Chapter 1: Gereral introduction (glass and ceramics)

Introduction

Ceramics are among the oldest materials created by humans and, at the same time, some of the most advanced materials used in modern technology. This dual identity makes ceramics unique: they are both **traditional** and **technical used in a wide variety of fields**..

From **clay vessels** used 10,000 years ago to store food and water, to **ceramic turbine blades** that withstand extreme temperatures in jet engines, ceramics have evolved into essential materials for human civilization.

- Why Study Ceramics?

- **Historical importance**: The first “engineered” materials used by ancient societies were ceramics such as pottery, bricks, and tiles.
- **Modern relevance**: Ceramics are now found in aerospace, electronics, energy, and medicine.
- **Everyday use**: Dishes, tiles, glasses, and sanitary ware.
- **High-tech applications**: Space shuttle thermal shields, biomedical implants, electronic components, sensors, and even artificial bones.

- 👉 Studying ceramics helps us understand both **the roots of material science** and **the innovations of the future**.

Transition to Modern Ceramics

Over the centuries, the role of ceramics expanded beyond pottery and construction. Advances in science and technology revealed new ceramic properties such as **hardness, chemical resistance, high melting point, and electrical insulation**.

In the 20th century, ceramics entered the **era of advanced materials**:

- **Structural ceramics**: Used in cutting tools, engine components, armor, and refractories.
- **Functional ceramics**: Used in electronics (capacitors, sensors, superconductors), medical implants, and energy systems (fuel cells).

This shift marked the **transformation of ceramics from traditional to high-tech materials**.

Historical Roots of Ceramics

- The oldest known ceramic artifacts date back over **25,000 years** (figurines and pottery).

- Around **10,000 years ago**, humans began to fire clay to make strong, durable containers for food storage and cooking.

- Ancient civilizations developed bricks, tiles, and glazes, allowing them to build lasting structures.

- Ceramics were not only **practical** but also **artistic**, representing culture and tradition.

Thus, ceramics were the **first material shaped and engineered by human hands**.

What are Ceramics?

•Definition:

Ceramics are **inorganic, non-metallic materials** made by shaping and then heating raw materials (usually powders) at high temperatures.

•Composition:

They are generally **compounds of metals and non-metals** (e.g., oxides, nitrides, carbides, borides).

•Typical Characteristics:

- High hardness and strength
- Brittle fracture (low ductility)
- High melting temperature
- Low electrical and thermal conductivity (though some are superconductors or semiconductors)
- Good resistance to corrosion, oxidation, and wear