

ME211

Materials Science and Engineering

Chapter 1

Introduction to Materials Science and Engineering

The four components of the discipline of materials science and their interrelationship.

المكونات الاربعة لعلم المواد و علاقتهم ببعضهم البعض

1. Structure أو الهيكل البناء

- The arrangement of material internal components.
(Subatomic level - atomic level – microscopic – macroscopic).

ترتيب مكونات المادة الداخلية

2. Property الخاصية

- Material response to a specific imposed stimulus.
- (Mechanical – electrical – thermal – magnetic – optical - deteriorative)

استجابة المادة لافتراض معين

3. Processes

- Process is controlling the structure of material. For example, heat treatment change structure so that desired strength or ductility is achieved.

4. Performance

- Material behavior under environmental conditions.
- Material's performance will be a function of its properties.

سلوك المادة تحت ظروف بيئة العمل



Q1. Explain in sentences, the interrelationship of four components of the discipline of materials science and engineering, listed alphabetically below:

- Performance
- Processing
- Properties
- Structure



Fig. 1 The four components of the discipline of materials science and engineering and their interrelationship

Q4. List six different property classifications of materials that determine their applicability:

Mechanical

Electrical

Thermal

Magnetic

Optical

deteriorative

Why should we Learn Materials Science and Engineering?

لماذا ندرس علم المواد أو هندسة المواد؟

For selecting the right material from the thousands available based on

- **The in-service conditions (ظروف الخدمة)** must be characterized (توصف) to dictate (لتحديد) the properties required of the material.
- **Deterioration (تدهور) of material properties** that may occur during service operation.
- **The cost (التكلفة)** .

Q5. List three important criteria in materials selection:

- 1- In-service condition
- 2- Deterioration of material
- 3- Cost

Classification of Materials

	Metals	Ceramics	Polymers	composites
composition	one or more metallic elements (such as iron, aluminum, copper) or nonmetallic element like carbon.	metallic and nonmetallic elements (oxides, nitrides, and carbides)	organic compounds that are chemically based on carbon, hydrogen, and other nonmetallic elements	two or more individual materials (Metals – Ceramics – polymers) to achieve a combination of properties that is not displayed by any single material
Examples	Steel Copper	aluminum oxide Al ₂ O ₃	Poly vinyl chloride PVC	Fiberglass GFRC (Glass-Fiber Reinforced Composite) wood and bone من الطبيعة
Advantages	Strong and ductile High fracture toughness high thermal and electrical conductivities Magnetic properties	Low coefficient of friction High melting point Corrosion resistance Inexpensive	Light weight Easy to manufacture. Cheap and durable	Relatively strong and stiff.
disadvantages	Dense Expensive Corrosion	Poor chock resistance Weak in tension low thermal and electrical conductivities	Can not withstand high temperature. Soft low thermal and electrical conductivities	brittle

Q2. List three basic categories of materials classification:

1- Metals 2- Ceramics 3- Polymers

What is a composite material?

A composite material is a combination of two or more materials metals, ceramics, and polymers.

Why do we use composite material?

to achieve a combination of properties that is not displayed by any single material.

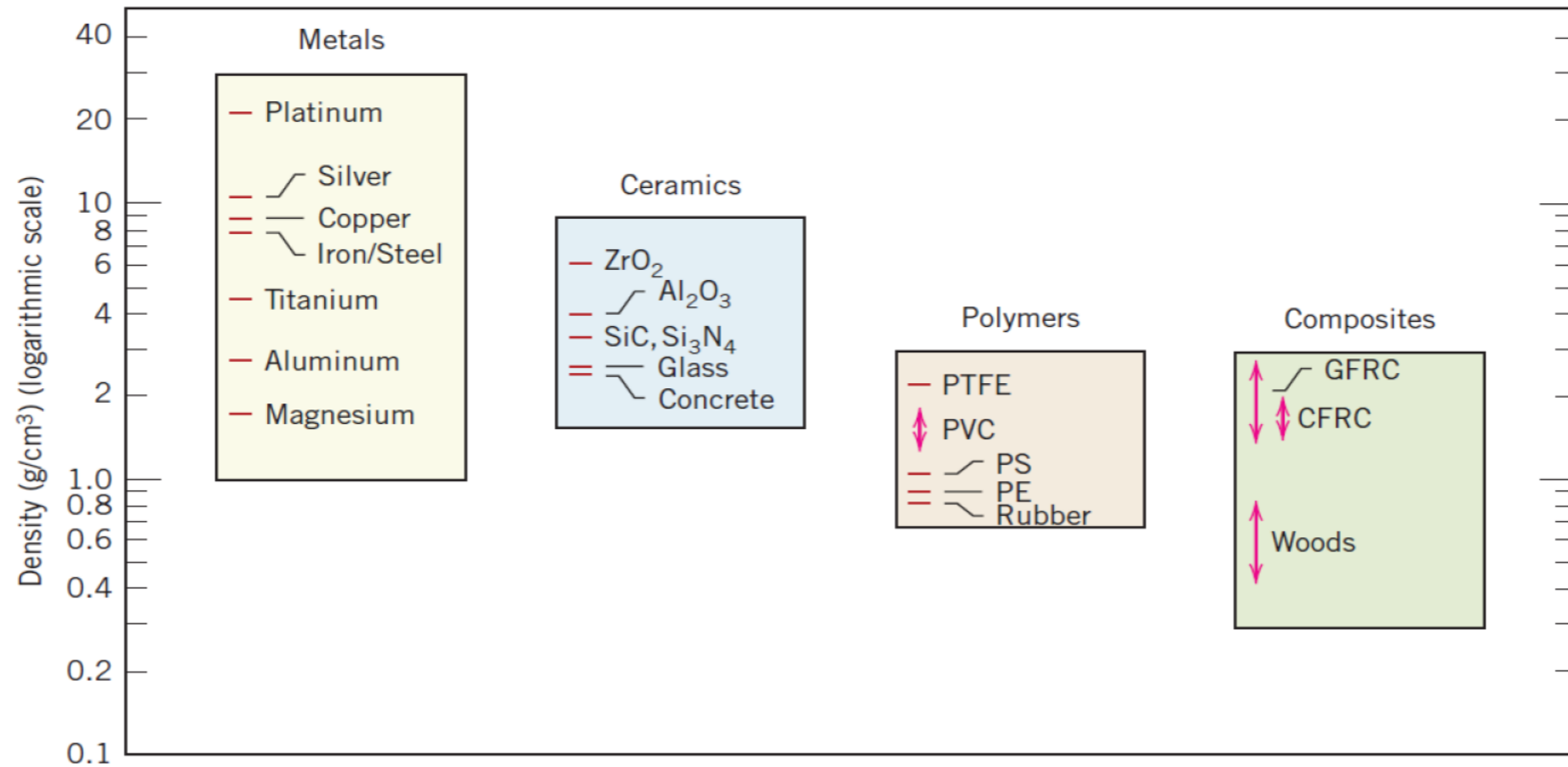
Give an example of natural composite material?

wood and bone.

Give an example of un-natural composite material?

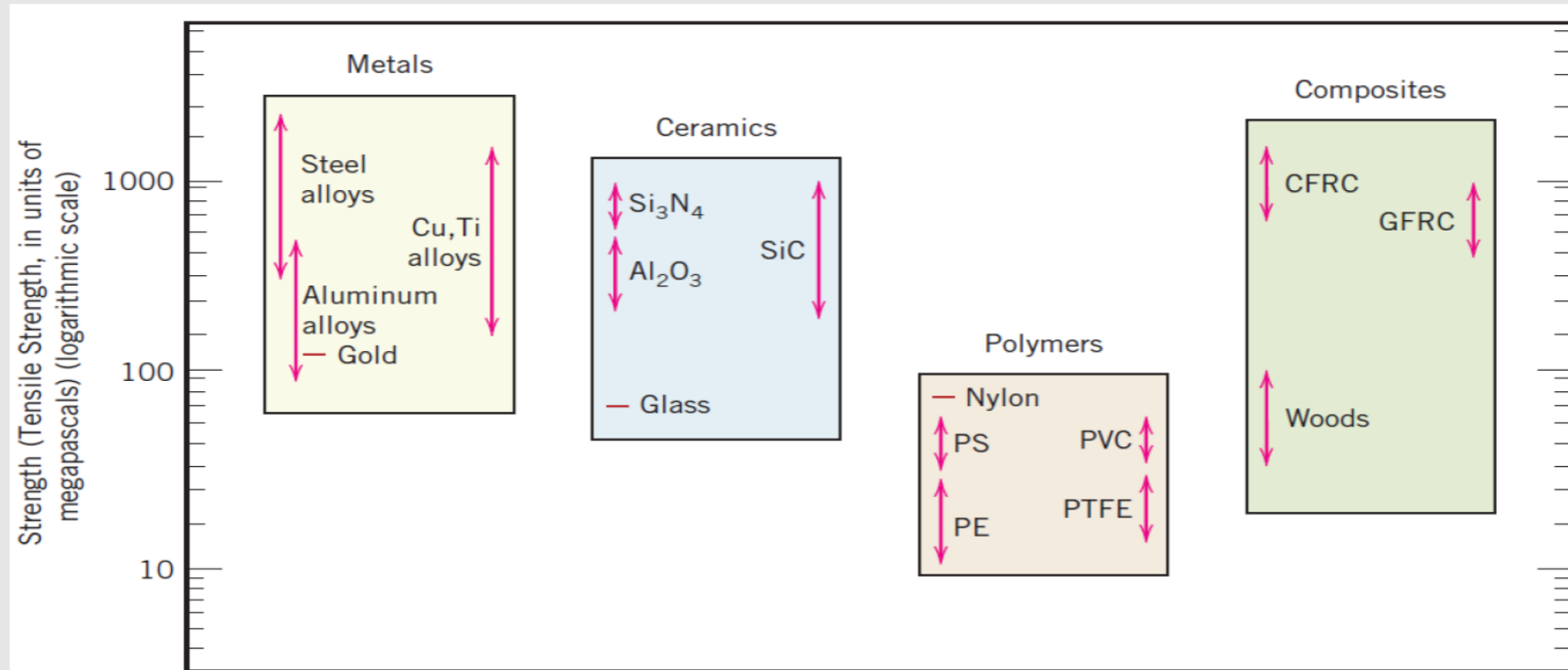
GFRC (Glass-Fiber Reinforced Composite).

CFRP (Carbon Fiber-Reinforced Polymer).



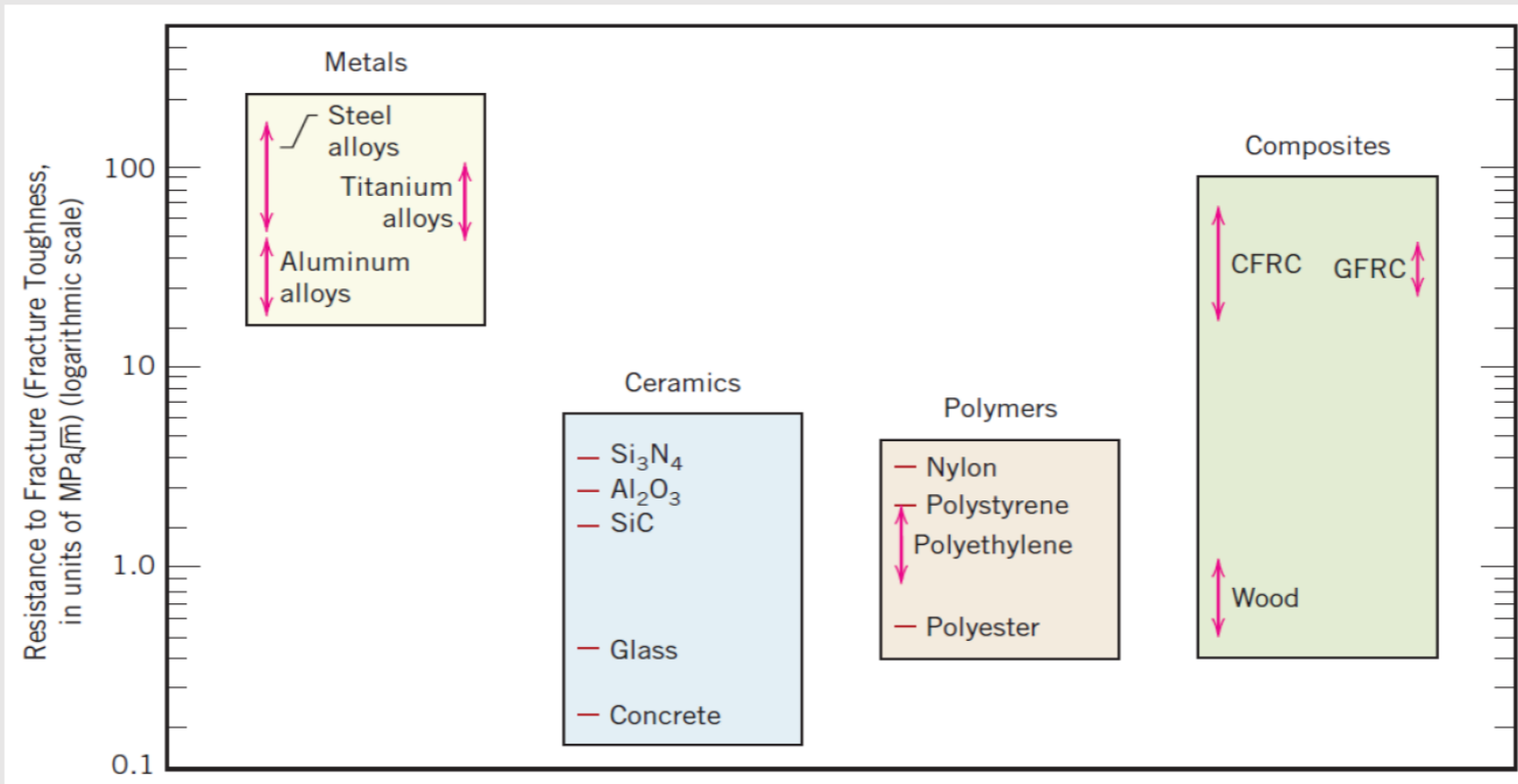
What is the lightest material?

What is the heaviest material?



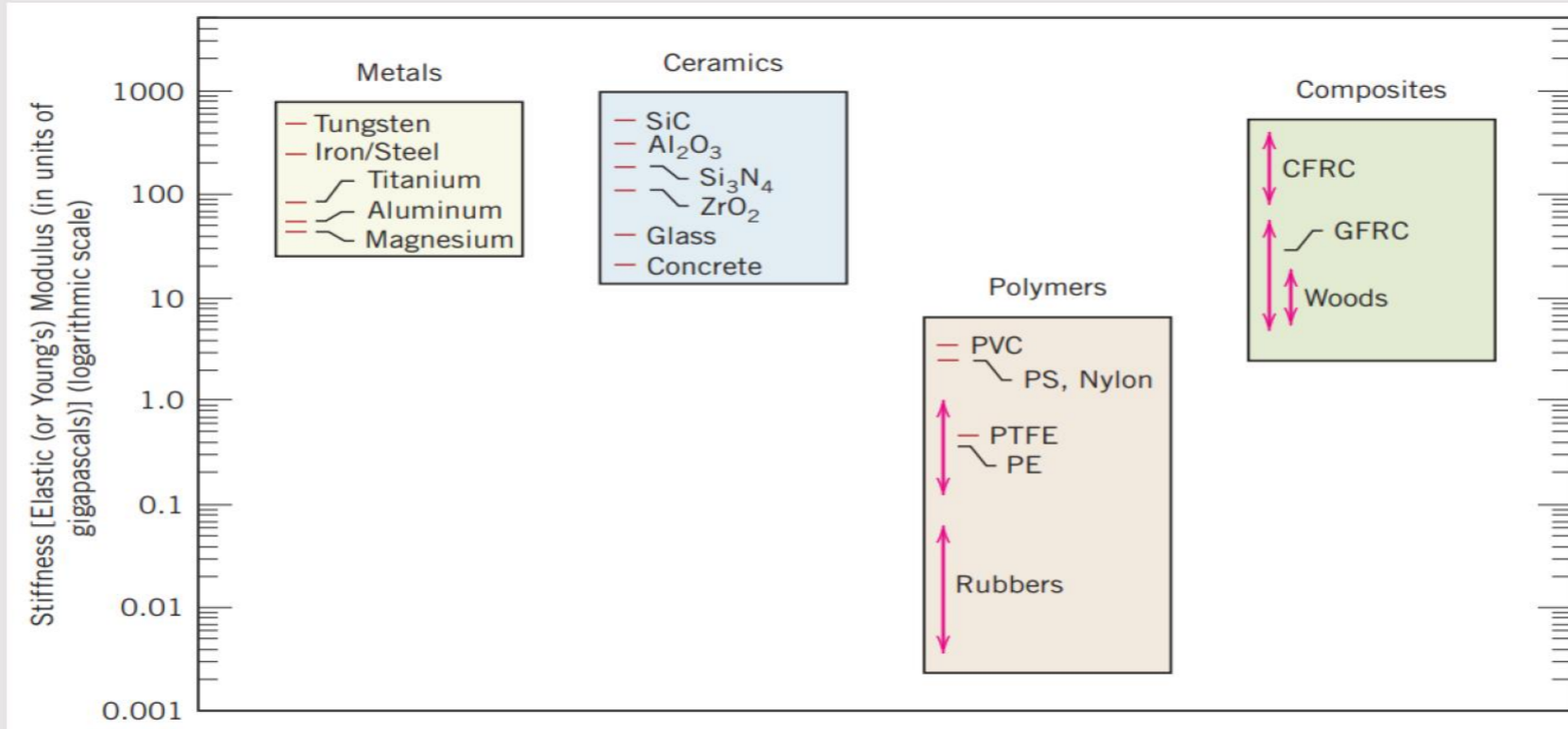
What is the strongest material ?

What is the weakest material ?



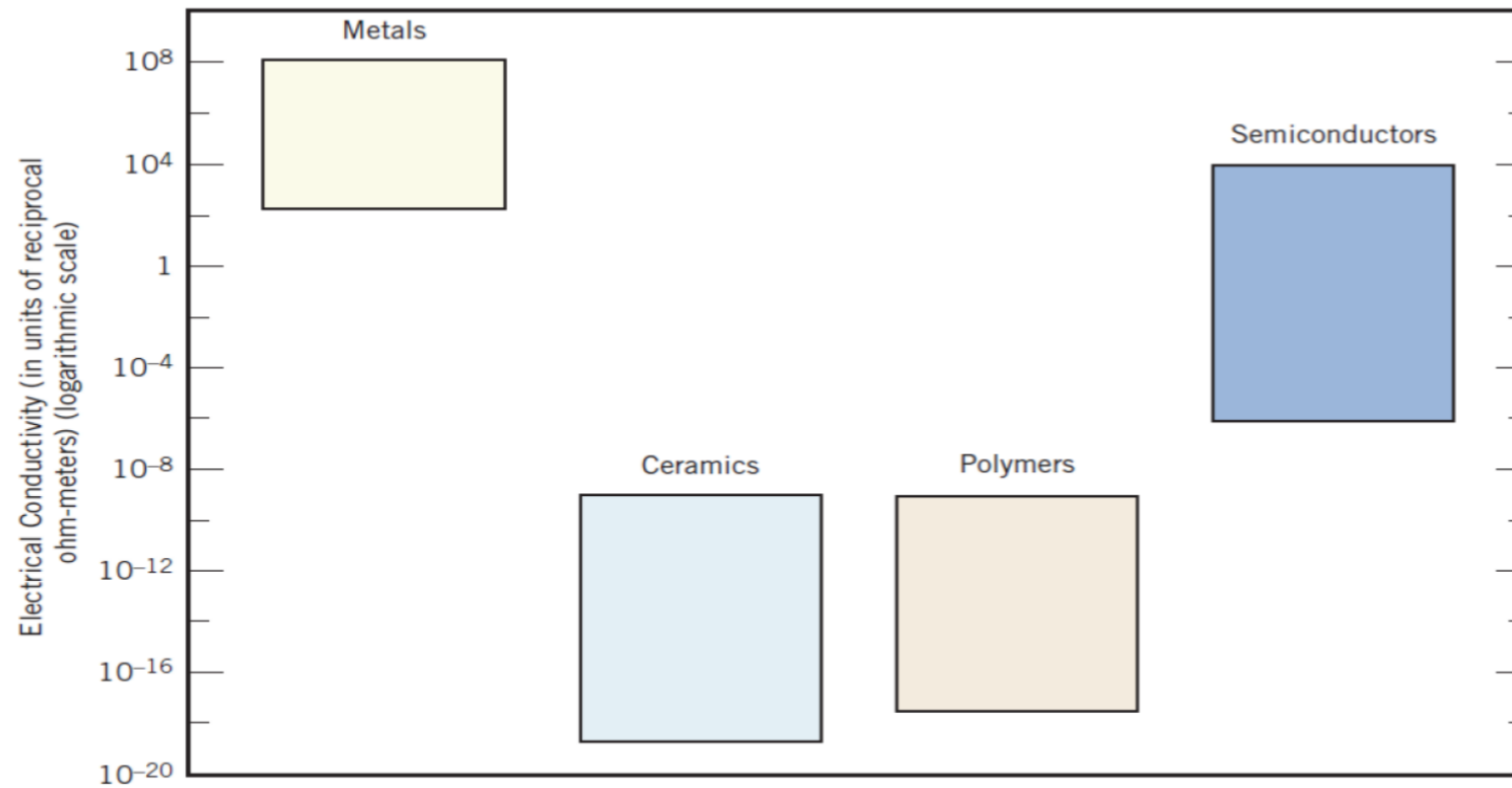
What material that most easily to crack and break?

What material that most difficult to crack and break?



What is the stiffest material?

What is the most flexible material?



The most electrically conductive material?

The least electrically conductive material?

Advanced Materials

1 – Semiconductors أشباه الموصلات

- Electrical properties are intermediate between conductors (metals) and insulators (polymers).
- Used in computer and electronic devices.

2 - Biomaterials

- Materials employed to replace damaged parts of human body.
- Must not produce toxic substances.

3 - Smart Materials

- Materials can sense changes and then respond to these changes in predetermined manners.

4 - Nanomaterials

- dimensions of these structural entities are on the order of a nanometer (10^{-9} m) - as a rule, less than 100 nanometers.

Q3. List four group of advanced materials:

Semiconductors Biomaterials Smart materials Nanomaterials