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Extended Abstract

Nano science, Nanotechnology, Graphene & 2D material: Mechanical, electronic, magnetic and thermal transport properties in two dimensional materials- Yang Han- Harbin Engineering University, China

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Abstract

Novel nanostructures have been fabricated continuously with the help of the development of nanotechnology. These structures have a series of greatly different physical properties from their bulk counterparts, making them to have a great potential application in the physics, chemistry, materials science, biology and life science, nanoelectronics and nanotechnology. Research on two-dimensional (2D) materials such as graphene and graphene-like group-IV materials is of fundamental scientific interest from the view of the variety of applications. For example, graphene possesses extreme mechanical strength, exceptionally high electrical and thermal conductivities, as well as many other supreme properties, all of which make it highly attractive for numerous applications. Inspired by the prospective properties of graphene, there has been increasing interest in its ???cousins???, i.e., two-dimensional honeycomb lattices composed of other group-IV elements, e.g. Si and Ge, which naturally have been considered to have a graphene-like hexagonal structure with similar exceptional properties. Layered silicon oxide is also an important building block that provides insulating barriers in electronic devices, e.g. as a gate oxide in field effect transistors. Moreover, thin silica films grown on metal single crystal substrates can be used as model systems for studying the structure-property relationships of silica and related materials using surface science techniques. This talk mainly focuses on the mechanical, electronic, magnetic and thermal transport properties of the two dimensional (2D) graphene-like materials.

In the last quarter of the century, fullerenes became one of the dominant discoveries in the field of physical chemistry. Fullerenes are a new allotropic form of carbon. Research on them has contributed to a huge number of scientific publications and their use is restricted by several hundred patents. In the year 1996, three explorers, Harold Kroto, Richard Smalley and Robert Curl, received the Nobel Prize in this field of chemistry, which confirmed the importance of this kind of science.1 Not so long ago, it was thought that coal occurs in two allotropic forms that differ in their crystal structure, namely, diamond and graphite, but in 1985, the above-mentioned scientists revolutionized knowledge about carbon and discovered a new allotropic variety, a caged form of carbon.2 The crystal structure of fullerenes is completely different from graphite and diamond, since it is made up of C60 and C70 carbon molecules. There are two fundamental differences between graphite, diamond and fullerenes. The first two mentioned varieties of carbon occur in atomic form, while fullerenes are its molecular form. In the crystalline networks of diamond or graphite, peripheral atoms are saturated with other elements, most often more reactive hydrogen; so, formally, carbon in these varieties does not occur in pure form. Fullerenes, on the other hand, are a variety of pure carbon. The discovery of fullerenes and the enormous development of research in this field have led to increased knowledge about carbon nanostructures. At the beginning of the 90s, carbon nanotubes (CNTs), carbon nanocrystallites with onion structure and carbon nanocapsules were discovered. Nanotechnology is an absolutely new quality in technology and, at the same time, it is something so different that it cannot be compared to anything else. It is an action in the world of small objects with sizes reaching individual molecules of chemical compounds. The smallest objects which man had dealt with were located on a micro-scale, which means that they were described in millionth of a meter. This was practically enough to deal with the anatomical description of the cells of living organisms and some of their structural parts. A limitation of the study of smaller structures was the resolution of optical microscopes. After the invention of the electron microscope in 1931, it became possible to distinguish two separate points even closer together. Nanotechnology can be defined as a science dealing with objects for which the smallest elementary particle does not exceed 100 nm even in one plane . This size is, in fact, comparable with the size of macromolecules such as enzymes or receptors (about 5 nm) and is smaller than the human cell, whose size is estimated at 10,000–20,000 nm.

This technology interferes with the structure of matter at the molecular level, and thanks to this, we can count on the rapid development of certain fields of science, particularly material engineering, as well as chemistry, electronics, optics, pharmacy, medicine and cosmetology. Thanks to nanostructures, many

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physicochemical properties of substances, for example, melting point and colour, can be controlled

There is a reasonable belief that the most important future applications of fullerenes lie in the field of medicine. After all, carbon is the basis of all living organisms and the fullerene discovery can certainly be compared to the discovery of benzene, whose derivatives account for 40% of all drugs, even the most popular aspirin. The C60 molecule can bind to any functional group. At the same time, it is indifferent, nontoxic and so small that it easily comes into contact with cells, proteins and viruses. In addition, its interior can also be filled with active substances. During working on small objects, we observe a very important feature, mainly increasing the surface to volume ratio, which makes the molecules chemically more reactive. Only this single feature makes it possible to drastically reduce the dose of the drug without impairing its therapeutic effect. Nanotechnology has allowed the development of new materials (called nanomaterials) with a number of properties that are desirable, such as antibacterial effect, magnetic excitation, increased conductivity or electrical resistance, increased resistance to corrosion and abrasion and increase in plasticity. That is why, they can be used in medicine.

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