

Lecture 1.1: Classification of Engineering Materials and Processing Techniques

Introduction

Materials are an important aspect of engineering design and analysis. The importance of materials science and engineering can be noted from the fact that historical ages have been named after materials. In the customer driven competitive business environment, the product quality is of paramount importance. The product quality has been found to be influenced by the engineering design, type of materials selected and the processing technology employed. Therefore, the importance of materials and their processing techniques cannot be undervalued in today's world. Materials form the stuff of any engineering application or product. It has been found that the engineers do not give adequate attention to this important subject. Moreover, it has not been adequately represented in the course curriculum of various universities. Therefore, it becomes imperative to highlight the importance of engineering materials for all engineers related to the various aspects of engineering applications.

There is a wide variety of materials available which have shown their potential in various engineering fields ranging from aerospace to house hold applications. The materials are usually selected after considering their characteristics, specific application areas, advantages and limitations. The challenge for designers is to select an optimal material suitable for the specific design requirements. The stringent design requirements generally lead to development of new materials to meet the specific operating conditions and environments. The new materials are developed from the conventional materials by either by the intrinsic or the extrinsic modification. In intrinsic modification, minor alloying or heat treatment is carried out. In extrinsic modification, external reinforcements are added to the parent material to alter its properties in order to meet the specific design requirements. The composite materials represent an example of the extrinsic modification. The modification is usually done to improve the properties of the existing materials. As the new materials are conceptualized and realized in the laboratories, the hunt for their commercialization begins.

The engineers are then entrusted with the task of finding suitable techniques which would lead to high quality cost-effective processing of these materials. In order to achieve this objective, it is imperative for all engineers to have a fundamental understanding of the existing materials and their processing techniques. It has been found that there are adequate of courses in the

curriculum of various universities where the processing techniques for metals are dealt in detail. The processing of non-metals is usually not covered as a core subject at the under-graduate level and therefore the engineers do not have a fundamental understanding about the processing of important non-metals such as plastics and ceramics. The course has been designed to study the basic nature of different non-metals and the manufacturing processes associated thereof. The various non-metals covered in the course include glasses, ceramics, plastics and different types of composite materials.

Classification and Selection of Materials:

The first module deals with the classification of the engineering materials and their processing techniques. The engineering materials can broadly be classified as:

- a) Ferrous Metals
- b) Non-ferrous Metals (aluminum, magnesium, copper, nickel, titanium)
- c) Plastics (thermoplastics, thermosets)
- d) Ceramics and Diamond
- e) Composite Materials
- f) Nano-materials

The engineering materials are often primarily selected based on their mechanical, physical, chemical and manufacturing properties. The secondary points to be considered are the cost and availability, appearance, service life and recyclability. In the present day, strict environmental legislations have forced the designers and engineers to select the environment friendly materials which have minimum environmental impact. Materials are often selected for their mechanical, physical, chemical and manufacturing properties for ensuring proper functioning under desired conditions. When several materials are suitable for a particular design requirement, the cheapest one is usually selected.

Classification of Processing Techniques

The basic aim of processing is to produce the products of the required quality at a reasonable cost. The basic processes can be broadly classified as:

- a) Primary Forming Processes
- b) Deformative Processes
- c) Material Removal Processes
- d) Joining Processes
- e) Finishing Processes

Most of the engineering materials are processed either individually or in combination by the above mentioned processes. The processes can further be classified as conventional and advanced processes. The specific application area of each will depend on the design requirements and the ability with which a material renders itself to various processing techniques. The selection of a processing technique for any engineering material would broadly depend on the properties (mechanical, physical, chemical) of the material and the required number of parts to be processed.