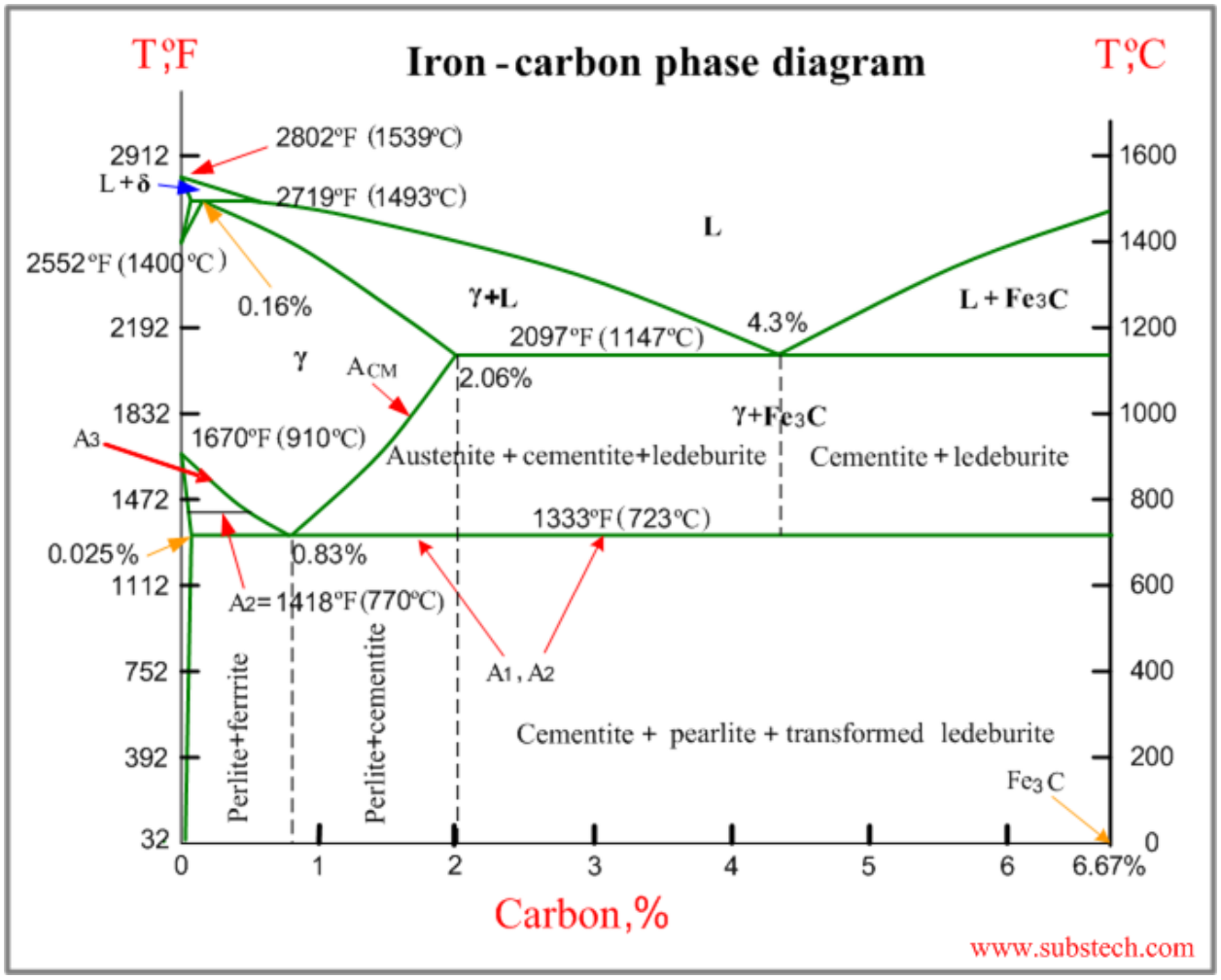
http://vimeo.com/32224002

http://www.substech.com/dokuwiki/doku.php?id=iron carbon_phase_diagram



➢ CAST IRON

Cast irons – iron alloys containing between 2.06 to 4.3% of carbon.

➢ Cast irons are divided onto the following groups:

- White cast irons
- Grey cast irons
- Malleable cast irons
- Nodular (ductile) cast irons

- **White cast irons :**

Properties–
❖ hard and brittle ❖ highly wear resistant cast irons consisting of pearlite and cementite. ❖ White cast irons are produced by chilling some surfaces of the cast mold. ❖ Chilling prevents formation of Graphite during solidification of the cast iron. ❖ It cannot be machined. ❖ Low compressive strength.

Applications of white cast irons:
brake shoes, shot blasting nozzles, mill liners, crushers, pump impellers and other abrasion resistant parts. Manufacturing Anvil, Railway coaches wheel.

- **Grey cast irons:**
  cast irons, produced at slow cooling and consisting of ferrite and dispersed graphite flakes.

Properties–
❖ cast irons, produced at slow cooling and consisting of ferrite and dispersed graphite flakes. ❖ Grey cast irons possess high compressing strength.

- It melting point is low as 1150˚ to 1200˚C..
- fatigue resistance and wear resistance.
- Presence of graphite in grey cast irons impart them very good vibration dumping capacity.

Applications of grey cast irons :

- gears, flywheels, water pipes, engine cylinders, brake discs, gears.
- In machine body.
- For manufacturing home appliances.

- **Malleable cast irons**

cast irons produced by heat treatment of white cast irons and consisting of ferrite and particles of free graphite.

Properties

- Malleable cast irons have good ductility and machinability.
- Ferritic malleable cast irons are more ductile and less strong and hard, than pearlitic malleable cast irons.
- Wear resisting.
- Absorb vibrations.
- Good machining property so easy to machined.

Applications of grey cast irons :

parts of power train of vehicles, bearing caps, steering gear housings, agricultural equipment, railroad equipment.

- **Nodular (ductile) cast irons:**

  Grey cast iron, in which graphite particles are modified by magnesium added to the melt before casting. Nodular cast iron consists of spheroid nodular graphite particles in ferrite or pearlite matrix.

Properties–

- ❖ Ductile cast irons possess high ductility.
- ❖ good fatigue strength, wear resistance.
- ❖ shock resistance and high modulus of elasticity**.**
- ❖ It is soft. Tensile strength is about 500-1000N/mm2.

Applications of grey cast irons :

- ❖ Automotive engine crankshafts, heavy duty gears, military and railroad vehicles.
- ❖ In pump & compressor parts.
- ❖ In paper mill machinery.
- ❖ To produce hydraulic cylinder.

- **Alloy cast iron:**

Properties–

- ❖ It has alloying elements like Ni, Cr, Mo, Si, and Mn in plain C.I.
- ❖ It is very strong. It can resist the heavy shock.
- ❖ Wear resistance and high corrosion resistance.
- ❖ It is resists heat and electric resistance.
- ❖ Tensile strength is about 450-750N/mm2.

Applications of grey cast irons :

- ❖ Raw material for piston, piston ring, cylinder, brake drum and crank.
- ❖ Ro produce crushing and grinding machines.
- ❖ To manufacture metal working rolls.
- ❖ To produce gear blanks.
- ❖ In crank shaft or diesel engine.

- **Chemical compositions of some cast irons**

Grade	C,%	Si,%	Mn,%	S,%	P%
White	1.8…3.6	0.5…1.9	0.25…0.8	0.06…0.2	0.06…0.18
Grey	2.5…4.0	1.0…3.0	0.25…1.0	0.02…0.25	0.05…1.0
Malleable	2.0…2.6	0.9…1.6	0.2…1.25	0.04…0.18	0.18 max.
Nodular	3.0…4.0	1.8…2.8	0.1…1.0	0.03 max.	0.1 max.

➢ CARBON STEEL

Carbon steels are iron-carbon alloys containing up to 2.06% of carbon, up to 1.65% of manganese, up to 0.5% of silicon and sulfur and phosphorus as impurities.

Carbon content in carbon steel determines its strength and ductility.

The higher carbon content, the higher steel strength and the lower its ductility.

According to the steels classification there are following groups of carbon steels:

❖ **Plain carbon steel :**

- Low carbon steels (C < 0.25%)
- Medium carbon steels (C =0.25% to 0.55%)
- High carbon steels (C > 0.55%)
- Tool carbon steels (C>0.8%)

❖ **Alloy steel :**

- Low alloy steel
- High alloy steel
- High speed steel

❖ **Plain carbon steel :**

Steel with a carbon as a principal hardening agent and all other alloying elements present in small percentages. other terms used are plain carbon, mild , low carbon etc.

- **Low carbon steels (C < 0.25%)**

Properties	**Applications**:
• good formability and weldability • low strength, low cost.	deep drawing parts, chain, pipe, wire, nails, some machine parts.

Medium carbon steels (C =0.25% to 0.55%)

Properties	**Applications**:
• good toughness and ductility • relatively good strength, may be hardened by quenching	rolls, axles, screws, cylinders, crankshafts, heat treated machine parts.

High carbon steels (C > 0.55%)

Properties	**Applications**
• high strength, hardness and wear resistance. • moderate ductility.	rolling mills, rope wire, screw drivers, hammers, wrenches, band saws.

Tool carbon steels (C>0.8%)

Properties	**Applications**
• very high strength, hardness and wear resistance. • poor weldability low ductility.	punches, shear blades, springs, milling cutters, knives, razors.

Alloy steels

Alloy steels are iron-carbon alloys, to which alloying elements are added with a purpose to improve the steels properties as compared to the Carbon steels. The total alloy addition of less than about 5%. It has varying corbon contents upto about1% according to steel product.

: Due to effect of alloying elements, properties of alloy steels exceed those of plane carbon steels.

classification divide alloy steels onto groups according to the major alloying elements

- Low alloy steels (alloying elements ⇐ 8%);
- High alloy steels (alloying elements > 8%).

❖ **Tool steel :**
They are defined as carbon or alloy steels capable of being hardened and tempered by U.S. steel producers. They are manufactured in electric furnace and melted by other techniques imparting cleanness and alloy control.

❖ **Stainless steel :**
These are the steels with atleast 10% chromium that exhibit passivity in oxidizing environments.

➢ Effect of alloying elements on steel properties

- **Alloying** is changing chemical composition of steel by adding elements with purpose to improve its properties as compared to the plane carbon steel.
- Characteristics of alloying elements
- **Manganese (Mn)** – improves hardenability, ductility and wear resistance. Mn eliminates formation of harmful iron sulfides, increasing strength at high temperatures.
- **Nickel (Ni)** – increases strength, impact strength and toughness, impart corrosion resistance in combination with other elements.
- **Chromium (Cr) –** improves hardenability, strength and wear resistance, sharply increases corrosion resistance at high concentrations (> 12%).
- **Tungsten (W) –** increases hardness particularly at elevated temperatures due to stable carbides, refines grain size.
- **Vanadium (V)** – increases strength, hardness, creep resistance and impact resistance due to formation of hard vanadium carbides, limits grain size.

- **Molybdenum (Mo)** – increases hardenability and strength particularly at high temperatures and under dynamic conditions.
- **Silicon (Si)** – improves strength, elasticity, acid resistance and promotes large grain sizes, which cause increasing magnetic permeability.
- **Titanium (Ti)** – improves strength and corrosion resistance, limits austenite grain size.
- **Cobalt (Co)** – improves strength at high temperatures and magnetic permeability.
- **Zirconium (Zr) –** increases strength and limits grain sizes.
- **Boron (B)** – highly effective hardenability agent, improves deformability and machinability.
- **Copper (Cu) –** improves corrosion resistance.
- **Aluminum (Al)** – deoxidizer, limits austenite grains growth.