Biomedical Engineering Dep.

Material science

Lab. Sheet Level 2

Semester 1

Experimental Title: Sample fabrication methods

Experimental no. 1

Objective

- ✓ To select materials and distinguish between them.
- ✓ To understand the outline of the manufacturing process.
- ✓ To know the methods of manufacturing each material, studying its various properties, and being able to use it in daily life applications.

Background

A material is defined as a (most often a solid, but other condensed phases can be included) that is intended to be used for certain applications. Materials can generally be further divided into two classes: crystalline and non-crystalline. The traditional examples of materials are metals, ceramics, composites, and polymers.

Metals

Mechanical and physical characteristics for these materials are relatively stiff and strong yet are ductile (i.e., capable of large amounts of deformation without fracture), and are resistant to fracture, thermal, electrical, and heat conductivity which accounts

for their widespread use in structural applications. The methods chosen depend on several factors; the most important are the properties of the metal, the size and shape of the finished piece, and the cost. The classifications of fabrication techniques shown in Figure (1)

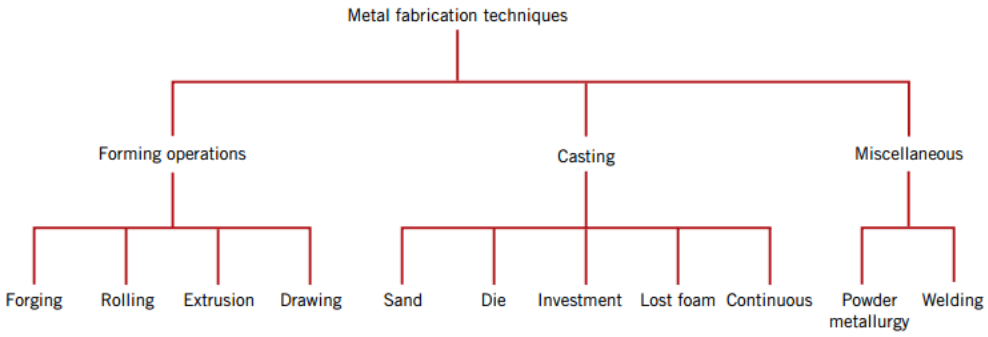

Figure 1: Classifications of Metal Fabrication Techniques

Ceramics

Ceramics are compounds between metallic and nonmetallic elements; they are most frequently oxides, nitrides, and carbides. For example, common ceramic materials include aluminum oxide (or alumina, Al_2O_3), silicon dioxide (or silica, SiO_2), silicon carbide (SiC), silicon nitride (Si3N4), and, also, what some refer to as the traditional ceramics—those composed of clay minerals (e.g., porcelain), as well as cement and glass. Concerning mechanical behavior, ceramic materials are relatively stiffness's and strengths comparable to those of metals. has low electrical conductivities and is more resistant to high temperatures and harsh environments than are metals and polymers. The classifications of fabrication techniques include various ceramic-forming methods shown in Figure (2)

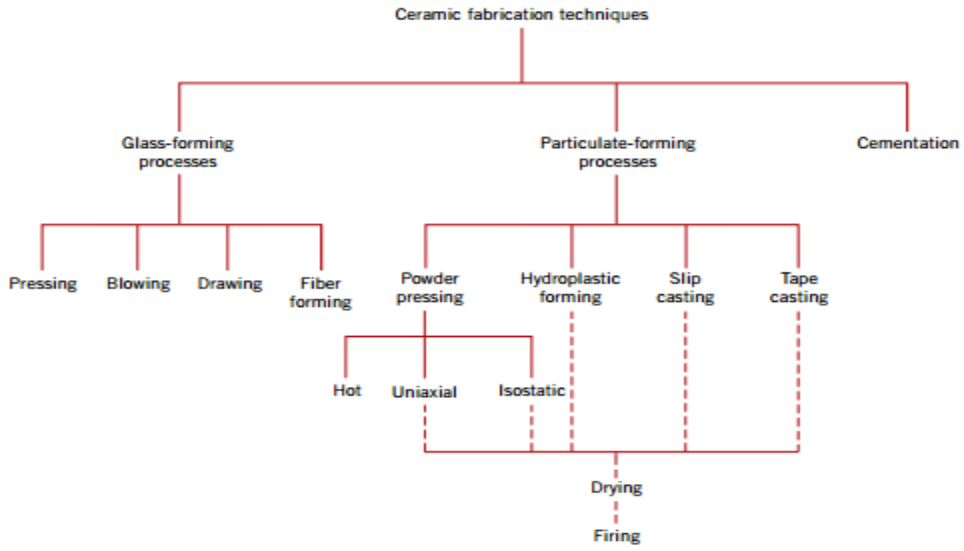

Figure 2: Classifications of Metal Fabrication Techniques

Polymer

A compound of high molecular weight (normally organic) the structure of which is composed of chains of small repeat units, the polymer includes the familiar plastic and rubber materials. Many of them are organic compounds that are chemically based on carbon and hydrogen. These materials typically have low densities, whereas their mechanical characteristics are generally dissimilar to those of the metallic and ceramic materials—they are not as stiff or strong as these other material types.

Thermoplastic (polymer)

A polymeric material that softens when heated and hardens upon cooling.

Thermosetting (polymer)

A polymeric material that, once having cured (or hardened) by a chemical reaction, will not soften or melt when heated

Elastomer

Any rubbery material composed of long chainlike molecules, or polymers, that are capable of recovering their original shape after being stretched to great extents—hence the name **elastomer**, from “elastic polymer”.

The classifications of Polymer fabrication techniques include:

- Compression and transfer molding
- Injection molding
- Extrusion
- Blow molding
- Casting

Composite

A composite is a structural material that consists of two or more combined constituents that are not soluble in each other. One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix. Most composites have been created to improve combinations of mechanical characteristics such as stiffness, toughness, and ambient and high-temperature strength.

1- according to the type of continuous phase (matrix) material

Metal-matrix composite (MMC)

A composite material that has a metal or metal alloy as the matrix phase

Ceramic-matrix composite (CMC)

A composite for which the matrix phase is the ceramic material

Polymer-matrix composite (PMC)

A composite for which the matrix phase is a polymer resin

2- according to the discontinuous phase (reinforcement) material

Fibrous (long or short) Composites

Particulate Composites

Laminate Composite

Experimental Procedure

1. Determination of composition (weight percent) for a powder of material.

2. Weight of powder material by the sensitive balance.

3. Mix the powder of material with the ball mill machine.

4. Press mixtures in the hydraulic piston.

5. Sintering or heat treatment of compressed materials

Discussion

1- **Compare the physical and mechanical properties of the materials (metal, ceramic, and polymer) for 10 different?**

2- **What is the most electrically conductive material and why?**