SYMMETRY IN THE NANOTUBE IN THE STUDY OF SOLID STATE PHYSICS

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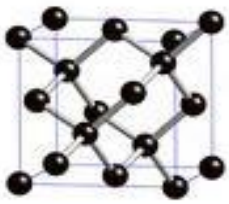
ABSTRACT

Although solids are similar in composition, there are substances that differ in structure and symmetry. This paper describes the symmetrical differences of substances with the same composition in the study of solid state physics.

Keywords: Solid, symmetry, nanotube, nanostructure, carbon, graphite, diamond, layer.

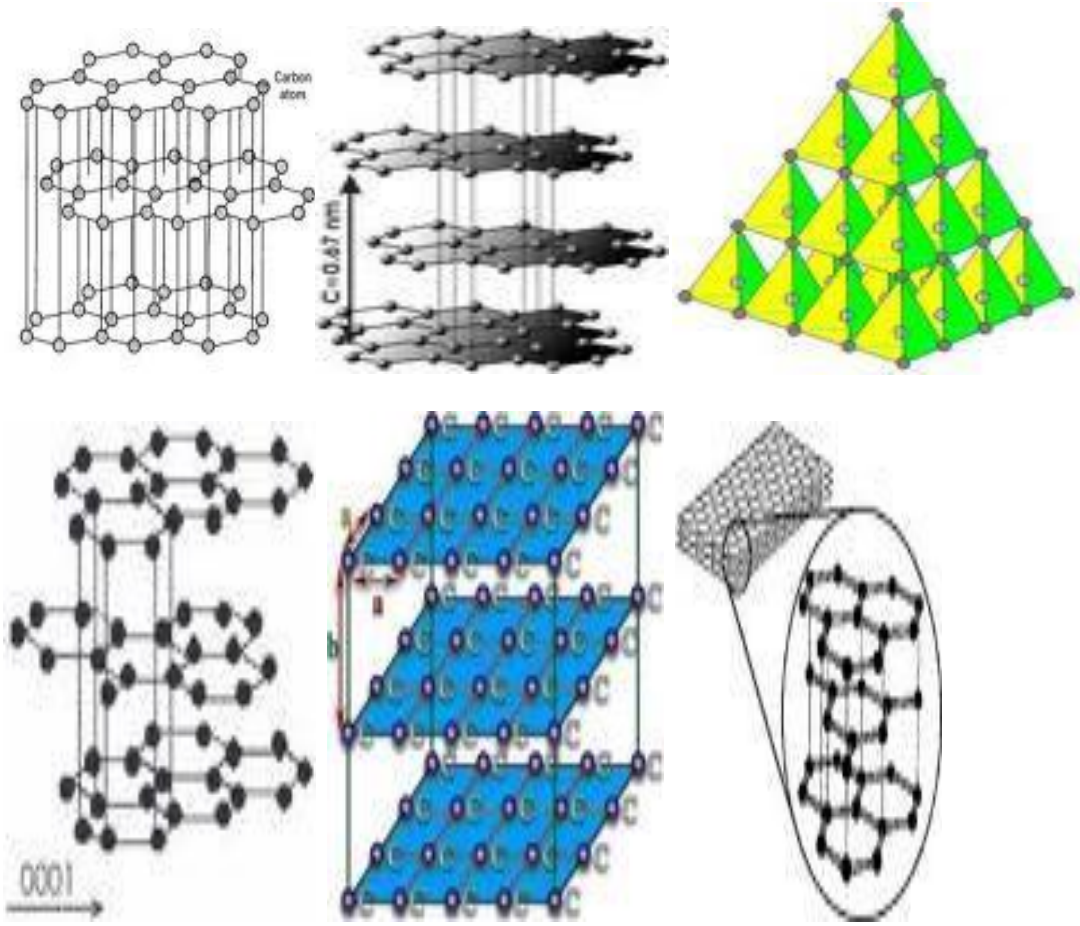
INTRODUCTION, LITERATURE REVIEW AND DISCUSSION

Crystals of solids have a specific symmetry. Symmetry determines the physical properties in them, i.e. mechanical strength, electrical conductivity, transparency to light and other rays, the symmetry of crystals depends on different directions. Solids formed on the basis of carbon atoms are no exception. Graphite and diamond differ from each other in their physical properties, and their crystallographic symmetry also varies. The symmetry in the crystal can be determined by the radius-vector values.



Crystal structure

A, b, c-primary vectors, m, n, p-whole numbers-indices. The distance between nodes in a solid body also varies. In diamond it is equal to $1{,}54\ A^0$, in graphite it is equal to $1{,}42\ A^0$ and the distance between the layers in it is much greater. Given that graphite nanotubes are formed from graphite layers, the sixth degree axis of symmetry $\tilde{N}_6$ is maintained in them. The fullerene, which is the last state of the graphite nanotube in small size, has ten of the $\tilde{N}_6$ axis of symmetry and six of the $\tilde{N}_5$ axis of symmetry and sixty of the $\tilde{N}_2$ axis of symmetry. The degree of symmetry in single-layer carbon nanotubes is lower than in fullerenes, and its symmetry decreases further as the size of the fullerene begins to increase. On the surface of the nanotube, pentagonal and hexagonal shapes appear between the hexagonal shapes, and the symmetry in the nanotube is broken. The nanotube enters a pentagonal shape, on the surface of which a convex content appears. On the surface of the hexagonal shape, a depression is formed.



Crystal symmetry

Such symmetrical distortions are a defect of the nanotube composition. In practice, the violation of the symmetry of the nanotube leads to a change in its physical properties. Defects reduce the mechanical strength, electrical conductivity of the nanotube. Similar changes can also occur with foreign elements embedded in the nanotube size. In the field of nanotechnology, it is important that researchers working in material science pay attention to the preservation of symmetry in nanotubes. The laws of symmetry play an important role in the physics of solids. As we have seen above, the fact that the structure of solids such as graphite and diamonds is formed from graphites in the process of physics education gives students an initial, understanding of nanostructures. Nanosymmetry expands their understanding of nanophysics by explaining to students the mechanism of nanostructure formation. It is also important in biology, ecology, energy, mechanical engineering, aircraft building, aerospace, exploration and mining of natural resources.

It should be borne in mind that the development of nanotechnology can raise civilization and human living conditions to a very high level, as well as its use in the military field poses unprecedented risks. It is estimated that in the next 10 years, millions of nanotechnology specialists will be needed and the benefits of nanotechnology products will exceed $ 1 trillion. Training of qualified personnel is mainly the responsibility of higher education institutions. In countries such as the United States, Japan, Germany and Russia, specialties and specialties in various fields of nanotechnology have been opened and hundreds of thousands of students study there. Of course, in order to master this field, students will need to master the natural sciences, such as physics, chemistry and biology.

The main task of pedagogical scientists of the Republic, as in other countries, is the creation of new types of electronic devices and devices, their use and improvement, analysis of the results obtained and training of personnel who can train specialists in this field. To successfully solve this task, it will be necessary to develop a concept of higher education in "Nanotechnology", which will solve the following key problems.

It is necessary to re-analyze the above-mentioned programs of natural sciences and include in them at least 14-16 hours of lectures on nanotechnology. For example, in the field of quantum mechanics in physics, you can add the necessary topics:

- It is expedient to include the subject of "Nanotechnology" in the programs of technical universities, pedagogical universities in the relevant areas and specialties;
- It is necessary to organize the exchange of experience and training of pedagogical scientists in developing countries in the field of new technologies, including Russia.
- It is necessary to send gifted students to study abroad or to organize their technological internships abroad;
- It is necessary to further strengthen the relationship of higher education institutions with research institutes and industrial enterprises of the Academy of Sciences of the Republic of Uzbekistan, to effectively use their specialties and equipment in teaching students.
- It is necessary to find equipment for laboratory work on the acquisition of nanomaterials from abroad and the study of the properties of materials.
- It is necessary to organize groups of highly qualified scientists and professors and teachers to write textbooks and manuals in the state language on the basis of science programs.

We believe that the training of highly qualified specialists with higher education and their involvement in the educational process, research and production will be the basis for the Republic to take a worthy place among the developed countries in the field of new technologies.

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