

Metals



Materials Engineering
(BMEGEMTAMM1)
1st April, 2026

Dr. Dorina Kovacs
kovacs.dorina@gpk.bme.hu
MT épület 061.

Cold forming steels

- high carbon content
- main alloying elements: Mn, Cr, Mo, V, W, Ni
- high hardness → low tempering temperature
- saw, cutting tool, punch

Examples:

95MnWCrV5, X210CrW12

Hot forming steels

- operation temperature higher than 200 °C
- main alloying elements Cr, Mo, W, Ni, Co
- carbide inclusions
- pressure casting dies, forging dies

Examples:

55NiCrMoV7, X40CrMoV5-1

Ferritic

- contain 11–18% Cr and very little or no Ni
- carbon content is low (often ≤ 0.05 – 0.10%) to avoid forming austenite or martensite
- moderate corrosion resistance
- washing machine drums, kitchen appliance panels

Examples:

AISI 430 – X6Cr17

AISI 409 – X2CrTi12

Martensitic

- carbon (typically 0.1% up to 1%) that can be hardened
- contain 11–18% Cr and no or low Ni (usually $\leq 2\%$ Ni)
- moderate corrosion resistance
- knife blades, cutting tools, surgical instruments, turbine blades

Examples:

AISI 410 – X12Cr13

X105CrMo17

Austenitic

- ~16–26% Cr and 8–20% Ni
- Carbon is usually low (often $\leq 0.08\%$)
- excellent corrosion resistance
- excellent formability and weldability
- food and beverage processing equipment, medical tools

Examples:

AISI 304 – X5CrNi18-10

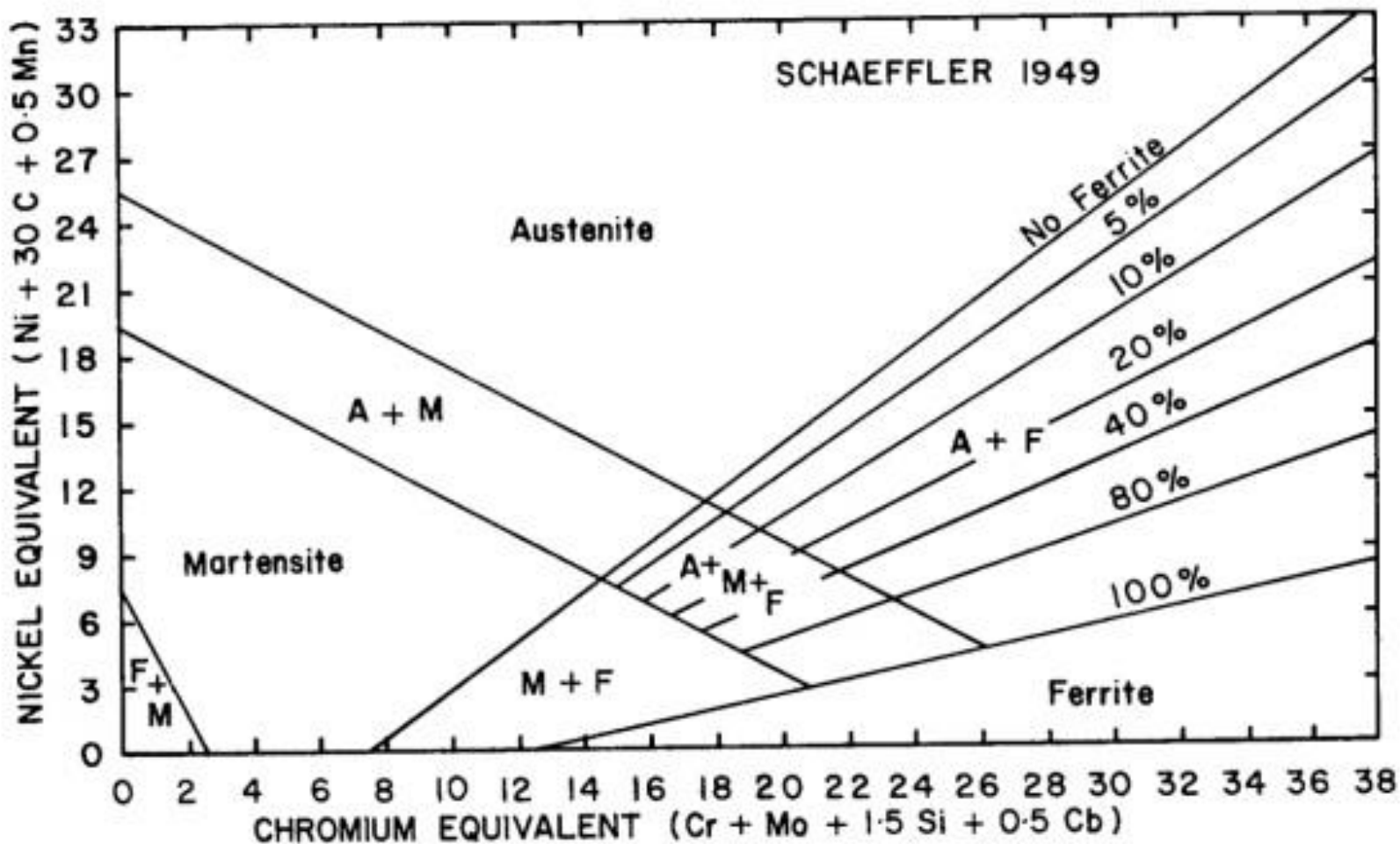
AISI 316 – X5CrNiMo17-12-2

Duplex

- Cr content in the 18–28% range, moderate Ni (4–8%), plus significant Mo (2.5–4%) and N (~ 0.1 –0.3%)
- the dual-phase structure: austenite and ferrite
- excellent corrosion resistance
- oil & gas production equipment, heat exchangers, pressure vessels

Examples:

2205 – X2CrNiMoN22-5-3





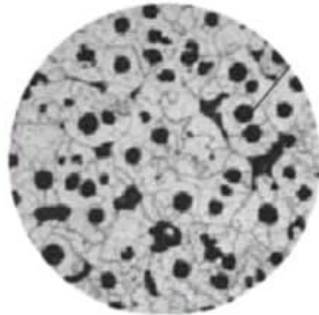
Gray Cast Iron



Engine blocks
Housing



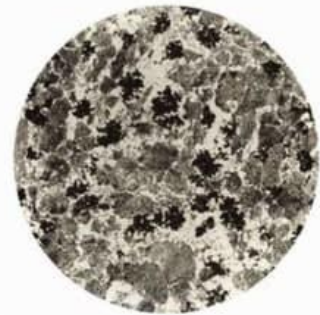
Ductile Cast Iron



Pistons
Pipes



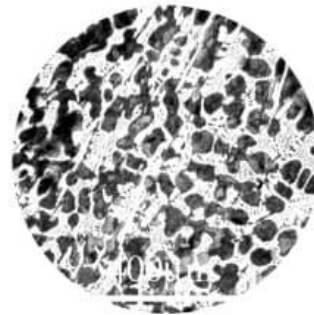
Malleable Cast Iron



Agricultural tools



White Cast Iron



(Contains carbon in
the form of Fe_3C)
Crushers



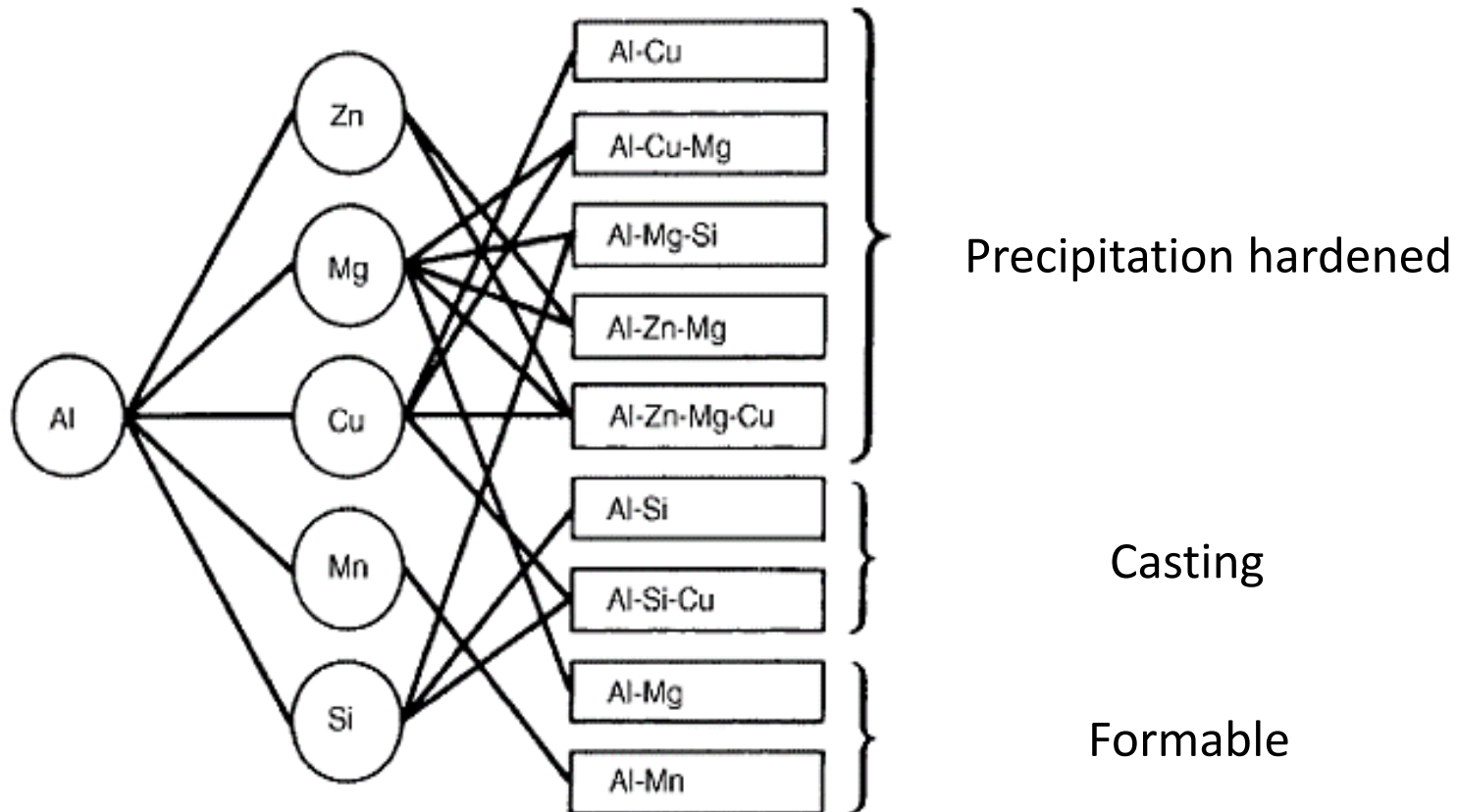
Alloy Cast Iron



Mining and
milling for
grinding balls

1 x x x (1000 series)	High purity aluminium
2 x x x (2000 series)	Cu-alloying
3 x x x (3000 series)	Mn-alloying
4 x x x (4000 series)	Si-alloying
5 x x x (5000 series)	Mg-alloying
6 x x x (6000 series)	Mg and Si alloying
7 x x x (7000 series)	Zn-alloying
8 x x x (8000 series)	Li-alloying
9 x x x (9000 series)	Other element

- Strength increaser: Cu, Mg, Zn, Mn, Si
- Grain size decreaser: Ti, Cr
- Corrosion resistance increaser: Mn, Sb
- Easy to turn: Co, Fe,





Pure

Leaded bronze:
Sn + 2-7% Pb

Alubronze:
6-11 % Al

Tinbronze:
5-14 % Sn

9-30 % Ni

7-20 % Ni

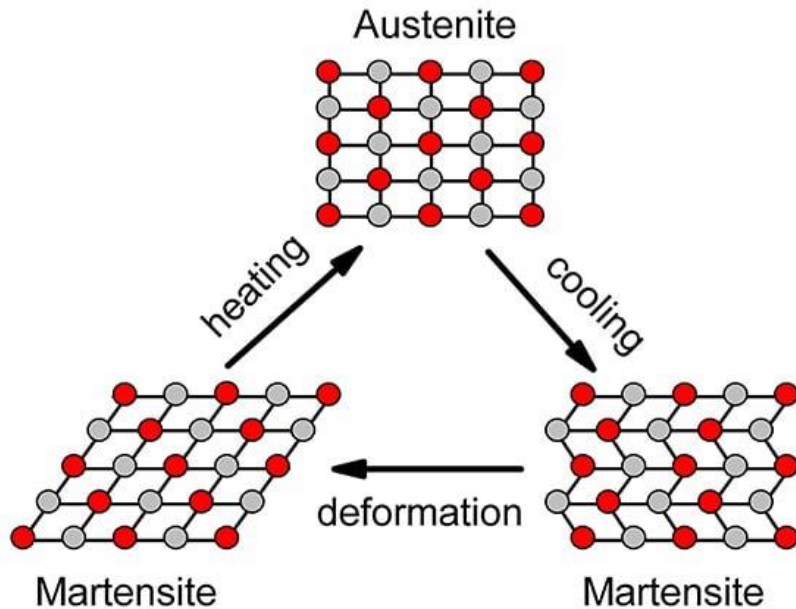
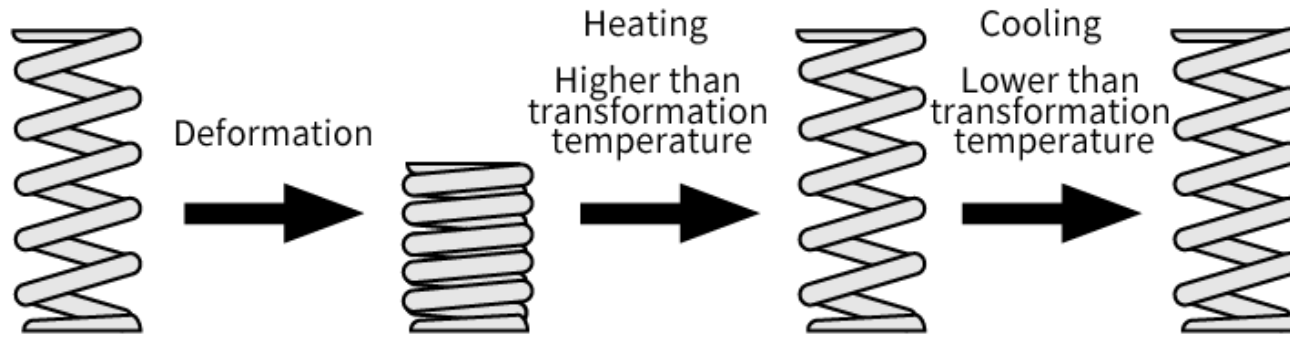
Classic: 5-40 %
Zn



Titanium has excellent mechanical properties such as corrosion resistance strength, fatigue, creep resistance. Titanium and its alloys have broad applications in aerospace engines, industries, construction, architecture, automobile, biomedical application.



One-way Shape memory



Shape Memory Alloys (SMAs) are a class of smart materials that can recover their original shape through reversible martensitic phase transformations triggered by thermal or mechanical stimuli.

