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ИНСТИТУТ МЕЖДУНАРОДНЫХ ОТНОШЕНИЙ,
ИСТОРИИ И ВОСТОКОВЕДЕНИЯ
Кафедра иностранных языков для физико-математического направления и информационных технологий

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NANOTECHNOLOGIES

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Предисловие

Настоящее учебное пособие предназначено для занятий со студентами 2 курса Института физики Казанского (Приволжского) федерального университета), обучающихся по направлению 28.03.01 «Нанотехнологии и микросистемная техника».

Учебное пособие разработано для развития навыков чтения текстов по специальности, создания у студентов необходимого в профессиональной деятельности лексического запаса, отработки навыков перевода специальных и научных текстов, а также навыков устной и письменной речи.

При отборе текстового материала в качестве основного критерия служила информативная ценность текстов и их соответствие специальности студентов. Большинство текстов пособия взято из оригинальной английской и американской литературы. В отдельных случаях тексты подвергались адаптации и сокращению.

Настоящее пособие состоит из 3 разделов: Unit 1 The Subject of Nanotechnology, Unit 2 Approaches in Nanotechnology, Unit 3 Application of Nanotechnology. Каждый раздел включает в себя 4 базовых текста, при прохождении которых предусматривается выполнение теста на основе пройденной тематики.

Приложение включает в себя рекомендации по составлению аннотаций, презентаций, словарь сокращений и условных обозначений и дополнительные тексты для чтения.

Contents

UNIT 1. THE SUBJECT OF NANOTECHNOLOGY

Text 1

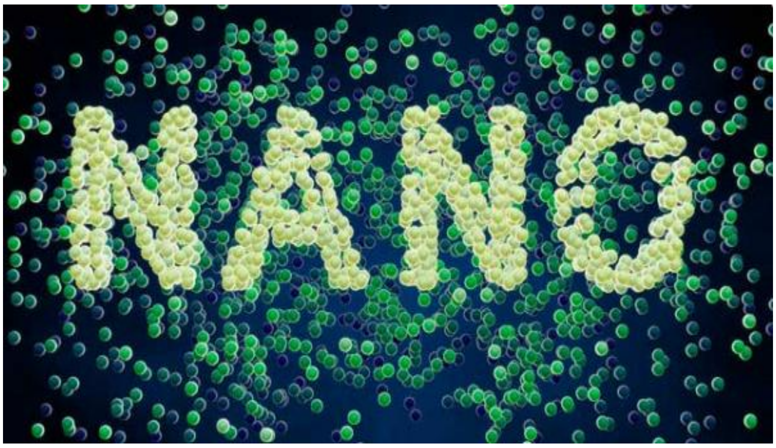
What is nanotechnology?

PRE-READING

1. Answer the following questions.

2. What kind of engineering is nanotechnology?

3. What does the prefix "nano" mean?



2. Practice reading the following words.

atom	['ætəm]	chemical	['kemikəl]
molecule	['molikju:l]	catalyst	['kætəlist]
synthesis	['sinθisis]	nanostructure	[nænəu'strΛktʃə]
nanometer	[nænəu'mi:tə]	toxicity	[ta:k'sisəti]

VOCABULARY

3. Study and remember the words.

dimension	измерение
interaction	взаимодействие
catalyst	катализатор
layer	слой
solid	твердое тело
scale	уровень

to deal with	иметь дело с
diverse extension	разнообразный расширение
range	спектр
toxicity	токсичность
speculation	предположение
to warrant	гарантировать
dwarf	карлик
continuum	сплошная среда
preponderance	преобладание
ductile	пластичный, вязкий
subtle	едва различимый
refine	усовершенствовать
doomsday	конец света
confinement	ограничение
alter	изменять

READING

4. Read the text and answer the questions below.

What is nanotechnology?

Nanotechnology, shortened to "nanotech", is the study of the controlling of matter on an atomic and molecular scale. Nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials or devices within that size. Nanostructures are assembled a single atom, molecule, or atomic layer at a time, as part of a vast new field of research in nanomaterials synthesis and assembly. In other words it is the engineering of functional systems at molecular scale. It offers ways to create smaller, cheaper, lighter and faster devices that can do more and cleverer things, use less raw materials and consume less energy.

Nanotechnology originates from the Greek word meaning “dwarf”. “Nano” is a prefix meaning one-billionth. A nanometer is one-billionth of a meter or it is about one hundred thousandth of the width of a hair! The world of atoms and molecules could not be visualized and managed until a new generation of microscopes were invented in 1980s in IBM in Switzerland.

Generally, structures smaller than a nanometer tend to behave much like individual atoms, while materials that are hundreds of nanometers or greater in size exhibit properties of the continuum. Nanoscale properties and behaviors can be quite different as the result of unique physical and chemical interactions. The preponderance of surfaces and interfaces, and the physical confinement of matter and energy, can alter nearly all properties of materials (physical, chemical, optical, etc.), and thus produce extraordinary new behaviors. Examples include generating light from dark materials, improving efficiencies of catalysts by orders of magnitude, and turning soft and ductile materials like gold into solids with hardness equivalent to bearing steel.

The final ingredient to nanotechnology is the ability to characterize and predict nanoscale properties and behavior. New experimental tools that are able to “see”, “touch”, and measure the behavior of individual nanostructures allow scientists and engineers to identify subtle differences in structure and properties that control nanoscale properties. By coupling new experimental techniques with advanced computational tools, researchers can develop, verify, and refine models and simulations that will allow the full potential for nanotechnology to be explored.

There has been much debate on the future implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with a vast range of applications, such as in medicine, electronics and energy production. On the other hand, nanotechnology raises many of the same issues as with any introduction of new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

Source: https://studfiles.net/preview/2968310/

QUESTIONS:

1. What structures are investigated by nanotechnology?
2. What advantages does nanotechnology offer in creating new products?
3. What is the origin of the word “nanotechnology”?
4. What basic inventions influenced the development of the new science?
5. Why do nanomaterials behave in other way than ordinary structures?
6. What is the extraordinary feature of nanotechnology?
7. What fields of science is nanotechnology applied in?

VOCABULARY WORK

5. Find English equivalents to the following word combinations in the text.

1) Молекулярный уровень;

2) атомный слой;

3) синтез и сборка;

4) сырьё;

5) потреблять энергию;

6) толщина волоса;

7) проявлять свойства;

8) изменять свойства материалов;

9) по порядку величины;

10) несущая сталь;

11) при соединении;

12) последствия нанотехнологии;

13) поднимают многие проблемы;

14) воздействие наноматериалов на окружающую среду;

15) сценарий конца света;

16) пропагандистские группы.

6. Find the synonyms to the following words in the text.

1) Substance;

2) level;

3) huge;

4) use;

5) show;

6) feature;

7) limitation;

8) flexible;

9) connecting;

10) improve;

11) investigate;

12) effects of smth;

13) problems;

14) discussion.

7. Insert the necessary word in the gap.

1) Nanotechnology is the engineering of functional systems at the … scale.

a) nuclear;

b) electron;

c) particle;

d) molecular.

2) Due to nanotechnology we can create things … less energy.

a) consuming;

b) producing;

c) converting;

d) generating.

3) Scientists could … the world of atoms owing to the invention of new microscopes.

a) verify;

b) offer;

c) visualize;

d) penetrate.

4) New … of microscopes helped advance the science of nanotechnology.

a) gravitation;

b) generation;

c) production;

d) contribution.

5) The science of nanotechnology attracted attention of scientists all over the world … its limitless possibilities.

a) in spite of;

b) because of;

c) instead of;

d) due to.

8. Find out the key words to make up the outline of the text.

9. Give the summary of the text using the key words.

COMPREHENSION

10. Make up the rendering of the following text.

Fundemental Concepts of Nanoscience and Nanotechnology

It's hard to imagine just how small nanotechnology is. One nanometer is a billionth of a meter, or 10^{-9} of a meter. Here are a few illustrative examples:

- There are 25,400,000 nanometers in an inch.
- A sheet of newspaper is about 100,000 nanometers thick.
- On a comparative scale, if a marble were a nanometer, then one meter would be the size of the Earth.

Nanotechnology involves the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms – the food we eat, the clothes we wear, the buildings and houses we live in, and our own bodies.

But something as small as an atom is impossible to see with the naked eye. In fact, it’s impossible to see with the microscopes typically used in a high school science classes. The microscopes needed to see things at the nanoscale were invented relatively recently – about 30 years ago.

Once scientists had the right tools, such as the scanning tunneling microscope (STM) and the atomic force microscope (AFM), the age of nanotechnology was born.

Although modern nanoscience and nanotechnology are quite new, nanoscale materials were used for centuries. Alternate-sized gold and silver particles created colors in the stained glass windows of medieval churches hundreds of years ago. The artists back then just didn’t know that the process they used to create these beautiful works of art actually led to changes in the composition of the materials they were working with.

Today's scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

Source: https://www.nano.gov/nanotech-101/what/definition

WRITING

11. Translate the following text into English.

Видели ли вы когда-нибудь монитор, толщина которого меньше миллиметра? А несгораемую и непромокаемую бумагу? Или одежду, которую невозможно испачкать? Это не фантастика! Это то, что ожидает нас в недалеком будущем. Такие необычные предметы могут подарить человеку нанотехнологии. То, что технология – это способ производства какого-либо объекта, знает каждый. А вот что означает приставка «нано»? «Нано» – одна миллиардная доля чего-либо. Один нанометр – миллиардная доля метра. 1нм = 0,000000001 м. Попробуем представить себе объекты такого размера. Нанометр меньше метра примерно настолько, насколько грецкий орех меньше земного шара. Размеры в несколько нанометров имеют большие молекулы, например, белки. Атомы и обычные молекулы меньше, они измеряются десятыми долями нанометров. Нанотехнология – комплекс методов, который позволяет создавать объекты наноразмеров (от 1 до 100 нм). Такие объекты имеют особые свойства. Именно эти свойства наноматериалов позволят использовать их для новейших научных достижений. Уже сейчас нанотехнологии – наиболее перспективное и финансируемое направление в мировой науке.

Source: http://www.festivalnauki.ru/statya/3477/chto-takoe-nanotehnologii

SPEAKING

12. Find more information in the Internet and continue the sentence:

Nanotechnology, a new field of science, is a technology that ….

Be ready to speak about 3 minutes.

Text 2

The history of nanotechnology

PRE-READING

1. Answer the following questions.

1. Is nanotechnology a new science?

2. Where did it come from?

2. Practice reading the following words.

microscope	['maikrəskəup]
oxide	['a:ksaid]
gravity	['græviti]
quantum	['kwa:ntəm]
carbon	['ka:bən]

VOCABULARY

3. Study the vocabulary list.

precise	точный
fullerenes	фуллерены
plausible	правдоподобный
enhance	улучшать
van der Vaals attraction	Ван-дер Ваальсовы силы
accusation	обвинение

cluster	группа
entity	сущность, элемент
carbon nanotubes	углеродные нанотрубки
deliberate	целенаправленный
evaluate	оценивать, рассматривать

READING

4. Read the text and answer the questions below.

The history of nanotechnology

Nanotechnology, in its traditional sense, means building things from the bottom up, with atomic precision. The first use of the concepts found in 'nanotechnology' (but pre-dating use of that name) was in "There's Plenty of Room at the Bottom," a talk given by physicist Richard Feynman at an American Physical Society meeting at Caltech on December 29, 1959. Feynman described a process by which the ability to manipulate individual atoms and molecules might be developed, using one set of precise tools to build and operate another proportionally smaller set, and so on down to the needed scale. In the course of this, he noted, scaling issues would arise from the changing magnitude of various physical phenomena: gravity would become less important, surface tension and van der Waals attraction would become increasingly more significant, etc. This basic idea appeared plausible, and exponential assembly enhances it with parallelism to produce a useful quantity of end products.

The term "nanotechnology" was defined by Tokyo Science University Professor Norio Taniguchi in a 1974 paper as follows: "'Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or by one molecule."

In the 1980s the basic idea of this definition was explored in much more depth by Dr. K. Eric Drexler, who promoted the technological significance of nano-scale phenomena and devices through speeches and the books, and so the term acquired its current sense. “Engines of Creation: The Coming Era of Nanotechnology” (1986) is considered the first book on the topic of nanotechnology. When Dr. K. Eric Drexler popularized the word 'nanotechnology', he was talking about building machines on the scale of molecules, a few nanometers wide – motors, robot arms, and computers, far smaller than a cell. Drexler spent the next ten years describing and analyzing these incredible devices, and responding to accusations of science fiction.

Two approaches are used in nanotechnology. In the “bottom-up” approach, materials and devices are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the “top-down” one, nano-objects are constructed from larger entities without atomic-level control.

Nanotechnology and nanoscience got started in the early 1980s with two major developments; the birth of cluster science and the invention of the scanning tunneling microscope (STM). This development led to the discovery of fullerenes in 1985 and carbon nanotubes a few years later. In another development, the synthesis and properties of semiconductor nanocrystals was studied; this led to a fast increasing number of metal and metal oxide nanoparticles and quantum dots. The atomic force microscope (AFM or SFM) was invented six years after the STM was invented. Combined with refined processes such as electron beam lithograthy and molecular beam epitaxy, these instruments allow the deliberate manipulation of nanostructures, and lead to the observation of novel phenomena.

In 2000, the United States National Nanotechnology Initiative was founded to coordinate Federal nanotechnology research and development and is evaluated by the President's Council of Advisors on Science and Technology.

Source: http://referatwork.ru/category/tehnologii/view/489788_nanotechnology

QUESTIONS:

1. What is nanotechnology in its traditional sense?
2. Who was the first to describe the theory of nanotechnology?
3. What is the role of Drexler in the advancement of nanotechnology?

4. When did the nanoscience start?
5. What inventions contributed to the development of nanotech?
6. What are the two main approaches in nanotechnology?

VOCABULARY WORK

5. Translate the following word combinations into Russian.

1) Atomic precision;
2) the ability to manipulate individual atoms and molecules;
3) surface tension;
4) useful quantity of end products;
5) the term acquired its current sense;
6) on the scale of molecules;
7) far smaller than a cell;
8) principles of molecular recognition;
9) properties of semiconductor nanocrystals;
10) the observation of novel phenomena.

6. Find English equivalents to the following word combinations in the text.

1) Одиночные атомы;
2) проблема масштабирования;
3) экспоненциальная сборка;
4) отвечая на обвинения;
5) подход «снизу – вверх»;
6) подход «сверху – вниз»;
7) групповая наука;
8) сканирующий туннельный микроскоп;
9) металооксидные наночастицы квантовых точек;
10) атомно-силовой микроскоп.

7. Find the words opposite in meaning in the text.

1) Unusul;
2) inaccurate;
3) similar;
4) useless;
5) relaxation;
6) connection;
7) surface;
8) miserable;
9) narrow;
10) late;
11) aimless;
12) familiar.

8. Mark the following sentences True or False.

1. The classical theory of nanotechnology is based on the “top-down” approach.
2. The American physicist Richard Feynman was the first to describe the fundamental concepts of nanotechnology.
3. Nanotechnology is supposed to appear in 1980.
4. R. Dexler worked out the technology that allowed him to build new devices at molecular scale.
5. The invention of AFM led to the discovery of nanotubes and the research of semiconductor nanocrystals.

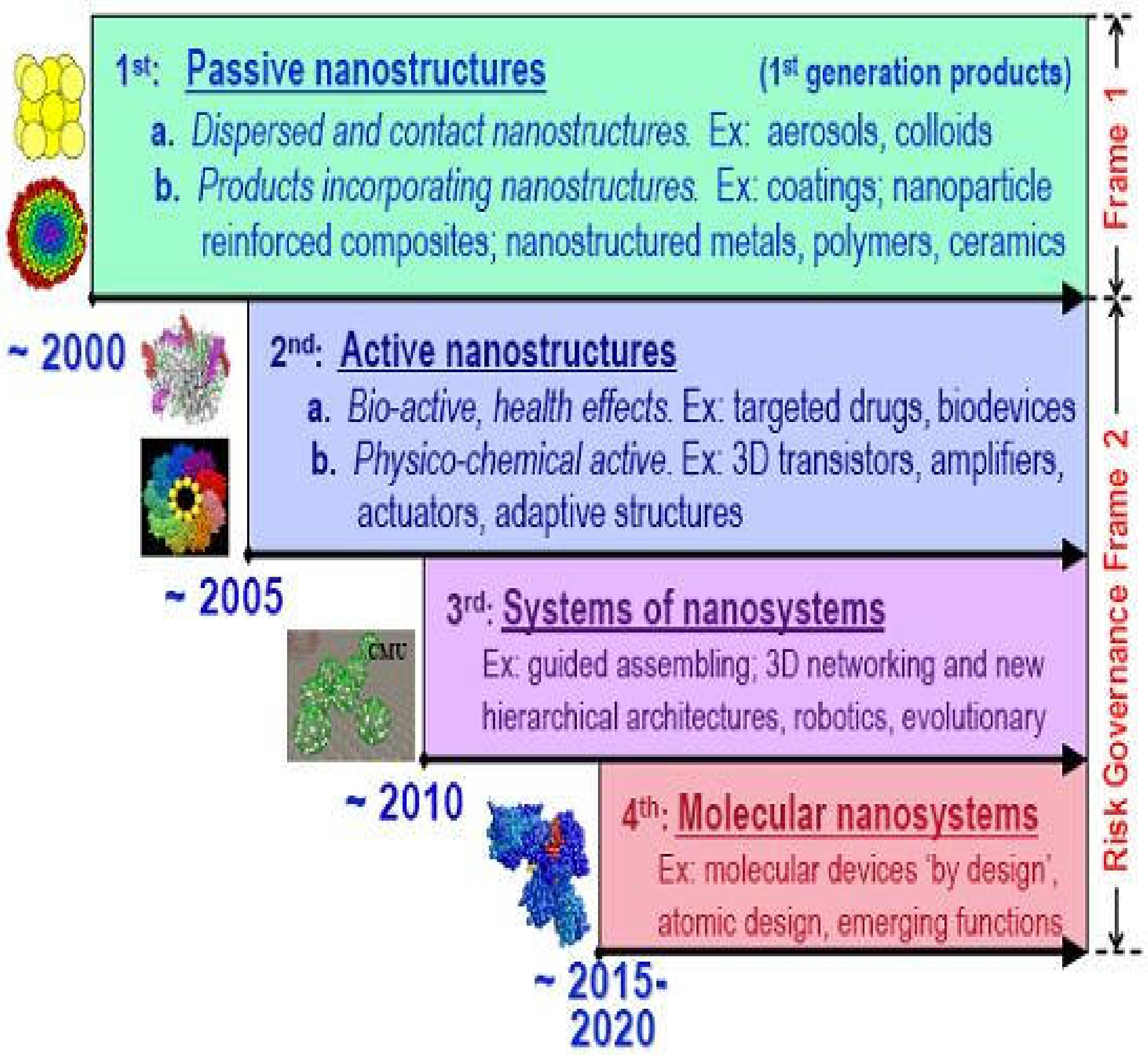
9. Divide the text into logical parts and give subtitles to each part.

10. Retell the text.

WRITING

11. Give the written translation of the text in Russian.

Four Generations



Mihail (Mike) Roco of the U.S. National Nanotechnology Initiative has described four generations of nanotechnology development. The current era, as Roco depicts it, is that of passive nanostructures, materials designed to perform one task. The second phase, which we are just entering, introduces active nanostructures for multitasking; for example, actuators, drug delivery devices, and sensors. The third generation is expected to begin emerging around 2010 and will feature nanosystems with thousands of interacting components. A few years after that, the first integrated nanosystems, functioning (according to Roco) much like a mammalian cell with hierarchical systems within systems, are expected to be developed.

Source: http://www.crnano.org/whatis.htm

12. Translate into English.

Даты важнейших открытий

Наиболее выдающиеся достижения в области нанотехнологий отмечены Нобелевскими премиями по **физике:**

- 1985 – за открытие квантового эффекта Холла;
- 1986 – за создание методов электронной и туннельной микроскопии высокого разрешения;
- 1998 – за открытие дробного квантового эффекта Холла;
- 2000 – за создание полупроводниковых гетероструктур и разработку полупроводниковых интегральных схем;
- 2010 – за исследования графена.

по химии:

- 1996 – за открытие фуллеренов;
- 1998 – за развитие теории функционала плотности и разработку вычислительных методов квантовой химии;
- 2000 – за открытие проводимости в полимерах;
- 2008 – за открытие и разработку методов использования зеленого флуоресцентного белка.

Source: http://docplayer.ru/26404118-Fundamentalnye-osnovy-nanotehnologiy.html

SPEAKING

13. Make up the presentation about the most important discoveries in the field of nanotechnology or the most famous physicists in nanoscience.

Text 3

Light is a wonderful medium for carrying information

PRE-READING

1. Answer the following questions.

1. Have you ever heard about “plasmons”?
2. What properties do plasmonic materials have?

2. Practice reading the following words.

fiber	['faɪbə]
capacity	[kəˈpæsɪtɪ]
circuit	[ˈsə:kɪt]
dielectric	[ˌdaɪɪˈlektrɪk]
diode	[ˈdaɪəud]
chemical	[ˈkemɪkəl]
tissue	[ˈtɪʃu:]

VOCABULARY

3. Study the vocabulary list.

to span	охватывать, простираться
voluminous	объемный, массивный
gargantuan	колоссальный, гигантский
to prophesy	пророчить, предсказывать
to constrain	сдерживать, сжимать, стеснять
silicon	кремний
minuscule	минускул (строчная буква в средневековых рукописях), крошечный
oscillations	колебания, вибрации
to propagate	распространяться, передаваться
ripples	рябь

boon	благо, дар, удобство
ultimately	в конечном счете, в конце концов
feasible	выполнимый, возможный, правдоподобный
interface	стык, граница
minute	мельчайший
extent	размер

READING

4. Read the text and answer the questions below.

Light is a wonderful medium for carrying information

Optical fibers span the globe, guiding light signals that convey voluminous streams of voice communications and vast amounts of data. This gargantuan capacity has led some researchers to prophesy that photonic devices – which channel and manipulate visible light and other electromagnetic waves – could some day replace electronic circuits in microprocessors and other computer chips. Unfortunately, the size and performance of photonic devices are constrained by diffraction limit; because of interference between closely spaced light waves, the width of an optical fiber carrying them must be at least half the light's wavelength inside the material. For chip-based optical signals, which will most likely employ near-infrared wavelengths of about 1,500 nanometers (billionths of a meter), the minimum width is much larger than the smallest electronic devices currently in use; some transistors in silicon integrated circuits, for instance, have features smaller than 100 nanometers.

Recently, however, scientists have been working on a new technique for transmitting optical signals through minuscule nanoscale structures. In the 1980s researchers experimentally confirmed that directing light waves at the interface between a metal and a dielectric (a nonconductive material such as air or glass) can, under the right circumstances, induce a resonant interaction between the waves and the mobile electrons at the surface of the metal. In a conductive metal, the electrons are not strongly attached to individual atoms or molecules. In other words, the oscillations of electrons at the surface match those of the electromagnetic field outside the metal. The result is the generation of surface plasmons – density waves of electrons that propagate along the interface like the ripples that spread across the surface of a pond after you throw a stone into the water.

Over the past decade investigators have found that by creatively designing the metal-dielectric interface they can generate surface plasmons with the same frequency as the outside electromagnetic waves but with a shorter wavelength. This phenomenon could allow the plasmons to travel along nanoscale wires called interconnects, carrying information from one part of a microprocessor to another. Plasmonic interconnects would be a great boon to develop ever smaller and faster transistors but have had a harder time building minute electronic circuits that can move data quickly across the chip.

In 2000 my group at the California Institute of Technology gave the name "plasmonics" to this emerging discipline, sensing that research in this area could lead to an entirely new class of devices. Ultimately it may be possible to employ plasmonic components in a wide variety of instruments, using them to improve the resolution of microscopes, the efficiency of light-emitting diodes (LEDs) and the sensitivity of chemical and biological detectors. Scientists are also considering medical applications, designing tiny particles that could use plasmon resonance absorption to kill cancerous tissues, for example. And some researchers have even theorized that certain plasmonic materials could alter the electromagnetic field around the object to such an extent that it would become invisible. Although not all these potential applications may prove feasible, investigators are eagerly studying plasmonics because the new field promises to literally shine a light on the mysteries of the nanoworld.

Source: Gordon Bell and Jim Gemmel "Scientific American", April, 2007

QUESTIONS:

1. What medium is used to convey vast amounts of data?
2. What is a new technique for transmitting optical signals?
3. What advantage do plasmonic interconnects have?
4. What is a new branch of science which could lead to a new class of devices?
5. What applications do possible new plasmonic components have?

VOCABULARY WORK

5. Find English equivalents to the following word combinations in the text.

1) Оптическое волокно;

2) голосовые сообщения;

3) фотонные приборы;

4) заменить электрические цепи;

5) дифракционный предел;

6) подтверждать;

7) при определенных обстоятельствах;

8) колебания электронов;

9) электромагнитное поле;

10) генерирование поверхностных плазмонов.

6. Translate the following word combinations into Russian.

1) Metal-dielectric interface;

2) to generate surface plasmons;

3) to travel along;

4) to be a great boon for;

5) to move data;

6) to lead to;

7) to employ;

8) to improve;

9) to alter;

10) nanoworld.

7. Give synonyms.

1) The globe;

2) voluminous;

3) gargantuan;

4) to induce;

5) to propagate;

6) to travel;

7) to be a great boon for;

8) tiny;

9) to alter;

10) application.

8. Give antonyms.

1) Visible;

2) unfortunately;

3) recently;

4) ultimately;

5) minuscule;

6) feasible;

7) vast;

8) outside;

9) sensitivity;

10) eagerly.

9. Insert prepositions and translate

1. Unfortunately, the size and performance … photonic devices are constrained … the diffraction limit; because … interference between closely spaced light waves, the width … an optical fiber carrying them must be … least half the light's wavelength inside the material.

2. The oscillations of electrons … the surface match those … the electromagnetic field outside the metal.

3. Ultimately it may be possible to employ components … a wide variety … instruments, the efficiency … light-emitting diodes and the sensitivity … chemical and biological detectors.
4. In 2000 my group … the California Institute … Technology gave the name “plasmonics” … this emerging discipline.
5. Investigators are eagerly studying plasmonics … the new field promises to literally shine a light … the mysteries … the nanoworld.

WRITING

10. Translate in written form.

Overview/Plasmonics

- Researchers have discovered that they can squeeze optical signals into minuscule wires by using light to produce electron density waves called plasmons.
- Plasmonic circuits could help the designers of computer chips build fast interconnects that could move large amounts of data across a chip. Plasmonic components might also improve the resolution of microscopes, the efficiency of light-emitting diodes, and the sensitivity of chemical and biological detectors.
- Some scientists have even speculated that plasmonic materials could alter the electromagnetic field around an object to such an extent that it would become invisible.

11. Find out the key words to make up the plan of the text.
12. Give a summary of the text.

COMPREHENSION

13. Render the text in English.

Плазмоны (волны электронной плотности) возникают в твердых телах или вблизи их поверхности в результате коллективных колебаний электронов проводимости относительно ионов. Объемные плазмоны описывают колебания электронов проводимости внутри ионной решетки кристалла. В свою очередь поверхностные плазмоны – это кванты колебаний плотности свободных электронов металла, распространяющиеся только вдоль его границы с диэлектриком. Частота плазмона равна плазменной частоте. Поверхностные плазмоны могут взаимодействовать с фотоном, образуя квазичастицы – поляритоны.

В твердых телах свет с частотой ниже плазменной частоты будет отражаться, в то время как свет с частотой выше плазменной будет проходить внутрь твердого тела. У большинства металлов плазменная частота находится в ультрафиолетовой области спектра, делая их блестящими в видимом диапазоне. В легированных полупроводниках плазменная частота обычно находится в инфракрасной области спектра.

Плазмоны рассматриваются как средство передачи информации в компьютерных чипах, так как провода для плазмонов могут быть намного тоньше, чем обычные провода, и могут поддерживать намного более высокие частоты (в режиме 100 ТГц, в то время как обычные провода обладают большими потерями при 10 ГГц). Они были также предложены как средство для литографии и микроскопии высокого разрешения из-за их чрезвычайно малых длин волн. Оба из этих применений с успехом были продемонстрированы в лабораториях.

Source: http://thesaurus.rusnano.com/wiki/article2213

Text 4

Nanoshells and invisibility cloaks

PRE-READING

1. Answer the following questions.

1. Have you ever read the tale "The Invisible Man" written by H.G. Wells?

2. Do you believe that Wells' invisible man may become a reality in future?

2. Practice reading the following words.

bloodstream	[ˈblʌdstriːm]
tumor	[ˈtjuːmər]
revolutionize	[revəˈluːʃnaɪz]
boundary	[ˈbaʊndərɪ]
enhancement	[ɪnˈhɑːnsmənt]
hazardous	[ˈhæzədəs]
intriguing	[ɪnˈtriːgɪŋ]
phenomena	[fɪˈnɔmɪnə]
yield	[jiːld]

VOCABULARY

3. Study the vocabulary list.

nanoshell	нанооболочка
to deposit	покрывать
tumor	опухоль
to embed	вставлять, врезать
odent	грызун
tissue	ткань

transparent	явный, прозрачный
enhancement	увеличение
hazardous	опасный
to offset	возмещать, вознаграждать
to yield	приносить, давать
array	масса, множество
to boost	повышать, увеличивать
to ensure	обеспечивать
trial	испытание
dye	краситель
well	колодец
fold	складывание
to bend	изгибать
gain	прирост
divert	отводить
elaborate	замысловатый

READING

4. Read the text and answer the questions below.

Nanoshells and invisibility cloaks

The potential uses of plasmonic devices go far beyond computing, however. Naomi Halas and Peter Nordlander of Rice University have developed structures called nanoshells that consist of a thin layer of gold – typically about 10 nanometers thick – deposited around the entire surface of a silica particle about 100 nanometers across. Exposure to electromagnetic waves generates oscillations in the gold shell; because of the coupling interaction between the fields on the shell's inner and outer surfaces, varying the size of the particle and the thickness of the gold layer changes the wavelength at which the particle resonantly absorbs energy. In this way, investigators can design the nanoshells to selectively absorb wavelengths as short as a few hundred nanometers (the blue end of the visible spectrum) or as long as nearly 10 microns (the near infrared).

This phenomenon has turned nanoshells into a promising tool for cancer treatment. In 2004 Halas, working with her Rice colleague Jennifer West, injected plasmonic nanoshells into the bloodstream of mice with cancerous tumors and found that the particles were nontoxic. What is more, the nanoshells tended to embed themselves in the rodents' cancerous tissues rather than the healthy ones because more blood was circulated to the fast-growing tumors. (The nanoshells can also be attached to antibodies to ensure that they target cancers.)

Fortunately, human and animal tissues are transparent to radiation at certain infrared wavelength. When the researchers directed near-infrared laser light through the mice's skin and at the tumors, the resonant absorption of energy in the embedded nanoshells raised the temperature of the cancerous tissues from about 37 degrees Celsius to about 45 degrees C.

The photothermal heating killed the cancer cells while leaving the surrounding healthy tissue unharmed. In the mice treated with nanoshells, all signs of cancer disappeared within 10 days; in the control groups, the tumors continued to grow rapidly. Houston-based Nanospectra Biosciences is currently seeking permission from the Food and Drug Administration to conduct clinical trials of nanoshells therapy in patients with head and neck cancer.

Plasmonic materials may also revolutionize the lighting industry by making LEDs bright enough to complete with incandescent bulbs. Beginning in the 1980s, researchers recognized that the plasmonic enhancement of the electric field at the metal-dielectric boundary could increase the emission rate of luminescent dyes placed near the metal's surface. More recently, it has become evident that this type of field enhancement can also dramatically raise the emission rates of quantum dots and quantum wells – tiny semiconductor structures that absorb and emit light – thus increasing the efficiency and brightness of solid-state LEDs. In 2004 my Caltech colleague Axel Sherer, together with co-workers at Japan's Nichia Corporation, demonstrated that coating the surface of a gallium nitride LED with dense arrays of plasmonic nanoparticles (made of silver, gold or aluminum) could increase the intensity of the emitted light.

Furthermore, plasmonic nanoparticles may enable researchers to develop LEDs made of silicon. Such devices, which would be much cheaper than conventional LEDs composed of gallium nitride or a gallium arsenide, are currently held back by their low rates of light emission. My group at Caltech, working with a team led by Albert Polman of the FOM Institute for Atomic and Molecular Physics in the Netherlands, has shown that coupling silver or gold plasmonic nanostructures to silicon quantum-dot arrays could boost their light emission by about 10 times. Moreover, it is possible to tune the frequency of the enhanced emissions by adjusting the dimensions of the nanoparticles. Our calculations indicate that careful tuning of the plasmonic resonance frequency and precise control of the separation between the metallic particles and the semiconductor materials may enable us to increase radiative rates more than 100-fold, allowing silicon LEDs to shine just as brightly as traditional devices.

Scientists are even working on a plasmonic analog to a laser. Mark Stockman of Georgia State University and Davis Bergman of Tel Aviv University have described the physics of such a device, which they called a SPASER (for surface plasmon amplification of stimulated emission of radiation). Although the SPASER exists only in theory so far, the researchers have suggested routes to fabricating it using semiconductor quantum dots and metal particles. Radiative energy from the quantum dots would be transformed into plasmons, which would then be amplified in a plasmonic resonator. Because the plasmons generated by the SPASER would be much more tightly localized than a conventional laser beam, the device could operate at very low power and selectively excite very small objects. As a result, SPASERs could make spectroscopy more sensitive and pave the way for hazardous –materials detectors that could identify minute amounts of chemicals or viruses.

Perhaps the most fascinating potential application of plasmonics would be the invention of an invisibility cloak. In 1897 H.G. Wells published *The Invisible Man*, a tale of a young scientist who discovers how to make his own body's refractive index equal to that of the air, rendering him invisible. (A material's refractive index is the ratio of the speed of light in a vacuum to the speed of light in the material.) Exciting a plasmonic structure with radiation that is close to the structure's resonant frequency can make its refractive index equal to air's, meaning that it would neither bend nor reflect light. The structure would absorb light, but if it were laminated with a material that produces optical gain – amplifying the transmitted signal just as the resonator in a SPASER would – the increase in intensity would offset the absorption losses. The structure would become invisible to radiation in a selected range of frequencies.

A true invisibility cloak, however, must be able to hide anything within the structure and work for all frequencies of visible light. The creation of such a device would be more difficult, but some physicists say it is possible. In 2006 John B. Pendry of Imperial College London and his colleagues showed that a shell of metamaterials could, in theory, reroute the electromagnetic waves traveling through it, diverting them around a spherical region within.

Although Wells' invisible man may never become a reality, such ideas illustrate the rich array of optical properties that inspire researchers in the plasmonics field. By studying the elaborate interplay between electromagnetic waves and free electrons, investigators have identified new possibilities for transmitting data in our integrated circuits, illuminating our homes and fighting cancer. Further exploration of these intriguing plasmonic phenomena may yield even more exciting discoveries and inventions.

Source: Gordon Bell and Jim Gemmel "Scientific American", April, 2007

QUESTIONS:

1) What is a nanoshell?

2) What is unusual in the structure of nanoshells?

3) What experiment with nanoshells did researchers of Rice University (USA) carry out in 2004?

4) What can the industrial applications for plasmonic materials be?

5) How can a tale “The Invisible Man” written by H.G. Wells be connected with plasmonics?

VOCABULARY WORK

5. Give English equivalents.

1) Частица кремния;
2) электронные колебания;
3) клинические испытания;
4) скорость испускания;
5) плазмонические наночастицы;
6) малое количество.

6. Give Russian equivalents.

1) To go far beyond;
2) oscillation inner and outer surfaces;
3) cancerous tissues;
4) incandescent bulb;
5) dense arrays of plasmonic nanoparticles;
6) light emission;
7) to tune frequency.

7. Give synonyms.

1) Entire;
2) because of;
3) to vary;
4) to raise;
5) rapid;
6) enhancement;
7) rate;
8) hazardous;

9) currently;
10) precise.

8. Give antonyms.

1) To change;
2) fortunately;
3) to raise;
4) to kill;
5) permission;
6) to complete;
7) to increase;
8) tiny;
9) to absorb;
10) cheap.

9. Insert prepositions and translate.

1) The phenomenon has turned nanoshells into a promising tool … cancer treatment.
2) Beginning … the 1980s, researchers recognized that the plasmonic enhancement … the electric field … the metal-dielectric boundary could increase the emission rate … luminescent dyes placed near the metal's surface.
3) Moreover, it is possible to tune the frequency … the enhanced emission … adjusting the dimensions … the nanoparticles.
4) Radiative energy … the quantum dots would be transformed … plasmons, which would then be amplified … a plasmonic resonator.
5) The structure would become invisible … radiation … a selected range … frequencies.

10. Complete the sentences using the correct variant.

1. Photonic device could someday replace … .

a) vacuum tubes;

b) capacitors;

c) electronic circuits;

d) microprocessors and other computer chips.

2. The width of an optical fiber carrying light waves must be at least … .

a) half near-infrared wavelength;

b) half light's wavelength;

c) half ultra-violet wavelength.

3. Plasmonic interconnects are … .

a) electronic circuits;

b) lectronic devices;

c) nanoscale wires.

4. Plasmonic components can be used … .

a) in a wide variety of instruments to improve their characteristics;

b) can not be used anywhere except electronics;

c) may shine a light on the mysteries of the nanoworld.

5. Nanoshells are structures, that consist of … .

a) a thin layer of silver;

b) a thin layer of gold about 10 nanometers thick deposited around the entire surface of a silica particle;

c) silica particles 10 nanometers thick.

6. The cancer cells were killed because of … .

a) using traditional methods of cancer treatment;

b) injecting plasmonic nanoshells into bloodstream;

c) enhancement of the electric field.

7. Light-emitting diodes (LEDs) using plasmonic nanoparticles … .

a) would be more expensive than conventional LEDs;

b) would be much cheaper than conventional LEDs;

c) would be inefficient because of decreasing light emission.

8. A new kind of laser, SPASER, … .

a) would operate at very low power and make spectroscopy more sensitive;

b) would operate at very high power that is why the SPASER exists only in theory;

c) would operate at very low power, but could not identify minute amounts of chemicals or viruses.

9. The most fascinating potential application of plasmonics would be ….

a) the invention of a nanodevice for atomic industry;

b) the invention of an invisibility cloak;

c) the invention of a new type of integrated circuit.

WRITING

11. Translate in writing three last paragraphs of the text beginning with *"Perhaps the most fascinating potential application…"*.

12. Find out the key words to make up an outline of the text.

13. Give a summary of the text.

SPEAKING

14. Develop the following statement. Make use of the following words and phrases: *in my opinion; one advantage is that…; finally; another point is that…; pros and cons; in conclusion; in fact; more over; for instance.*

Plasmonic phenomena are a promising tool for cancer treatment.

Test 1 (Unit 1)

1. Translate the following words and word combinations into Russian:

Optical fibers; to propagate; capacity; the light's wavelength; electronic devices; dimension; confinement; cluster; carbon nanotubes; subtle differences.

2. Translate the following words and word combinations into English:

Взаимодействие; размер частицы; толщина золотого слоя; оболочка; изменять электромагнитное поле; выборочно поглощать длину волны; сплошная среда; твёрдое тело; молекулярный уровень; с точностью до атомов.

3. Give the full names to the following abbreviations and translate them:

1) STM –
2) LED –
3) SPASER –
4) IBM –
5) AFM –

4. Translate the sentences:

1) Unfortunately, the size and performance of photonic devices are constrained by the diffraction limit.
2) Because of interference between closely spaced light waves, the width of an optical fiber carrying them must be at least half the light's wavelength inside the material.
3) Plasmonic circuits could help the designers of computer chips build fast interconnects that could move large amounts of data across a chip.
4) Plasmonic components might also improve the resolution of microscopes, the efficiency of light-emitting diodes, and the sensitivity of chemical and biological detectors.
5) Some scientists have even speculated that plasmonic materials could alter the electromagnetic field around an object to such an extent it would become invisible.

5. Translate Russian sentences into English using the following words:

to work on, to transmit, to confirm, under circumstances, to induce, to employ, to improve, resolution, light-emitting diodes, tiny particles, plasmon, atomic force microscope.

1) Ученые работают над новой техникой передачи оптических сигналов через наноструктуры.

2) В 80-е годы исследователи экспериментально подтвердили, что прямые световые волны на поверхности между металлом и диэлектриком уменьшают резонансное взаимодействие между волнами и мобильными электронами на поверхности металла.

3) Плазмонические материалы можно использовать в разнообразных инструментах, чтобы улучшить разрешение микроскопов, эффективность светоиспускающих диодов и чувствительность химических и биологических детекторов.

4) Ученые считают, что крошечные частицы, которые могли бы использовать плазмоническое резонансное поглощение, убивают раковые ткани.

5) С помощью атомно-силового микроскопа можно не только перемещать отдельные атомы, но и измерять силу, необходимую для этого.

UNIT 2. APPROACHES IN NANOTECHNOLOGY

Text 1

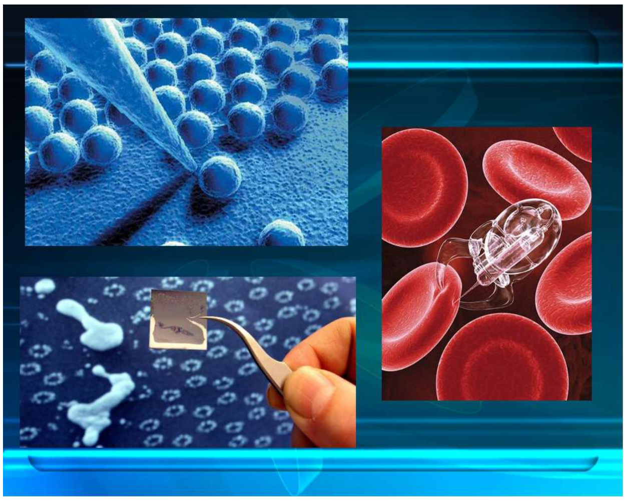
Fullerenes, the Building Blocks

PRE-READING

1. Answer the following questions.

What are the fullerenes?

Why are they called the building blocks in nanotechnology?



2. Practice reading the following words.

technique [tək'ni:k]	appropriate [əp'rɔpriət]
accessible [ək'sesibl]	production [prə'dʌkʃən]
structural ['strʌktʃərəl]	dimensional ['daimənʒənəl]
isolated [aisə'leitid]	viewpoint ['vju:'point]
synthesis [sin'Θesis]	recently ['risəntli]
refer [ri'fə:]	previous ['priviəs]
concept ['kɔnsəpt]	co-axial ['koʊ'eksəl]
consequently [kən'si:kwəntli]	recently ['risəntli]
essentially [ə'senʃəli]	thermodynamic ['Θe:mədai'nemik]

VOCABULARY

3. Study the vocabulary list.

property	свойство
size/performance dependence	соотношение размера и производительности
arc discharge technique-based synthesis	синтез методом электродугового разряда
geodesic cage	*горн.* Подъемная клеть
electric arc discharge-synthesized nanotubes	НТ, синтезированные методом электродугового разряда
availability	доступность
verification	сверка, контроль, подтвеждение
arc-discharge evaporation	испарение методом электродугового разряда, электродуговое испарение
TEM – transmission electron microscopy	просвечивающая электронная микроскопия
CNT – carbon nanotube	углеродная нанотрубка
single-walled carbon nanotubes (SWCNT)	одностенные углеродные нанотрубки
multi-walled carbon nanotubes (MWCNT)	многостенные углеродные нанотрубки
graphene sheet	графеновая пластина
exfoliated graphite	эксфолированный графит
co-axial tubes	коаксиальные трубки

READING

4. Read the text and answer the questions below.

Fullerenes, the Beginnings and Current State

Historically, the possibility of creating graphite balloons similar to geodesic cages was first discussed in 1966 by David Jones who was writing under the pseudonym ''Daedalus'' in the journal the New Scientist. The most famous form of fullerene molecules, however, is the 60 fullerene or C60, commonly known as buckyball, made of 60 carbon atoms in a spherical shape that resembles a soccer ball. The earliest record of a fullerene molecule, however, was in an article (in Japanese) by Eiji Osawa in 1970. In this article, Osawa speculated that such a molecule would be stable. Two years later, in 1973, Bochavar and Gal'pern used Hückel calculations to determine the energy levels and molecular orbitals in the C60 molecule. Later, in 1981, Davidson applied general group theory techniques to a range of highly symmetrical molecules, one of which was the C60. Hence, by 1981 the idea of stable fullerene molecules did, in fact, exist and early studies had been carried out to explore the energy levels and molecular orbitals as well as symmetry properties of such molecule. The molecule itself was not yet experimentally observed. In September 1985, such observation took place. While trying to simulate stellar nucleation conditions Richard Smalley and his co-workers at Rice University, USA, Curl, Kroto, Smalley, and their co-workers vaporized graphite and a serendipitous discovery was made. The C60 molecule was observed and found to be remarkably stable. The molecule was named Buckminsterfullerene (later fullerene for short) after the famous architect Buckminster Fuller (1895–1983) who first created the geodesic cage or dome design that the fullerene molecule resembles.

This interesting and long awaited discovery triggered a scientific race to investigate each and every aspect of the new molecule. At first, however, progress was slow due to the fact that the amount of C60 produced by Smalley's method was minute. The real race of development started in 1990 with the findings of Krätschmer of the Max Planck Institute at Heidelberg, Huffman of the University of Arizona, and their co-workers, who could produce C60 molecules in macroscopic amounts using a simpler, more accessible technique than that used by Smalley. The new technique vaporized graphite using a simple carbon arc in helium atmosphere. The soot deposited on the walls of the vessel, once dispersed in benzene, produced a reddish solution. Once dried, the solution produced beautiful crystals of "fullerite", which turned to be made of 90 % C60 and 10 % C70. By using the method of Krätschmer and Huffman, C60 and other allotropes of fullerenes could be produced in reasonable amounts in a way accessible to many laboratories. This accelerated the fullerene investigation race and started what Curl described as "the Dawn of Fullerenes". By 1991 fullerenes were the subject matter of 90 % of the most cited papers, and the subject is still of current scientific interest.

Electron microscopy revealed that the needles consist of co-axial tubes of several graphitic sheets (between 2 and 50). These new molecular cylinders of graphitic sheets were called carbon nanotubes. In fact, Iijima's report on carbon nanotubes was not the first in the literature. As early as 1952, Radushkevich and Lukyanovich reported, in the Journal of Physical Chemistry of Russia, the first TEM evidence for the tubular nature of some nano-sized carbon filaments. In 1974, Oberlin, Endo, and Koyama working on benzene derived carbon fibers reported that: "These fibres have various external shapes and contain a hollow tube with a diameter ranging from 20 to more than 500 A˚ along the fibre axis".

The transmission electron micrographs was first produced by Endo and Iijima for what we currently refer to as carbon nanotubes. The history of carbon nanotubes and the question of who should be credited for their discovery was recently discussed by Monthioux and Kuznetsov. In 1993, Iijima and Ichihashi reported the observation of a more interesting carbon nanospecies, the single-walled carbon nanotubes. They found the single-shell tubes in carbon soot formed in a carbon arc chamber similar to that used for fullerene production.

The discovery of fullerene molecules in 1985 and the later discovery of carbon nanotubes in early 1990s established a new field of carbon nanosciences and triggered an active international scientific race to investigate the structure and properties of such fascinating molecules and to discover other allotropes of this class of matter. The search for new allotropes of carbon was crowned in 2004 with the ability to isolate and manipulate single sheets of graphite currently referred to as graphene sheets or nano-ribbons. Graphene sheets are essentially related to a much older form of graphite known as exfoliated graphite. Scientific and technological developments in the field of exfoliated graphite took place in the late 1960s when flexible graphite foils were made of exfoliated graphite and used for high-temperature gaskets and seals. The ability to isolate single layers of graphene, however, at the age of nanotechnology spawned intensive research into the synthesis, properties, applications, and methods of the mass production of this new form of carbon.

Production methods of the graphene ribbons involve both traditional exfoliated graphite techniques and more sophisticated techniques based on unzipping of carbon nanotubes. The importance of graphene sheets lies in the fact that they provide a unique opportunity for experimental investigation of truly two-dimensional systems – an opportunity that scientists never had before. In their profound recent article, Geim and Novoselov described graphene as: "the mother of all graphitic forms. It can be wrapped into a 0D buckyballs, rolled into 1D nanotubes, or stacked into 3D graphite."molecules and cylinders) – the new flat forms of carbon nanospecies showed that even the carbon nano-world could be flat.

Source: Maher S. Amer "Raman Spectroscopy, Fullerenes, and Nanotechnology"// RSC Nanoscience & Nanotechnology, 2010 – 304 p.

QUESTIONS:

1. What are the fullerenes?
2. What are the other names for fullerene?
3. What are the basic classifications of fullerenes?
4. What are the main fullerene species according to dimensional classification?
5. Who discovered fullerenes?
6. Why can many systems be defined as building blocks?

7. When did scientists focus on fullerene studies?
8. Why are graphene sheets important in Nanotechnology?
9. Why were fullerenes named as Buckminsterfullerene?
10. Why is graphene important in Nanotechnology?

VOCABULARY WORK

5. Translate the following words into Russian.

Оборачивать, складывать, пусковой крючок, служить началом, трубчатый, уплотнители, размышлять, сажа, купол, разглядеть, испарение, доступный, примечательно, случайный, форма, сосуд, ускорить, углерод, вычисления, наноленты, существенный, структурный, метод, подход, сложная техника.

6. Translate the following phrases into Russian.

TEM, CNT, sophisticated techniques, arc-discharge evaporation, co-axial tubes, exfoliated graphite, laser evaporation cluster, stellar nucleation, conditions, single walled CNT, multi-layered, multi-walled, size/performance dependence, flexible graphite foils, needle-like tubes, geodesic cage, laser vaporisation cluster.

COMPREHENSION

7. Make up the rendering of the following text.

Nanotechnology is based upon nanobuilding blocks that are essentially small thermodynamic systems.

Hence, for nanotechnology, any thermodynamic small system is, indeed, a building block. Consequently, any cluster of matter, regardless of its physical size, should satisfy the definition and can be considered as a building block. To this end, many systems can be defined as building blocks. Some of these building blocks are, themselves, made of smaller building blocks such as biological cells, or even biological species. Nature is the best designer for nanosystems. Interestingly, nature used one particular element most frequently in its designs, especially for living systems: carbon. Hence, as we discuss the building blocks of nature’s preferred technology, carbon-based building blocks should be a good choice for discussion.

Fullerenes are a recently discovered form of crystalline carbon. They come in different geometrical shapes. Spherical, or generally speaking, balloon-like, shapes are usually referred to as fullerenes or buckyballs. Cylindrical shapes are more popularly known as single-walled carbon nanotubes (SWCNT), and, more recently, the single-sheet form referred to as graphene has also been produced and utilized as a building block for nanotechnology. There are different types of carbon nanospecies, namely, fullerenes, single- and multi-walled carbon nanotubes, carbon nano-onions, and graphene sheets. In these structures different nano-building blocks, can be incorporated into new structures. For example, a mesostructure known as a peapod. In this structure fullerene molecules are inserted inside single-walled carbon nanotubes (C60-SWCNT). Another type of structure, usually referred to as nano-buds. In nanobuds, fullerene molecules are attached to the surface of single-walled carbon nanotubes.

Source: Maher S. Amer "Raman Spectroscopy, Fullerenes, and Nanotechnology"// RSC Nanoscience & Nanotechnology, 2010 – 304 p

WRITING

8. Translate the following sentences in the written form.

1. Cylindrical shapes are more popularly known as single-walled carbon nanotubes (SWCNT), and, more recently, the single-sheet form referred to as graphene has also been produced and utilized as a building block for nanotechnology.
2. For a concept to develop into a technology, the availability of suitable building blocks is a must.
3. Material building blocks enable experimental verification of the theory behind the concept and provide the essential ingredient enabling devices and products to be built, bringing the new technology into reality.
4. To this end, many systems can be defined as building blocks.
5. To keep the subject focused and of practical value, we will concentrate on some of the recently discovered and investigated building blocks which are essentially man-made.

6. Once dried, the solution produced beautiful crystals of ‘‘fullerite’’, which turned to be made of 90% C60 and 10% C70.
7. They found the single-shell tubes in carbon soot formed in a carbon arc chamber similar to that used for fullerene production.
8. The search for new allotropes of carbon was crowned in 2004 with the ability to isolate and manipulate single sheets of graphite currently referred to as graphene sheets or nano-ribbons.
9. Hence, as we discuss the building blocks of nature’s preferred technology, carbon-based building blocks should be a good choice for discussion.
10. While trying to simulate stellar nucleation conditions of cyanopolyyenesi using the, then recently, developed laser vaporization cluster technique by Richard Smalley and his co-workers at Rice University, USA, vaporized graphite and a serendipitous discovery was made.

9. Translate into English.

1. Фуллерены – это необычный класс молекул, представляющих собой одну из форм существования углерода (так называемых аллотропных модификаций).
2. Всем известные алмаз и графит – тоже разные аллотропные формы углерода.
3. В структуре алмаза атомы углерода собраны в тетраэдры, а графит состоит из плоских слоев, образованных шестиугольниками.
4. Фуллерены – это шарообразные молекулы с замкнутой поверхностью.
5. Самый простой из фуллеренов содержит 60 атомов углерода и напоминает по своей структуре футбольный мяч.
6. Его поверхность образована чередующимися пяти- и шестиугольниками, размер этого «мяча» составляет всего 1 нм (нанометр).
7. Еще в 70-е годы XX века были сделаны теоретические квантово-химические расчеты, предсказывающие существование подобных молекул.
8. Однако лишь в 1985 году их впервые обнаружили при исследовании паров графита после его лазерного облучения.

9. Позднее фуллерены были найдены и в природных минералах.

10. Физики и химики нашли фуллеренам множество применений: их используют при синтезе новых соединений в оптике и при производстве проводников.

SPEAKING

10. Make a presentation on application of fullerenes.

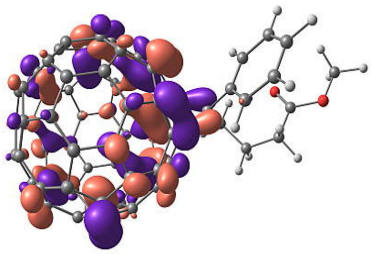
Text 2

Production Methods of Fullerenes

PRE-READING

1. Answer the following questions.

1. Are fullerenes easy to produce?
2. What fullerene production methods do you know?



2. Practice reading the following words.

crucial ['kru:ʃl]	pure ['pjuə]
chloroform [klərə'fɔ:m]	atmosphere [ətməs'fiə]
essentially [ə'senʃəli]	supply [səp'lai]
mechanical [mi'kenikəl]	maintain [mein'tein]
temperature ['tempritʃə]	polycyclic [pəli'saiklic]
actually [ək'tʃəli]	diameter ['daiəmitə]
pressure ['preʃə]	attributed [ət'ri:bjutid]
instead [ins'ted]	hydrocarbon ['haidrə'ka:bən]
deficient [di'fiʃənt]	pyrolysis ['pairə'laisis]
initiate [i'niʃi,eit]	graphite [grə'fait]

VOCABULARY

3. Study and remember the words.

carbon-rich vapor	пар, насыщенный углеродом
benzene combustion	бензольное горение
oxygen-deficient environment	горение в условиях восстановительной смеси
electrode gap	расстояние между двумя электродами
polycyclic aromatic hydrocarbons	полициклические ароматические углеводороды
simple bench-top reactor	простой настольный реактор
AC (alternative current)	переменный ток
arc welding	электродуговая сварка
high boiling point	высокая точка кипения
solvents	растворитель
evacuation chamber	вакуумная камера
suppress	подавлять
elusive	неуловимый, расплывчатый, слабый
flash vacuum pyrolysis	импульсно-вакуумный пиролиз
dissolve	растворять
thimble	втулка, раструб
flask	колба
sub-atmospheric pressure	отрицательное давление, давление, ниже атмосферного
pyrolytic dehydrogenation	пиролитическое дегидрирование
dehydrohalogenation	дегидрогалогенирование

molecular moiety	молекулярное вещество
closed-loop system	замкнутая система регулирования
sublime	сублимировать
rotary evaporator	роторный испаритель
diethyl ether	диэтиловый эфир
evacuated quartz tube	вакуумная кварцевая трубка
insoluble remains	нерастворимый остаток
temperature gradient	температурный перепад, температурный градиент

READING

4. Read the text and answer the following questions.

Production Methods of Fullerenes

Fullerenes can be generally produced in laboratory facilities in different ways involving the generation of a carbon-rich vapor or plasma. There are essentially three methods – with many modifications – to produce zero-dimensional fullerenes: the Huffman–Krätschmer, or arc-discharge process, benzene combustion in an oxygen-deficient environment, and the condensation of polycyclic aromatic hydrocarbons.

1. Huffman–Krätschmer Method

As mentioned above, this was the first method to produce fullerenes in significant amounts and its development, actually, marked the beginning of fullerene science. The Huffman–Krätschmer method involves arc-discharge between highly pure carbon rods in a helium or argon atmosphere at 100–200 Torr. A mechanical mechanism is needed to translate the electrodes together to maintain the electrode gap as the electrodes are consumed. Controlling such a gap was reported to be essential for the process and to prevent temperature drop. At an estimated electrode tip temperature of 2000 1C the yield of fullerene in the produced soot is about 4%. However, at an estimated electrode tip temperature of B4700 1C the yield of fullerene in the produced soot was reported to increase into the 7–10 % range. Notably, the yield calculations tend to account for all types of formed fullerenes. C60 and C70, however, constitute the majority in the produced fullerene.

A simple bench-top reactor was developed to produce fullerene with 4 % yield as well. The reactor utilizes an inexpensive AC arc welding power supply to initiate and maintain a contact arc between two graphite electrodes in a helium atmosphere. Since this technique does not require a mechanism to translate the electrodes together as they become consumed, it is termed the "contact arc method". Instead, the technique utilizes flexible support for the upper electrode and relies on gravity to maintain contact between the two vertical electrodes. In a leap forward, Parker et al. used a plasma arc in a fixed gap between two horizontal electrodes. The developed apparatus is known as fullerene generator due to the high yield it generates, reaching B40 % in high boiling point solvents. The exceptionally high yield was attributed to the fine control of the arc gap combined with proper convection of the atmosphere in the apparatus and careful extraction.

Several processing parameters are presently known to affect the fullerene yield in an arc-discharge process. The optimum atmosphere to be used was found to be highly pure helium. While most reactors are operated in the 100–200 Torr region, the optimum operation pressure was reported to be highly sensitive to the actual chamber design and should be determined for each specific reactor. Although the purity of the carbon electrodes was found not to affect the soot production rate, smaller-diameter electrodes gave higher yields of soot. In addition, small contaminations of hydrogen or moisture in the generation chamber seriously suppress fullerene generation.

2. Benzene Combustion

Method Evidence that fullerenes can be formed in flames was at first elusive, but progress was eventually made. In 1991 significant quantities of C60 and C70 were found in samples collected from low-pressure premixed benzene/oxygen flames. Further investigations showed that fullerenes can be produced in substantial quantities by sub-atmospheric pressure, laminar, premixed flames of benzene in an oxygen-deficient atmosphere with or without the presence of an inert gas. The largest yield of soot into fullerene was reported to be 20 % at a pressure of 37.5 Torr. It was also reported that fullerene formation in the flame can take place with the presence of hydrogen and oxygen. The promise of the combustion method encouraged the Frontier Carbon Corporation, a subsidiary of Mitsubishi Chemical Corporation, to construct a large-scale fullerene factory in Japan in 2003. The factory has the capacity of producing 5000 ton of fullerene annually.

3. Condensation Method

The condensation method is based upon condensation of polycyclic aromatic hydrocarbons through pyrolytic dehydrogenation or dehydrohalogenation processes. While the method does not produce fullerenes in sufficient quantities for practical applications, it provides a means of deducing the mechanism of fullerene formation. The method was used to produce only C60 fullerene from a molecular polycyclic aromatic precursor bearing chlorine substituents at key positions subjected to flash vacuum pyrolysis at 1100 1C through a 12-step reaction.

Source: Maher S. Amer "Raman Spectroscopy, Fullerenes, and Nanotechnology"// RSC Nanoscience & Nanotechnology, 201

QUESTIONS:

1. What are the basic methods used in fullerene production?
2. What is the Huffman–Krätschmer method?
3. What was a simple bench-top reactor developed for?
4. What is the optimal pressure in arc-discharge process?
5. What is the benzene combustion method?
6. What is the condensation method?

VOCABULARY WORK

5. Translate the following expressions into English.

Высокая чистота, угольный стрежень, сообщалось, экстракционный метод (излечения), существенный, важный, относительно низкие температуры, лабораторное оснащение, производительность, сублимационный метод (метод возгонки), электронный пучок, электрическая дуга, производительность, твердотельная фаза, оптимальная среда, обрабатывать (разрушать) ультразвуком.

6. Translate the following expressions into Russian.

A non-solvent based method, contact arc method, the yield calculations, other soluble impurities, the quartz tube, solvent vapors, fullerene contamination with sulfur, non-extractable portion, removal of solvent traces, chlorine substituents, in sufficient quantities, extractable molecular moieties, condenser unit, exceptionally high yield, hot distilled solvent extracts, various molecular weight fullerenes, benzene/oxygen flames, a 12-step reaction, involve, in different ways.

COMPREHENSION

7. Make up the rendering of the following text.

Extraction Methods of Fullerenes

The main method used to extract fullerene from the produced soot is the traditional Soxhlet extraction method. The Soxhlet method is traditionally used to extract molecular moieties from solid phases using organic solvents capable of dissolving the molecular moieties. The solid sample containing the molecular moiety to be extracted is loaded into a thimble in the Soxhlet extractor. As the solvent is boiled in the flask at the bottom, solvent vapors rise through the side channel on the left of the extractor and condense near the bottom of the condenser unit, resulting in dripping hot distilled solvent into the thimble through the solid sample. The hot distilled solvent extracts the molecular moiety on its way down through the solid sample, and the solution, then, makes its way back to the flask via the tube to the right. This closed-loop system is usually operated for several hours, during which all extractable molecular moieties are collected in the flask. The non-extractable portion of the solid sample remains in the thimble.

Fullerenes are extracted from the produced soot using the Soxhlet apparatus with any of different types of solvents. Many solvents have been used in the extraction process, such as chloroform, toluene, benzene, n-hexane, 1,2- dichlorobenzene, etc. The type of the solvent controls the speed of the extraction process and dictates subsequent processes. For example, chloroform results in a very slow process. The use of 1,2-dichlorobenzene results in a very fast extraction process but requires a high vacuum process for removal of solvent traces. In addition, if carbon disulfide is used, it has to be vigorously removed under vacuum to avoid fullerene contamination with sulfur. Selective extraction of various molecular weight fullerenes by varying the extraction solvent has also been reported. Higher mass fullerenes are better extracted with more polar and higher boiling point solvents.

An efficient alternative method has also been proposed in the literature. In this method, the produced carbon soot is dispersed in tetrahydrofuran (THF) at a concentration of 0.1 gmL#1 at room temperature and then sonicated for 20 min. After filtration to remove insoluble remains, the THF is removed using a rotary evaporator operated at 50 1C, leaving fullerenes and other soluble impurities in the flask. In this case, the impurities contain many polyaromatic hydrocarbons that can be removed by washing the extract in diethyl ether before it is further purified. A non-solvent based method, the sublimation method, was also utilized for fullerene extraction from the produced soot. C60 and C70 powders are known to sublime in vacuum at relatively low temperatures (i.e., 350 and 460 1C, respectively). The advantage of the sublimation extraction method is that it produces fullerene samples that are solvent free. In the sublimation method, the soot sample is placed in one end of an evacuated quartz tube placed in a furnace with a temperature gradient. The tube end containing the soot sample is kept at the highest temperature zone of the furnace (600–700 1C). Fullerenes will sublime and drift down the temperature gradient to condense on the walls of the quartz tube. The higher the fullerene mass, the closer to the soot it will condense.

Source: Maher S. Amer "Raman Spectroscopy, Fullerenes, and Nanotechnology"// RSC Nanoscience & Nanotechnology, 2010 – 304 p

WRITING

8. Translate the following sentences into Russian.

1. A mechanical mechanism is needed to translate the electrodes together to maintain the electrode gap as the electrodes are consumed.
2. Controlling such a gap was reported to be essential for the process and to prevent temperature drop.
3. However, at an estimated electrode tip temperature of B4700 1C the yield of fullerene in the produced soot was reported to increase into the 7–10 % range.
4. Notably, the yield calculations tend to account for all types of formed fullerenes.
5. The reactor utilizes an inexpensive AC arc welding power supply to initiate and maintain a contact arc between two graphite electrodes in a helium atmosphere.
6. The exceptionally high yield was attributed to the fine control of the arc gap combined with proper convection of the atmosphere in the apparatus and careful extraction.
7. Although the purity of the carbon electrodes was found not to affect the soot production rate, smaller-diameter electrodes gave higher yields of soot.
8. In 1991 significant quantities of C60 and C70 were found in samples collected from low-pressure premixed benzene/oxygen flames.
9. The hot distilled solvent extracts the molecular moiety on its way down through the solid sample, and the solution, then, makes its way back to the flask via the tube to the right.
10. Higher mass fullerenes are better extracted with more polar and higher boiling point solvents.

9. Translate the following text into English.

Известны две группы методов получения фуллеренов**:** *возгонка графита* с последующей *десублимацией* и *пиролиз углеводородов*. При возгонке графита**,** требующей температур выше 2000 К, используют несколько способов нагревания: 1) с помощью электрической дуги (дуговой), 2) резистивное (за счет джоулева тепла), 3) лучевое (с помощью лазерного излучения, солнечных концентраторов или электронного пучка), 4) плазменное, 5) индукционное (токами высокой частоты). Для перевода графита в газовую фазу применяют также магнетронное распыление. Первые эксперименты, приведшие к открытию фуллеренов, были проведены с возгонкой графита импульсным *лазерным лучом* сравнительно большой мощности в импульсе. Метод позволял синтезировать фуллерены в миллиграммовых количествах и не был масштабирован. Наиболее распространенным и относительно простым методом получения фуллеренов в лаборатории является возгонка и десублимация графита в *электрической дуге*, горящей между графитовыми электродами в потоке инертного газа (чаще всего – гелия). Лабораторный вариант процесса был описан В. Кретчмером и Д.Р. Хуффманом. В процессе расходуется анод и образуются два продукта – фуллеренсодержащая сажа, которая осаждается на стенках реакционной камеры, и плотно спеченный катодный осадок. В сажу переходит лишь 30–40 % возгоняемого углерода. Температура в дуге достигает 4000 К. При диаметре графитового анода 6 мм наибольший выход фуллеренов (10–15 %) достигается при токе 80 А, давлении гелия 106 кПа (800 мм рт. ст.) и расстоянии до катода 3–5 мм. Поскольку определяющим параметром является не величина тока, а его плотность, изменение геометрии анода меняет оптимальную для образования фуллеренов величину тока. Большое значение имеет также давление в реакционной камере. Дуговые установки созданы в нескольких вариантах. Помимо описанной выше двухэлектродной испытаны трехэлектродные с полым катодом, с псевдоожиженным слоем, с дугой, погруженной в циркулирующий органический растворитель и др. Испытана двухэлектродная установка с подачей порошкообразного графита в дугу и трехэлектродная установка с подачей порошкообразного графита через отверстие в катоде. Для модифицирования фуллеренов другими веществами их вводят в электроды, например покрывая последние снаружи тонкой металлической пленкой.

Source: http://helpiks.org/9-15111.html

SPEAKING

10. Make a presentation about fullerene production methods and techniques.

Text 3

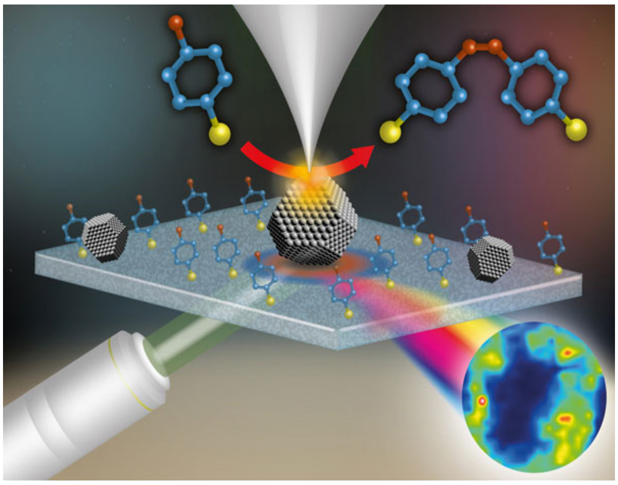
Raman spectroscopy – the diagnostic tool

PRE-READING

1. Answer the following questions.

1. What is Raman effect?

2. Why is it applied in Nanotechnology?



2. Practice the pronunciation of the following words.

devices [di'vaisiz]	florescence ['flurəsəns]
liquids ['likwidz]	resources [ri'sɔ:siz]
incident ['insidənt]	spatial ['speiʃəl]
frequency ['frikwənci]	successfully [sək'sesfəli]
dynamic [dai'nemik]	imaging ['imədʒiɳ]
ion ['aiən]	monochromator ['mɔnəkrɔ'meitə]
diode ['daiəd]	utilize ['jutilaiz]
analyze [əne'laiz]	sequentially [sik'wenʃəli]

VOCABULARY

3. Study and remember the words.

scattered light	рассеянное световое излучение
incident light	падающий луч
inelastic scattering	неупругое рассеяние
excitation light	возбуждающий свет
optical guide	оптический волновод
data acquisition unit	устройство сбора данных
ion line	линия излучения иона
solid-state laser	твердотельный лазер, твердотельный оптический квантовый генератор
backscattered light	отраженный свет
cartesian axes	декартовы оси координат
spatial resolution	пространственное разрешение
laser spot	пятно лазерного пучка
confocal optical arrangements	конфокальная оптическая схема, конфокальное оптическое устройств
near-field microscope	ближнепольный микроскоп
notch filter	узкополосный блокирующий фильтр
strokes (anti-Stokes) lines	стоксово (антистоксово) рассеяние
edge filter	линейный фильтр, щелевой фильтр
exit slit	выходная щель
stray light	рассеянный свет, посторонний свет
charge coupled device	прибор с зарядовой связью

READING

4. Read the text and answer the following questions.

Raman spectroscopy – the diagnostic tool

In 1922, Chandrasekhara Venkata Raman, an Indian professor of physics, at the University of Calcutta, working on light interaction with liquids published the first of a series of papers with his collaborator K.S. Krishnan. The first paper entitled "Molecular Diffraction of Light" ultimately led to his famous discovery on 28 February, 1928. A week earlier, two Russian professors – G.S. Landsberg and L.I. Mandelstam – working at Moscow State University on light interaction with crystals since 1926 reported, independently, the same phenomenon. The observed phenomenon indicated that when light is scattered by matter a small percentage of the scattered light will have a frequency that is different from the frequency of the incident light. The observed shift in the scattered frequency is the result of a combination between the frequency of the incident light and the frequency of molecular motion of the interacting material.

In Russian literature, the phenomenon is known as combinatorial scattering of light. In the rest of the world, the phenomenon is known as the Raman effect. C.V. Raman received the Nobel Prize in Physics in 1930. Seventy years after its discovery, in 1998, the Raman effect was designated by the American Chemical Society as a National Historical Landmark in recognition of its significance as a tool for analyzing materials systems.

The Raman effect, or phenomenon, can be defined as an inelastic scattering of light by matter. When a monochromatic light is scattered by matter, two types of interaction take place and result into two distinctive types of scattered light. One type of interaction does not involve energy transfer or exchange between the incident light photon and the molecules, or atoms, of matter. Hence, the scattered photon will have the same energy, or frequency, as the incident light. This type of scattering is elastic in nature and referred to as Rayleigh scattering. The second type of interaction involves energy exchange between the incident photon and the material's molecules. Hence, the scattered photon will have a new frequency, or energy, which is simply equal to the sum or the difference between the frequencies of the incident photon and the natural frequency of the thermally excited and kinetically active species in the material. This type of scattering is inelastic in nature and is referred to as Raman scattering.

Source: Maher S. Amer "Raman Spectroscopy, Fullerenes, and Nanotechnology"// RSC Nanoscience & Nanotechnology, 2010 – 304 p.

QUESTIONS:

1. Who is Chandrasekhara Venkata Raman?
2. What is he famous for?
3. What is Raman spectroscopy?
4. What is it used for?
5. What are Raman images? How are the obtained?
6. What are the main elements of spectrometer?
7. What is the Raman effect and how can it be defined?
8. What is the Raman technique?
9. What are the monochramators? What disadvantages do the have?
10. What are the CCD? What are they used for?

VOCABULARY WORK

5. Translate the following phrases into English.

Ультрафиолетовый, вышеупомянутый, равномерно, длина волны, химическое соединение, одноканальный, многоканальный, разработать, высокое разрешение, лазерный луч, визуализация, способность, позволять, определять, биологические образцы, хранить, работать с данными, спектр волны, освещение, высокая чувствительность, надежность, относительно низкая себестоимость, настраиваемый.

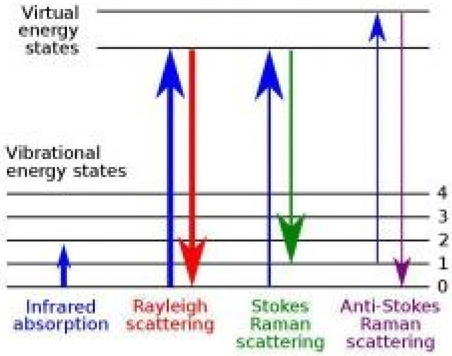
WRITING

6. Translate the following sentences into Russian in the written form.

1. The second approach to Raman imaging involves using a computer-controlled stepping motor driven sample stage.
2. Advanced data manipulation software has been developed to enable better data presentation, especially in the Raman imaging branch of experimental Raman spectroscopy.
3. Time-gated CCDs and time-gated confocal microscopy have recently shown strong potential for another lead in the field.
4. Notably, the more sophisticated the spectrometer system is, the higher its resolution, the higher its stray light rejection capability, and the lower its throughput will be.
5. In addition to being, currently, less expensive than notch filters, edge filters have the advantage of allowing observation of Raman lines closer to the Rayleigh line.
6. The second purpose of the spectrometer is to analyze the collected optical signal, which is carried out by dispersing the incoming light according to its wavelength and then reimaging the output spectrum at the exit slit.
7. This allowed good resolution depth profiling of interfacial regions in layered materials systems.
8. It enjoys major leaps with every advance made in electronics, optical devices, control software, or data capturing and analysis fields.
9. The reader is encouraged to refer to these resources for details regarding such an important aspect of the Raman technique.
10. Hence, the scattered photon will have a new frequency, or energy, which is simply equal to the sum or the difference between the frequencies of the incident photon and the natural frequency of the thermally excited and kinetically active species in the material.

7. Translate into English.

Рамановская спектроскопия (спектроскопия комбинационного рассеяния)



Рамановское рассеяние (иначе – комбинационное рассеяние света) это неупругое рассеяние оптического излучения на молекулах вещества (твёрдого, жидкого или газообразного), сопровождающееся заметным изменением его частоты. В отличие от рэлеевского рассеяния, в случае рамановского рассеяния в спектре рассеянного излучения появляются спектральные линии, которых нет в спектре первичного (возбуждающего) света. Число и расположение появившихся линий определяется молекулярным строением вещества.

На рисунке представлена энергетическая схема упругого и неупругого взаимодействия фотона с веществом. При рэлеевском рассеянии частота отраженного света не меняется. Это "обычное" отражение света от поверхности или из объема вещества. При рамановском рассеянии происходит излучение или, наоборот, поглощение колебания молекулы (фонона в твердом теле). Если при рассеянии частота света уменьшается, такой процесс называется "стоксовское рассеяние". Если, наоборот, частота отраженного света больше, такой процесс называется "антистоксовский".

Рамановская спектроскопия, иначе спектроскопия комбинационного рассеяния света является эффективным методом химического анализа, изучения состава и строения веществ.

Source: http://www.laser-portal.ru/content_459

COMPREHENSION

8. Read the second part of the text and summarize the main idea.

The most important thing to know is that Raman instrumentation is a very dynamic field. It enjoys major leaps with every advance made in electronics, optical devices, control software, or data capturing and analysis fields. Generally speaking, the instrument consists of six main parts: an excitation light source, an optical guiding system, an optical microscope, a spectrometer, a detector, and a data acquisition unit. The excitation light source is always a laser. It can be a monochromatic laser or a tunable dye laser. The most commonly used lasers line in Raman spectroscopy is the argon ion line at 514.5 nm. Other laser lines are very widely used as well. Solid-state lasers with an excitation wavelength in the 780nm range are preferred for biological samples to avoid, or reduce, the detrimental effect of florescence. Recently, UV lasers in the 200–300nm wavelength range have become preferred for carbon nanotube investigations. Regular optical microscopes are used to focus the laser light on the sample, to collect the backscattered light and send it to the spectrometer, and to define the Cartesian axes for the experiment for polarization directions definition purposes. Moving microscope stages (with a micron and submicron step size) are widely used to conduct Raman mapping experiments. With a typical optical microscope, the spatial resolution of the technique will be limited to the size of the laser spot interaction volume with the sample. A spatial resolution of 1 micron was successfully reached. More recently, high-resolution near-field microscopes were employed to further enhance the spatial resolution and capabilities of the Raman technique. The purpose of the spectrometer is twofold: First to separate the Rayleigh scattered light from the Raman signal (by Rayleigh light rejection), which can be done by a holographic notch filter, an edge filter, or a monochromator. Notch filters will enable the collection of both Stokes and anti-Stokes lines, while edge filters will allow collection of the Stokes Raman lines only. In addition to being, currently, less expensive than notch filters, edge filters have the advantage of allowing observation of Raman lines closer to the Rayleigh line. The second purpose of the spectrometer is to analyze the collected optical signal, which is carried out by dispersing the incoming light according to its wavelength and then reimaging the output spectrum at the exit slit. The spectrometer consists of a group of gratings and mirrors that can be arranged in different ways to give one of the following spectrometer subclasses:

1. Monochromator, which presents one wavelength at a time from the exit slit, and can be tuned to select the required wavelength.
2. Scanning monochromator: in this case the monochromator is motorized to scan a range of wavelengths sequentially.
3. Polychromator: in this arrangement, selected wavelengths are presented at various exit slits.
4. Spectrograph: in this arrangement, a range of wavelengths is imaged at an exit plane, and here is no exit slit.
5. Imaging spectrograph: in this case, special corrective optics are used to maintain better image quality along the two axes of the imaging plane.

Monochromators usually have high resolution, high stray light rejection, but low throughput. Spectrographs, on the other hand, have lower resolution, lower stray light rejection, but higher throughput. A spectrometer can contain one or more of the aforementioned subclasses arranged in a way to give single, double, triple, or a single plus double monochromator systems. Spectrographs can also be combined with monochromators in the same system. Notably, the more sophisticated the spectrometer system is, the higher its resolution, the higher its stray light rejection capability, and the lower its throughput will be. Higher stray light rejection allows observation of Raman bands closer to the laser line. Detectors can be either a single channel or multi-channel. Single-channel detectors (photomultiplier tubes, PMTs) read one wavelength at a time, and have long been used in Raman studies due to their high sensitivity, low background count, wide covered range, reliability, and relatively low cost. Their main disadvantage is the low sensitivity, requiring a long time to record a spectrum. Multi-channel detectors can be an intensified diode array or a charge coupled device (CCD). It is hard to catch up with the rapid developments in the field of CCD cameras. Time-gated CCDs and time-gated confocal microscopy have recently shown strong potential for another lead in the field. The data acquisition unit is simply a PC interfaced with the detector to store, display, and manipulate the data. Advanced data manipulation software has been developed to enable better data presentation, especially in the Raman imaging branch of experimental Raman spectroscopy. The optical guiding system consists of a group of mirrors to direct the laser beam from the source to the sample and back to the spectrometer, holographic filters to remove the plasma lines from the laser beam, and a set of polarizing units to control the polarization of the incident and the scattered beams. It is important to add that recently instruments have been developed with the ability to obtain microscopic images known as "Raman images". Two approaches have been described to obtain a Raman image. The first involves the illumination of the whole field-of-view of the microscope uniformly with the laser light. The microscope then transfers the sample image to a monochromator that selects predetermined wavelengths to be imaged on a TV camera at the exit focal plane. If the predetermined wavelength represents the Raman band of an element or a compound, the image will show the distribution of that element or compound within the selected area of the sample. The second approach to Raman imaging involves using a computer-controlled stepping motor driven sample stage. An area of the sample is mapped by recording spectra from a series of spatial points. The produced map can be either one- or two-dimensional profiles that show the intensity of the Raman band of a certain element or compound.

Text 4

Symmetry

PRE-READING

1. Answer the following questions.

1. What is symmetry?

2. Can one calculate symmetry?

2. Practice reading the following words.

symmetry ['simətri]	identical [ai'dentikl]
rigorously ['rigərəsli]	inversion [in'və:ʃn]
concerned [kən'sə:nd]	equivalent [ik'wivəlnt]
separately ['sepərətli]	linear [lai'niə]
indistinguishable [,indis'tiŋgwiʃəbl]	rotate [rɔ'teit]
images ['imidʒiz]	occupied [əkju'paid]
vertical ['və:tikl]	diagonal ['daiəgənəl]
horizontal [,hɔri'zɔntəl]	perpendicular [pəpən'dikələ]
determination [,ditəmi'neiʃən]	bisecting [bai'sektiŋ]

VOCABULARY

3. Study and remember the words.

reflection	отражение
express	выражать
perfection	совершенство
rotation angle	угол вращения
symmetry plane	плоскость симметрии
symmetry point	центр симметрии

symmetry line	ось симметрии
correspondence	соответствие
inversion center	центр инверсии
center of symmetry	центр симметрии
identity element of symmetry	единица симметрии
(anti)clockwise	по (против) часовой стрелки
rotation axis	ось вращения
proper rotation	собственное вращение
rotation order	порядок врящения
angle of rotation	угол вращения
space filling	плотное заполнение
assume	предполагать
n-fold rotation axes	оси симметрии n-порядка
linear molecule	молекула с неразветвленной (нормальной) цепью
mirror image	зеркальное отображение
mirror plane	зеркальная плоскость симметрии
planar molecule	плоская молекула
rotation reflection axis	оси зеркально-поворотной симметрии
improper rotation axis	симметрия несобственного вращения

READING

4. Read the text and answer the following questions.

Symmetry

Symmetry is an amazing natural concept. It can be observed in almost everything around us including, not surprisingly, ourselves. Nature used symmetry billions of years before man and must have taught mankind how to understand symmetry and use it. The German mathematician Hermann Weyl (1885–1955) said that through symmetry man always tried to perceive and create order, beauty, and perfection. The correlation between symmetry and beauty would become clear if one was ever moved by the symmetry, or beauty, of a snowflake, a crystal, or a flower.

The mathematical formulation of symmetry was rigorously developed in the nineteenth century. According to Hermann Weyl, an object is called symmetrical if it can be changed “somehow” to obtain the same object. The mathematical description of symmetry is concerned with the correspondence of positions on opposite sides of a point, a line, or a plane. Mathematicians realized that at most, five different elements of symmetry are needed to fully describe the correspondence of two point positions. In other words, one would need at most five different elements of symmetry that once operated separately on a point the point can be moved to a new indistinguishable position. To correlate this concept more closely with molecules, one may note that every molecule would possess one or more symmetry elements that once operated the molecule will assume a new configuration indistinguishable from the original one. Hence, the “somehow” turns out to be simply the operation of any of the following five symmetry elements.

Identity (E)

The identity symmetry element exists in everything in the universe. It is usually given the symbol (E) for the German word "Einheit" ['ainhait] meaning unity. Loosely, the word can be translated as “the same” or “identical”.

Center of Symmetry (i)

A center of symmetry is a point in space that occupies a midpoint on a line connecting two indistinguishable positions. The center of symmetry is also known as inversion center, hence, the designation “i”. If one connects a line from an atom in a molecule, or, generally speaking, a site or position in space, through a center of symmetry, extending the line for the same distance should lead to an equivalent indistinguishable atom, or position. For example, the carbon atom in a CO_2 molecule occupies a center of symmetry. If we consider any of the oxygen atoms, connecting a line from that oxygen to the carbon and extending the line an equidistance, will lead us to the second oxygen atom in the molecule that is indistinguishable from the one we started at. Note that a center of symmetry of a molecule may, or may not, be occupied by an atom. For example, both CO_2 and C_2H_2 molecules possess a center of symmetry. While that center of symmetry is occupied by a carbon atom in the case of CO_2 , it is unoccupied in the case of ethyne, and actually lies on the midpoint between the two carbon atoms. As mentioned above, if we operate the center of symmetry operation on one of the oxygen atoms in CO_2 we will move that atom to the second oxygen atom position. Now what if we operate the center of symmetry on the same oxygen atom twice? This will bring the oxygen atom back to its original (i.e., identical) position. Clearly, then, operating a center of symmetry element twice (this is mathematically expressed as i^2) is equivalent to the identity element of symmetry (E). Mathematically this can be expressed as $i^2=E$.

Rotation Axes (C_n)

If one could rotate a molecule (clockwise or anticlockwise) about an axis into a new configuration that is indistinguishable from the original configuration, the molecule is said to possess a rotation axis of symmetry (C_n)[v]. This symmetry element is also referred to as proper rotation axis. The subscript ‘‘*n*’’ is the rotation order describing the angle of rotation required to reach an indistinguishable configuration of the molecule. The rotation angle can be $2\pi/n$ ($360°/n$). For crystals, due to space filling requirements, n can only assume the values 1, 2, 3, 4, and 6. For molecules, however, n may take any integer value (1, 2, 3. . .∞). For example, a CO_2 molecule possesses two two-fold rotation axes (C_2) normal to the molecular axis. If the molecular axis is in the *x*-direction, rotation of 180° ($2\pi/2$) about either the *y*-axis or the *z*-axis will bring the molecule into an indistinguishable configuration. It is also important to note that for such linear molecules, the molecular axis represents a (C_∞) rotation axis. It is also simple to observe that a benzene molecule possesses a six-fold rotation axis (C_6) normal to its plane. If one rotates a molecule that possesses a two-fold rotation axis 180° about that axis, this operation can be expresses as C^1_2. Similarly, rotation of 60° about a six-fold rotation axis is expressed as C^1_6. Also, a rotation of 120° about a sixfold axis is expressed as C^2_6. Both operations will bring the molecule into an indistinguishable configuration. A rotation of 360° about any rotation axis can be expressed as C^n_n. Such symmetry operation will bring the molecule into the original (identical) configuration. Hence, it is equivalent to the identity symmetry element (E). Mathematically this can be expressed as $C^n_n = E$.

Planes of Symmetry (σ) (Mirror Planes)

If a molecular configuration can be divided by a plane into two parts that are mirror images of each other, then the molecule possesses a symmetry plane (σ) [sigma]. This symmetry element is also known as *mirror plane*. If the molecule possesses two symmetry planes intersecting in a line, the intersection line will be a rotation axis. Three different types of symmetry planes have been distinguished: vertical (σ_v), horizontal (σ_h), and diagonal (σ_d); σ_v is used to denote symmetry planes intersecting in a rotation axis. If the symmetry planes are bisecting the angle between two successive two-fold axes, the planes are denoted as diagonal planes (σ_d). Horizontal symmetry planes (σ_h) are usually those in the plane of planar molecules. Some texts use primes to distinguish different types of symmetry planes. Usually, symmetry planes in a plane of planar molecules are designated as $\sigma^{/}$. Symmetry planes out of the molecular plane are designated as σ_0. In addition, reflection in a symmetry plane twice (σ^2) results in the original configuration, hence $\sigma^2 = E$.

Rotation Reflection Axes (S_n) (Improper Rotation)

For some molecules, an indistinguishable configuration can be reproduced by rotation to a certain degree (360°/*n*) about an axis and then reflection through a reflection plane that is perpendicular to the rotation axis. Such symmetry element is denoted as a rotation reflection axis, or improper rotation axis (S_n). The symbol S is, again from German, from the word *Spiegel* ['ʃpi:gəl], meaning a mirror; n is the order of the axis. If we consider an ethane molecule (H_3–C–C–H_3), the positions of any two of the indistinguishable hydrogen atoms can be exchanged by rotating 60° about a vertical axis, then reflecting in a horizontal plane. Such a symmetry element is denoted as (S_6). Note that neither a C_6 nor a σ_h are present on their own. An improper rotation axis can also be operated in stages exactly like rotation axes. Repeating the operation again results in S^2_6. An S^2_6 is indeed equivalent to a C_3 rotation. One can clearly understand this by realizing that in a S^2_6 we rotate a total of 120° (equivalent to a C_3) and reflect in the same horizontal plane twice (σ^2 =E). Improper rotation axes also have the characteristic that S^n_n=E, if *n* is even. Another unique characteristic of improper rotation axes is that $S^{n/2}_n$= i, if *n* is even and *n*/2 is odd (S^2_6 for example). Understanding such characteristics of symmetry elements enables easier determination of all symmetry elements of a molecule. For example, if a molecule possesses a S_6 symmetry element, it must have an inversion center (i). The opposite is not necessarily true.

QUESTIONS:

1. What is symmetry?
2. What are the examples of symmetry in nature?
3. What is the history of symmetry investigation?
4. What are the elements of symmetry?
5. What is center of symmetry?
6. What are rotation axes?
7. What are the planes of symmetry?
8. What are rotation reflection axes?

VOCABULARY WORK

5. Translate the following expressions into Russian.

Are denoted as diagonal planes, another unique characteristic, enables easier determination, if we consider an ethane molecule, reflecting in a horizontal plane, this operation can be expresses as, to distinguish different types of symmetry planes, in stages exactly like rotation axes, symmetry planes intersecting in a line, mathematical formulation, rigorously developed, it is also important to note that, are designated as, original configuration.

6. Translate the following expressions into English.

Элемент симметрии, симметрия относительно оси (точки, плоскости), шестикратная симметрия, симметрия вращения, диагональная плоскость, вращение под определенным углом, ось вращения, неразличимая конфигурация.

WRITING

7. Translate the following sentences into Russian.

1. The mathematical description of symmetry is concerned with the correspondence of positions on opposite sides of a point, a line, or a plane.
2. To correlate this concept more closely with molecules, one may note that every molecule would possess one or more symmetry elements.
3. If one connects a line from an atom in a molecule through a center of symmetry, extending the line for the same distance should lead to an equivalent indistinguishable atom, or position.
4. While that center of symmetry is occupied by a carbon atom in the case of CO_2, it is unoccupied in the case of ethyne, and actually lies on the midpoint between the two carbon atoms.
5. If one could rotate a molecule (clockwise or anticlockwise) about an axis into a new configuration that is indistinguishable from the original configuration, the molecule is said to possess a rotation axis of symmetry $(C_n)^v$.
6. The subscript "*n*" is the rotation order describing the angle of rotation required to reach an indistinguishable configuration of the molecule.
7. If the molecular axis is in the *x*-direction, rotation of 180° (2π/2) about either the *y*-axis or the *z*-axis will bring the molecule into an indistinguishable configuration.
8. The opposite is not necessarily true.
9. If the symmetry planes are bisecting the angle between two successive two-fold axes, the planes are denoted as diagonal planes (σ_d).

10. For some molecules, an indistinguishable configuration can be reproduced by rotation to a certain degree (360°/*n*) about an axis and then reflection through a reflection plane that is perpendicular to the rotation axis.

8. Translate the following sentences into English.

1. Операция совмещения частей симметричной фигуры и фигуры в целом называется симметрическим преобразованием.

2. Каждому элементу соответствует своё симметрическое преобразование, посредством которого фигура совмещается сама с собой.

3. В кристаллических многогранниках возможны элементы симметрии: плоскости симметрии, центр инверсии, оси симметрии и инверсии.

4. Плоскостью симметрии называется плоскость, которая делит фигуру на две равные части, расположенные друг относительно друга как предмет и его зеркальное отражение.

5. Плоскость симметрии обозначается буквой Р.

6. Симметрическое преобразование, отвечающее плоскости симметрии, есть отражение в плоскости.

7. Ось симметрии n-го порядка – линия при полном обороте вокруг которой плоская или пространственная фигура несколько раз приходит в совмещение сама с собой,

8. Число совмещений при полном обороте называется порядком оси, а наименьший угол поворота, при котором фигура совмещается сама с собой, – элементарным углом поворота.

9. На рисунке представлены изображения с осями симметрии следующих порядков: 2, 3, 4, 5, 6, 7 и соответственно элементарными углами поворота - 180, 120, 90, 72 градуса и т. д.

10. Наряду с осью симметрии n-го порядка в каждом из приведенных изображений имеется несколько пересекающихся осей симметрии.

9. Make up a plan and retell the text *"Symmetry"*.

Test 2 (Unit 2).

1. Give full names for these abbreviations and translate them into Russian:

CNT –

MWCNT –

SWCNT –

TEM –

CCD –

UV laser –

PMT –

AC –

2. Translate this introduction words and phrases and make up sentences using them:

Notably, clearly, currently, therefore, moreover, indistinguishable, in addition, on the other hand, generally speaking, hence, thus, interestingly, for instance, essentially, significant, presumably, particularly, consequently.

3. Translate the following terms into Russian:

Arc discharge technique-based synthesis, electric arc discharge-synthesized nanotubes , Inversion center, Identity element of symmetry, linear molecule, improper rotation axis, Exfoliated graphite, Co-axial tubes, non-solvent based method, contact arc method, the yield calculations, other soluble impurities, Solid-state laser, backscattered light, Cartesian axes, Confocal optical arrangements, spatial resolution.

4. Translate the following terms into English:

Испарение методом электродугового разряда, ось симметрии, угол вращения, графеновая пластина, разглядеть, испарение, доступный, примечательно, случайный, форма, сосуд, ускорить, углерод, вычисления, наноленты, существенный, структурный, высокой чистоты, угольный стрежень, сообщалось, экстракционный метод (излечения), существенный, важный, относительно низкие температуры, лабораторное оснащение, производительность, высокое разрешение, лазерный луч, визуализация, способность, позволять, определять, биологические образцы, хранить, работать с данными, спектр волны.

5. Translate the following sentences into English:

1. Плоскостью симметрии называется плоскость, которая делит фигуру на две равные части, расположенные друг относительно друга как предмет и его зеркальное отражение.

2. При рэлеевском рассеянии частота отраженного света не меняется.

3. Фуллерены – это шарообразные молекулы с замкнутой поверхностью.

4. На рисунке представлена энергетическая схема упругого и неупруго-го взаимодействия фотона с веществом.

5. Первые эксперименты, приведшие к открытию фуллеренов, были проведе-ны с возгонкой графита импульсным *лазерным лучом* сравнительно большой мощности в импульсе.

6. ***Translate the following sentences into Russian:***

1. Hence, the scattered photon will have a new frequency, or energy, which is simply equal to the sum or the difference between the frequencies of the incident photon and the natural frequency of the thermally excited and kinetically active species in the material.

2. If one could rotate a molecule (clockwise or anticlockwise) about an axis into a new configuration that is indistinguishable from the original configuration, the molecule is said to possess a rotation axis of symmetry (C_n)[v].

3. With a typical optical microscope, the spatial resolution of the technique will be limited to the size of the laser spot interaction volume with the sample.

4. By using the method of Krätschmer and Huffman, C60 and other allotropes of fullerenes could be produced in reasonable amounts in a way accessible to many laboratories.

5. In addition, if carbon disulfide is used, it has to be vigorously removed under vacuum to avoid fullerene contamination with sulfur.

UNIT 3. APPLICATION OF NANOTECHNOLOGY

Text 1

Current trends in nanotechnology

PRE-READING

1. Answer the following questions.

1) What is the future of nanotechnologies?

2) Where can we apply nanotechnology?

2. Learn this information and answer the question.

Can you figure out how tall you are in nanometers?

Ordinary objects are absolutely huge measured on what scientists call the nanoscale:

Atom: ~0.1 nanometers.

Atoms in a molecule: ~0.15 nanometers apart.

DNA double-helix: ~2 nanometers in diameter.

Typical protein: ~10 nanometers long.

Computer transistor (switch): ~100–200 nanometers wide.

Typical bacteria: ~200 nanometers long.

Human hair: ~50,000–100,000 nanometers in diameter.

One piece of paper: ~100,000 nanometers thick.

Girl 1.2 m (4ft) tall: ~1200 million nanometers tall.

Man 2m (6.5 ft) tall ~ 2000 million nanometers tall.

Empire State Building: 381m (1250 ft) tall: ~381,000 million nanometers tall.

3. Practice reading the following words.

Billionth	[ˈbɪlɪənθ]
Tiny	[ˈtaɪnɪ]
Cellular	[ˈseljʊlə]
Discernible	[dɪˈsɜːnəbl]
Ambiguity	[æmbɪˈgjuːɪtɪ]
Ubiquitous	[juːˈbɪkwɪtəs]
Pervasive	[pɜːˈveɪsɪv]

VOCABULARY

4. Study and remember the words.

measure	мера, степень, измерять, мерить
tiny	крошечный, незначительный, ничтожный
cellular	сотовый, клеточный, клетчатый, ячеистый, сотовая связь
flexible	гибкий, эластичный, упругий
durable	прочный, долговечный, длительного пользования
discernible	заметный, ощутимый, явный, различимый
ambiguity	неясность, сомнительность, дву-смысленность, неоднозначность
ATM (Automatic Teller Machine)	банкомат
fingerprints	отпечатки пальцев
ubiquitous	повсеместный, распространенный
pervasive	повсеместный, полный
embedded	встроенный, интегрированный

sync	синхронизация звука и изображения
iris	радужная оболочка глаза
withdraw	зд. снимать
retina	сетчатка

READING

5. Read the text and answer the questions below.

Current trends in nanotechnology

By all accounts, nanotechnology – the science of making devices from single atoms and molecules – is going to have a huge impact on both business and our daily lives. Nano devices are measured in nanometers (one billionth of a metre) and are expected to be used in the following areas.

• Nanocomputers: Chip makers will make tiny microprocessors with nanotransistors, ranging from 60 to 5 nanometres in size.

• Nanomedicine: By 2020, scientists believe that nano-sized robots, or nanobots, will be injected into the body's bloodstream to treat diseases at the cellular level.

• Nanomaterials: New materials will be made from carbon atoms in the form of nanotubes, which are more flexible, resistant and durable than steel or aluminum. They will be incorporated into all kinds of products, for example stain-resistant coatings for clothes and scratch-resistant paints for cars.

Artificial Intelligence (AI) is the science of making intelligent machines and programs. The term originated in the 1940s, when Alan Turing said: 'A machine has artificial intelligence when there is no discernible difference between the conversation generated by the machine and that of an intelligent person.' A typical AI application is robotics. One example is ASIMO, Honda's intelligent humanoid robot. Soon, engineers will have built different types of android, with the form and capabilities of humans.

Another AI application is expert systems – programs containing everything that an 'expert' knows about a subject. In a few years, doctors will be using expert systems to diagnose illnesses. Neural networks are a new concept in computer programming, designed to replicate the human ability to handle ambiguity by learning from trial and error. They use silicon neurons to imitate the functions of brain cells and usually involve a great number of processors working at the same time.

Imagine you are about to take a holiday in Europe. You walk out to the garage and talk to your car. Recognizing your voice, the car's doors unlock. On the way to the airport, you stop at an ATM. A camera mounted on the bank machine looks you in the eye, recognizes the pattern of your iris and allows you to withdraw cash from your account.

When you enter the airport, a hidden camera compares the digitized image of your face to that of suspected criminals. At the immigration checkpoint, you swipe a card and place your hand on a small metal surface. The geometry of your hand matches the code on the card, and the gate opens. You're on your way.

Does it sound futuristic? Well, the future is here. Biometrics uses computer technology to identify people based on physical characteristics such as fingerprints, facial features, voice, iris and retina patterns.

Ubiquitous computing, also known as pervasive computing, is a new approach in which computer functions are integrated into everyday life, often in an invisible way. Ubiquitous devices can be anything from smartphones to tiny sensors in homes, offices and cars, connected to networks, which allow information to be accessed anytime and anywhere – in other words, ubiquitously. In the future people will interact naturally with hundreds of these smart devices (objects containing a microchip and memory) every day, each invisibly embedded in our environment and communicating with each other without cables.

In the ideal smart home, appliances and electronic devices work in sync to keep the house secure. For example, when a regular alarm system senses that someone is breaking into the house, it usually alerts the alarm company and then the police. A smart home system would go further, turning on the lights in the home and then sending a text message to the owner's phone. Motorola Homesight even sends images captured by wireless cameras to phones and PCs. Smart homes can remember your living patterns, so if you like to listen to some classical music when you come home from work, your house can do that for you automatically. They will also know when the house is empty and make sure all appliances are turned off. All home devices will be interconnected over a home area network where phones, cable services, home cinemas, touch screens, smart mirrors and even the refrigerator will cooperate to make our lives more comfortable.

Source: The Richmond Times-Dispatch, www.businessweek.com

QUESTIONS:

1. What sphere of life are nanotechnologies expected to be used in?
2. Where can nanopmaterials be used?
3. What is android?
4. What is the application of AI?
5. Why are silicon neurons used?
6. How does biometrics help computer technology?
7. What is ubiquitous computing?
8. What way will smart homes facilitate our life in the future?

VOCABULARY WORK

6. Find English equivalents to the following word combinations in the text.

Огромное влияние; судя по тому, что говорят; устойчивые к царапинам краски; возможности человека; незаметно встроенный; провести электронной картой по считывающему устройству; воспроизводить способность человека; снимать наличные; предполагаемые преступники; узор сетчатки глаза; полная информатизация; система сигнализации; модель проживания.

7. Match the definitions with the words from the text.

1. A household appliance used for keeping food fresh	A. Molecule
2. An apparatus or device, usually powered electrically, used in homes to perform domestic functions.	B. Cell
3. The branch of computer science dealing with the reproduction or mimicking of human-level thought in computers.	C. Retina
4. Muscular diaphragm that controls the size of the pupil which in turn controls the amount of light that enters the eye; it forms the colored portion of the eye.	D. Atom
5. The innermost light-sensitive membrane covering the back wall of the eyeball; it is continuous with the optic nerve.	E. Memory
6. A cell of the nervous system, which conducts nerve impulses; consisting of an axon and several dendrites, it processes and transmits information through electrical and chemical signals.	F. Artificial Intelligence
7. The ability of an organism to record information about things or events with the facility of recalling them later at will.	G. Appliance
8. It is the smallest unit of life that is classified as a living thing.	H. Neuron
9. The smallest possible amount of matter which still retains its identity as a chemical element, now known to consist of a nucleus surrounded by electrons.	I. Refrigerator
10. the smallest part of any substance which possesses the characteristic properties and qualities of that substance, and which can exist alone in a free state.	J. Iris

8. Put the missing words in the text into gaps and translate it.

How big is "nano"?

nanometer	nanoscopic	kilometers	nanoscale	electron	world	instruments
photos	microscopic					

We live on a scale of meters and __________ (thousands of meters), so it's quite hard for us to imagine a _________ that's too small to see. You've probably looked at amazing _________ in science books of things like dust mites and flies photographed with _________ microscopes. These powerful scientific _________ make images that are __________, which means on a scale millionths of a meter wide. __________ involves shrinking things down to a whole new level. Nano means "billionth", so a ___________ is one billionth of a meter. In other words, the __________ is 1000 times smaller than the microscopic scale and a billion (1000 million) times smaller than the world of meters that we live in.

SPEAKING

9. Speak about 3 minutes according to the questions

1. What do wheels enable people to do?
2. How important may they be?

COMPREHENSION

10. Make up the rendering of the following text.

The future of nanotechnology: nanodream or nano-nightmare?

Engineers the world over are raving about nanotechnology. This is what scientists at one of America's premier research institutions, the Los Alamos National Laboratory, have to say: "The new concepts of nanotechnology are so broad and pervasive, that they will influence every area of technology and science, in ways that are surely unpredictable.... The total societal impact of nanotechnology is expected to be greater than the combined influences that the silicon integrated circuit, medical imaging, computer-aided engineering, and man-made polymers have had in this century." That's a pretty amazing claim: 21st-century nanotechnology will be more important than all the greatest technologies of the 20th century put together!

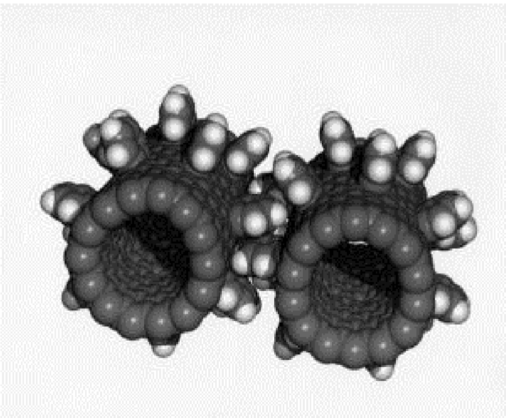


Photo: These nanogears were made by attaching benzene molecules (outer white blobs) to the outsides of carbon nanotubes (inner gray rings). Image by NASA Ames Research Center courtesy of Internet Archive.

Nanotechnology sounds like a world of great promise, but there are controversial issues too that must be considered and resolved. Some people have raised concerns that nanoscale organisms or machines could harm human life or the environment. One problem is that tiny particles can be extremely toxic to the human body. No one really knows what harmful effect new nanomaterials or substances could have. Chemical pesticides were not considered harmful when they were first used in the early decades of the 20th century; it wasn't until the 1960s and 1970s that their potentially harmful effects were properly understood. Could the same happen with nanotechnology?

The ultimate nano-nightmare, the problem of "gray goo", was first highlighted by Eric Drexler. What happens if well-meaning humans create nanobots that run riot through the biosphere, gobbling up all living things and leaving behind nothing but a chewed-up mass of "gray goo"? Drexler later backed away from that claim. But critics of nanotechnology still argue humans shouldn't meddle with worlds they don't understand, but if we took that argument to its logical conclusion, we'd have no inventions at all–no medicines, no transportation, no agriculture, and no education–and we'd still be living in the Stone Age. The real question is whether the promise of nanotechnology is greater than any potential risks that go with it. And that will determine whether our nano-future becomes dream–or nightmare.

Source: http://www.explainthatstuff.com/nanotechnologyforkids.html

WRITING

11. Translate the following text into English.

Нанотехнологии в электронике, искусстве

С появлением новых средств наноманипулирования возможно создание механических компьютеров, способных в кубе с ребром 100 нм функционально повторить современный микропроцессор. Планируется создание нанороботов размером всего 1–2 микрон, оснащенных бортовыми механокомпьютерами и источниками энергии, которые будут полностью автономны и смогут выполнять разнообразные функции, вплоть до самокопирования.

Музыка, литература, балет, театр и все, что относится к выражению творческого потенциала человека, всегда стояли несколько особняком от научно-технического прогресса. Таким образом, перспективы развития науки и техники также определяют пути искусства. В 2001 году японские учёные, используя передовые лазерные технологии, создали самую маленькую в мире скульптуру. Она изображает разъярённого быка, разворачивающегося для атаки. Размеры “микробыка” впечатляют: 10 мкм в длину и 7 мкм в высоту – не больше, чем у красных кровяных телец человеческой крови. Увидеть его можно только в сверхмощный микроскоп.

Source: Мир Знаний http://mirznanii.com/a/287120-4/po-teme-nanotekhnologii-v-sovremennom-mire-4

Text 2

Myths and realities of nano futures

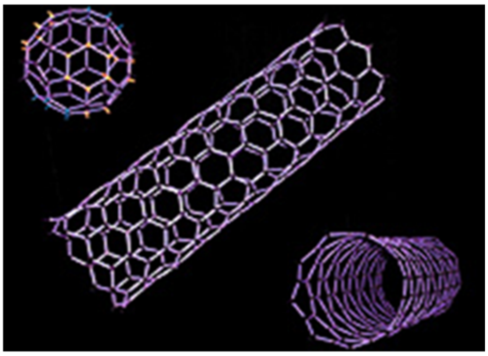
PRE-READING

1. Answer the following questions.

1) What countries does "Nanotechnology cult" exist?

2) What products of Russian nanotechnology do you know?

3) What are the main tasks should be solved with the help of nanotechnology?



2. Practice reading the following words.

miniaturize	[ˊmɪnɪ(ə)tʃəraɪz]
efficient	[ɪˈfɪʃənt]
laughable	[ˈlɑːfəbl]
shrinking	[ˈʃrɪŋkɪŋ]
robust	[rəʊˈbʌst]
nanotechnology	[nænətekˈnɒlədʒɪ]

VOCABULARY

3. Study and remember the words.

miniaturization	миниатюризация
pinhead	булавочная головка
property	свойствоср, характеристикаж, особенность

exploit	использовать, эксплуатировать
ground-breaking	новаторский
gecko	геккон
enabling	позволяющий, дающий возможность, обеспечивающий
coating	защитное покрытие
crude	примитивный, непродуманный, сырой
conservative	консервативный, осторожный
uncompressed	несжатый
postage	почтовый
shrinking	сокращающийся, уменьшающийся
super-fine	сверхтонкий
robust	прочный, крепкий, сильный
tune	регулировать

READING

4. Read the text and answer the questions below.

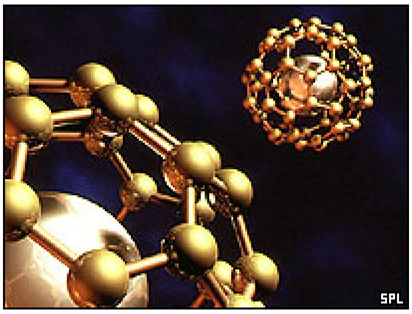
Myths and realities of nano futures

Ever since John Dalton convinced the world of the existence of atoms in 1803, scientists have wanted to do things with them.

Micro-submarine in an artery, Science Library image. Machines in the blood: Still science fiction

Nanotechnology takes that ability on to a new plane and opens up all kinds of futuristic imaginings. Essentially, nanotech is manipulation at the molecular scale – distances that may cover just a few millionths of a millimetre. But its potential is not just about being able to miniaturize things. Indeed, scientists and engineers recognize that there are fundamental limits to pure miniaturization. Working at a scale a million times smaller than a pinhead allows researchers to "tune" material properties, making them behave in different ways to normal, large-scale solids. This behaviour can be exploited in quite ground-breaking ways.

Nature has been doing nanotechnology for a long time, and it has become expert in it. Consider the super-fine hairs on a gecko's feet which allow it to stick to walls and even hang upside down on a glass sheet.



How nanotechnology is building the future from the bottom up

Learning from nature, nanotechnology promises humans ways of making systems that are smaller, lighter, stronger, more efficient, but cheaper to produce.

"Nanotechnology is not a technology in its own right", explained Professor Mark Welland, head of the University of Cambridge Nanoscale Science Laboratory. "It is an enabling technology, so it will appear in many different products. "It is already appearing in flash memory, computer chips, and it will increasingly be an enabling technology in other products like coatings, new types of sensors, especially in the medical area".

It is expected to transform the performance of materials, like polymers, electronics, paints, batteries, sensors, fuel cells, solar cells, coatings, computers and display systems. In five years' time, batteries that only last three days will be laughable, said Professor Welland. Similarly, in 10 years' time, the way medical testing is done now will be considered crude. To say that in five years, an iPod will have 10 times its current storage capacity will be conservative, he said. In the not-so-distant future, a terabit of data – equivalent to 10 hours of fine quality uncompressed video – will be stored on an area the size of a postage stamp. Clearly, the devices themselves will not be nano-sized. But nanotechnology will play its part in shrinking components, and making them work together a lot more efficiently.

Although nano-devices can be built atom by atom, it is not realistic as a manufacturing option because it is slow and expensive, thinks Professor John Ryan, head of the Bionanotechnology Centre at Oxford University.

"One of the major scientific challenges in the years ahead is to understand the fundamental biological principles and apply them to produce new types of nanotechnology", he said. "Armed with these design rules it may then be possible to make new types of nano-device using materials that are more robust than biomaterials".

Source: Jo Twist BBC News Online science and technology staff
http://news.bbc.co.uk/2/hi/science/nature/3920685.stm#graphic

QUESTIONS:

1. What is a potential of nanotechnology?
2. What do researches allow to do with the help of miniaturization?
3. What does nanotechnology promise people?
4. Where is nanotechnology already appearing?
5. What materials will be transformed due to nanotechnology?
6. What is not realistic by Professor John Ryan's opinion?
7. What is the main scientific tasks in the future?

VOCABULARY WORK

5. Translate these sentences into Russian in written form.

Material changes

1) Industrial giants like GE are heavily involved in developing nanotechnology.
2) "We think that the biggest breakthroughs in nanotechnology are going to be in the new materials that are developed", said Troy Kirkpatrick at GE Global Research.

3) These include corrosion-resistant coatings to make hydro-electric turbines more efficient in heavily-silted waters, and nano-membrane water filters to make for faster filtration.

4) GE is also studying the properties of nano-ceramics, which can offer extreme strength, while still being lightweight.

5) Because of the molecular structure of such materials, nano-ceramic coatings on aircraft could make them 10 % more efficient, so less energy is used, producing fewer emissions.

6) GE Global Research is also looking to the electronics industry.

7) "If you look at the chip makers of the world, the challenge they have is not to figure out how to make them faster.

8) "The problem is they run so fast, the chips generate too much heat and melt. They need better materials for heat management", said Mr Kirkpatrick.

9) Using materials which exploit properties of nanoparticles, GE has developed chip adhesives that can transfer heat out of the processor system more efficiently.

10) "It is a start, and it is to show nanotechnology is finding its way into production and is changing the way we are doing science", said Mr Kirkpatrick.

Source: Jo Twist BBC News Online science and technology staff
http://news.bbc.co.uk/2/hi/science/nature/3920685.stm#graphic

6. Fill in the gaps with suitable verb forms and translate the text.

Range of impacts

enable	***to improve***	***could***	***is***	***exploit***	***offers***	***were superseded***
said	***are arranged***	***provide***	***lead***	***change***		

Nano-materials _________ unusual electrical, optical and other properties because of the very precise way in which their atoms __________. This means fabrics could _________ colour electronically. Exposing an army uniform to ultra-violet light _________ activate changes without undressing. But it is in medicine that nanotechnology ________ the most remarkable advances, according to Professor Ryan.

"Nanomedicine will ________ earlier and better diagnostics and treatment will combine earlier and more precisely targeted drug delivery", he said. The possibility of individualised therapy _________ also on the horizon. Nanotechnology in the form of flexible films containing miniaturised electrodes is expected _________ the performance of retinal, cochlear and neural implants. And it could ________ to the miniaturisation of medical diagnostic and sensing tools, ________ Professor Ryan, which could drive down costs of such kits for developing countries. In this respect, nanotechnology could _________ developing nations to leapfrog older technologies, in the way that copper wire and optical fibre telephony __________ mobile phones.

7. Match nano uses with their definitions.

1. Various optical components 2. Chips that contain movies with more than 1,000 hours of playing time 3. Printable electronic circuits 4. New forms of computer memory 5. PCs with the power of today's computer centres 6. Solar energy collection (photovoltaics) 7. Direct hydrogen production 8. Replacements for human tissues and organs 9. Composites containing nanotubes 10. Glues, paints and lubricants 11. Lightweight plastic windows with hard transparent protective layers	A. Медицинские диагностические инструменты и датчики B. Коллекция солнечной энергии (фотовольтаика) C. Прямое производство водорода D. Гибкие технологии отображения и электронная бумага E. Композиты, содержащие нанотрубки F. Клеи, краски и смазки G. Новые формы компьютерной памяти H. Печатные электронные схемы I. Различные оптически компоненты

12. Cheap hydrogen storage possibilities for a regenerative energy economy 13. Flexible display technologies and e-paper 14. Miniaturised data storage systems with capacities comparable to whole libraries' stocks 15. Medical diagnostic tools and sensors	J. Миниатюрные системы хранения данных с возможностями, сравнимыми с запасами целых библиотек K. Компьютеры с мощью современных компьютерных центров L. Чипы, которые содержат фильмы с более чем 1000 часов игрового времени M. Замена тканей и органов человека N. Дешевые возможности хранения водорода для регенеративной экономии энергии O. Легкие пластиковые окна с жесткими прозрачными защитными слоями

8. Do you consider nano uses from exercise 7 short-term or long-term nano uses? Put them in the right column.

SOME SHORT-TERM NANO USES vs SOME LONGER-TERM NANO USES

9. Put prepositions and conjunctions into the gaps and translate the text into Russian.

Uncertainties and worries

for (2), in, if, to (2), of (2), but.

Whatever nanotechnology does _______ the future, it will be an evolutionary process. One certainty is that there remains a plethora of uncertainties _______ the emerging field _______ nanotechnology.

"Medical sensing is very attractive _______ everybody, but there could be a downside," explained Professor Welland ".______ medical sensors become ubiquitous, our physical state could be monitored 24 hours a day, and if someone hacked into that data, there could be concerns." Which is indeed why regulation has to be addressed, _______ must not stifle nanotechnology's potential.

"One of the important things ______ me is that it ultimately means the most efficient use of materials and processes, which means it does not have to benefit just the G8 nations", argued Professor Welland. "These sorts ______ materials, if they are able to do their job using less energy, should be available ______ everybody".

Source: Jo Twist BBC News Online science and technology staff
http://news.bbc.co.uk/2/hi/science/nature/3920685.stm#graphic

10. Match the sentences with the picture.

1 – Nano-engineered cochlear implant

2 – Nano-particle paint to prevent corrosion

3 – Thermo-chromic glass to regulate light

4 – Photovoltaic film that converts light into electricity

5 – Organic Light Emitting Diodes (OLEDs) for displays

6 – Fabrics coated to resist stains and control temperature

7 – Carbon nanotube fuel cells to power electronics and vehicles

8 – Bucky-tubeframe is light but very strong

9 – Scratch-proof coated windows that clean themselves with UV

10 – Intelligent clothing measures pulse and respiration

11 – Hipjoint made from biocompatible materials

12 – Magnetic layers for compact data memory

COMPREHENSION

11. Make up the rendering of the following text.

Future fears

Proponents say misconceptions and misrepresentation of nanotechnology's potential have fuelled many dystopian scenarios. Some are frightening, others are impossible. The Royal Society and the Royal Academy of Engineering has looked at current and future developments in nanotechnology and has reported on whether it will require new controls. It is hoped that the report grounds some unrealistic scenarios, while recognising that real concerns need to be addressed with regulation.

"The one fantastical idea that has dogged nanotechnology is the self-replicating machine, the 'grey goo', scenario", said Professor Welland. "That is simply too far off. I think anyone who is worrying about self-replicating machines should not be looking at nanotechnology for that. "The complexity of designing a molecular machine is bad enough, but if you try to imbue that with self-replication, you could not even put a toe in the water to design it".

The scenario sees swarms of self-replicating robots, smaller than viruses, multiplying uncontrollably and devouring Earth. Eric Drexler, who many consider to be a "father of nanotechnology", has distanced himself from the idea, saying such self-replicating nanomachines are unlikely to be widespread. Similarly, fears over "green goo", the concern that self-replicating, nano-sized biological particles will move into human bodies and do unpredictable things, is scaremongering, thinks Professor Welland.

Professor Ryan agrees: "These science fiction scenarios have not only diverted attention away from the real advantages of nanotechnology, but also from issues that do raise concern". Inhaled nanoparticles found in the bloodstream which have dispersed throughout the brain is a concern, he says. Whether this poses a health risk is not known. "If you look around at the moment in a big city, a significant proportion of material that you breathe in is already particulates – and a proportion of that is nano-sized, like diesel emissions", said Professor Welland.

Source: Jo Twist BBC News Online science and technology staff

http://news.bbc.co.uk/2/hi/science/nature/3920685.stm#graphic

SPEAKING

12. Give your ideas on the following topics. How will it affect our lives?

1) Nanotechnologies in medicine in 50 years;

2) Nanotechnologies in space in 30 years;

3) Nanotechnologies in computer science in 20 years.

And comment the ideas of your groupmates.

Useful phrases

Giving opinion:	***Giving arguments:***
I agree/ disagree	**The main argument against/in favour is…**
In my opinion, … / From my point of view, … / As far as I am concerned, …	**First of all, I would like to consider…** **The first thing I would like to consider is…** **To begin with, …/ To start with, …**
I believe that…/ It seems to me that…	**Despite the fact that…/ In spite of the fact that…**
I am in favour of… / I am against the idea of…	**On the one hand, … /On the other hand, …**
According to…	**Besides,…/ In addition,…**
Some people say that… **It is said/believed that…**	**What is more, …/ Moreover, …/ More than that, …**
There is no doubt that…	**Finally, …**
It cannot be denied that…	**However, … / …, though**
It goes without saying that…	**…although…**
We must admit that…	**Nevertheless,…**

WRITING

13. Translate the following text into English.

Молекулярный компьютер (нанокомпьютер) – это вычислительное устройство размером несколько нанометров. Достижения современных информационных технологий и очевидная неизбежность появления в ближайшем будущем принципиально новых разработок порой тесно переплетаются со вчерашней фантастикой.

Представьте себе транзистор, состоящий всего из одной молекулы. Если из миллиарда таких транзисторов построить процессор – он будет не больше песчинки. При этом его производительность возрастет в сотни или даже тысячи раз по сравнению с современными компьютерами.

Молекулярные процессоры можно будет встраивать в любые, даже самые крошечные устройства, внедрять их в волокна ткани, превращая одежду в надеваемый компьютер. "Молекулярные блоки памяти" обеспечат плотность хранения данных, немыслимую для полупроводниковых микросхем.

Основные компоненты молекулярного компьютера должны быть теми же, что и у обычного компьютера: система ввода информации, вычислительный блок (процессор), система хранения информации (память) и, наконец, система вывода информации. Ну и, конечно, провода и блок питания.

Source: Pandia «Нанотехнологии и молекулярные компьютеры»

http://pandia.ru/text/78/380/829.php

Text 3

Nanoengineered bioinks for 3D printing

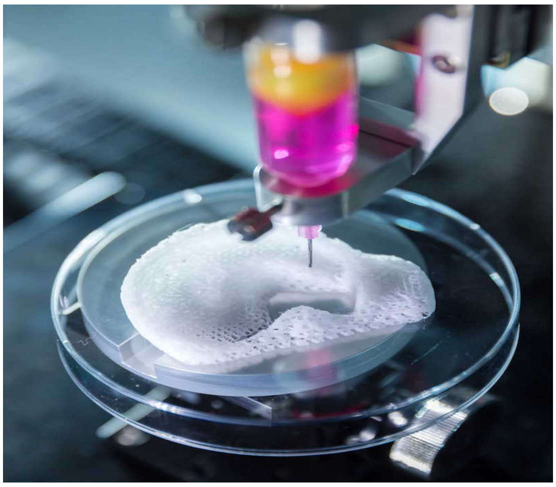
PRE-READING

1. Answer the following questions.

1) What is the main goal and the most priority task of nanotechnology (the broad opportunities for their application in medicine, chemistry, physics or something)?

2) When will nanotechnology products become available to ordinary consumers?

3) What nano products will be the first on the market?



2. Practice reading the following words.

self-sustaining	[ˌselfsəˊsteɪnɪŋ]
design	[dɪˈzaɪn]
strengthening	[ˈstreŋθnɪŋ]
nanocomposite	[nænəˈkɒmpəzɪt]
ionic-covalent	[aɪˈɔnɪk kəʊˊveɪlənt]
entanglement	[ɪnˈtæŋglmənt]
nanoengineered	[ˈnɒnəʊ endʒɪˈnɪəd]
thinning	[ˈθɪnɪŋ]
synergistic	[sɪnəˈdʒɪstɪk]
resilient	[rɪˈzɪlɪənt]
embedded	[ɪmˈbedɪd]
expertise	[ekspɜːˈtiːz]

VOCABULARY

3. Study and remember the words.

self-sustaining	самоподдерживающий
strengthening	усиливающийся, укрепляющийся
nanocomposite	нанокомпозитный
ionic-covalent	ионно-ковалентный
entanglement	переплетение, перепутывание
nanoengineered	нанотехнический
concentrations	плотность распределения
bioinks	биочернила
boost	импульс, толчок
replicate	воссоздавать, имитировать
fabricating	изготовление
cell-laden	заполненный клетками
scaffold	каркас
fidelity	точность воспроизведения
to reinforce	усилить, подкрепить
nanosilicates	наносиликат
shear thinning	истончение сдвига
synergistic	взаимоусиливающий
dually	двойственно, раздвоенно
blend	смешивать
crosslinked	сшитый
conventional	общепринятый, традиционный
density	плотность
resilient	упругий, эластичный, гибкий
embedded	встроенный, интегрированный
stiffness	плотность, устойчивость
custom	сделанный на заказ, оригинальный

READING

4. Read the text and answer the questions below.

Nanoengineered bioinks for 3D printing

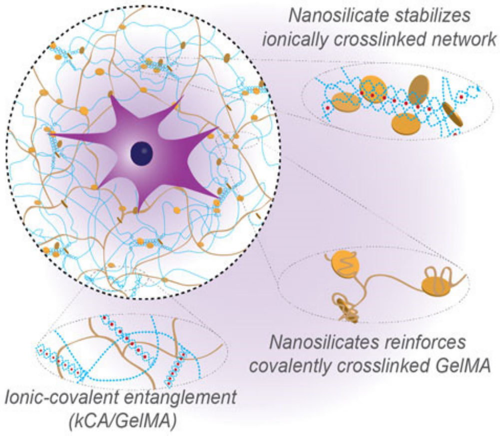
Imagine being able to print out healthy tissue with just a sample of a patient's own cells. While printed replacement human body parts might seem like science fiction, the use of 3D printing technologies for medical applications is a relatively new but rapidly expanding research field, although still quite a way from clinical application for treating patients.

Currently, two of the biggest problems facing three-dimensional (3D) bioprinting are that bioinks – a jelly-like substance consisting mostly of water – don't print with anywhere near the performance of other 3D printed materials; and they aren't strong enough at cell-friendly concentrations. In other words, currently available bioinks cannot 3D print self-sustaining anatomic-size structures containing live cells.

Another major challenge that bioinks present is their complexity. It's clear that simple polymer solutions that were initially tried are not meeting all of the requirements of bioinks, so more and more researchers are looking into state-of-the-art material science techniques to give bioinks a boost. It looks like 3D bioprinting is developing into a very multidisciplinary field that is going to require scientists to become knowledgeable outside their main field, including biology as well as materials science and chemistry, in order to develop advances.

However, not all tissue engineering labs have the necessary chemistry and materials science expertise and support to replicate the more complex designs that are coming out, which is part of the reason why researchers at Texas A&M University stuck to inexpensive and widely available ingredients to create a novel bioink. To overcome the limitations of existing bioinks, they report the development of a highly printable bioink for fabricating large scale, cell-laden, bioactive scaffolds.

"We have achieved these improvements through a novel bioink strengthening strategy that combines nanocomposite reinforcement with ionic-covalent entanglement (ICE) to create a bioactive nanoengineered ionic-covalent entanglement (NICE) bioink with excellent printability, mechanical properties, and shape fidelity", Akhilesh K. Gaharwar, an Assistant Professor at Texas A&M University, tells Nanowerk.



(Image: Inspired Nanomaterials and Tissue Engineering (iNanoTE) Lab, Texas A&M University)

The NICE bioinks use nanosilicates to reinforce an ionic-covalent entanglement hydrogel made from GelMA and κCA, creating a dually reinforced hydrogel network. These interactions allow the NICE bioink to behave as a solid at low shear stresses and improve shear thinning characteristics during bioprinting. After cross-linking, ICE and nanosilicate reinforcement synergistically improve mechanical strength. The core finding of this work is that it is possible to combine two very different hydrogel reinforcement techniques to obtain synergistic reinforcement and improved printability without sacrificing the cell-friendly nature of the hydrogel.

While nanocomposite reinforcements and dual crosslinked polymer blends (ICEs) have both been investigated separately for improving mechanical properties of hydrogels, they have never been applied simultaneously to a bioink for tissue engineering or bioprinting applications.

And it turns out that the combination (NICE) is even more effective than the sum of its individual parts. From a mechanical perspective, this is notable because conventional bioinks had to increase crosslinking density to gain mechanical strength, to a point that that was damaging to cell in the ink.

In contrast, the unique characteristics of the NICE bioink is its ability to 3D print larger, taller tissue structures that are tough and resilient, while keeping the embedded cells alive during the printing process. The high structural fidelity and mechanical stiffness of the bioprinted structures using NICE bioinks could be used as custom implants. In addition, 3D bioprinted structures from NICE bioink can be used to understand cancer progression as well as drug testing.

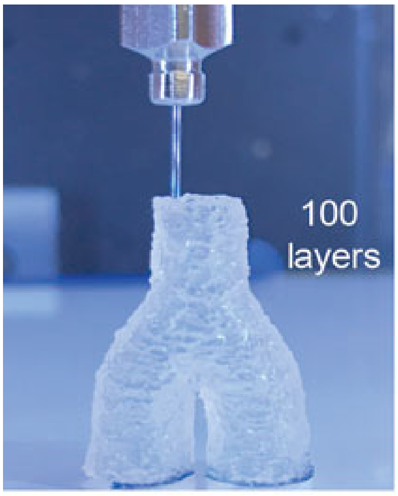
Source: Michael Berger –https://www.nanowerk.com/spotlight/spotid=49747.php

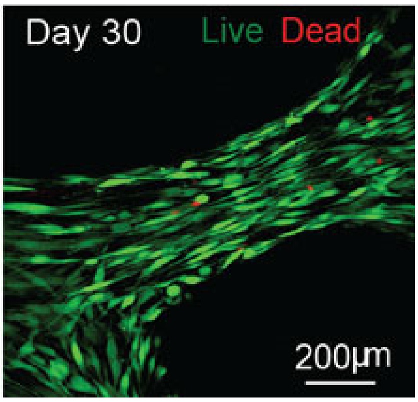
QUESTIONS:

1. What is expanding research field?
2. Name problems of (3D) bioprinting.
3. What are researchers looking into?
4. What knowledge are scientists required to know in order to develop advances?
5. What do they report to overcome the limitations of existing bioinks?
6. What allows the NICE bioink to behave as a solid?
7. Why is it possible to improve printability and to obtain synergistic reinforcement?
8. What is the main feature of the NICE bioink?

VOCABULARY WORK

5. Match pictures with their descriptions.





1) The cross-linked structures are stiff and elastomeric, and can support more than 50-times their own weight.

2) The 3D printed structures from NICE bioink have high structural fidelity.

3) The encapsulated cells aligning parallel to 3D printed NICE scaffold structures after 30 days in culture and show high survival rates.

4) The NICE bioinks print freestanding hydrogel structures with a high aspect-ratios and high print fidelity.

6. Put the verbs into right place using Past Simple, Past Continuous or Present Simple.

be (2x)	*make*	*note*	*work*	*flow*	*ask*	*start*

"As a nanomaterials lab, we _______ already _______ with nanoengineered hydrogels, so we _______ ourselves if there _______ anything more we could do to improve strength even further", _______ Gaharwar. "That ______ when we ________ experimenting with combining nanoparticles reinforcement into ionic-covalent entanglement hydrogels". The group's earlier work has already shown that nanosilicates can improve hydrogel printing because they are shear-thinning, which _______ inks ________ more smoothly. These nanosilicates are disc-shaped, mineral nanoparticles 30-50 nm in diameter and about 1 nm thick.

7. Translate these sentences into Russian in written form.

1) Nanosilicate interactions can improve stiffness, elasticity, adhesiveness viscoelastic modulus, and cell adhesion in some hydrogels, and imbue hydrogel solutions with complex fluid behavior that can improve bioprintability.
2) Furthermore, Laponite nanosilicates have shown broad biocompatibility in vivo and in vitro, and are used extensively in cosmetics and toothpastes as well as in drug delivery and tissue engineering.
3) The team is now moving on to testing their bioink in animals to obtain a much clearer picture of how NICE bioinks interact with living tissue.
4) We will be able answer questions on how quickly cells from adjoining tissue can infiltrate within the bioprinted structure.
5) While all of the materials in this NICE formulation are biocompatible, we need to evaluate how this specific formulation interacts with the body to be able to fine-tune degradation rate in order to maximize tissue regeneration.
6) As the scientists gain data from animal experiments they will be able to create specific compositions for regenerating different tissue types.

7) This will include customizing the amounts of different components in order to match target mechanical properties and incorporating drug and biomarker delivery into the structures to better control cell behavior.
8) There are some challenges, though. For one, covalent crosslinking in bioinks is most often done using photoinitiators and UV light.
9) This setup has been streamlined to require only a small application of UV-A (365nm) light and most reported research has not shown any obvious effects on cells.
10) Nevertheless, it is a concern that UV light might still be damaging cells in minor ways, so there is certainly a need to find safer photoinitiators for bioinks.

8. Put the words into the gaps changing them by adding suffixes or prefixes.

For the ink itself, its thermosensitivity, which is crucial	
to its _________, can be a challenge to work with, as	PRINT
the ink must be kept ________ above room temperature	LIGHT
during printing. It took the team some doing to find a	
way to ________ keep the ink from gelling in the print-	RELY
er tip and causing clogs. They are currently ______ new	DESIGN
printer tips that make this much ______ to manage.	SIMPLE
"We are hoping that our work can be used as a spring-	
board for _________ who want to develop their own	RESEARCH
accurate 3D __________ of human tissue parts," con-	CONSTRUCTION
cludes Gaharwar. "Accurate and cell-friendly structures	
can be used in a wide range of ________ research, in-	BIOMEDICINE
cluding tissue engineering as well as drug design, dis-	
ease progression, and cancer therapy."	

9. Guess the answers in the Quiz.

1) Chips are created, forming a relief:
– on a gold plate;

– on a silicon plate;

– on a wooden plate.

2) How many nonautomobiles can be placed in the parking lot with an area of one square millimeter?

– five;

– thousand;

– ten billion.

3) What does "nanobioreactor" stand for:

– plant;

– dolphin;

– bacteria or virus.

4) What is the name of the device for assembling nanomechanisms?

– disassembler;

– assembler;

– icosahedron.

5) With the help of nanobiotechnology medicines can be made:

– specifically for each person, given the characteristics of his body;

– one cure for all diseases for all people;

– in the era of nanotechnology people will not need any medicines.

6) What is the name of the metal that protects itself from heat?

– sweating the metal;

– freezing metal;

– protecting metal.

7) Nanoparticles of what metal effectively compete with bacteria and viruses?

– iron;

– silver;

– aluminum.

COMPREHENSION

10. Make up the rendering of the following text.

Solar Cells: New technology for cheap crystalline silicon fabrication from Russian scientists

Dramatic oil prices increase that we watched in 2008 called for alternative competing energy sources. One of them is sustainable solar energy, which in most applications is being converted to electricity using silicon photovoltaic modules. Polycrystalline silicon is a key component of solar panel construction. The photovoltaic solar industry is growing rapidly but is likely going to be very limited due to severe shortages and allocations of the polysilicon material. Currently, there are only twelve production plants for solar grade polysilicon in the world. It causes scarcity of materials for solar panels and due to that the prices for polysilicon and monosilicon scrap quickly increase.

The hydrogen pyrolysis of SiHCl3 is currently widely used to produce polysilicon. It is a very energy consuming chemical process and has low efficiency. The utilization of SiCl4 as a raw material to produce polysilicon could decrease the effectiveness of the process even lower. In addition the latter process runs in a very aggressive environment under very high temperature, which spoils purity of polysilicon. Obviously there is a need in a new highly efficient, energy saving and environmentally clean pure polysilicon production technology.

Actually we even propose to replace the one large chamber for chemical reaction by a group of smaller reactors, having mutual gas delivery and evacuation system and united computerized management and power supply system. Thus, one crystal of the polysilicon will be grown in the reactor based on 1 kW magnetron (sometimes it could be a group of silicon particles). It would allow using the power in a more rational way. It will be safer also.

Source: Eugene Birger. Principal Analyst.NanoNewsNet.ru

SPEAKING

11. In pairs, make your own NanoQuiz. Find 10 most interesting facts about nanotechnologies, present your quiz in class.

WRITING

12. Translate the following text into English.

Компания «Planetary Resources» уже озвучила планы по добыче астероидов для пополнения ресурсов воды и драгоценных металлов, а НАСА работает над программами 3D печати, которые будут применены в использовании космических ресурсов. В какой-то момент Марс будет колонизирован и терраформирован с помощью миллиардов экороботов, создающих атмосферу, влажность и удобрения. Отдалённые планеты, так как нам нужно будет постоянно преобразовывать энергию Солнца.

Нанотехнология является ключом к решению этого вопроса. Когда космический корабль будут собирать машины, а не люди, из сырья, добытого в космосе, тогда эти же машины смогут построить очень близко к Солнцу гигантские солнечные улавливатели, которые будут направлять энергию. Энергия – это благосостояние, которое можно превращать в ресурсы или расходовать на ресурсы. Посредством такой энергии будущего можно будет избежать смерти. В будущем появятся напечатанные 3D кибернетические устройства наряду с напечатанными органами, и нанотехнология сможет значительно увеличить продолжительность жизни, контролируя и влияя на здоровье в реальном времени с помощью роботов здоровья в кровотоке. Как только нервная система человека будет синтезирована, мы окажемся на шаг ближе к прекращению существования наших физических тел и свободному перемещению нашего сознания в виртуальные реальности. По словам известного футуролога Рэя Курцвейла: «Вы сможете жить достаточно долго, чтобы жить вечно».

Source: Теория нанотехнологии о печатании вечности

http://3dpmake.com/post/1-nano-tech

Text 4

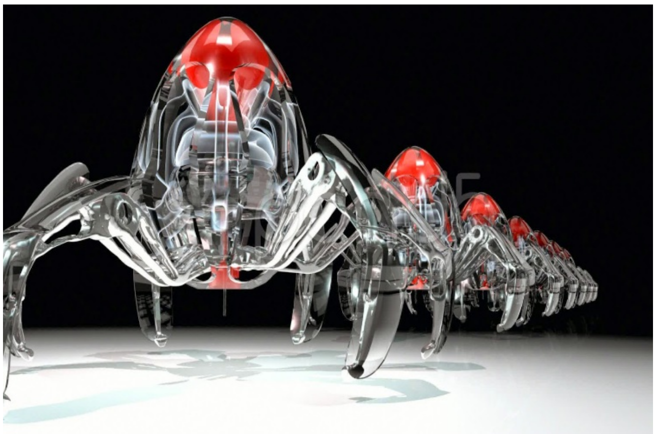
Mind the gap – nanotechnology robotics vision versus lab reality

PRE-READING

1. Answer the following questions.

1) Nanotechnology is young and little known science, what are the benefits and dangers for humans and for all mankind?

2) Is the emergence of fundamentally new types of weapons based on these technologies possible?



2. Practice reading the following words.

realm	[relm]
nanoactuators	[nænəˈæktjʊeɪtə]
mundane	[ˈmʌndeɪn]
actuation	[ækʧʊˈeɪʃn]
spatial	[ˈspeɪʃəl]
quintessential	[kwɪntɪˈsenʃəl]
comparable	[ˈkɔmpərəbl]
synthesis	[ˈsɪnθɪsɪs]
shrinking	[ˈʃrɪŋkɪŋ]
piezoelectrics	[paɪəzəʊəˈlektrɪks]

VOCABULARY

3. Study and remember the words.

realm	сфера, область
nanofabrication	нанопроизводство
nanoactuators	нанопривод, исполнительное наноустройство
holy grail	idiom заветная мечта
assembler	сборочно-монтажное устройство
self-replication	саморепродукция
mundane	повседневный, рутинный, будничный
actuation	срабатывание, запуск, включение, приведение в действие
spatial	пространственный
quintessential	наиболее существенный
inorganic	неорганическое соединение
due to	благодаря, с помощью, обусловленный чем-л.
comparable	сопоставимый, сравнимый, соизмеримый
array	большое количество, целый ряд
synthesis	обобщение
linear	линейный
tradeoff	выбор оптимального соотношения
relatively	относительно, довольно
shrinking	сокращающийся, уменьшающийся
piezoelectrics	пьезокерамика

READING

4. Read the text and answer the questions below.

Mind the gap – nanotechnology robotics vision versus lab reality

Science fiction style robots like Star Wars' R2-D2 or the NS-5 model in I, Robot firmly belong into the realm of Hollywood – and so do "nanobots" à la Michael Crichton's Prey. Staying with both feet firmly on scientific ground, robotics can be defined as the theory and application of robots, a completely self-contained electronic, electric, or mechanical device, to such activities as manufacturing. Scale that robot down to a few billionth of a meter and you are talking nanotechnology robotics; nanorobotics in short.

The field of nanorobotics brings together several disciplines, including nanofabrication processes used for producing nanoscale robots, nanoactuators, nanosensors, and physical modeling at nanoscales. Nanorobotic manipulation technologies, including the assembly of nanometer-sized parts, the manipulation of biological cells or molecules, and the types of robots used to perform these tasks also form a component of nanorobotics.

Nanorobotics might one day even lead to the holy grail of nanotechnology where automated and self-contained molecular assemblers not only are capable of building complex molecules but build copies of themselves – "self-replication" – or even complete everyday products.

Whether this will ever happen is hotly debated – to understand where both sides stand, read the famous 2003 debate where Drexler and Smalley make the case for and against molecular assemblers. Today's nanorobotics research deals with more mundane issues such as how to build nanoscale motors and simple nanomanipulators.

Nanotechnology robots are quintessential NEMS (nanoelectromechanical systems) and raise all the important issues that must be addressed in NEMS design: sensing, actuation, control, communications, power, and interfacing across spatial scales and between organic and inorganic materials. Due to their size, comparable to biological cells, nanorobots have a vast array of potential applications in fields such as environmental monitoring or medicine.

"Ultimately, one of the most important applications of nanorobotic manipulation will be nanorobotic assembly" Bradley J. Nelson explains to Nanowerk. "However, it appears that until assemblers capable of replication can be built, the parallelism of chemical synthesis and self-assembly are necessary when starting from atoms".

Actuation at the nanoscale

The positioning of nanorobots and nanorobotic manipulators depends largely on nanoactuators, i.e. nanoscale devices that create mechanical motion by converting various forms of energy to rotating or linear mechanical energy.

"During the design of an actuator, the tradeoffs among range of motion, force, speed (actuation frequency), power consumption, control accuracy, system reliability, robustness, load capacity, etc. must be taken into consideration" says Nelson.

While nano-sized actuators for nanorobots are still under exploration and relatively far from implementation, microelectromechanical system (MEMS)-based efforts are focused on shrinking their sizes. The various nanoactuation principles include electrostatics, electromagnetics and piezoelectrics.

Source: Michael Berger https://www.nanowerk.com/spotlight/spotid=1730.php

QUESTIONS:

1. What disciplines does nanorobotics bring together?
2. What nanofabrication processes used for?
3. What do nanorobotic manipulation technologies include?
4. What automated and self-contained molecular assemblers are capable of?
5. What mundane issues does nanorobotics research deal with?
6. In what field do nanorobots have a great potential applications?
7. Why are the parallelism of chemical synthesis and self-assembly necessary?
8. What does the positioning of nanorobots and nanorobotic manipulators depend on?
9. What must be taken into consideration during the design of an actuator?
10. What do the various nanoactuation principles include?

5. Translate these sentences into Russian in written form.

Nanorobotic manipulation systems

1) With the invention of the scanning tunneling microscope in 1981 at the IBM research laboratory in Zurich, Switzerland, began the development of a series of scanning probe microscopes (SPM).

2) They are based on different physical principles, that allowed scientists not only to look at nanoscale objects but also to touch and manipulate them.

3) Atomic Force Microscopes, Scanning Tunnelling Microscopes as well as other SPMs and optical and magnetic tweezers are now used extensively for positional and/or force control at the nanoscale. This process is called nanomanipulation.

4) A nanomanipulation system generally includes nanomanipulators as the positioning device, microscopes as 'eyes', various end-effectors including probes and tweezers among others as its 'fingers', and types of sensors (force, displacement, tactile, strain, etc.)

5) All of these help to facilitate the manipulation and/or to determine the properties of the objects.

6) Example of a nanorobotic manipulator that features up to four positioners that grasp, move, test, and optimally position micro- and nanoscale samples with four axes of movement.

7) Three basic types of nanomanipulation processes are performed: Lateral noncontact nanomanipulation (sliding); lateral contact nanomanipulation (pushing/pulling); and vertical nanomanipulation (picking and placing).

8) The choice of which process to use is dependent on the environment (air, liquid, vacuum), the properties and size of the objects and the observation methods.

6. Match these phrases with the translation.

1) Nanorobotic manipulation;

2) master–slave control;

3) quartz substrates;

4) nanoscale resolution;

5) production-oriented technique;

6) controlled nanoassembly;

7) mesoscopic physics;

8) promising strategy;

9) genuine benefits;

10) carbon nanotubes;

11) accurate actuators;

12) directed self-assembly.

A) Реальная выгода;

B) нанорobототехническая обработка;

C) точный электровоспламенитель (актуатор);

D) контролируемая наносборка (наноузел);

E) кварцевая подложка;

F) нанометровое разрешение;

G) копирующее управление;

H) перспективная стратегия;

I) углеродная нанотрубка;

J) мезоскопическая физика;

K) направленная самосборка;

L) метод направленный на производство.

7. Put the phrases from exercise 6 into the gaps of text.

Nanorobotic assembly

"Nanomanipulation is a _________ ________ for nanoassembly" says Nelson. "Key techniques for nanoassembly include the structuring and characterization of nano building blocks, the positioning and orientation control of the building blocks with ________ ________, and effective connection techniques". A ________ _________ requires two basic abilities: to anchor a nanoscale structure in a defined location, preferably without anchoring every molecule, and to assemble and chemically couple molecules between anchor points in three dimensions with full position and orientation controls.

One example for effective 3-D ________ ________ is the structuring and assembly of ________ ________ into nanodevices. Nelson cautions that, "at present nanomanipulation is still performed in a serial manner with _______ ________, which is not a large-scale ________ _________. Nevertheless, with advances in the exploration of ________ _________, better control of the synthesis of nanotubes, more ________ _________, and effective tools for manipulation, high-speed and automatic nanoassembly will be possible".

"Many in the field believe that one future for nanotubes will be as digital electromechanical logic elements in future computers" says Nelson. "There are _________ ________ over silicon, but there is a lot of work to do to get there. Our recently published work on batch fabrication of carbon nanotube bearings using dielectrophoretic ________ ________ is one possible avenue, but there are other promising approaches, such as John Rogers' work at the University of Illinois at Urbana-Champaign on growing CNTs on ________ _________. It is certainly an exciting time to be working in this field".

Source: Michael Berger https://www.nanowerk.com/spotlight/spotid=1730.php

8. Translate the sentences into English.

1) Нанороботы – роботы, созданные из наноматериалов и размером сопоставимые с молекулой. Они должны обладать функциями движения, обработки и передачи информации, исполнения программ.

2) Размеры нанороботов не превышают нескольких нанометров. Согласно современным теориям, нанороботы должны уметь осуществлять двустороннюю коммуникацию: реагировать на акустические сигналы и быть в состоянии подзаряжаться или перепрограммироваться извне посредством звуковых или электрических колебаний.

3) Также важной представляются функции репликации – самосборки новых нанитов и программированного самоуничтожения, когда среда работы, например, человеческое тело, более не нуждается в присутствии в нем нанороботов. В последнем случае роботы должны распадаться на безвредные и быстовыводимые компоненты.

4) Немало нанотехнологических устройств уже создано и хотя они пока являются экспериментальными разработками, практические перспективы очевидны.

5) Разработан наноэлектродвигатель, имеющий обмотку из одной длиной молекулы, способной без потерь передавать ток. При подаче напряжения начинал вращаться ротор, состоящий из нескольких молекул.

6) Существует также устройство линейной транспортировки, способное перемещать молекулы на заданное расстояние. Разрабатываются также молекулярные биосенсоры, антенны, манипуляторы.

7) Сфера применения нанороботов очень широка. По сути, они могут быть необходимы при создании, отладке и поддержании функционирования любой сложной системы.

8) Наномашины могут применяться в электронике для создания миниустройств или электрических цепей – данная технология называется молекулярной наносборкой. В перспективе любая сборка на заводе из компонентов может быть заменена простой сборкой из атомов.

COMPREHENSION

9. Make up the rendering of the following text.

Key Applications of Nano and Micro-Machines

The applications of these nano and micro-machines are nearly endless.

Here are some of the most exciting ones:

Cancer Treatment: Identifying and destroying cancer cells more accurately and effectively.

Drug Delivery Mechanisms: Targeted drug delivery mechanisms for disease control and prevention.

Medical Imaging: Creating nanoparticles that gather in certain tissues and then scanning the body with a magnetic resonance imaging (MRI) could help highlight problems such as diabetes.

New Sensing Devices: With near limitless customizable sensing properties, nanorobotics would unlock new sensing capabilities we can integrate into our systems to monitor and measure the world around us.

Information Storage Devices: A bioengineer and geneticist at Harvard's Wyss Institute have successfully stored 5.5 petabits of data – around 700 terabytes – in a single gram of DNA, smashing the previous DNA data density record by a thousand times.

New Energy Systems: Nanorobotics might play a role in developing more efficient renewable energy system. Or they could make our current machines more energy efficient such that they'd need less energy to operate at the same or high capacities.

Super-strong Metamaterials: There is lots of research going into these metamaterials. A team out of Caltech developed a new type of material, made up of nanoscale struts crisscrossed like the struts of a tiny Eiffel Tower, that is one of the strongest and lightest substances ever made.

Smart Windows and Walls: Electrochromic devices, which dynamically change color under applied potential, are widely studied for use in energy-efficient smart windows – these can control the internal temperature of a room, clean themselves, and more.

Ocean-cleaning Microsponges: A carbon nanotube sponge capable of soaking up water contaminants such as fertilizers, pesticides and pharmaceuticals more than three times more efficiently than previous efforts has been presented in a study published in IOP Publishing's journal Nanotechnology.

Replicators: Also known as a "Molecular Assembler", this is a proposed device able to guide chemical reactions by positioning reactive molecules with atomic precision.

Health Sensors: These sensors could monitor our blood chemistry, notify us when something is out of whack, detect spoiled food or inflammation in the body, and more.

Connecting Our Brains to the Internet: scientists believe nanorobots will allow us to connect our biological nervous system to the cloud by 2030.

Source: Nanorobots: Where We Are Today and Why Their Future Has Amazing Potential https://singularityhub.com/2016/05/16/nanorobots-where-we-are-today-and-why-their-future-has-amazing-potential/#sm.000sys3a41a4mf97x031942d06xlp

SPEAKING

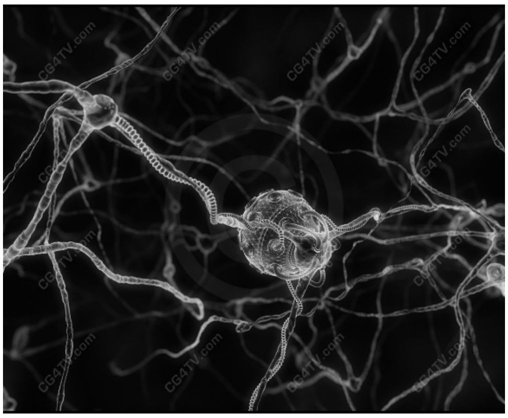
10. Speak about 3 minutes on the following topic: *Nanorobots – man-made creation the size of a molecule that are designed to perform the most important tasks in various spheres of life, from science to medicine, from military technology to space exploration. Previously, nanotechnology existed only in fiction and film, but in recent years, the leading scientific centers of all developed countries of the world give this topic of paramount importance. Development of full-fledged technology of nanorobots will radically change the world science and will bring us closer to the enchanting future that science fiction has been waiting for.*

11. Make a presentation *"Nanorobots: future in the present – Nanorobots in medicine; Nanorobots in the third world war".*

WRITING

12. Translate the following text into English.

Нанороботы: сегодня и завтра



Команды по всему миру работают над созданием первого практичного медицинского наноробота. Роботы от миллиметра в диаметре до относительно громоздких, в два сантиметра длиной, уже существуют, хотя и не испытываются на людях. Возможно, мы всего в нескольких годах от выхода нанороботов на медицинский рынок. Сегодняшние микророботы остаются прототипами, которым не хватает способностей выполнять медицинские задачи.

В будущем нанороботы могут совершить революцию в медицине. Врачи смогут лечить все, от сердечно-сосудистых заболеваний до рака, при помощи крошечных роботов, по размерам сопоставимых с бактериями, намного меньших, чем нынешние нанороботы. Некоторые считают, что полуавтономные нанороботы уже вот-вот будут доступны – доктора смогут имплантировать роботов, способных патрулировать человеческое тело и реагировать на любые проблемы. В отличие от экстренного лечения, эти роботы будут оставаться в теле пациента навсегда.

Другое потенциальное применение нанороботов в будущем – укрепление нашего тела, повышение иммунитета, увеличение силы или даже улучшение интеллекта. Сможем ли мы в один прекрасный день обнаружить тысячи микроскопических роботов, плывущих по нашим венам и вносящим коррекции и изменения в наши разрушенные тела? С нанотехнологиями, похоже, все будет возможно.

Source: Как будут работать нанороботы? https://hi-news.ru/technology/kak-budut-rabotat-nanoroboty.html

Test 3 (Unit 3)

1. Translate the following words and word combinations into Russian:

1) Nanofabrication;

2) Iris;

3) Cellular;

4) Super-fine;

5) Boost;

6) Tradeoff;

7) Assembler;

8) Corrosion-resistant coating;

9) Nanoscale resolution;

10) Shear thinning.

2. Translate the following words and word combinations into English:

1) Саморепродукция;

2) Прямое производство водорода;

3) Узор сетчатки глаза;

4) Возможности человека;

5) Молекулярные процессоры;

6) Точность воспроизведения;

7) Биочернила;

8) Нанопривод;

9) Кварцевая подложка;

10) Углеродная нанотрубка.

3. Give the full names to the following abbreviations and translate them:

NEMS – ______________

AI – __________________

ICE – ________________

NICE – _______________

MEMS – ______________

DNA – _______________

4. Translate the sentences into Russian:

1) As the scientists gain data from animal experiments they will be able to create specific compositions for regenerating different tissue types.

2) Nanotechnology sounds like a world of great promise, but there are controversial issues too that must be considered and resolved.

3) Proponents say misconceptions and misrepresentation of nanotechnology's potential have fuelled many dystopian scenarios.

4) The team is now moving on to testing their bioink in animals to obtain a much clearer picture of how NICE bioinks interact with living tissue.

5) If you look around at the moment in a big city, a significant proportion of material that you breathe in is already particulates – and a proportion of that is nanosized, like diesel emissions.

5. Translate Russian sentences into English:

1) В ближайшем будущем нанотехнология сможет значительно увеличить продолжительность жизни, контролируя и влияя на здоровье в реальном времени с помощью роботов здоровья в кровотоке.

2) Молекулярные процессоры можно будет встраивать в любые, даже самые крошечные устройства, внедрять их в волокна ткани, превращая одежду в надеваемый компьютер.

3) Планируется создание нанороботов размером всего 1–2 микрон, которые смогут выполнять разнообразные функции.

4) Основные компоненты молекулярного компьютера должны быть теми же, что и у обычного компьютера: система ввода информации, вычислительный блок (процессор), система хранения информации (память) и, наконец, система вывода информации.

5) Согласно современным теориям, нанороботы должны уметь осуществлять двустороннюю коммуникацию: реагировать на акустические сигналы и быть в состоянии подзаряжаться или перепрограммироваться извне посредством звуковых или электрических колебаний.

SUPPLEMENTARY READING

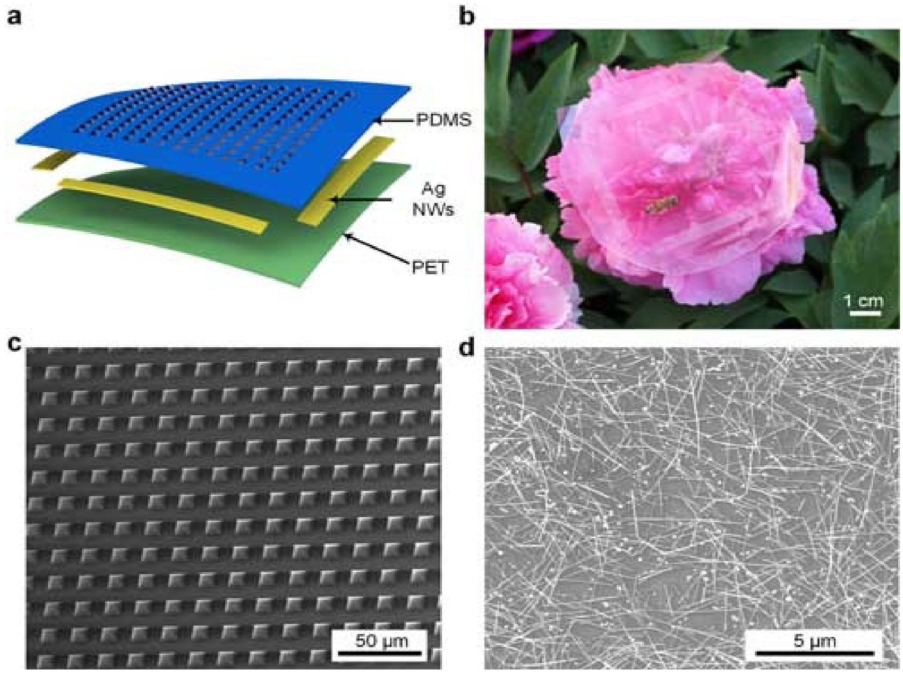
TEXT 1. An analogue smart skin that is self-powered

In order to make robots and robotic technology more human-like and more human-friendly, *smart skin* technology is a critical element that helps robots sense the world. These electronic or smart skins could help machines to accurately perceive the environment and better assist human owners.

However, conventional smart skins – no matter if they are based on resistance, capacitance or transistors – all need a power supply. It's kind of awkward for users to have a high-tech, state-of-the-art thin, flexible and light-weight smart skin and have to power it with a hard and heavy battery which can just work for hours.

Furthermore, in conventional smart skins higher resolution always means higher energy consumption and complex circuits. These two aspects need to be carefully balanced to result in a practical device. So the obvious question is: Is it possible to achieve higher resolution and at the same time reduce energy consumption?

A self-powered smart skin as the one just recently developed by a team of Chinese researchers fundamentally solves this problem. In this work, the scientists combine the triboelectric effect and planar electrostatic induction and apply it in a subtle device structure for the first time to create a self-powered analogue smart skin.



Structure of analogue smart skins. (a) Schematic diagram of an analogue smart skin. (b) Optical image of the transparent, flexible, and lightweight smart skin. The smart skin with a honey bee landing on it will not deform the peony. (c) SEM image of microstructures on the PDMS film. (d) SEM image of the silver nanowire electrodes. (Reprinted with permission by American Chemical Society)

Reporting their findings in *ACS Nano* ("Self-Powered Analogue Smart Skin"), a team led by Prof. Haixia Zhang at the National Key Laboratory of Science and Technology on Micro/Nano Fabrication, Peking University, presents a self-powered analogue smart skin to detect location as well as contact velocity, based on a single-electrode contact electrification effect and planar electrostatic induction.

In this paper, the team presents two significant achievements. The first is that their smart skin is intrinsically self-powered.

"We use spontaneous triboelectric charges, combined with planar electrostatic induction, to sense the touch applied on the smart skin", Zhang explains to Nanowerk. "Triboelectric charges occur in our daily life everywhere when two surfaces touch each other. And when the charged surface approaches a metal block (or electrode) it will induce the opposite charge, which is the so-called 'electrostatic induction' effect".

The beauty of this approach is that it makes use of the charges from triboelectric effect – which exist everywhere. Imagine a scenario, when you want to drink some coffee: you walk towards a table, and by doing so the opposite charges will be generated on the surface of shoes and ground respectively; you pick up the cup to drink, and the opposite charges will be generated on the skin of your palm and the handle of the cup; furthermore, even swallowing the coffee will generate charges on the surface of your digestive tract and the coffee.

The Chinese researchers utilize these spontaneous – but often be ignored – charges to make their smart skin completely self-powered.

The intensity of the electrostatic induction effect depends on the distance between the charged surface and the metal electrode. The scientists use fixed electrodes to detect the intensity of the electrostatic induction effect, allowing them to confirm the location based on the relative intensity.

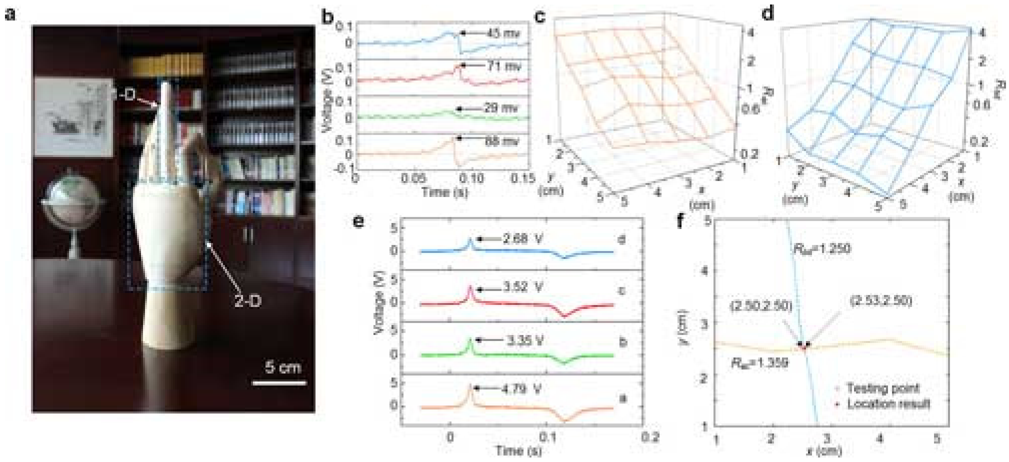
That way, no extra power supply is required for operating the analogue smart skin.

The second achievement is that only four electrodes are necessary to achieve millimeter bi-dimensional resolution (precision) because of the utilization of analogue localizing method to sense the touch stimulation.

"Compared with the previous works (see references 1–3 below), this smart skin reduces the number of electrodes remarkably", Zhang points out. "This helps a lot to reduce the complexity of the signal processing circuit. Although using less electrodes, our smart skins achieve 1.9 mm resolution, much better than previous results".

She notes that, compared with digital smart skins which have been studied extensively, analogue smart skins still need more in-depth study.

"Analogue smart skins have obviously advantages at resolution and energy consumption", she says. "I hope our work can draw more attention to the field of analogue smart skins. Furthermore, it will contribute to the areas of artificial intelligence and portable electronics as the self-powered high-resolution sensor offers a solution for smart skin applications".



Use of smart skin on an artificial hand. (a) Photograph of an artificial hand covered by two-dimensional analogue smart skins on the curved back of the hand and one-dimensional analogue smart skins on the middle finger. (b) Voltage output when a honey bee approaches and leaves the two-dimensional smart skin swiftly. (c,d)

Voltage ratios of electrodes a-d. (e) Voltage output when the two-dimensional smart skin on the artificial hand is touched. (f) Location result of analogue smart skins. The testing point is (2.50, 2.50), and the result is (2.53, 2.50), with a slight deviation of only 0.3 mm. (Reprinted with permission by American Chemical Society) (click on image to enlarge)

Going forward, the team will work on the stretchability of their smart skin (the current version is not stretchable) and on improving the resolution. According to the team, due to the theoretically infinite resolution, there still is plenty of room to improve on the current performance. Furthermore, they will try to integrate more sensing parameters as well as signal transmission in the design.

Last but not the least, they will explore approaches to shield the smart skin from environmental interference, which is critical for practical applications.

Zhang notes that the current device design provides opportunities for including additional sensing capabilities such as temperature, contact velocity, or gas composition.

TEXT 2. Top 5 Trends in Nanotechnology

For many, nanotechnology is viewed as merely a way to make stronger and lighter tennis rackets, baseball bats, hockey sticks, racing bikes, and other athletic equipment. But nanotechnology promises to do so much more. A more realistic view is that it will leave virtually no aspect of life untouched and is expected to be in widespread use by 2020. Mass applications are likely to have great impact particularly in industry, medicine, new computing systems, and sustainability. Here are some underlying trends to look for, many interconnected, and all expected to continue to accelerate.

1. Stronger Materials/Higher Strength Composites

The next generation of graphene and carbon nanotube-based devices will lead to even lighter but stronger structures than has been made possible by carbon fiber and will become increasingly obvious in cars, bicycles, and sporting equipment, says Clint Landrock, chief technology officer of NanoTech Security.

Dr. Samuel Brauer, founder Nanotech Plus, an alliance of consultants offering analysis and operational assistance about the business of nanotechnology, cites as one area of advancement the development of carbon nanotube pre-impregnated materials which offer better conduction, overcoming one of the major challenges of conventional carbon fiber/epoxy composites. He notes that carbon nanotube meshes have already flown on some space missions, for example, the Juno probe to Jupiter.

2. Scalability of Production

One big challenge is how to produce nanomaterials that makes them affordable. According to Dr. Timothy Fisher, Purdue University professor of mechanical engineering, technologies that can impact grand challenge problems such as food, water, energy, and environment must be scalable.

"The main reason that these problems are so grand is that they are ubiquitous and therefore the related commercial markets have become commoditized. Very often, a technology that exploits a unique attribute of a nanomaterial can offer improvements in functional or engineering performance, but almost as often, these technologies require scarce materials (and therefore expensive) or slow or complicated manufacturing processes (and also expensive). "That limited scalability often hinders application despite outstanding functional performance in the laboratory or prototype stage, he explains.

3. More Commercialization

Over the next several years, significant advances are expected in carbon nanotube manufacturing technology, specifically in controlling the purity and structure, and in reducing costs due to economies of scale, according to David J. Arthur, CEO, SouthWest NanoTechnologies, a producer of carbon nanotubes.

"Advances will make the use of carbon nanotube materials even more compelling for mechanical engineers", he says. In addition to transforming the automotive, aerospace, and sporting goods fields, nanotechnology is facilitating so many diverse improvements: thinner, affordable, and more durable flat panel displays; improved armor materials to protect soldiers; sensors for medical testing; more humane and effective treatments for cancer patients; enhanced cathode materials for safer and longer life Li-ion batteries; and the list goes on.

4. Sustainability

One main goal of the National Nanotechnology Initiative, a U.S. government program coordinating communication and collaboration for nanotechnology activities, is to find nanotechnology solutions to sustainability. Mike Nelson, chief technology officer, NanoInk Inc., says nanomaterials and nanostructured surfaces are increasingly employed in many advanced energy storage and conversion projects, and nanomaterials and nanomanufacturing contribute to products that are more energy efficient in both production and use.

Dr. Eric Majzoub, associate director, Center for Nanoscience, University of Missouri - St. Louis, says this is done by controlling thermodynamics of solid-solid reactions through nanoscale size reduction and it can improve energy-storage materials including batteries, supercapacitors and hydrogen storage.

Nelson sees the greatest near-term impact in sustainability coming in the areas of transportation (more efficient and lighter materials for autos and aircraft, requiring less fuel) and in three other related areas: lighting, photovoltaics, and energy storage. "The types of nano technologies being employed in all three of these are similar in terms of using nanostructured surfaces or materials to improve efficiencies from an electronic performance perspective whether it's batteries or solar cells or LED lighting", he adds.

5. Nanomedicine

Nowhere is the application of nanotechnology more exciting than in the biomedical field, where advances are being made in both diagnostics and treatment areas. Houston-based Nanospectra Biosciences has been developing a new therapy using a combination of gold nanoshells and lasers to destroy cancer tumors with heat. Based on work done by Rice University professors, Dr. Naomi Halas and Dr. Jennifer West, the technology promises to destroy tumors with minimal damage to adjacent healthy tissue.

John Stroh, Nanospectra CEO, says he is hoping for European approval in the second or third quarter of this year and FDA approval early next year after 10 years of ongoing development and testing. In the diagnostics area, nanosensors that can detect, identify, and quantify biological substances in body fluids are leading to early disease detection and earlier treatments as well as the ability to detect environmental contaminants in the body.

TEXT 3. Merging nanotechnology and liquid crystals for better displays

(Nanowerk Spotlight) Liquid crystals displays (LCDs) are widely used for laptops, smartphones, tablets etc. Typically, an electric field applied across a thin layer of liquid crystals changes their physical properties thus enabling the use of liquid crystalline materials in displays.

Small traces of ions inherently present in liquid crystal materials can compromise the overall performance of liquid crystal devices leading to various side effects such as image sticking, image flickering, or slow response.

Ideally, the amount of ions in liquid crystals designed for display applications should be as small as possible. However, even highly purified liquid crystals can get contaminated in uncontrollable ways during device manufacturing or during its daily use. This uncontrollable contamination is a serious challenge that needs to be overcome.

One promising solution can be found by merging liquid crystals and nanotechnology. In short, nanoparticles dispersed in liquid crystals can trap mobile ions thus reducing their concentration and providing a permanent purification of liquid crystals. This simple concept was tested by many independent research groups (more details can be found in a recent review: Crystals, "Nano-Objects and Ions in Liquid Crystals: Ion Trapping Effect and Related Phenomena").

We have highlighted the necessity to consider the ionic purity of nanoparticles for the correct interpretation of experimental results and achieving the purification and/or contamination of liquid crystals in two previous Nanowerk Spotlights: "Ionic purity of nanoparticles is key to switching between purification and contamination regimes in liquid crystal devices" and "A nanotechnology approach to purifying liquid crystals".

"The majority of the reported experimental results do not discuss the effect of substrates on the purification / contamination regimes achieved in liquid crystals doped with nanoparticles", Yuriy Garbovskiy, PhD, a researcher at the UCCS BioFrontiers Center & Department of Physics, University of Colorado, tells Nanowerk. "However, liquid crystals sandwiched between two substrates constitute a major component of practically any electro-optical device utilizing these materials. Therefore, the consideration of the interactions of ions with substrates of the liquid crystal cell is very important".

An analysis of the combined effect of nanoparticles and substrates on the concentration of mobile ions in liquid crystals is the focus of Garbovskiy's recent paper in Applied Physics Letters ("Ion capturing/ion releasing films and nanoparticles in liquid crystal devices"). His analysis considers both 100% pure and contaminated with ions substrates (alignment layers) and nanoparticles.

These results could be very useful for R&D engineers trying to apply nanotechnology to liquid crystal devices. Specifically, the control of mobile ions in liquid crystals by means of nanoparticles and substrates of the cell tailored for specific applications – liquid crystal displays, light shutters, switches, modulators, etc.

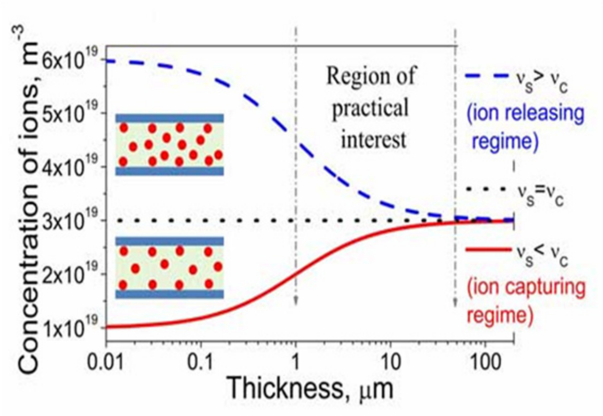


Figure 1. The dependence of the concentration of mobile ions in the cell filled with pristine liquid crystals on the thickness of the cell. The ionic purity of substrates is quantified by means of the dimensionless contamination factor vS. (Image: Dr. Yuriy Garbovskiy, University of Colorado, Colorado Springs)

"In general, we should consider interactions of ions in liquid crystals with both substrates and nanoparticles", says Garbovskiy. "To understand how substrates of the cell can affect the concentration of mobile ions in liquid crystals consider pristine (no nanoparticles are added) liquid crystals. Mobile ions in liquid crystals can stick to the surface of the substrates (the adsorption process)".

As a result, this process leads to the reduction in the concentration of mobile ions as shown in Figure 1 (solid curve). As can be seen from this, the magnitude of this effect depends on the cell thickness. It is very pronounced if relatively thin cells are used and becomes negligibly small in the case of relatively thick cells. The reduction in the concentration of mobile ions can always be observed if 100 % substrates are used.

However, the use of contaminated substrates can result in three different regimes, namely, the ion capturing regime (Figure 1, solid curve), the ion releasing regime (Figure 1, dashed curve), and no change in the concentration of mobile ions (Figure 1, dotted curve).

"If nanoparticles are added to liquid crystals, we should consider the combined effect of substrates and nanoparticles", notes Garbovskiy.

Some of these effects are shown in Figure 2.

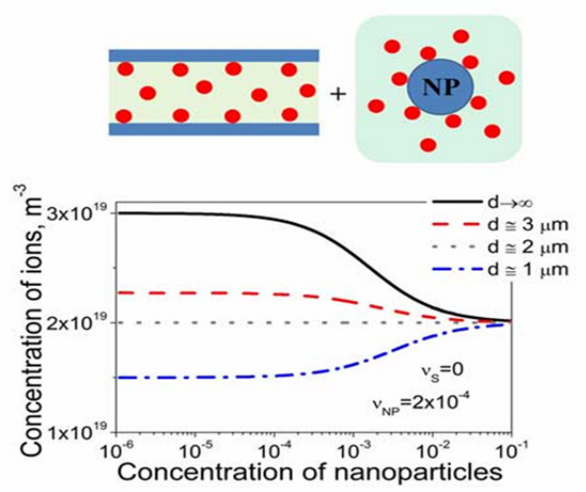


Figure 2. The dependence of the concentration of mobile ions in the cell filled with liquid crystal nanocolloids (liquid crystals doped with nanoparticles) on the weight concentration of nanoparticles calculated at several values of the cell thickness, d. Nanoparticles are contaminated with ions (the contamination factor vNP=0.0002) and the substrates are 100 % pure (the contamination factor vS=0). (Image: Dr. Yuriy Garbovskiy, University of Colorado, Colorado Springs)

As can be seen from Figure 2, depending on the cell thickness, different types of the behavior can be observed. Garbovskiy's recent paper in APL provides a detailed discussion of scenarios which can be achieved if the combined effect of substrates and nanoparticles is taking into account.

All these effects are very sensitive to the ionic purity of both nanoparticles and substrates of the liquid crystal cell.

These results have important practical implications. Figures 1 and 2 indicate that the electrical properties of liquid crystals and liquid crystal nanocolloids depend on the thickness of the cell. Moreover, this dependence is a strong function of the ionic purity of both nanoparticles and substrates of the cell.

As Garbovskiy points out: "We should revisit standard procedures used to characterize electrical properties of liquid crystals and include electrical measurements taken at different values of the cell thickness to the existing experimental protocols. The type of substrates used in experiments should be specified. Moreover, the manufacturers of liquid crystals should add all mentioned information to the materials datasheets".

The next step in his research will be to study various types of ion-capturing/ion-releasing substrates to compile a database and identify the most promising candidates.

"In my recent paper I assumed fully ionized symmetrical species of a single type; in other words: positive and negative ions are characterized by the same values of their adsorption/desorption rate constants", Garbovskiy says. "The consideration of ionic species of several types is also very interesting and important".

"Research on ions and nano-objects in liquid crystals is very diverse; it can go different ways by exploring various combinations of substrates, nanoparticles and liquid crystals", he concludes. "The design and characterization of ion-capturing/ion-releasing films and nanoparticles for their use in liquid crystal devices is a very interesting and promising direction".

TEXT 4. How Stuff Works

There's an unprecedented multidisciplinary convergence of scientists dedicated to the study of a world so small, we can't see it – even with a light microscope. That world is the field of nanotechnology, the realm of atoms and nanostructures. Nanotechnology i¬s so new, no one is really sure what will come of it. Even so, predictions range from the ability to reproduce things like diamonds and food to the world being devoured by self-replicating nanorobots.

In order to understand the unusual world of nanotechnology, we need to get an idea of the units of measure involved. A centimeter is one-hundredth of a meter, a millimeter is one-thousandth of a meter, and a micrometer is one-millionth of a meter, but all of these are still huge compared to the nanoscale. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair.

As small as a nanometer is, it's still large compared to the atomic scale. An atom has a diameter of about 0.1 nm. An atom's nucleus is much smaller – about 0.00001 nm. Atoms are the building blocks for all matter in our universe. You and everything around you are made of atoms. Nature has perfected the science of manufacturing matter molecularly. For instance, our bodies are assembled in a specific manner from millions of living cells. Cells are nature's nanomachines. At the atomic scale, elements are at their most basic level. On the nanoscale, we can potentially put these atoms together to make almost anything.

In a lecture called "Small Wonders: The World of Nanoscience," Nobel Prize winner Dr. Horst Störmer said that the nanoscale is more interesting than the atomic scale because the nanoscale is the first point where we can assemble something -- it's not until we start putting atoms together that we can make anything useful.

In this article, we'll learn about what nanotechnology means today and what the future of nanotechnology may hold. We'll also look at the potential risks that come with working at the nanoscale.

In the next section, we'll learn more about our world on the nanoscale.

Experts sometimes disagree about what constitutes the nanoscale, but in general, you can think of nanotechnology dealing with anything measuring between 1 and 100 nm. Larger than that is the microscale, and smaller than that is the atomic scale.

Nanotechnology is rapidly becoming an interdisciplinary field. Biologists, chemists, physicists and engineers are all involved in the study of substances at the nanoscale. Dr. Störmer hopes that the different disciplines develop a common language and communicate with one another. Only then, he says, can we effectively teach nanoscience since you can't understand the world of nanotechnology without a solid background in multiple sciences.

One of the exciting and challenging aspects of the nanoscale is the role that quantum mechanics plays in it. The rules of quantum mechanics are very different from classical physics, which means that the behavior of substances at the nanoscale can sometimes contradict common sense by behaving erratically. You can't walk up to a wall and immediately teleport to the other side of it, but at the nanoscale an electron can - it's called electron tunneling. Substances that are insulators, meaning they can't carry an electric charge, in bulk form might become semiconductors when reduced to the nanoscale. Melting points can change due to an increase in surface area.

Much of nanoscience requires that you forget what you know and start learning all over again.

So what does this all mean? Right now, it means that scientists are experimenting with substances at the nanoscale to learn about their properties and how we might be able to take advantage of them in various applications. Engineers are trying to use nano-size wires to create smaller, more powerful microprocessors. Doctors are searching for ways to use nanoparticles in medical applications. Still, we've got a long way to go before nanotechnology dominates the technology and medical markets.

In the next section, we'll look at two important nanotechnology structures: nanowires and carbon nanotubes.

TEXT 5. It's a Small World After All

At the nanoscale, objects are so small that we can't see them – even with a light microscope. Nanoscientists have to use tools like scanning tunneling microscopes or atomic force microscopes to observe anything at the nanoscale. Scanning tunneling microscopes use a weak electric current to probe the scanned material. Atomic force microscopes scan surfaces with an incredibly fine tip. Both microscopes send data to a computer, which can assemble the information and project it graphically onto a monitor.

Currently, scientists find two nano-size structures of particular interest: nanowires and carbon nanotubes. Nanowires are wires with a very small diameter, sometimes as small as 1 nanometer. Scientists hope to use them to build tiny transistors for computer chips and other electronic devices. In the last couple of years, carbon nanotubes have overshadowed nanowires. We're still learning about these structures, but what we've learned so far is very exciting.

A carbon nanotube is a nano-size cylinder of carbon atoms. Imagine a sheet of carbon atoms, which would look like a sheet of hexagons. If you roll that sheet into a tube, you'd have a carbon nanotube. Carbon nanotube properties depend on how you roll the sheet. In other words, even though all carbon nanotubes are made of carbon, they can be very different from one another based on how you align the individual atoms.

With the right arrangement of atoms, you can create a carbon nanotube that's hundreds of times stronger than steel, but six times lighter. Engineers plan to make building material out of carbon nanotubes, particularly for things like cars and airplanes. Lighter vehicles would mean better fuel efficiency, and the added strength translates to increased passenger safety.

Carbon nanotubes can also be effective semiconductors with the right arrangement of atoms. Scientists are still working on finding ways to make carbon nanotubes a realistic option for transistors in microprocessors and other electronics.

In the next section, we'll look at products that are taking advantage of nanotechnology.

Graphite vs. Diamonds

What's the difference between graphite and diamonds? Both materials are made of carbon, but both have vastly different properties. Graphite is soft; diamonds are hard. Graphite conducts electricity, but diamonds are insulators and can't conduct electricity. Graphite is opaque; diamonds are usually transparent. Graphite and diamonds have these properties because of the way the carbon atoms bond together at the nanoscale.

You might be surprised to find out how many products on the market are already benefiting from nanotechnology.

Bridgestone engineers developed this Quick Response Liquid Powder Display, a flexible digital screen, using nanotechnology.

- Sunscreen – Many sunscreens contain nanoparticles of zinc oxide or titanium oxide. Older sunscreen formulas use larger particles, which is what gives most sunscreens their whitish color. Smaller particles are less visible, meaning that when you rub the sunscreen into your skin, it doesn't give you a whitish tinge.

- Self-cleaning glass – A company called Pilkington offers a product they call Activ Glass, which uses nanoparticles to make the glass photocatalytic and hydrophilic. The photocatalytic effect means that when UV radiation from light hits the glass, nanoparticles become energized and begin to break down and loosen organic molecules on the glass (in other words, dirt). Hydrophilic means that when water makes contact with the glass, it spreads across the glass evenly, which helps wash the glass clean.

- Clothing – Scientists are using nanoparticles to enhance your clothing. By coating fabrics with a thin layer of zinc oxide nanoparticles, manufacturers can create clothes that give better protection from UV radiation. Some clothes have nanoparticles in the form of little hairs or whiskers that help repel water and other materials, making the clothing stain-resistant.
- Scratch-resistant coatings – Engineers discovered that adding aluminum silicate nanoparticles to scratch-resistant polymer coatings made the coatings more effective, increasing resistance to chipping and scratching. Scratch-resistant coatings are common on everything from cars to eyeglass lenses.
- Antimicrobial bandages – Scientist Robert Burrell created a process to manufacture antibacterial bandages using nanoparticles of silver. Silver ions block microbes' cellular respiration. In other words, silver smothers harmful cells, killing them.

Appendix 1

1. Как составить аннотацию к тексту на русском языке

При написании аннотации используйте следующие клише:

Статья (текст) посвящена проблеме/вопросу … В начале статьи

– речь идет о …

– дается определение …

– обосновывается значимость …

– привлекается внимание …

Далее

– описывается …

– рассказывается…

– рассматривается …

– излагается …

В частности

– отмечается, например, …

– подробно излагается …

– описывается схема …

– указывается …

– доказывается мысль …

Наконец

– рассказывается…

В заключение

– приводятся примеры

Подытоживая сказанное, следует отметить …

Как мне кажется, статья может представлять интерес для …

Думается, статья может оказаться полезной для …

2. Как составить аннотацию к тексту на английском языке

Для составления аннотации используйте следующие клише:

The text/article under review … (gives us a sort of information about …).

The article deals with the problem …

The subject of the text is …

At the beginning (of the text) the author describes … (dwells on …; explains…; touches upon …; analyses …; comments …; characterizes …)

The article begins with the description of …, a review of …, the analyses of … The article opens with …

Then (after that, further on, next) the author passes on to…, gives a detailed (thorough) analysis (description), goes on to say that …

To finish with, the author describes …

At the end of the article the author draws the conclusion that …; the author sums it all up (by saying …)

In conclusion the author …

3. Как подготовить презентацию

Phrases which help you to make a presentation:

1. Introduction

• Good morning, everybody! (ladies and gentlemen).

• Let me introduce myself. My name is.. ./I am a first year law student.

• The topic of my presentation is.. ./Today I would like to tell you about…

• I have chosen this topic because…, / The purpose of my presentation is to inform/ to persuade…

• The form of my presentation is .. ./The body of my presentation consists of… parts.

• It will take only 5-7minutes of your time.

2. Body

• First..

• I have divided my presentation into 2-3 parts.

• Then…

• After that I'd like to move on to… /-Next I'd like to move on to… /-Finally I'd like to move on to…

3. Conclusion

• Let us summarize briefly what we have looked at.

• Let us briefly summarize the main issues.

• In conclusion I want to say.

• That is the end of my presentation.

• Thank you for your listening/attention.

4. Inviting questions

• You are welcome with your questions.

• I am ready to answer any of your questions.

• Could you repeat your question?

• I am sorry, but I didn't follow your question.

• If there are no more questions thank you again for your attention.

Appendix 2

Numbers

numbers	25 – twenty-five 514 – five hundred and fourteen 7,938 – seven thousand nine hundred and thirty-three 2,045,238 – two million forty-five thousand two hundred and thirty eight
fractions and decimals	½ kilometer – half a kilometer 1/3 ton – one third of a ton 0.2 – point two 6.145 – six point one four five

Abbreviations

A

AC – alternating current

AFM – atomic force microscope

AI – Artificial Intelligence

ATM – Automatic Teller Machine

C

CCD – charge coupled device

CNT – carbon nanotubes

D

DNA – deoxyribonucleic acid

I

IBM – Internatinal Business Mashines

ICE – ionic-covalent entanglement

i.e. – id est (то есть, т. е.)

L

LED – light-emitting diodes

M

MEMS – microelectromechanical system

MRI – magnetic resonance imaging

MWCNT – multi-walled carbon nanotubes

N

NEMS – nanoelectromechanical systems

NICE – nanoengineered ionic-covalent entanglement

O

OLEDs – Organic Light Emitting Diodes

S

SPASER – surface plasmon amplification of stimulated emission of radiation

SPM – scanning probe microscopes

STM – scanning tunneling microscope

SWCNT – single walled carbon nanotubes

T

TEM – transmission electron microscope

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