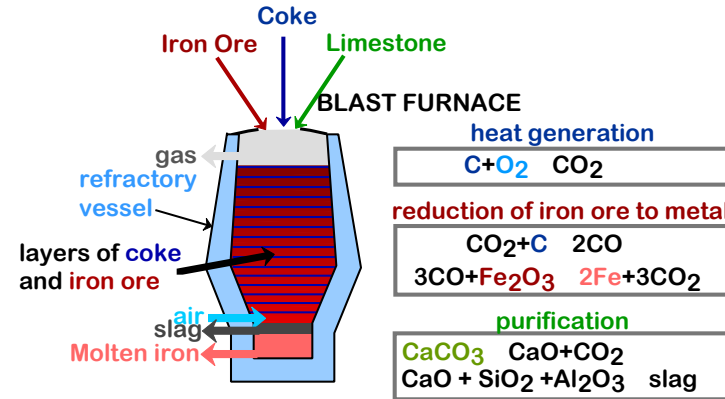


Chapter 12: Metal Alloy Selection

Issues to address...

- **Refinement from ore:**
How is it done?
- **Fabrication:**
How do we get the desired shape?
- **Terminology:**
How are properties designed?
- **Material Selection:**
Choose the right material for the right job!

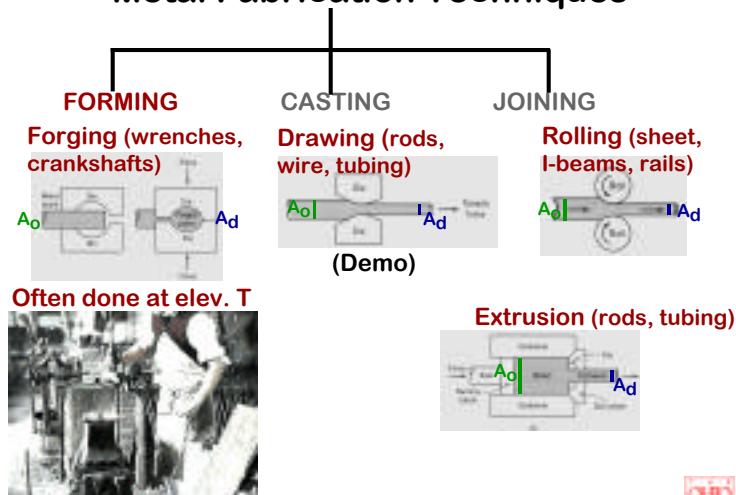
Refining Steel from Iron Ore



Anderson 205-12-1

Anderson 205-12-2

Metal Fabrication Techniques



Anderson 205-12-3

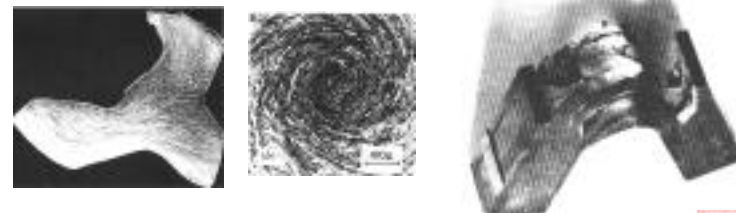
Forming Temperature

Hot working
recrystallization
less energy to deform
oxidation: poor finish
lower strength

Cold working
work hardening
more energy to deform
good finish
higher strength

Cold Worked Microstructures

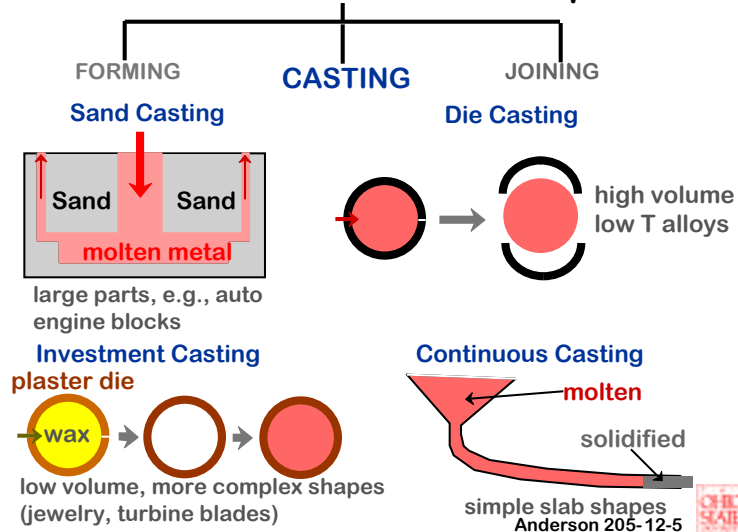
- Forged
- Swaged
- Fracture resistant!



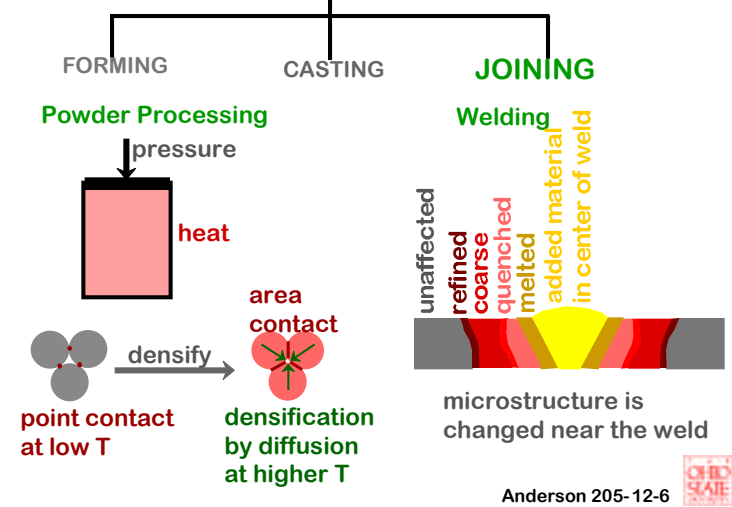
Directional Microstructure Anisotropic!

Anderson 205-12-4

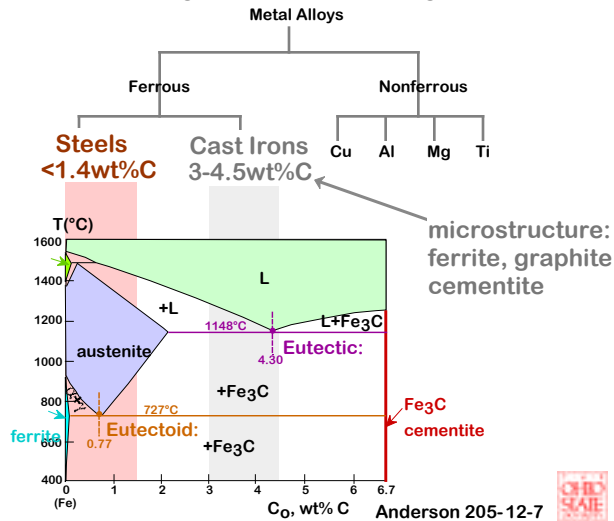
Metal Fabrication Techniques



Metal Fabrication Techniques



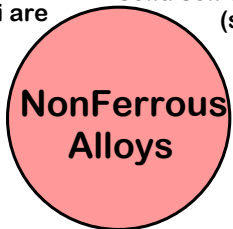
Taxonomy of Metal Alloys



Steels

Name	Low Alloy				High Alloy			
	low carbon $< 0.25\text{wt}\% \text{C}$	med carbon 0.25-0.6wt% C	high carbon 0.6-1.4wt% C	plain	heat treatable	plain	tool	austenitic stainless
Example	1010	4310	1040	4340	1095	4190	304	
Additions	none	Cr, V, Ni, Mo	none	Cr, Ni, Mo	none	Cr, V, Mo, W	Cr, Ni, Mo	
Hardenability	0	+	+	++	++	+++	0	
TS	-	0	+	++	+	++	0	
EL	+	+	0	-	-	--	++	
Uses	auto struc. sheet	bridges towers press. vessels	crank shafts bolts hammers blades	pistons gears wear applic.	wear applic.	drills saws dies	high T applic. turbines furnaces V. corros. resistant	

increasing strength, cost, decreasing ductility



• **Cu Alloys**

Brass: Zn is subst. impurity
(costume jewelry, coins,
corrosion resistant)

Bronze: Sn, Al, Si, Ni are
subst. impurity
(bushings, landing
gear)

Cu-Be:
precip. hardened
for strength

• **Ti Alloys**

-lower : 4.5g/cm^3 vs 7.9 for steel
-reactive at high T
-space applic.

• **Al Alloys**

-lower : 2.7g/cm^3
-Cu, Mg, Si, Mn, Zn additions
-solid sol. or precip. strengthened
(struct. aircraft parts
and packaging)

• **Mg Alloys**

-very low : 1.7g/cm^3
-ignites easily
-aircraft, missiles

• **Refractory metals**

-high melting T
-Nb, Mo, W, Ta

• **Noble metals**

-Ag, Au, Pt
-oxid./corr. resistant

Anderson 205-12-9

