2007 Exam #1 Reviews

1. Steel

Steel is an alloy whose major component is iron, with carbon content between 0.02% and 1.7% by weight, depending on grade. Steel with increased carbon content can be made harder and stronger than iron, but is also more brittle. The maximum solubility of carbon in iron is 1.7% by weight, occurring at 1130 degrees Celsius; higher concentrations of carbon or lower temperatures will produce cementite which will reduce the material's strength

Steels are iron based alloy that can be plastically formed.

※ Iron, steel, and wrought-iron?

Iron and steel are regarded as a single thing theses days but wrought iron is pure iron with carbon content less than 0.035%.

2. Yield strength, tensile strength, elongation

Yield strength. The stress required to produce a very slight yet specified amount of plastic strain (0.002 strain offset is commonly used)

Tensile strength. The maximum engineering stress that can be sustained without fracture. (Ultimate strength)

Elongation. Materials ductility is often expressed as percent elongation (percentage of plastic strain at fracture) or percent reduction in area. Brittle materials, approximately, have 5% of elongation (Al: 40 % EL)

3. Quench

Quench is a rapid cooling. In metallurgy, it is the most common way to harden steel by introducing martensite. It has to go through the eutectoid temperature (~727°C for steel); it can be done at a lower temperature by adding alloying metals (Ni, Mn).

4. Heat treatment. (Annealing, quenching and tempering)

Properties of metals and alloys can be easily manipulated by heat treatment (controlling diffusion rate and cooling rate). Ex. fast cooling in steels, increases hardness and fast cooling in precipitation hardened alloy like 2, 6, and 7000 series Al-alloys results in a softer metal

Annealing (1) heating to the desired T (2) holding at that T (3) cooling to room T

To [1] relieve stresses [2] increase ductility and toughness by refining grains [3] produce a specific microstructure

Tempering (1) Heating to T (400~600°C) below eutectoid T (2) Holding for a specified time (3) Cooling naturally

To [1] increase toughness by transforming brittle martensite to bainite or ferrite [2] relieve internal stresses (lower T)

5. Solution heat treatment

Precipitation hardening is accomplished by two heat treatments. In **solution heat treatment** as the first, all atoms are dissolved to form a single-phase solid solution. (Similar to the first and second step of annealing)

6. Ageing

Precipitation heat treatment is sometimes called '**Ageing**'. It consists of almost same procedure with Tempering but precipitation hardening and tempering are totally different. **Ageing** is used to produce precipitate particles to improve strength or hardness thus it has to be hold for hours at the elevated T unlike ordinary tempering. Tempering is used to increase toughness by transforming M – B or F without decreasing strength or hardness. They should not be confused.

7. Phase diagram

A graphical representation of the relationships between environmental constraints (T.P), composition, and regions of phase stability under equilibrium conditions.

Students are referred to Chap 9.

8. Phase and state

States of matter refer to the differences between gases, liquids and solids, etc. And Phase is a homogeneous portion of a system that has uniform physical and chemical characteristics. If there are two regions in the same chemical system that are in different states of matter, then they must be different phases. However, the reverse is not true -- a system can have multiple phases which are in equilibrium with each other and also in the same state of matter. For example, diamond and graphite

9. Solid solution

A homogeneous crystalline phase which contains two or more chemical species.

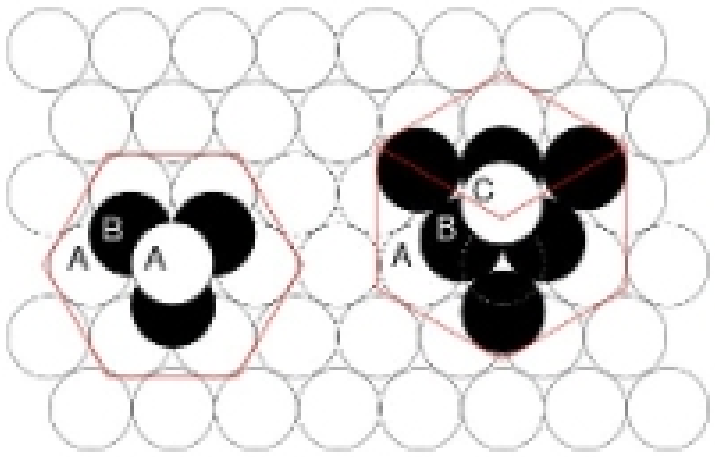
Substitutional type Impurity atoms replace or substitute the host atoms without changing crystal structure. 4 features governing substitutional solid solution. (Atomic size, crystal structure, electonegativity, and valences)

Interstitial Impurity atoms fill the voids among the host atoms

11. Brass

Alloy of Copper and Zinc

12. Close packing



Atoms are packed with the greatest possible packing density (0.74). If they are packed as the ABAB sequence, it is HCP. If they are packed as ABCABC, it is FCC

13. Tensile test

14. Hardness

Hardness is a property of a material expressing its resistance to plastic deformation.

15. Hardness test

16. Plastic deformation

Deformation is permanent or nonrecoverable after release of the applied load. It is accompanied by permanent atomic displacement.

17. Plain carbon steel vs. alloy steel

Plain carbon steel is a metal alloy, a combination of two elements, iron and carbon, where