Course Title: Metallurgy Engineering

- ***1st & 2nd/ Academic Year 2020 – 2021***
- ***Number of hours tuition (total):* 60 hours / 2 hours per week**
- ***Aims of the Course*: To learn the students the following:**

    1- The relationship between metal's properties and its microscopic structure.

    2- Solidification of metallic alloys and the formation of microstructure through various types of phase diagrams.

    3- The various types of heat treatment applied to steel.

    4- The microstructure and property changes that occur in cold worked and recrystallizations of metal

- ***Grading Policy:***
    - **Quizes + Exam = 30**
    - **Final examination = 70**
- ***References:***
    - Materials Science and Engineering by **William D. Callister, Jr.**
    - **كارل- أي كايزر** اسس هندسة المعادن
    - **د. قحطان الخزرجي** المعاملات الحرارية للمعادن والسبائك الحديدية واللاحديدية

- ***Course structure:***

CRYSTAL STRUCTURE OF METALS

WHY STUDY MATERIALS SCIENCE AND ENGINEERING?

Why do we study materials? Many an applied scientist or engineer, whether mechanical, civil, chemical, or electrical, will at one time or another be exposed to a design problem involving materials. Examples might include a transmission gear, the superstructure for a building, an oil refinery component, or an integrated circuit chip.

Of course, materials scientists and engineers are specialists who are totally involved in the investigation and design of materials. Many times, a materials problem is one of selecting the right material from the many thousands that are available. There are several criteria on which the final decision is normally based. First of all, the in-service conditions must be characterized, for these will dictate the properties required of the material. On only rare occasions does a material possess the maximum or ideal combination of properties. Thus, it may be necessary to trade off one characteristic for another. The classic example involves strength and ductility; normally, a material having a high strength will have only a limited ductility. In such cases a reasonable compromise between two or more properties may be necessary.

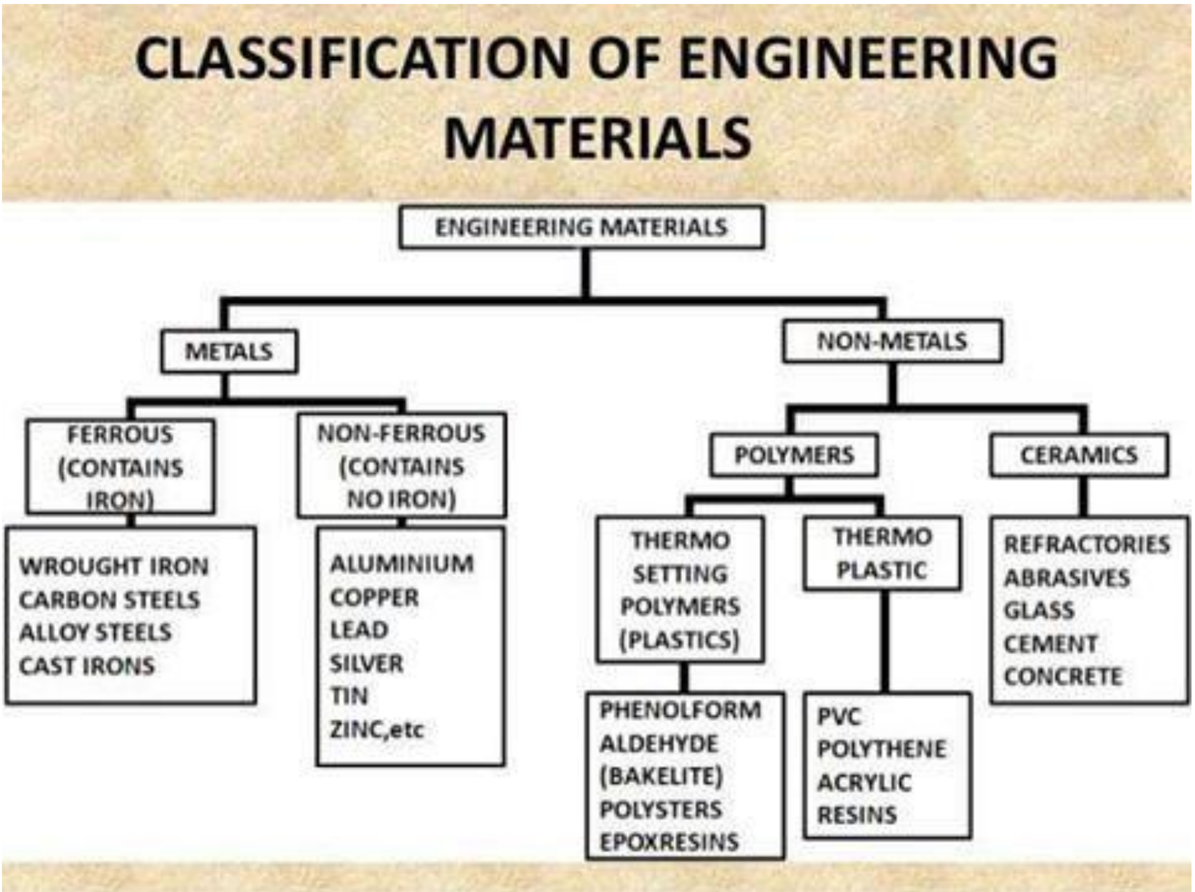
A second selection consideration is any deterioration of material properties that may occur during service operation. For example, significant reductions in mechanical strength may result from exposure to elevated temperatures or corrosive environments.

Finally, probably the overriding consideration is that of economics: What will the finished product cost? A material may be found that has the ideal set of properties but is prohibitively expensive. Here again, some compromise is inevitable.

The cost of a finished piece also includes any expense incurred during fabrication to produce the desired shape.

Chapter One

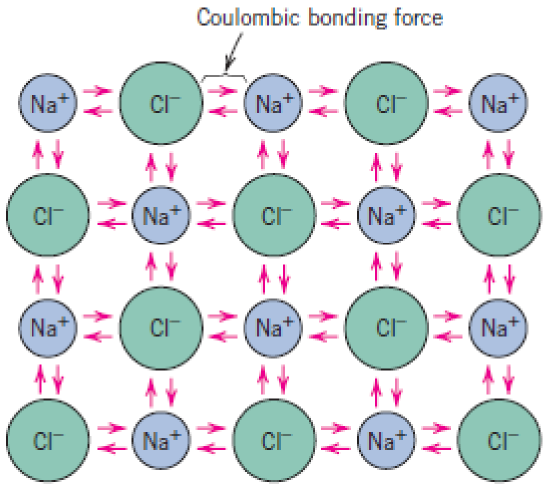
Classification of Engineering Materials:



PRIMARY INTERATOMIC BONDS

Ionic bonding:

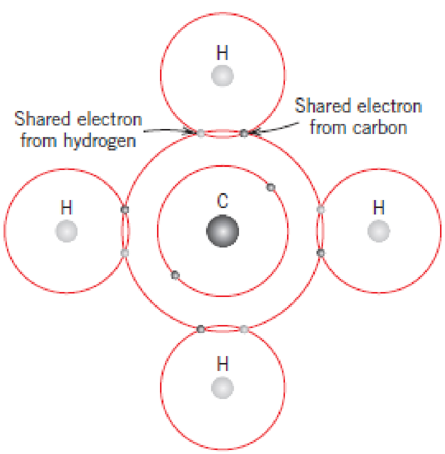
is perhaps the easiest to describe and visualize. It is always found in compounds that are composed of both metallic and nonmetallic elements, elements that are situated at the horizontal extremities of the periodic table. Atoms of a metallic element easily give up their valence electrons to the nonmetallic atoms. In the process all the atoms acquire stable or inert gas configurations and, in addition, an electrical charge; that is, they become ions. Sodium chloride (NaCl) is the classic ionic material.



Schematic representation of ionic bonding in sodium chloride (NaCl).

Covalent Bonding

In **covalent bonding,** stable electron configurations are assumed by the sharing of electrons between adjacent atoms. Two atoms that are covalently bonded will each contribute at least one electron to the bond, and the shared electrons may be considered to belong to both atoms. Covalent bonding is schematically illustrated in Figure 2.10 for a molecule of methane . The carbon atom has four valence electrons, whereas each of the four hydrogen atoms has a single valence electron.



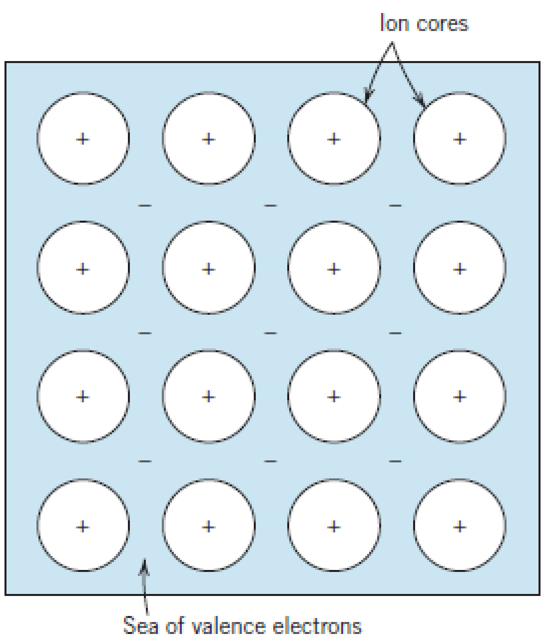
Schematic representation of covalent bonding in a molecule of methane (CH4)

Metallic Bonding

Metallic bonding, the final primary bonding type, is found in metals and their alloys.

A relatively simple model has been proposed that very nearly approximates the bonding scheme. Metallic materials have one, two, or at most, three valence electrons.

With this model, these valence electrons are not bound to any particular atom in the solid and are more or less free to drift throughout the entire metal. They may be thought of as belonging to the metal as a whole, or forming a "sea of electrons" or an "electron cloud."



Schematic illustration of metallic bonding.

Secondary, van der Waals, or physical **bonds** are weak in comparison to the primary or chemical ones; bonding energies are typically on the order of only 10 kJ/mol (0.1 eV/atom). Secondary bonding exists between virtually all atoms or molecules, but its presence may be obscured if any of the three primary bonding types is present.

Secondary bonding is evidenced for the inert gases, which have stable electron structures, and, in addition, between molecules in molecular structures that are covalently bonded.