СВОЙСТВА МАТЕРИАЛОВ

Task 1

Прочтите текст. Дайте определение понятию – физическое свойство материала.

Physical property

A physical property is any property that is measurable whose value describes a physical system's state. The changes in the physical properties of a system can be used to describe its transformations (or evolutions between its momentary states).

Physical properties can be intensive or extensive. An intensive property does not depend on the size or amount of matter in the object, while an extensive property does. In addition to extensiveness, properties can also be either isotropic if their values do not depend on the direction of observation or anisotropic otherwise. Physical properties are referred to as observables. They are not modal properties.

Often, it is difficult to determine whether a given property is physical or not. Color, for example, can be "seen"; however, what we perceive as color is really an interpretation of the reflective properties of a surface. In this sense, many ostensibly physical properties are termed as *supervenient*. A supervenient property is one which is actual (for dependence on the reflective properties of a surface is not simply imagined), but is secondary to some underlying reality. This is similar to the way in which objects are supervenient on atomic structure. A "cup" might have the physical properties of mass, shape, color, temperature, etc., but these properties are supervenient on the underlying atomic structure, which may in turn be supervenient on an underlying quantum structure.

Chemical properties determine the way a material behaves in a chemical reaction. Physical properties do not change the chemical nature of matter.

Task 2

Прочтите текст. Составьте список основных физических свойств материалов. Выпишите основные физические свойства материала.

Physical properties

Hardness

Hardness is the measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied. Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: *scratch hardness*, *indentation hardness*, and *rebound hardness*. Hardness is dependent on ductility, elastic stiffness, plasticity, strain, strength, toughness, viscoelasticity, and viscosity.

Common examples of hard matter are ceramics, concrete, certain metals, and superhard materials, which can be contrasted with soft matter.

Elasticity and plasticity

In solid mechanics, solids generally have three responses to force, depending on the amount of force and the type of material:

- They exhibit elasticity—the ability to temporarily change shape, but return to the original shape when the pressure is removed. "Hardness" in the elastic range—a small temporary change in shape for a given force—is known as stiffness in the case of a given object, or a highelastic modulus in the case of a material.
- They exhibit plasticity—the ability to permanently change shape in response to the force, but remain in one piece. The yield strength is the point at which elastic deformation gives way to plastic deformation. Deformation in the plastic range is non-linear, and is described by thestress-strain curve. This response produces the observed properties of scratch and indentation hardness, as described and measured in materials science. Some materials exhibit both elasticity and viscosity when undergoing plastic deformation; this is called viscoelasticity.
- They fracture—split into two or more pieces.

Strength

Strength is a measure of the extent of a material's elastic range, or elastic and plastic ranges together. This is quantified as compressive strength, shear strength, tensile strength depending on the direction of the forces involved. Ultimate strength is an engineering measure of the maximum load a part of a specific material and geometry can withstand.

Brittleness

Brittleness, in technical usage, is the tendency of a material to fracture with very little or no detectable deformation beforehand. Thus in technical terms, a material can be both brittle and strong. In everyday usage "brittleness" usually refers to the tendency to fracture under a small amount of force, which exhibits both brittleness and a lack of strength (in the technical sense). For perfectly brittle materials, yield strength and ultimate strength are the same, because they do not experience detectable plastic deformation. The opposite of brittleness isductility.

Toughness

The toughness of a material is the maximum amount of energy it can absorb before fracturing, which is different from the amount of force that can be applied. Toughness tends to be small for brittle materials, because elastic and plastic deformations allow materials to absorb large amounts of energy.

Task 13

Назовите, какие вы знаете электрические свойства материалов.
Прочтите тексты об электрических свойствах.

Electrical properties

Electrical resistivity (also known as resistivity, specific electrical resistance, or volume resistivity) is a measure of how strongly a material opposes the flow of electric current. A low resistivity indicates a material that readily allows the movement of electric charge. The SI unit of electrical resistivity is the ohm·metre (Ω·m). It is commonly represented by the Greek letter ρ (rho).

Electrical conductivity or specific conductance is the reciprocal quantity, and measures a material's ability to conduct an electric current. It is commonly represented by the Greek letter σ (sigma), but κ (kappa) (especially in electrical engineering) or γ gamma are also occasionally used.

If there is electric field inside a material, it will cause electric current to flow. The electrical resistivity ρ (Greek: rho) is defined as the ratio of the electric field to the current it creates: p = E : J, where

ρ is the resistivity of the conductor material (measured in ohm·metres, Ω·m),

E is the magnitude of the electric field (in volts per metre, $V \cdot m^{-1}$),

J is the magnitude of the current density (in amperes per square metre, $A \cdot m^{-2}$).

For example, rubber is a material with large resistivity and small conductivity, because even a very large electric field in rubber will cause almost no current to flow through it. On the other hand, copper is a material with small resistivity and large conductivity, because even a small electric field pulls a lot of current through it.

Electrical resistivity of the elements

A conductor such as a metal has high conductivity and a low resistivity.

An insulator like glass has low conductivity and a high resistivity.

The conductivity of a semiconductor is generally intermediate, but varies widely under different conditions, such as exposure of the material to electric fields or specific frequencies oflight, and, most important, with temperature and composition of the semiconductor material.

The degree of doping in semiconductors makes a large difference in conductivity. To a point, more doping leads to higher conductivity. The conductivity of a solution of water is highly dependent on its concentration of dissolved salts, and other chemical species that ionize in the solution. Electrical conductivity of water samples is used as an indicator of how salt-free, ion-free, or impurity-free the sample is; the purer the water, the lower the conductivity (the higher the resistivity). Conductivity measurements in water are often reported as *specific conductance*, relative to the conductivity of pure water at 25 °C. An EC meter is normally used to measure conductivity in a solution.

Task 14

Прочитайте объяснение причин проводимости материалов в учебнике по физике. Прочитайте текст и составьте словарь эквивалентов английского и русского языков, используемой при объяснении явления проводимости.

Causes of conductivity

Band theory simplified

Quantum mechanics states that the energy of an electron in an atom cannot be any arbitrary value. Rather, there are fixed energy levels which the electrons can occupy, and values in between these levels are impossible. When a large number of such allowed energy levels are spaced close together (in energy-space) i.e. have similar (minutely differing energies) then we can talk about these energy levels together as an "energy band". There can be many such energy bands in a material, depending on the atomic number (number of electrons) and their distribution (besides external factors like environment modifying the energy bands). Two such bands important in the discussion of conductivity of materials are: the valence band and the conduction band (the latter is generally above the former). Electrons in the conduction band may move freely throughout the material in the presence of an electrical field. In insulators and semiconductors, the atoms in the substance influence each other so that between the valence band and the conduction band there exists a forbidden band of energy levels, which the electrons cannot occupy. In order for a current to flow, a relatively large amount of energy must be furnished to an electron for it to leap across this forbidden gap and into the conduction band. Thus, even large voltages can yield relatively small currents.