Quiz 5 Cast Iron, Stainless Steel, Nonferrous Alloys

You Should Be Able to:

Ferrous

Steel

- identify carbon content from the last two digits of the 4 digit AISI/SAE numbers
- state the difference between low, medium, and high carbon steels with respect to carbon content, properties, and applications

Stainless steel

- name the element and concentration of that element that is required to be alloyed with steel to make it "stainless"
- name the four major classes of stainless steels (ferritic, austeinitic, martensitic, precipitation hardening) especially compare the properties, microstructure, and significant applications of each

Cast Iron

- name the four major classes of cast iron (gray, white, malleable, ductile) and compare the properties, microstructure, and significant applications of each

Non-Ferrous

- name two significant attributes and applications of Copper/ Aluminum/ Magnesium/ Titanium/ Superalloys/ Refactories/ Noble metals

Vocabulary

Chap 12

Alloy steel
Brass
Bronze
Cast iron
Ductile iron
Ferrous
Gray cast iron
HSLA steel
Malleable iron
Nonferrous
Stainless steel
Temper designation
White cast iron

Ferrous

Plain Carbon Steel (carbon is only alloy)

Low Carbon	0<%C<0.25	structural forms, sheet, plate
Med Carbon	0.25<%C<0.6	machine parts (shafts, gears)
High Carbon	0.6<%C<1.3	springs, bearings, cutting tools

Stainless Steel (>11%Cr)

http://www.matter.org.uk/steelmatter/manufacturing/coating/inherent.html shows why 11%

Class	Microstructure	Properties	Applications
Ferritic	Ferrite and Pearlite Cr is primary alloy	Mid range strength and ductility, lower cost	Auto exhaust systems, 410,430
Austenitic	Austenite (stable at room temp and below) >8%Ni stabilizes FCC	Best ductility High strain hardening Non-magnetic Cryogenic apps	Piping and pumps for chemical/pharmaceutical industries. 304, 316
Martensitic	Tempered Martensite	Very hard	Cutlery, surgical tools, firearms, 420, 440
Precipitation Hardening	coherent second phase	Very hard	dies, fixtures (can be machined after quench, age w/o distortion. 17-4

http://www.nidi.org//index.cfm/ci_id/11021.htm if you want to know more from the Nickel Development Institute

Engineer online also has some good info

http://engineeronline.ws/elmes/StainlessSelection.htm

Cast Iron >2%C for more info

http://www.castingsource.com/tech_art_understanding.asp

Class	Processing	Microstructure	Properties	Applications
White CI	faster cool <~4in thick	No graphite All C is in Fe_3C >2%C	V. Hard 500-600BHN brittle <1% elong	Rolls, wear plates, pump linings
Malleable Iron	"tempered" white CI	Carbide converts to carbon clumps or nodules when heated	significant ductility (1-20%) reasonable strength (20-80 ksi) soft grades machinable	differential cases, U-joint yokes
Ductile Iron	Add Mg to ladle at pour	3-4%C Carbon in nodules (spheres). Dates to 1948	60-120 ksi %elong to 20%	Pipelines, suspension parts
Gray CI	slower cool	>2% C Think steel with graphite flakes, (ferrite pearlite, martensite,...)	less hard than white, UTS - 20-40ksi Brittle (flakes) Vibration damping	engine blocks, piston rings, exhaust manifolds

Nonferrous

Metal	Why Use It?	Challenges	Applications
Copper	Electrical Conductivity Thermal Conductivity	Dense Expensive	80% of use is Pure Cu - wire, pipe +Zn=Brass Plumbing fixtures +Sn,Al,Si,Ni=Bronze Bushings +Be=Age Hardenable UTS=165-190 ksi
Aluminum	Density Sp.Gr.=2.7 (Fe=7.8) Ductile (FCC) Conductive (Elec, thermal) Can die cast, extrude	Fatigue Corrosion Resistance Tmelt	25% is containers/packaging, cans,foil 20% is architectural, windows, siding 10% is conductors can cold work (1xxx, 3xxx, 5xxx) foil, highway signs can age harden (2xxx, 6xxx, 7xxx) bikes, airplanes
Titanium	High strength to weight Sp.Gr.=4.5, UTS to 200ksi Corrosion Resis	Cost	Aircraft parts, Russian subs Biomed implants
Nickel Alloys	High Temp of Use Corrosion Resis	Dense Expensive	Gas Turbine parts Chemical processing plants
Refractory Metals	High Temperatures	costly	Niobium, Molybdenum, Tungsten, Tantalum
Magnesium	Low density SpGr=1.7 die castable	combustible chips, poor ductility	Power tool and computer housings
Zinc	Easy to die cast (cheap) galvanize steel	brittle	competes with injection molded plastic (handles, cranks)

More on
Copper http://www.copper.org/
Zinc http://www.zinc.org/
Titanium http://www.titanium.org/titanium.htm
Magnesium http://members.tripod.com/Mg/ (this one is very unofficial, but I like it)