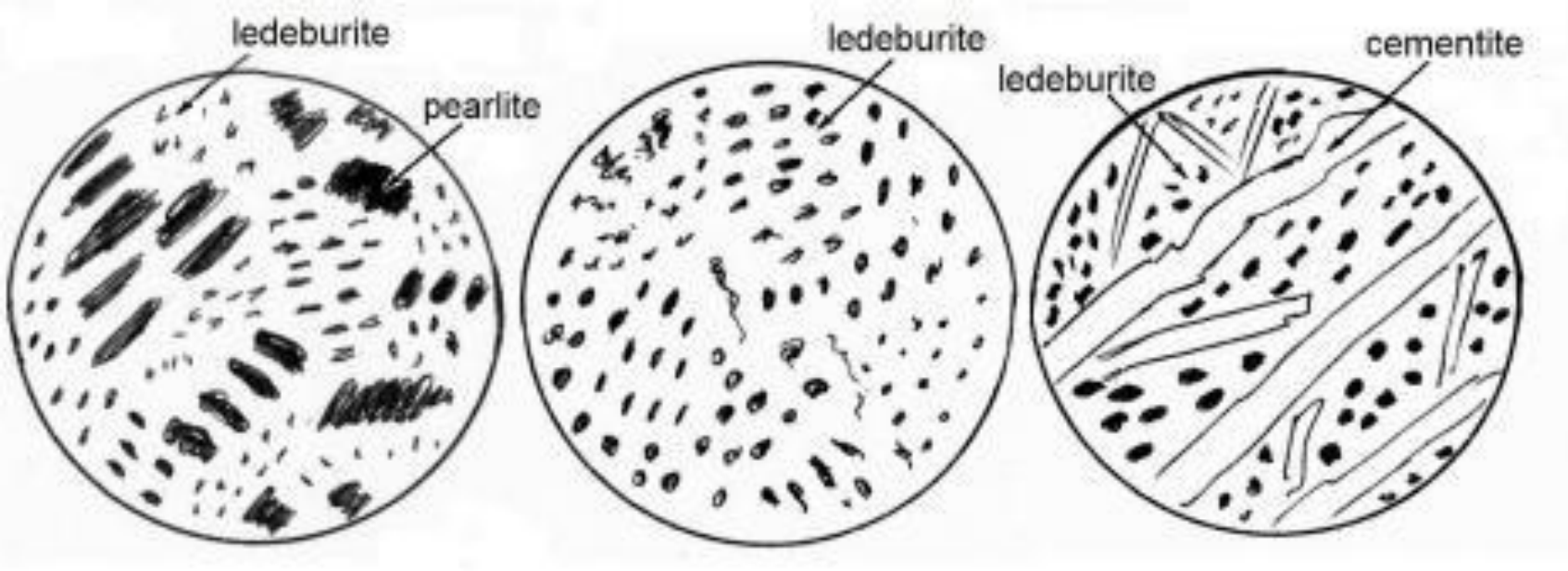
Hierros colados


Carbon steels and cast irons, Fe-C phase-diagram
°C
K
°F
Temperature
Ferromagnetic ferrite (α)
δ
L+δ
δ+γ
Solidification begins
Solidification ends
Liquid (L)
Liquid (L) + Austenite (γ)
Liquid (L) + Graphite
Liquid (L) + Fe3C (Cementite) I
1227 °C
1153 °C
1147 °C
Austenite (γ)
Austenite transformation
A3
γ + Fe3C II
γ+α
738 °C
727 °C
A2
Magnetic transformation of ferrite
A1
Austenite pearlite transformation
A0
Magnetic transformation of cementite
207 °C
Austenite (γ) + Ledeburite I + Cementite II
Cementite I + Ledeburite I
Ferrite (α) + Pearlite
Cementite II + Pearlite
Pearlite + Ledeburite II + Cementite II
Cementite I + Ledeburite II
Pearlite (eutectoid mixture) C 0.8%
Ledeburite (eutectic mixture) C 4.3%
C 6.67%
STEELS
CAST IRONS
Hypo-eutectoid
Hyper-eutectoid
C(mass %)
C(atom %)
Fe3C(mass %)
The dashed red lines on the diagram are for carbon as graphite
Non-exact diagram; for educational use only.

Eutectoide



Eutéctica



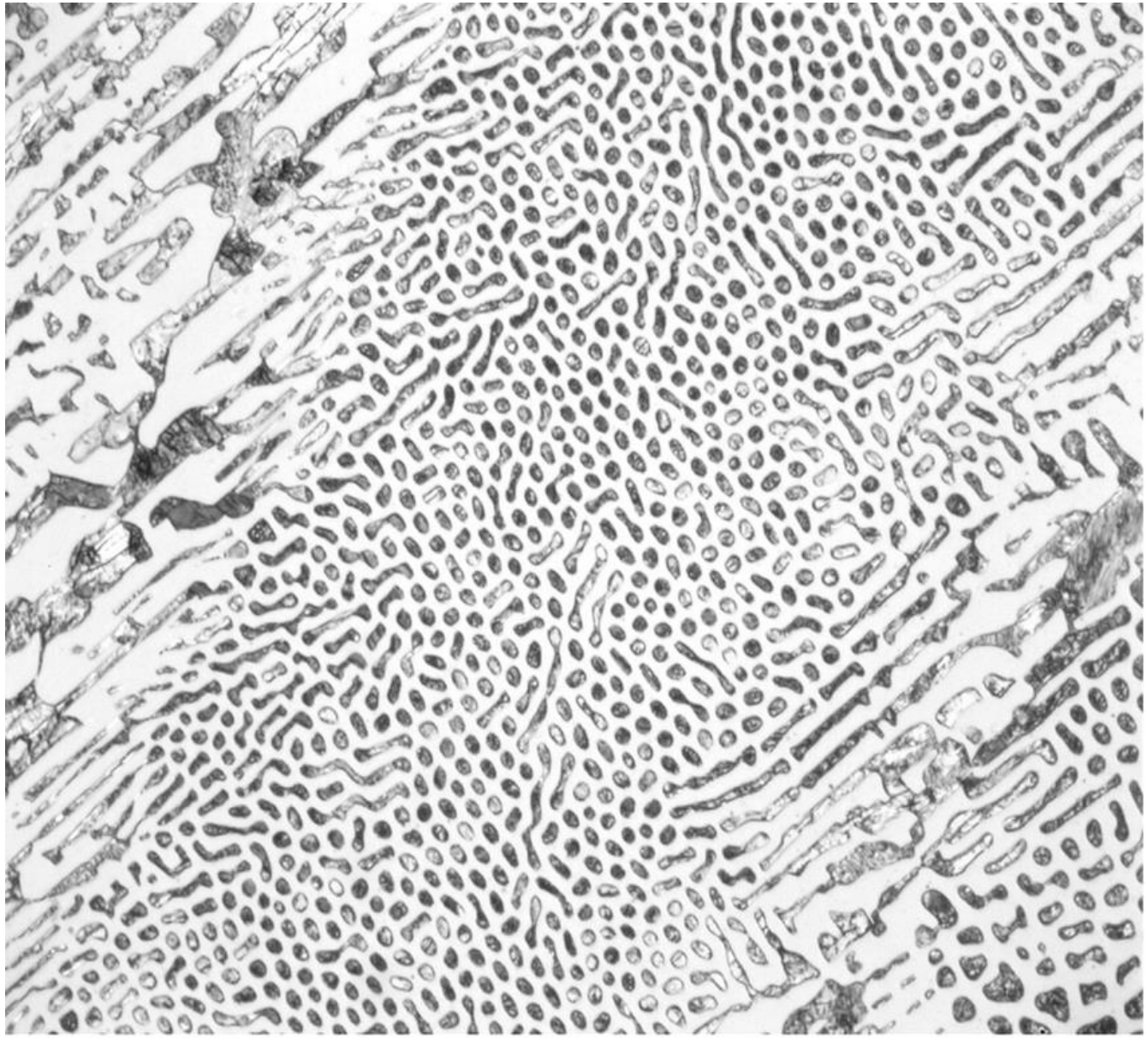


FIGURE 3.30 Ledeburite in a white cast iron (Fe–4.0% C–0.3% Si–0.16% Mn–0.91% Cr) etched with Beraha's sulfamic acid reagent (100 mL water, 3 g $K_2S_2O_5$ and 2 g NH_2SO_3H). Original at 500× magnification. Taken in polarized light with sensitive tint.

Diagrama Fe-Fe_3C

1. Reacción Eutéctica.

   Líquido $\longrightarrow$ Solido 1 + Sólido 2

   Líquido $\longrightarrow$ (γ + Fe_3C) Ledeburita [Microconstituyente]

2. Reacción Eutectoide

Solido 1 $\longrightarrow$ Solido 2 + Solido 3

γ $\longrightarrow$ (α + Fe_3C) Perlita [Microconstituyente]

A temperatura Eutectoide

Ledeburita $\longrightarrow$ Pseudoledeburita o Ledeburita Transformada

(γ + Fe_3C) $\longrightarrow$ (P + Fe_3C) [Microconstituyente]

(perlita + cementita)

Descripción de la solidificación y enfriamiento del sólido hasta temperatura ambiente.

Fundición Blanca Hipoeutéctica

Diagrama Fe – Fe_3C | Diagrama Fe – Fe_3C | Diagrama Fe – Fe_3C

$$Líquido \rightarrow \gamma + Líquido \rightarrow \gamma + (\gamma + Fe_3C) \rightarrow P + (P + Fe_3C)$$

Perlita Libre

Temperatura Liquidus | Temperatura Eutéctica | Temperatura Eutectoide

Ledeburita

PseudoLedeburita

Fundición Blanca Hipereutéctica

Diagrama Fe – Fe_3C | Diagrama Fe – Fe_3C | Diagrama Fe – Fe_3C

$$Líquido \rightarrow Fe_3C + Líquido \rightarrow Fe_3C + (\gamma + Fe_3C) \rightarrow Fe_3C + (P + Fe_3C)$$

Fe_3C Libre

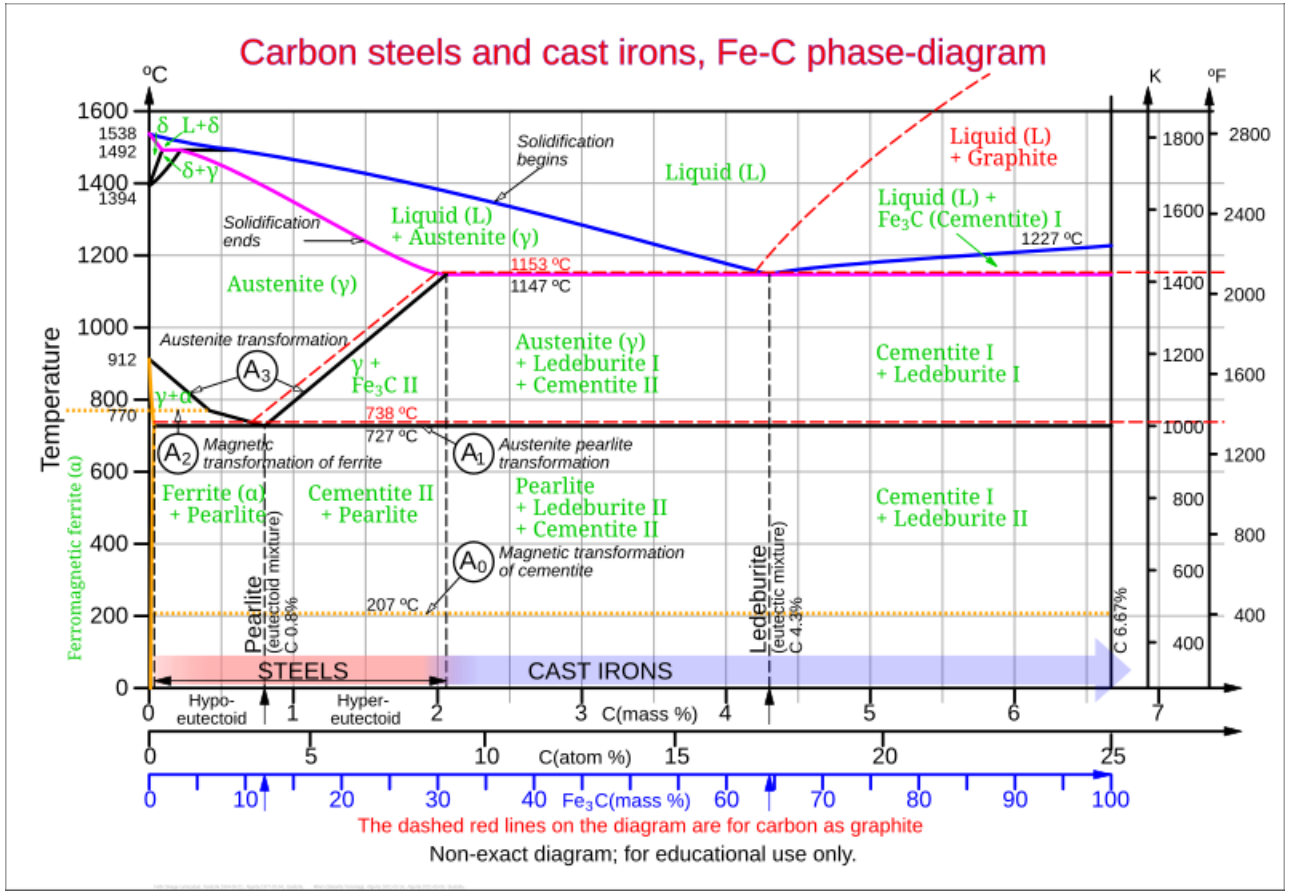
Temperatura Liquidus | Temperatura Eutéctica | Temperatura Eutectoide

Ledeburita

PseudoLedeburita

Tipos de Cementita

	Origen
1. Cementita Primaria Fe_3C_P	Líquido
2. Cementita Secundaria Fe_3C_S	Austenita
3. Cementia Terciaria Fe_3C_T	Ferrita



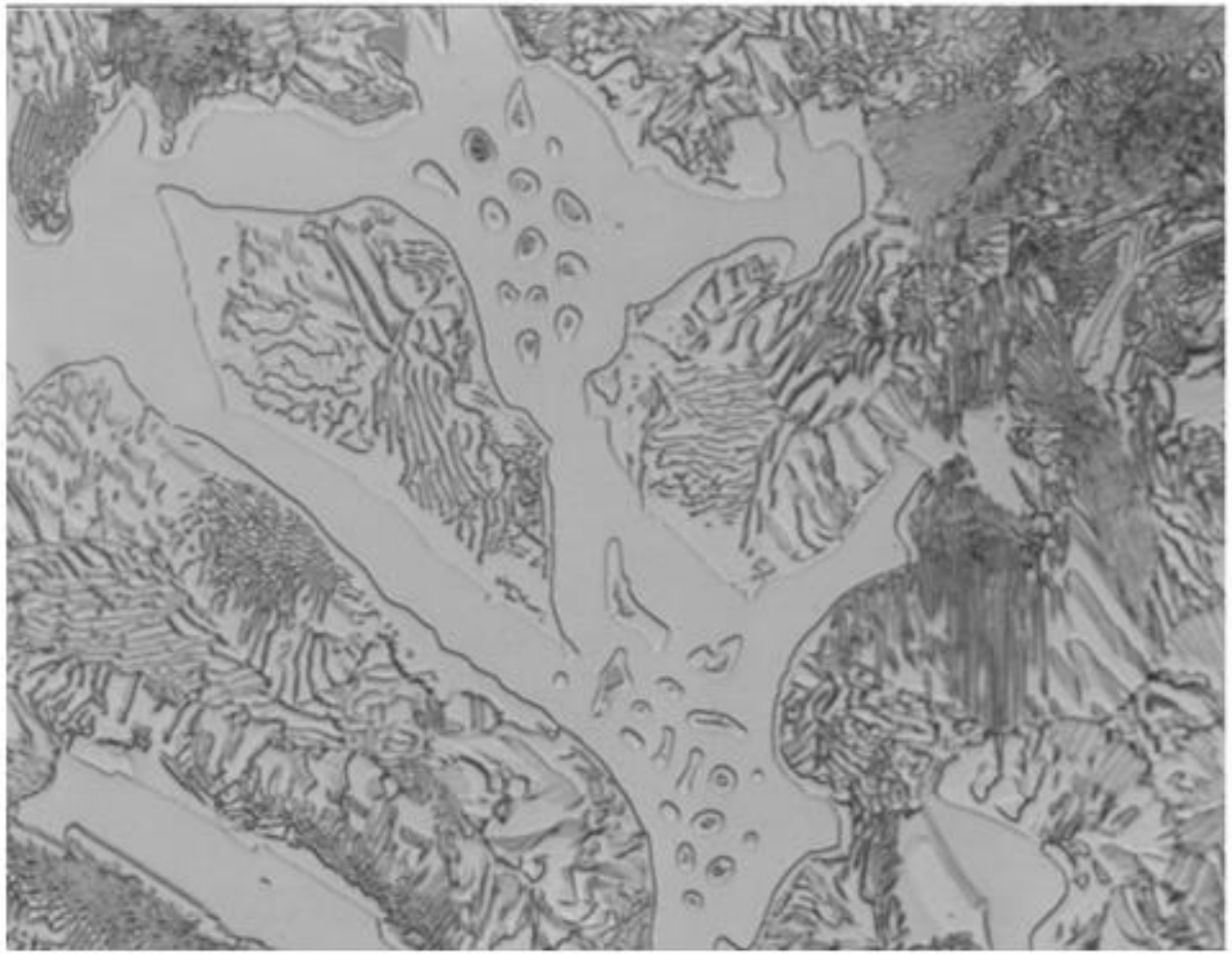


FIGURE 3.31 Microstructure of white cast iron revealed using 2% nital and consisting of lamellar pearlite and cementite (white). Original at 1000×.

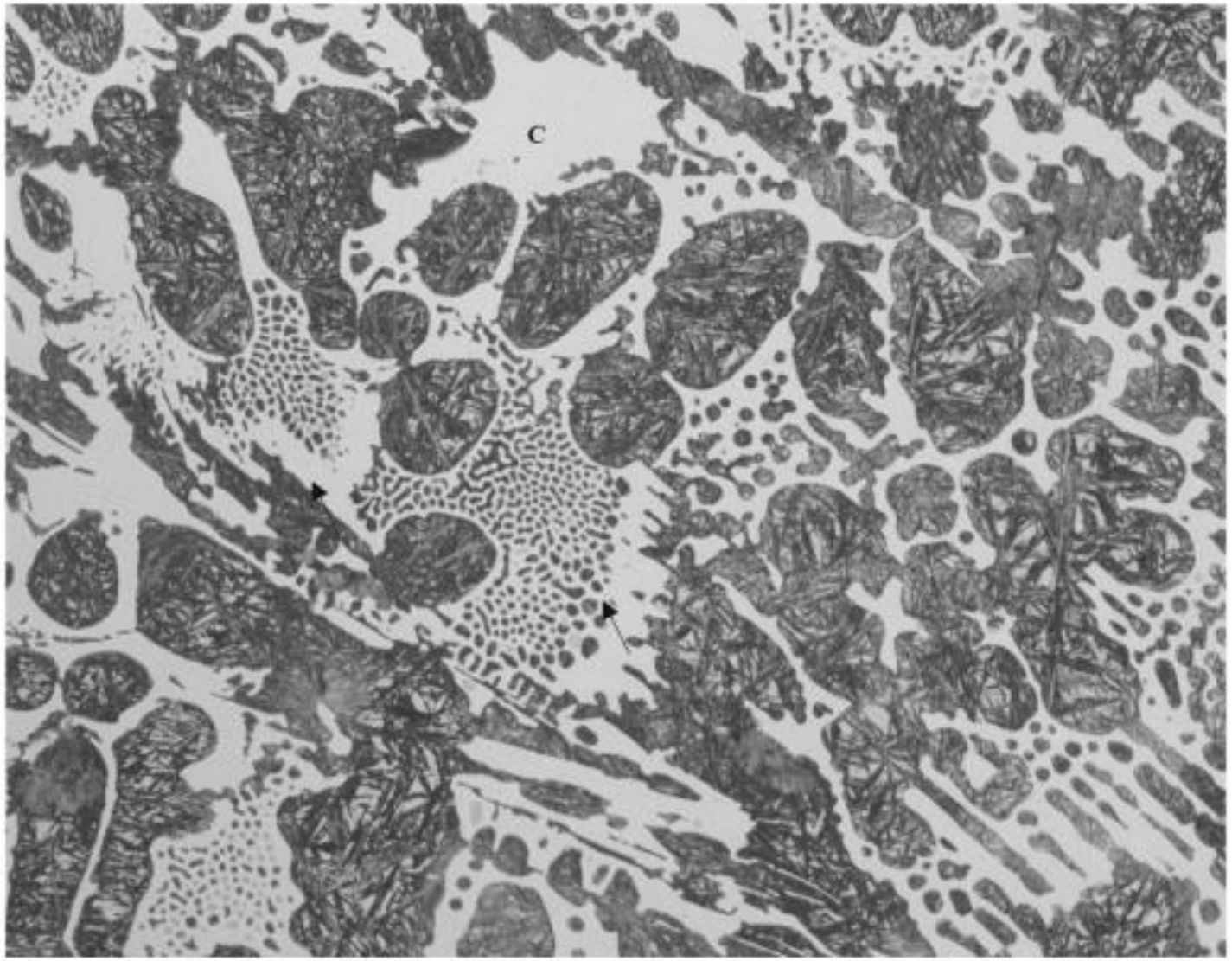


FIGURE 3.36 Microstructure of Ni-Hard cast iron (Fe–3.3% C–0.9% Mn–0.9% Si–1.8% Cr.4.4% Ni–0.4% Mo) revealing massive cementite (C), ledeburite (arrows) and patches of plate martensite and retained austenite. Etched with aqueous 10% $Na_2S_2O_5$. Original at 200×. Ledeburite is a eutectic of cementite and austenite where, with cooling, the austenite transforms to ferrite and cementite in the form of pearlite.

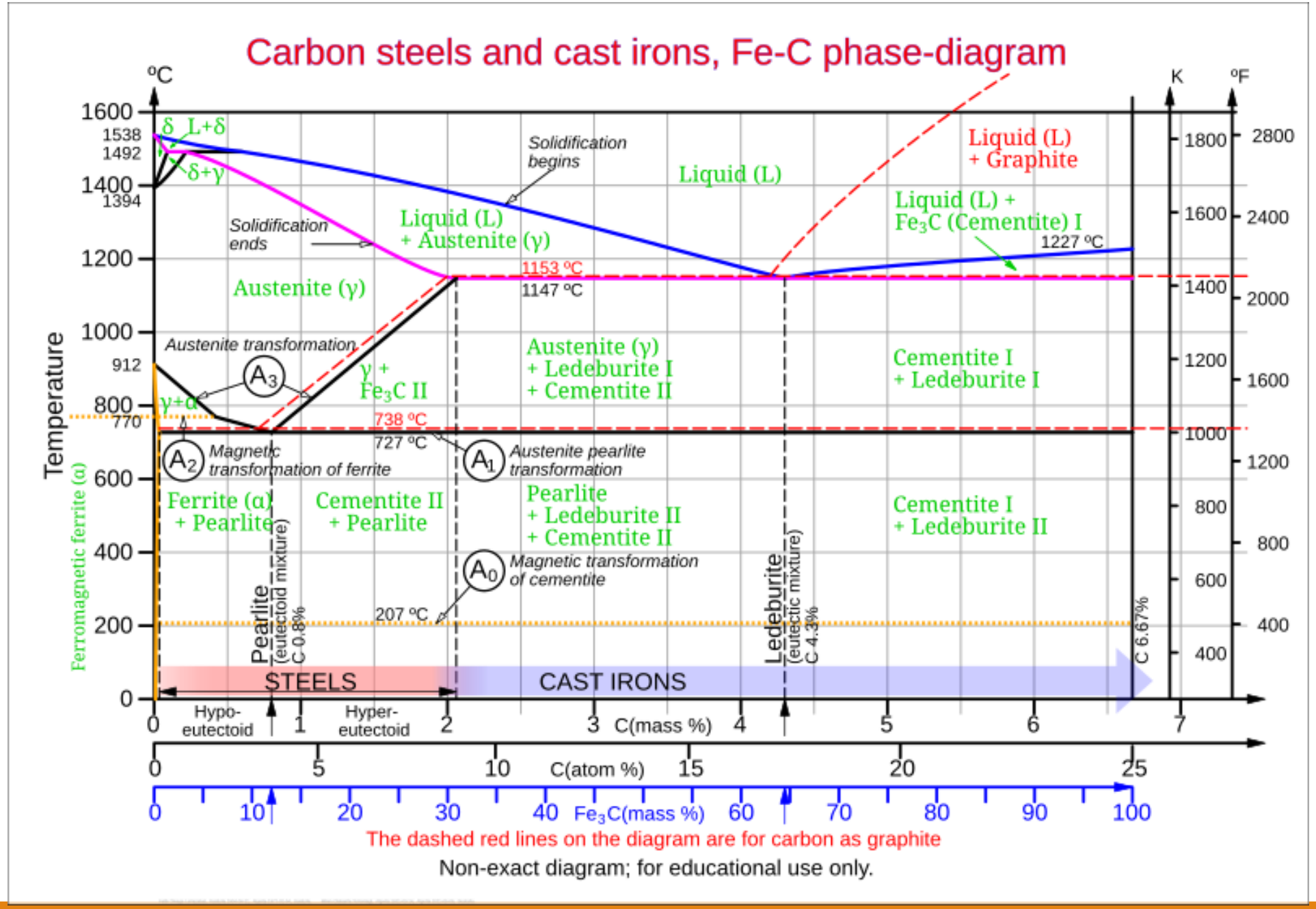

Carbon steels and cast irons, Fe-C phase-diagram
°C
K
°F
Temperature
Ferromagnetic ferrite (α)
δ
L+δ
δ+γ
Solidification begins
Solidification ends
Liquid (L)
Liquid (L) + Austenite (γ)
Liquid (L) + Graphite
Liquid (L) + Fe3C (Cementite) I
1227 °C
1153 °C
1147 °C
Austenite (γ)
Austenite transformation
A3
γ + Fe3C II
γ+α
738 °C
727 °C
A2
Magnetic transformation of ferrite
A1
Austenite pearlite transformation
A0
Magnetic transformation of cementite
207 °C
Austenite (γ) + Ledeburite I + Cementite II
Cementite I + Ledeburite I
Ferrite (α) + Pearlite
Cementite II + Pearlite
Pearlite + Ledeburite II + Cementite II
Cementite I + Ledeburite II
Pearlite (eutectoid mixture) C 0.8%
Ledeburite (eutectic mixture) C 4.3%
C 6.67%
STEELS
CAST IRONS
Hypo-eutectoid
Hyper-eutectoid
C(mass %)
C(atom %)
Fe3C(mass %)
The dashed red lines on the diagram are for carbon as graphite
Non-exact diagram; for educational use only.

Diagrama Fe-C

1. Reacción Eutéctica.

   Líquido $\longrightarrow$ Sólido 1 + Sólido 2

   Líquido $\longrightarrow$ γ + Cg [Microconstituyentes]

2. Reacción Eutectoide

Solido 1 $\longrightarrow$ Sólido 2 + Sólido 3

$\gamma \longrightarrow \alpha + Cg$ [Microconstituyentes]

Descripción de la solidificación y enfriamiento del sólido hasta temperatura ambiente.

Fundición Gris Hipoeutéctica

Diagrama Fe – $C_{(grafito)}$

Diagrama Fe – $C_{(grafito)}$

Diagrama Fe – $C_{(grafito)}$

$$Líquido \rightarrow \gamma + Líquido \rightarrow \gamma + \gamma + C_{grafito} \rightarrow \alpha + \alpha + C_{grafito}$$

Temperatura Liquidus

Temperatura Eutéctica

Temperatura Eutectoide

Hierro gris de matriz ferritica

Fundición Gris Hipereutéctica

Diagrama Fe – $C_{(grafito)}$

Diagrama Fe – $C_{(grafito)}$

Diagrama Fe – $C_{(grafito)}$

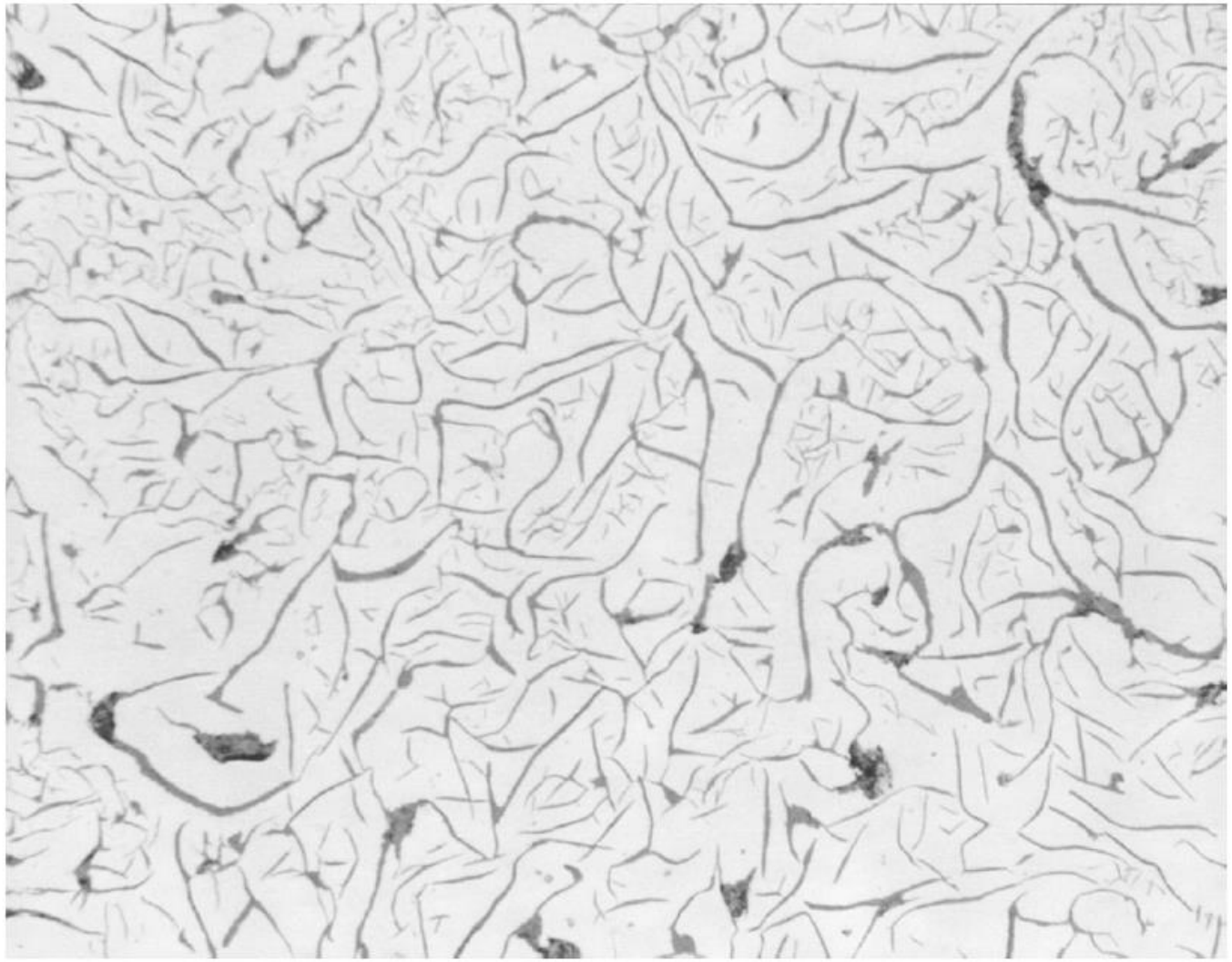
$$Líquido \rightarrow C_{grafito} + Líquido \rightarrow C_{grafito} + \gamma + C_{grafito} \rightarrow C_{grafito} + \alpha + C_{grafito}$$

Temperatura Liquidus

Temperatura Eutéctica

Temperatura Eutectoide

Hierro gris de matriz ferritica

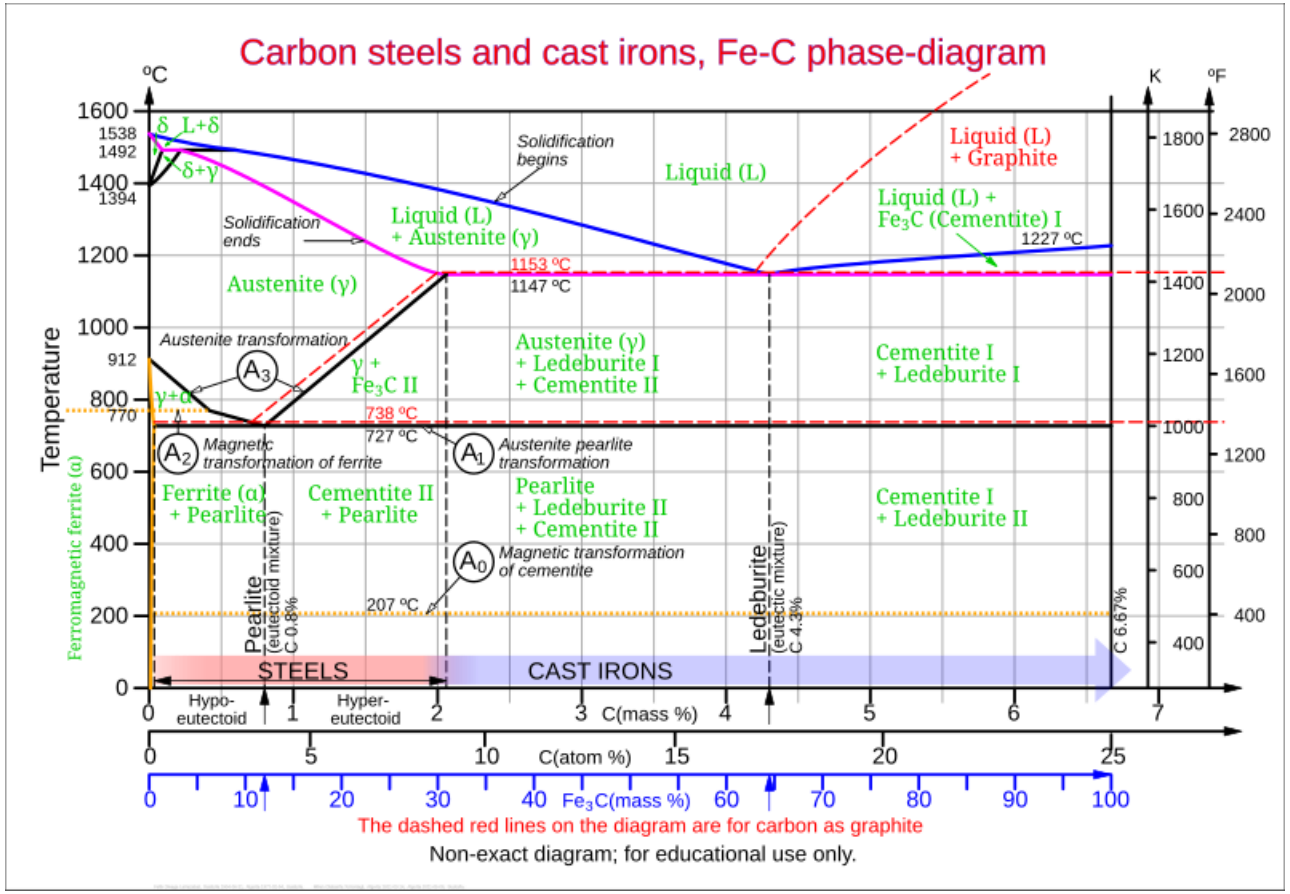


Gray Cast Iron

Well-formed flakes of graphite in gray cast iron. As-polished; original at 200×.

Tipos de Grafito

	Origen
1. Grafito Primario Cg_P	Líquido
2. Grafito Secundario Cg_S	Austenita
3. Grafito Terciario Cg_T	Ferrita



Descripción de la solidificación y enfriamiento del sólido hasta temperatura ambiente.

Obtención de Hierros grises con:

Matriz perlítica ó
Matriz ferrítico-perlítica (F-P) ó
Matriz perlítico-ferrítica (P-F).

Manejando Diagramas de fases
Fe – Cg y Fe - Fe_3C

Fundición Gris Perlítica

Diagrama Fe – $C_{(grafito)}$	Diagrama Fe – $C_{(grafito)}$	Diagrama Fe – Fe_3C

$$Líquido \rightarrow \gamma + Líquido \rightarrow \gamma + \gamma + C_{grafito} \rightarrow P + C_{grafito}$$

Temperatura Liquidus	Temperatura Eutéctica	Temperatura Eutectoide

Hierro gris de matriz perlítica

Fundición Gris P-F o F-P

Diagrama Fe – $C_{(grafito)}$	Diagrama Fe – $C_{(grafito)}$	Diagrama Fe – Fe_3C

$$Líquido \rightarrow \gamma + Líquido \rightarrow \gamma + \gamma + C_{grafito} \rightarrow P + C_{grafito}$$

$$\gamma + C_{grafito} \rightarrow \alpha + C_{grafito}$$

Temperatura Liquidus	Temperatura Eutéctica	Temperatura Eutectoide

Hierro gris de matriz P-F ó F-P

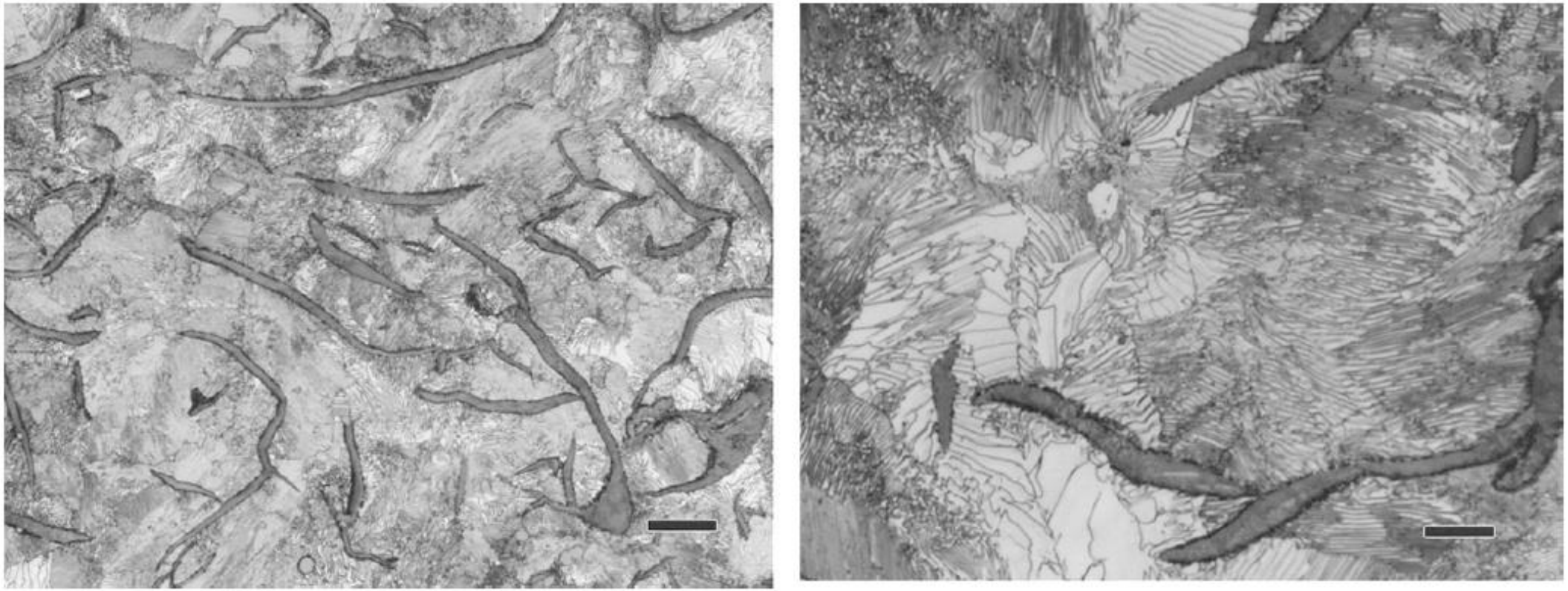


FIGURE 3.8 Examples of fully pearlitic gray irons (high strength) with well-formed flakes. The specimen on the right has a slightly coarser interlamellar spacing. The specimens were etched with 2% nital (left) and 4% picral (right) and the magnification bars are 20 and 10 μm long, respectively.

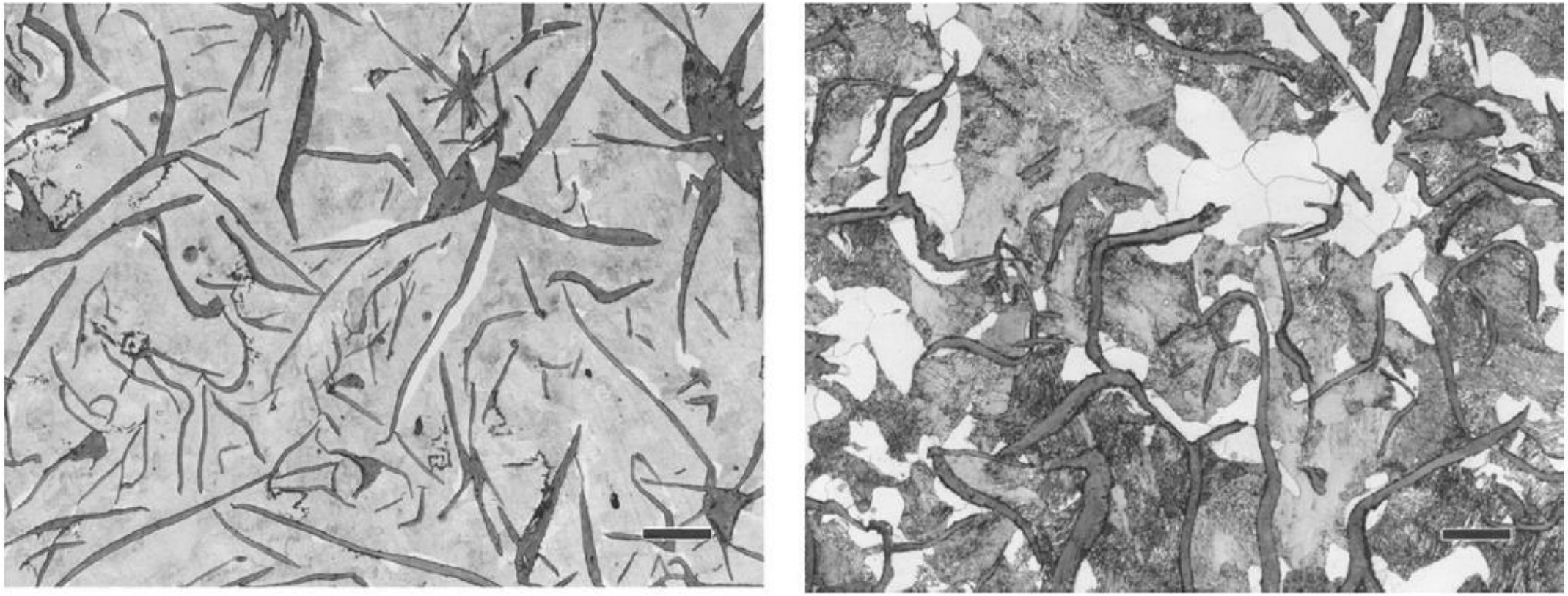


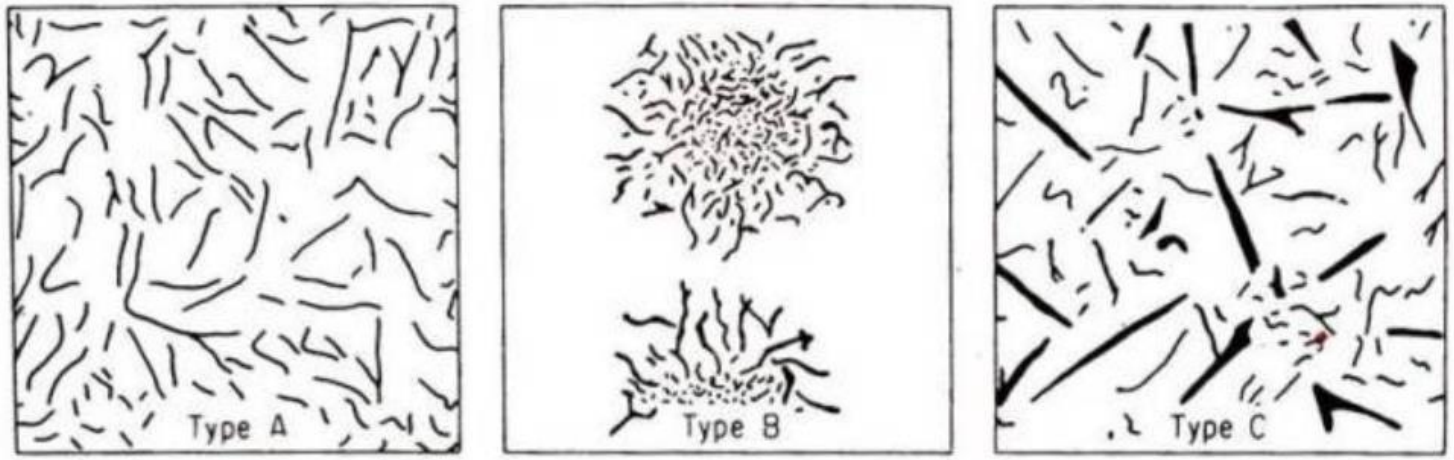
FIGURE 3.9 Examples of pearlitic gray irons with small amounts of ferrite (1.5% at left and 18% at right). Both specimens were etched with 2% nital. The magnification bar lengths are 50 and 20 μm, left and right.

FIGURE 3.10 Examples of ferritic gray iron specimens, both are etched with 2% nital. The specimen at left has 30% pearlite while the specimen at right is fully ferritic. The magnification bar lengths are 100 and 20 μm, left and right.

Tipos de Hojuelas de Grafito (ISO 945)

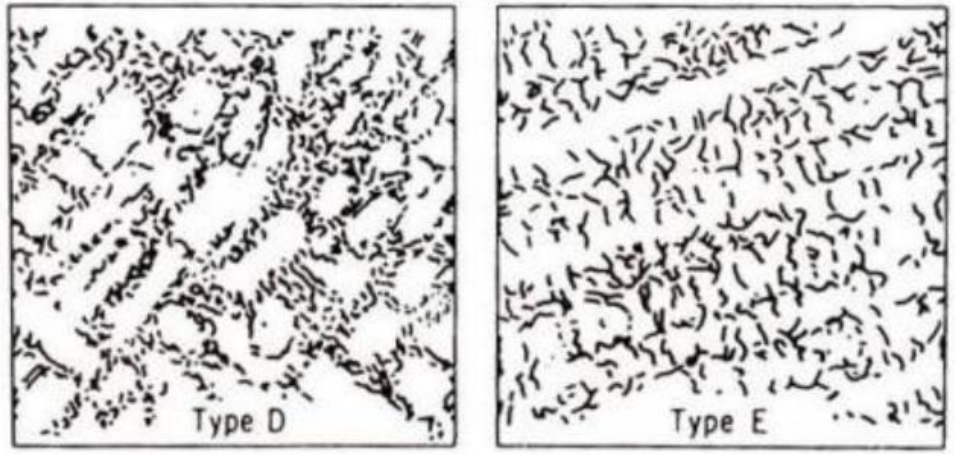
Enfriamiento muy rápido

Forma preferida



Hipereutéctico

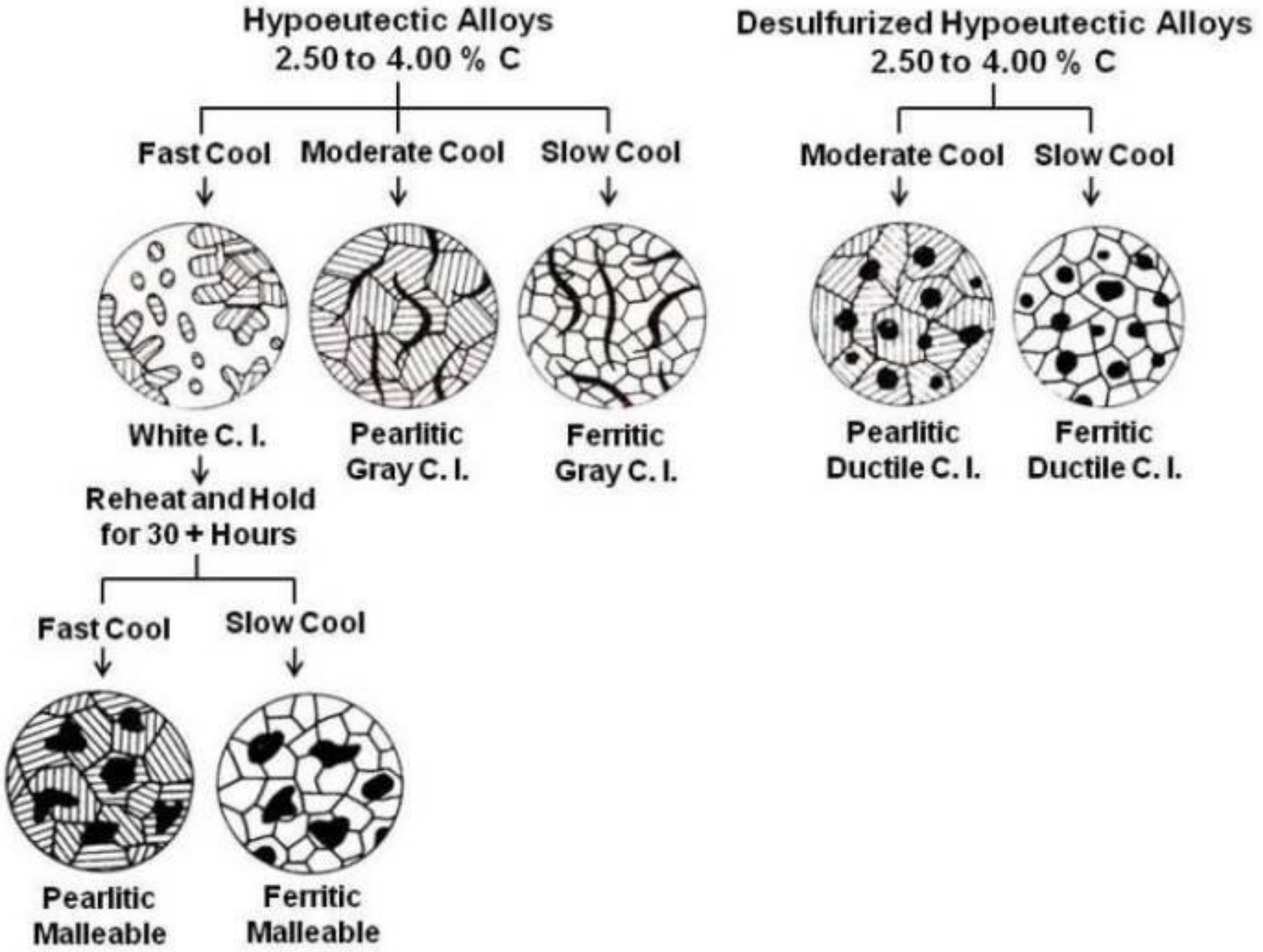
Enfriamiento rápido



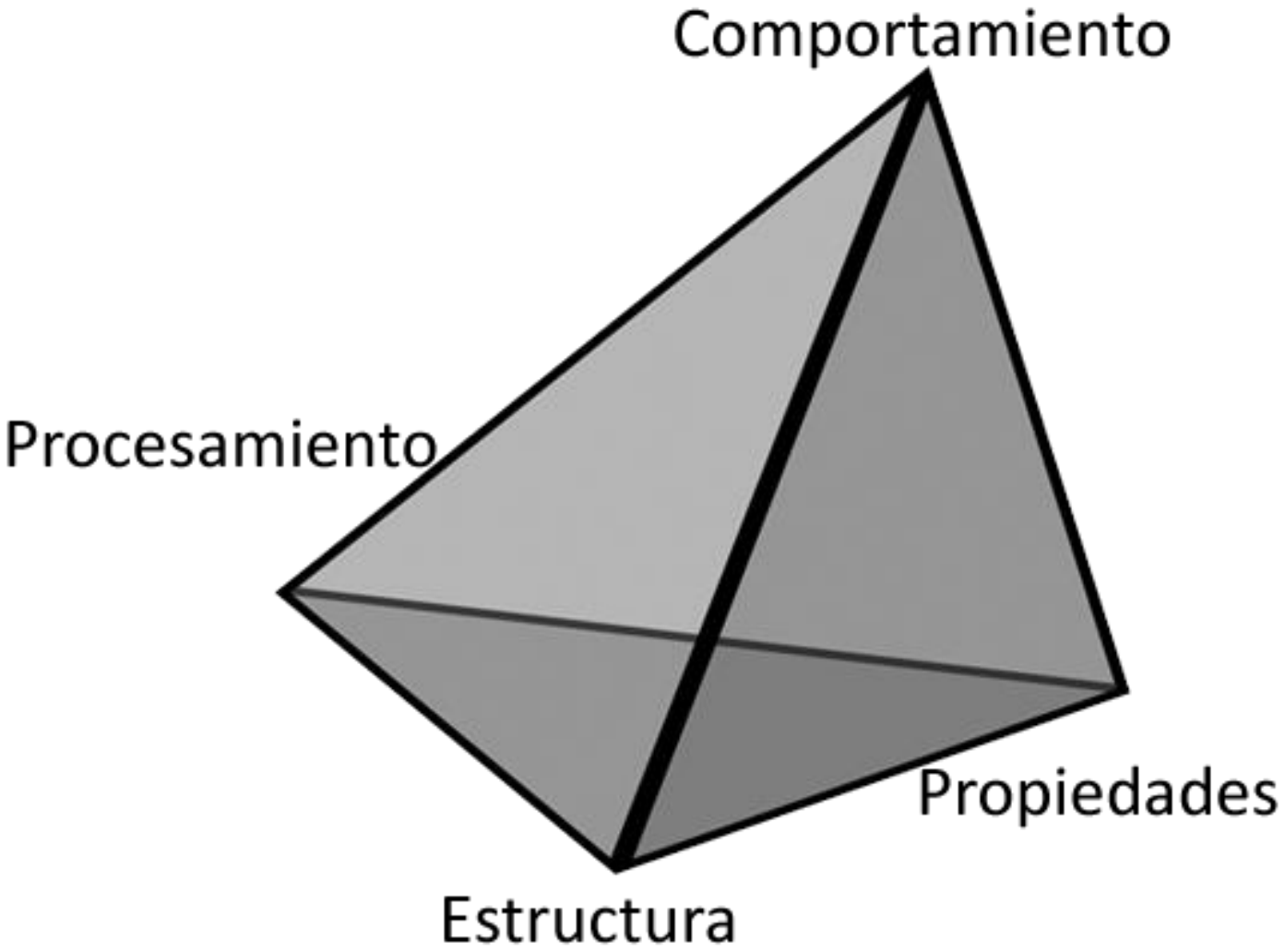
Enfriamiento rápido en matriz perlítica

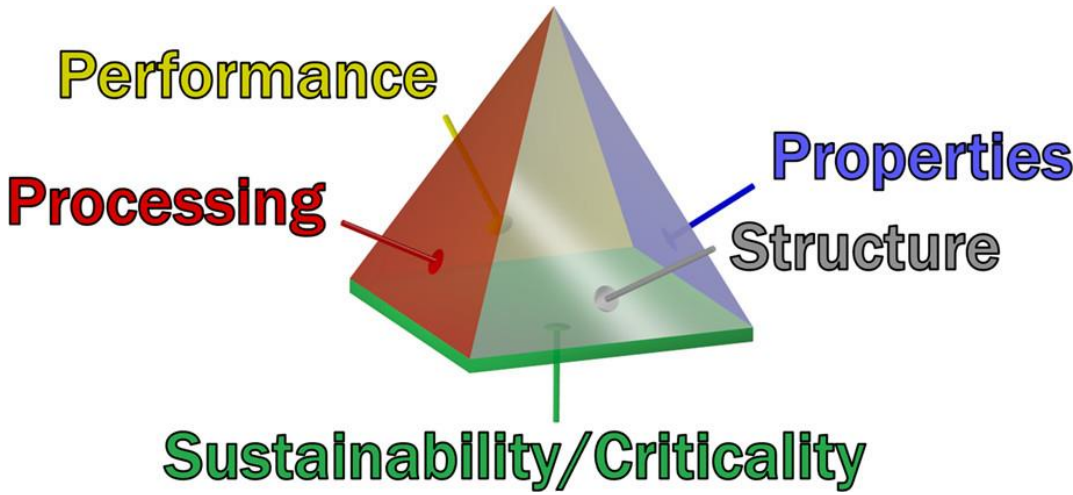
Graphite-flake Types

Type A: Uniform distribution, random orientation
Type B: Rosette groupings, random orientation
Type C: Superimposed flake sizes, random orientation
Type D: Interdendritic segregation, random orientation
Type E: Interdendritic segregation, preferred orientation



Summary of Cast Iron Microstructure


Comportamiento
Procesamiento
Propiedades
Estructura


Performance
Properties
Processing
Structure
Sustainability/Criticality