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Analysis of Research on the Properties, Production and Use of Carbon Nanoparticles

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A hexagonal two-dimensional crystal lattice made up of graphene-carbon atoms. A hexagonal grid with graphene can be thought of as two variables triangular grids. It is an allotropic form of carbon, which consists of a single layer of carbon atoms in sp²-hybridization that are bonded by ζ- and π- bonds directed out of the plane. Graphene is the building block of many other carbon allotropes such as graphite, diamond, coal, and fullerene.

Graphene fragments are obtained by mechanical action on highly oriented pyrolytic graphite or kvish-graphite. First, pieces of flat graphite are placed between the adhesive tapes and repeatedly split to form very thin layers (among the many films obtained are single- and double-layer materials, which are of interest to scientists. Thin film graphite adhesive tape is printed on an oxidized silicon substrate.In this case, it is difficult to obtain a film of a certain size and shape on the solid parts of the substrate (layers are usually about 10 μm) [1].

Scientists have been thinking about graphene for many years. It has been produced accidentally in small quantities as a result of the use of pencil and similar graphite over the centuries. It was first discovered in electron microscopes in 1962, but it was only studied when applied to metal surfaces. In 1986, Boem and his colleagues coined the term graphene as single-layer graphite. The first graphene layers grown on Ru, Rb, Ni metal substrates were obtained in 1970 by John Grant and Blakely. This material was later rediscovered, isolated, and described in 2004 by Andrei Geim and Konstantin Novoselov at the University of Manchester.

This work earned them the 2010 Nobel Prize in Physics for their ―twodimensional material‖ -graphene-based experiments. In 2013, Michael Kasnelson was awarded the Spinoza Prize for his development of basic concepts and terms used by science in the field of graphene. The International Union of Theoretical and Applied Chemistry (IUPAC) states: ―In the past, the term graphene used descriptions such as graphite, carbon layers, or carbon layers ... it is incorrect to use the term for a layer, referring to this three-dimensional structure holds.

The term ―graphene‖ should only be used to discuss reactions, structural relationships, or other properties of individual layers [3].

Graphene has many unusual properties. It is the strongest material tested, conducts heat and energy efficiently and is almost transparent. Graphene shows larger and nonlinear diamagnetism than graphite and can be lifted using neodymium magnets. The atomic structure of isolated single-layer graphene was studied on graphene sheets suspended between metal mesh rods. Electron diffraction patterns showed the expected beehive cage [4].

Graphene is the only form of solid carbon in which chemicals can act on each atom in two ways due to its two-dimensional structure. The atoms at the edge of the graphene sheet have a special chemical reactivity. Defects inside the plate increase its chemical reactivity. The initial reaction temperature between the single-layer graphene and the oxygen gas plane is below 260 ° C (530 K).

Graphene burns at 350 ° C (620 K). Graphene usually interacts with oxygen and nitrogen functional groups and is analyzed using infrared spectroscopy and Xray photoelectron spectroscopy. However, good control of the structures is required to identify graphene structures with oxygen and nitrogen functional groups [5].

Graphene is inert to acids and alkalis at room temperature due to its strong carbon covalent bonds. However, the presence of some chemical compounds in the atmosphere can affect the inertness of graphene, which has allowed the use of high-sensitivity sensors - detectors of individual molecules. For chemical modification, the covalent bonds of graphene must be broken with high temperatures and strong reagents. In other words, the definition of ideal graphene varies in chemistry and physics. For example, in order to form hydrogen graphene, a strong fluorination agent, xenon diphthoride, must be applied to the protons in the gas plasma. Both of these materials exhibit dielectric properties, i.e., their resistance increases with decreasing temperature [6].

Under ambient conditions, graphene placed on a soda lime glass substrate showed spontaneous n-doping (1.33 × 1013 e / cm2) by surface transfer. The semiconductor copper was stored in n-doping with SLG in an indium-gallium alloy and reached 2.11 × 1013 e / cm2 [2]. Various graphene derivatives, such as cyanografen and graphenic acid, can be obtained on the basis of fluorophene [7].

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Preliminary measurements of the thermal conductivity of molten grapheme show a very high thermal conductivity of 5300 W-1 * K-1 at room temperature relative to the thermal conductivity of pyrolytic graphite close to 2000 W-1 * K-1. Subsequent studies, however, have cast doubt on the overestimation of this very high value, and instead have a thermal conductivity of 1500–2500 W-1 * K-1 for single-layer graphene. The large range can be explained by measurement inaccuracies, as well as changes in the quality and processing conditions of graphene [8].

Furthermore, when single-layer graphene is used in an amorphous material, the thermal conductivity decreases to about 500-600 W-1 × K-1 and may be lower as a result of the propagation of the graphene lattice wave to the substrate at room temperature. Similarly, polymer residues can also help to reduce suspended graphene to about 500–600 W-1 × K-1 for two-layer graphene [9].

Despite its many advantages, graphene is relatively brittle and has a fracture resistance of about 4 MPa, indicating that imperfect graphene is as brittle as ceramic materials and can crack. Graphene exhibits the ability to distribute impact force more than any known material, which is ten times greater than steel per unit of weight [10].

In 2011, graphene was shown to accelerate osteogenic differentiation of human brain stem cells without the use of biochemical inducers [11].

In 2016, it was discovered that graphene was not used without altering properties such as scar tissue formation or as a neurointerface electrode.

Graphene electrodes in the body are more stable than tungsten or silicon electrodes due to properties such as flexibility, biomic and conductivity [12].

It is believed that a ballistic transistor can be built on the basis of graphene. In March 2006, a group of researchers from the Georgia Institute of Technology announced the acquisition of a graphene field-effect transistor and a quantum interference device. Researchers believe that because of their achievements, a new class of transistor graphene nanoelectronics with a thickness of 10 nm will soon emerge. This transistor has a large signal current, i.e. the two states of closed and open channel are indistinguishable [13].

In developed countries, a number of research projects are underway to create graphene-based filters for wastewater and salt treatment. In recent years, two-dimensional nanopowders with a carbon thickness of one carbon atom have been widely used in technology. This powder was first obtained in 2004 by Russian researchers K. Novoselov and A. Game (for these discoveries they were awarded the Nobel Prize in 2010) [14].

However, obtaining graphene nanopowders is one problem, while storing the nanopowders in the form of nanoparticles is another. This is because carbon nanoparticles combine very quickly to fill their crystal lattice with carbon atoms and turn into graphite. Scientists are working to find different solutions to these problems. For example, a group of scientists from the Australian State Association for Scientific and Applied Research (CSIRO) have proposed a cheap and effective way to treat sea salt using graphene-based material (GraphAir). They made graphene nanomaterials using soybean oil. It is recognized that there are nanoscale microscopic channels in the soybean oil layer, and when graphene powder is sprinkled on them, nanoparticles settle into these channels and form a membrane that only carries water molecules.

According to scientists, this filter is able to purify 100% of sea salt water.

A. Game, a professor at the University of Manchester (England), conducted research on graphene oxide and obtained a graphene film that is 100 times thinner than human hair. It has been suggested that the film can hold only water molecules and even gas molecules [10]. Engineers at the University of Buffalo (USA) are proposing to get graphene gel. Graphene gel was obtained on the basis of graphene powder, synthetic polydopamine and bovine serum (albumin). The resulting gel forms a nanoparticle the thickness of a carbon atom and transmits only water molecules. The authors acknowledged that the gel was 100% water-purified even after repeated use to purify wastewater from biological microparticles [11].

Nakhul Nair, a professor at the University of Manchester, is researching graphene oxide-based seawater desalination filters. Neur suggested mixing graphene oxide nanoparticles with epoxy resins. The film obtained by this method traps sodium chloride molecules and transfers water molecules [14].

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