

### 一、 Fill in the blanks (1'×10 = 10')

1. The four basic types of bonding arrangements which hold atoms together are the \_\_\_\_\_ bond, \_\_\_\_\_ bond, ionic bond and the van der Waals forces.
2. One of the main factors on the brittle nature of glass is the \_\_\_\_\_.
3. The small molecules in polymers are termed \_\_\_\_\_, the reactions by which they combine are termed \_\_\_\_\_.
4. A property of a material is determined by analyzing the \_\_\_\_\_ of the material to some outside influence, generally by means of a \_\_\_\_\_ standard test.
5. Hardened concrete should be \_\_\_\_\_, strong, watertight and resistant to abrasion.
6. It is the behavior and properties of the \_\_\_\_\_ that generally control the properties of composites.
7. \_\_\_\_\_ is not only one of the most abundant elements in the earth's crust, but it is also the most abundant metal in the earth's crust.

### 二、 True or false (indicate with “√” or “×”, 1'×10 = 10')

1. All amorphous materials are glasses.
2. Magnesium is the lightest of all structural metals.
3.  $\text{Al}_2\text{O}_3$  纤维和 Al 基体组成颗粒增强复合材料。
4. The constituent atoms of glass and ceramics are stacked together in a regular repeating pattern.
5. The weight ratio of water to cement in concrete is called water-cement ratio.
6. The copper-zinc alloys are referred to as brasses.
7. The basic unit of the traditional ceramic is the  $\text{SiO}_4$  tetrahedron.
8. 纤维增强树脂是一种复合材料，而混凝土不是复合材料。
9. The aluminum oxide ( $\text{Al}_2\text{O}_3$ ) is typical type of metal and is a good heat and electric conductor.
10. The crystalline state of a solid is more stable than amorphous state.

### 三、 Choose the right answer (1'×10 = 10')

1. More than 90% of the glass in use is based on oxides and in particular \_\_\_\_\_.  
a. oxides    b. salts    c. calcium    d. silica
2. A material that will not deform plastically under load is said to be \_\_\_\_\_. Excessive cold working causes loss of \_\_\_\_\_.  
a. tough    b. brittle    c. value    d. ductility
3. Most metals occur in nature as compounds which must be \_\_\_\_\_ to free the metal.  
a. reduced    b. oxidized    c. extracted    d. excavated
4. Polymers vary in their mechanical behavior depending on the degree of \_\_\_\_\_, degree of crosslinking, and the values of  $T_g$  and  $T_m$ .  
a. structure    b. crystallinity    c. melting point    d.  $T_g$
5. The ductility of a material is investigated with the \_\_\_\_\_ test.  
a. compression    b. shear    c. tensile    d. torsion
6. 用铝合金制作门窗是利用铝合金\_\_\_\_\_的优点。  
a. 不易腐蚀    b. 硬度较大    c. 熔点较低    d. 导热良好
7. The chain polymerization starts with the \_\_\_\_\_ reaction.  
a. initiation    b. addition polymerization    c. propagation    d. termination

#### 四、Terms and definitions (4'×5 = 20')

1. Polymer
2. Ductility
3. Free radical
4. Physical properties
5. Packing factor

#### 五、Questions and replies (8'×4 = 32')

1. How are the porosity defined in normal ceramics based on the connectivity? and how is the strength of ceramics affected by pores?
2. How many kinds of composites can be classified based on the form of the matrix? Please list the factors influencing the properties of the polymer-matrix composites.
3. Please explain why metals are good electrical conductors and most ceramics are good electrical insulators in regard to their atomic bonding.
4. 简述填料在复合材料中的作用。

#### 六、Read and discuss (9'×2 = 18')

1. Ceramic materials are generally things like tile, bricks, plates, glass, and toilets. They can be found in products like watches (quartz tuning forks-the time keeping devices in watches), snow skis (piezoelectric-ceramics that stress when a voltage is applied to them), automobiles (sparkplugs and ceramic engine parts found in racecars), and phone lines. They can also be found on space shuttles, appliances (enamel coatings), and airplanes (nose cones). Depending on their method of formation, ceramics can be dense or lightweight. Typically, they will demonstrate excellent strength and hardness properties; however, they are often brittle in nature. Ceramics can also be formed to serve as electrically conductive materials, objects allowing electricity to pass through their mass, or insulators, materials preventing the flow of electricity. Some ceramics, like superconductors, also display magnetic properties.

**Question:**

Please explain the major advantages of ceramics that we consider when choosing the ceramic for certain applications and main disadvantage?

2. Strength test of concrete is undoubtedly the most common type of test to evaluate the properties of hardened concrete. The compressive strength of concrete at 28 days is almost universally adopted as the basis for structural calculations. It is also used to designate concrete. When concrete is placed on site, samples of concrete are taken to make cubes (or cylinders) that are cured in a specified condition and tested at different ages.

**Question:**

Please explain why the strength of concrete is generally used to evaluate the quality of hardened concrete.

# 参考答案

## 一、Fill in the blanks (1'×10 = 10')

1. [metallic, covalent](#)
2. [surface defect](#).
3. [monomers, polimerization](#).
4. [reaction, normalized](#)
5. [durable](#)
6. [interface](#)
7. [Aluminum](#)

## 二、True or false (1'×10 = 10')

- (×) (√) (×) (×) (√)  
(√) (×) (×) (×) (√)

## 三、Choose the right answer (1'×10 = 10')

1. (d) 2. (b, d) 3. (a) 4. (b) 5. (a) 6. (d) 7. (c) 8. (a) 9. (a)

## 四、Terms and definitions (4'×5 = 20')

1. Polymer: macromolecules built up by the linking together of large numbers of much smaller molecules.
2. Ductility: The property that allows a metal to deform permanently when loaded in tension.
3. Free radical: it is simply a molecule with an unpaired electron.
4. Physical properties: The behavior of materials subjected to the action of temperature, electric or magnetic fields or light.
5. Packing factor: The ratio of the volume of all elementary particles per elementary cell to the total volume of the elementary cell.

## 五、Questions and replies (8'×4 = 32')

1. Many applications that use advanced ceramics are limited by pores, which scatter light and make them opaque or translucent. Pores can also make the ceramic too brittle and ruin the flow of electrons and/or heat through the material. Questions:
  - a. How are the porosity defined in normal ceramics based on the connectivity?
  - b. How is the strength of ceramics affected by pores?

### Answer:

a: There are two types of porosity. Open porosity refers to the network of pores in a material that is open to the surface. [2'] Closed porosity refers to those pores that have become sealed within the grain structure [2'].

b: Pores affect the strength of ceramics in two ways. First, they produce stress concentrations [2']. Second, pores reduce the strength of ceramics because they reduce the cross-sectional areas over which a load can be applied [2'].

2. Composite materials (or composites for short) are engineered materials made from two or more constituent materials with significantly different physical or chemical properties which remain

separate and distinct on a macroscopic level within the finished structure.

- a. How many kinds of composites can be classified based on the form of the matrix?
- b. Please list the factors influencing the properties of the polymer-matrix composites.

**Answers:**

Three main groups: Polymer Matrix Composites (PMC's), Metal Matrix Composites (MMC's), Ceramic Matrix Composites (CMC's) [3']

Factors determining the properties of the composite are:

- (1) the properties of the fibre [1'];
- (2) the properties of the resin [1'];
- (3) the ratio of fibre to resin in the composite (Fibre Volume Fraction (FVF)) [2'];
- (4) the geometry and orientation of the fibres in the composite [1']

3. Please explain why metals are good electrical conductors and most ceramics are good electrical insulators in regard to their atomic bonding.

**Answer:**

Metals: metallic bonding, there are free electrons[3']. The free movement of electrons accounts for the high electrical and heat conductivity of metals [2'].

Ceramics: ionic bonding and covalent bonding[2'], there are no free electrons[1'].

4. 简述填料在复合材料中的作用。

**答:** 填料可以提高复合材料的强度和刚度[2'], 提高复合材料的耐热性和冲击韧性[2'], 降低基体树脂的固化放热和固化收缩, 以及提高制品的尺寸稳定性[2']。但填料的加入也会增加树脂体系的黏度, 其适用的成型工艺受到一定程度的限制, 且会对树脂的固化和储存期产生一定的影响[2']。

## 六、Read and discuss (9'×2 = 18')

3. Ceramics are all around us. This category of materials includes things like tile, bricks, plates, glass, and toilets. Ceramics can be found in products like watches (quartz tuning forks-the time keeping devices in watches), snow skis (piezoelectric-ceramics that stress when a voltage is applied to them), automobiles (sparkplugs and ceramic engine parts found in racecars), and phone lines. They can also be found on space shuttles, appliances (enamel coatings), and airplanes (nose cones). Depending on their method of formation, ceramics can be dense or lightweight. Typically, they will demonstrate excellent strength and hardness properties; however, they are often brittle in nature. Ceramics can also be formed to serve as electrically conductive materials, objects allowing electricity to pass through their mass, or insulators, materials preventing the flow of electricity. Some ceramics, like superconductors, also display magnetic properties.

Question: please explain the major properties of ceramics that we consider when choosing the ceramic for certain applications?

**Answers:**

Advantage: (1) extreme hardness [2']; (2) heat resistance [2']; (3) corrosion resistance [2']; (4) low electrical and thermal conductivity [2]

Disadvantage: low ductility or brittleness [1']

4. Strength test of concrete is undoubtedly the most common type of test to evaluate the properties of hardened concrete. The compressive strength of concrete at 28 days is almost universally adopted as the basis for structural calculations. It is also used to designate concrete. When concrete is placed on site, samples of

concrete are taken to make cubes (or cylinders) that are cured in a specified condition and tested at different ages.

Question: please explain why the strength of concrete is generally used to evaluate the quality of hardened concrete.

**Answers:**

(1) the strength of concrete in compression, tension, shear or a combination of these has a direct influence on the load carrying capacity of both plain and the reinforced structures [3’].

(2) of all the properties of hardened concrete, those concerning strength can usually be determined most easily [3’].

(3) by means of correlations with other more complicated tests, the results of strength tests can be used as qualitative indications of other properties of hardened concrete [3’].