**МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ**

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**СБОРНИК НАУЧНЫХ ТЕКСТОВ НА АНГЛИЙСКОМ ЯЗЫКЕ**

*Учебно-методическое пособие*

Рекомендовано методической комиссией ИФиЖ для студентов ННГУ, обучающихся по направлениям подготовки:

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**Богатова О.П., Дедегкаева Т.А., Зыбцева В.Я.**

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Настоящий сборник предназначается для студентов старших курсов, магистрантов и аспирантов естественнонаучных специальностей.

В сборник включены научно - популярные и оригинальные тексты на английском языке, а также послетекстовые упражнения, которые способствуют активизации лексического и грамматического материала, пройденного на младших курсах.

Целью данного сборника является обогащение словарного запаса, приобретение навыков правильного понимания и перевода оригинального английского текста, развитие умения адекватно извлекать информацию из текста и передавать её средствами английского или русского языка.

Ответственный за выпуск:

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Text 1

## Crystal Structure

Crystals are formed from atoms, sometimes in simple and some­times in complicated ways. It is fairly accurate to think of a few crystals as built up of neutral atoms only weakly deformed by the crystalline binding-crystals of the rare gas atoms are like this.

Many crystals may be thought of as built up of ions bearing po­sitive and negative charges: rock salt is composed of Na+ and Cl− ions. Crystals of the alkali metals are made up of small positive ion cores immersed in a negatively charged sea of conduction elect­rons. Some crystals are made up of neutral atoms having slightly overlapping electron clouds forming electron bridges or covalent bands between neighbouring atoms; we may think of diamond and sili­con in this way. Other crystals consist of neutral molecules bound together in the solid by weak interactions: many crystals of orga­nic molecules are of this type.

The differences among these varieties of crystalline binding forces are closely connected with differences in the mechanical, electrical and magnetic properties of crystals. Yet in all crystals the actual interaction which causes the binding is almost entirely the ordinary Coulomb electrostatic interaction between charges -the attraction between the negative charges of the electrons and the positive charges of the nuclei. The differences in the types of crystalline binding thus are not differences in the nature of the interaction, but are qualitative differences in the distribu­tion of electronic charge. The distribution of charge is determined in principle by the theory of quantum mechanics. Although exact solutions of crystalline problems are not attainable, it is often possible to use the theory guided by experiment to obtain helpful insight. One of the questions we should always ask ourselves, and on which we should seek experimental enlightment when, possible, is "Where are the nuclei and the electrons in the solid?" This prob­lem is called the determination of the structure of the solid.

ASSIGNMENTS

I. Refresh your grammar. Analyse and translate the following sentences paying attention to the Absolute Participle Construction.

1. The conductor being a solution of salt in water, the molecules of salt are ionized.
2. Ice, when being formed on a water surface, crystallizes in a form analogous to that of the snow crystals, all the sixsided figures being horizontal.
3. With new devices coming into use, scientists renewed their attempts to learn what cosmic rays consist of.
4. In 1912 Wilson created a method by which one may observe the parts of X-ray particles, this method being used extensively in modern atomic physics.
5. Restricting our table to ordinary point groups we notice a number of differences, the most important one being the different position of 43 m.
6. The termo-dynamics and dynamics of the system in both phases are written as functions of those spin variables, the disordered state being characterized by = 0.
7. The preceding chapters have dealt with the thermal, electrical and mechanical properties of a crystal, each property being treatedin isolation from the others.
8. Atoms and molecules in a gas move with almost complete independence, with occasional collisions taking place.
9. Other things being equal, the grain size is related to the electrical performance in a complicated way.
10. A space charge is set up, the receiving end of the specimen becoming negatively charged.
11. The temperature being changed, certain crystals have the property of developing an electric polarization.
12. A spontaneous polarization being present,a change of temperature alters it, this phenomenon being called pyroelectricity.

II. Silently read the text and be ready to answer the following questions;

1. Are all crystals formed in one and the same way?
2. What are the differences among crystalline binding forces connected with?
3. What does the difference in the types of crystalline binding depend upon?

III. Look up the first paragraph of the text and be ready to speakabout crystal structure of rock salt, alkali metals, diamond andsilicon, crystals of organic molecules.

IV. Look up the second paragraph and be ready to translate the fol­lowing questions and answer them.

1. С чем связаны различия в силах кристаллической связи?
2. Что из себя представляет действительное взаимодействие в кристаллах?
3. Является ли различие в типах кристаллической связи различием в характере взаимодействия?
4. Чем вызвано различие в типах кристаллической связи?
5. Чем определяется распределение заряда?

V. Make a short written summary of the text.

VI. Be ready to speak of crystal structure in detail.

Text 2

## Symmetry of Crystals

All atoms are constructed of various elementary particles (elect­rons, protons, neutrons, etc.), and a complete description of a so­lid would simultaneously specify the condition of all these particles. However, such a description seems to be unnecessarily complex for most purposes. An approximation sufficiently accurate for the study of the geometrical arrangement of entire atoms in crystals is to suppose the atoms to be round, hard balls. These balls rest agains each other in various geometrical arrangements, each solid having its own mode of atom placement.

The solids of primary interest for us have an arrangement of atoms, (or molecules) in which the atoms are arranged in some regu­lar repetitions pattern in three dimensions. Such solids are called crystals, the arrangement of atoms being termed the crystal structure. The internal regularity of atom placement in solids often leads to a symmetry of their external shapes. Rook-salt, crystals, for examp­le, are known to be rectangular parallelepipeds with faces which are identical when looked at from several different directions; these crystals have a high degree of symmetry. Crystalline quartscrystals, though have symmetry of a lower order. By examining external features only, crystallographers were able to build up a large body of know­ledge about the symmetry properties of crystals long before modern methods were used to determine more directly the internal symmetry of atom arrangements.

Being deposited under favourable conditions some elements and compounds (e.g.rocksalt, snow crystals, sulfur, calcite, quartz) display their crystal symmetry clearly. For many others, such as glasses and metals, the symmetry is usually not apparent. The glas­ses indeed, are not crystalline at all: they are extremely viscous liquids. The metals are crystalline when solid, but shapes imposed by manufacturing operations usually render the crystalline natureof metalic objects invisible under casual observation. In reality metals and alloys are usually composed of many tiny crystallites too small to be seen by the unaided eye, though metals deposited carefully (say, by vapour deposition) may assume the highly symmetrical shapes which we commonly associate with "crystals". The tiny crystallites of a metal (they may be as little as 0.001 in in length) are indeed nearly perfect crystals, as X-ray evidence shows.

ASSIGNMENTS

I. Refresh your grammar. Analyse and translate the following sentences paying attention to the Gerund.

1. We will therefore begin by subdividing all the substances into two categories.
2. Maxwell was first to succeed in evolving a truly adequate general theory of electricity and magnetism.
3. Before dis­cussing the application of focused maser beams, two technological applications using the unfocused maser beam may be mentioned.
4. The possibility of observing the scattering of light by light by using the intense radiation from optical masers has been examined.
5. This must be performed at temperatures above 120°C, or otherwise instead of obtaining a uniform etching, a domain pattern is revealed.
6. By comparing the theoretically predicted characteristics with the ex­perimental observations a specific model was derived.
7. The problem of removing completed crystals from a hot solution without getting cracks is difficult, however, and no satisfactory technique has been developed.
8. Apart from being restricted to the volume of the sample, an electron's potential energy will decrease when it moves close to a positive ion.
9. This fact can be illustrated by citing recent advances in both linear and nonlinear optics, progress in understanding electronic band structure, knowledge of lattice vibrations and of the interaction of defects and vibrations.
10. X-rays had been discovered by Röntgen, and their power of penetra­ting through substances that are opaque to light was soon utilized especially in medicine for revealing details inside living creatu­res.
11. The argument that we have used above does not depend upon the Fermi surface being a sphere; it ought to be true for a Fermi surface of arbitrary shape.
12. The method resulted in a smaller fraction of the material being deposited in microcrystalline form.
13. The dipole moment of a diatomic molecule is sometimes thoughtof as being due to one atom being slightly positively charged, and the other being negatively charged.
14. By subtracting approp­riate multiples of the smallest of these numbers from the remai­ning ones these are made as small as possible.
15. This case is conveniently treated by making use of the reciprocal lattice.
16. It is possible to produce a change in the shape of a solid without changing its volume.
17. The atom can be excited to higher energy states by absorbing a photon, or quantum of electromagnetic radia­tion, from an external source.
18. Their having developed important new technologies is of great importance.
19. His having inter­preted the new data in this way is extremely significant.
20. He remembers their having carried out quantum-mechanical calculations of these probabilities.
21. We know of this field of science having provided opportunities for first-class research.

II. Silently read the text and be ready to answer the following questions:

1. How may we regard the atom?
2. What arrangement of atoms have the solids of primary interest?
3. What elements display their crys­tal symmetry clearly and when?
4. Can we see crystallites of metals by the unaided eye?

III.Read paragraph 2 over again and give:

1. The definitions of crystals and crystal structure;
2. The examples of crystals with a high degree of symmetry and with symmetry of a lower order.

IV.Read paragraph 3 and say whether the following statements aretrue or not:

1. In all cases some elements and compounds display their crystal symmetry clearly.
2. The symmetry of glasses end metals is quite apparent.
3. The glasses are extremely viscous liquids.
4. It is possible to see the crystallites of metals and alloys by the un­aided eye.
5. Metal deposited carefully may assume highly symmet­rical shapes.

V. Substitute the underlined words by the words from the text:

1. All atoms are made up ofvarious elementary particles.
2. A com­plete descriptionof a solid defines the condition of all these par­ticles.
3. Such a description is complex for most tasks.
4. Regar­ding geometrical position of atoms we shall considerthem to be round, hard balls.
5. If atoms are arranged in some regular repetitions pattern in three dimensions they are called crystals.
6. The inner regularity of atom arrangement leads to a symmetry of their outerforms.
7. Some elements and compounds show their crystal sym­metry clearly.
8. For other elements the symmetry is not evident.
9. Metals which are not kept carefully may take the highly symmet­rical shapes.

VI. Translate the following questions into English and answer them:

1. Из чего состоят атомы?
2. Каким образом мы можем рассматривать атомы при изучении их геометрического положения?
3. Какие твёрдые тела называются кристаллами?
4. Что называется кристаллической структурой?
5. К чему ведёт внутреннее регулярное расположение атомов?
6. Какие элементы и соединения проявляют кристаллическую симметрию?
7. Чем могут быть вызваны изменения в кристаллической структуре металлических предметов?
8. Можем ли мы видеть кристал­литы металлов невооружённым глазом?
9. Как можно доказать, что мельчайшие кристаллиты металлов являются почти совершенными крис­таллами?

VII. Be ready to speak about structure and symmetry of crystals.

**Tex**t 3

## Proton-Induced X-Ray Emission Analysis of Thick and Thin Targets

The paper considers the problem of preparing materials of biological origin for trace element analysis using PIXE (proton-induced X-ray emission). We distinguish between targets in which beam energy loss and X-ray absorption are negligible (thin) and those in which they are not (thick). The PIXE technique has found wide­spread success in performing routine analyses of environment, bio­logical and medical samples. As PIXE systems push towards increased accuracy and sensitivity and decreased coat per analysis, the prob­lems of target preparation should attract increased attention.

The authors' experience in analyzing a wide range of samples (including human and fish tissues and organs, leaf and grass samples, soil samples, whole blood, urine, fuel oil and participate air filters) indicates that they require a correspondingly wide range of target preparation techniques. The choice of a technique will, of course, be governed by the considerations of the required accuracyprecision and sensitivity of the analysis, as well as the time required and coat of the various preparation methods.

In the paper the authors present a discussion of "thin" and "thick" target analyses with PIXE. They define a thick target as one in which significant corrections to the X-ray yield are requir­ed due to energy loss of the proton beam in the target and attenuation of the emitted X-rays passing through the target. For protonenergies of 3 MeV, the dividing line between thin and thick targets of biological materials is about 1mg/cm2 . Any sample in which theproton beam stops completely in the target is considered to be in­finitely thick.

The authors are interested in investigating the comparative me­rits of thick and thin targets because thick targets are often easy to prepare and thin targets are often relatively difficult. Thick target analyses have been criticized on the grounds that (1) quan­titative yield correction factors are difficult to determine, (2) inhomogeneities within the target, surface irregularities and loss of volatile elements due to beam heating may preclude quantitative measurements, and (3) the amount of material effectively irradiat­ed is too small to be representative of the bulk sample. Although thick target analyses may be subject to the problems mentioned above, they also appear to have many advantages. In one of the sec­tions a number of target preparation methods is described, advan­tages and disadvantages being mentioned too. Besides, the article deals with calibration of the PIXE system and discusses the quanti­tative analysis of thick targets including computer techniques de­veloped to calculate the necessary correction factors. In the fi­nal paragraph experimental results of measurements of elemental abundances for a set of thick and thin targets are presented and conclusions are drawn about the accuracy, precision and detection limits of these measurements.

The authors believe that the results presented in the paper show that, in favourable circumstances, thick targets of biologi­cal material may be used for quantitative trace element determinations with PIXE. Quantitative yield correction factors have been calculated and agree well with empirically derived ones. Finally their experimental comparisons of thick pellets and thin ashed de­posits of a material for which the composition is known have shown that while both are capable of good accuracy, the pellet resultsare significantly more precise than those of the ashed deposits. Further, the background or blank counting rates for pellets and heavily ashed targets are roughly equal and hence the detection limits for the thick pellets are approximately equal to those of the thin ashed deposits. Because the preparation methods for thin targets are generally more costly, time consuming, and subject to contamination than those for thick targets, one should turn to thick targets without hesitation for analyses of those biological materials which have a high degree of homogeneity.

In conclusion the authors draw our attention to the fact that PIXE techniques are now well documented in the literature. Although some developmental work remains to be done, effort is likely to move from development to widespread application of the PIXE method.

ASSINGMENTS

I. Refresh your grammar. Analyse and translate the following senten­ces paying attention to the Subjunctive Mood:

1. If the interfere states were determined by amorphous SIO, some parts of the observed density might be originated from the locali­zed states of amorphous SiO.
2. It is desirable that we should exa­mine the interface states induced by defects at the Si-Si02 inter­face.
3. Thick target analyses wouldn't have been criticized if the amount of material effectively irradiate hadn't been too small to be representative of the bulk sample.
4. The ideal target for PIXE (proton-induced X-ray emission) analyses would have the following, properties: thinness, homogeneity, high electrical and heat conduc­tivity, stability in vacuum, stability to beam damage, minimal sam­ple preparation.
5. One could easily prepare calibrated elemental standards by depositing a drop of the sample - in solution form -on a clean, thin supporting material.
6. It is necessary that care­ful measurements should be made of elemental abundances in the tar­get supporting material andin any reagent used, when using solu­tion deposited targets.
7. If specimens were dried or lyophilized and finely ground theywould be suitable for making pellets which have been found in several cases to be good targets for PIXE analy­sis.
8. The principal drawback to thick targets is the requirement that they be sufficiently uniform so that the effective irradiated mass might be representative of the bulk sample.
9. The results presented in the previous sections show that, in favourable circumstances, thick targets of biological material might be used for quantitative trace element determinations, with PIXE.
10. In order to present these results in a form directly comparable to that to be given for photons, it is necessary that the conditions of the exposure and the size of sample should be defined.
11. If the un­known source of detector background could be eliminated, the sensi­tivity of the photon-induced X-ray method could be significantly improved.
12. The recent observation of "temperature waves" in solid helium could not have been accomplished if large chemically and isotopically pure single crystals of helium could not be grown.
13. A complete theory of the structure of matter would enable us to evalu­ate the energy of each particle under all possible conditions.
14. A complete theory would also relate the energies of the particles of the substance to its temperature, pressure, and physical state.
15. Should they repeat the experiment they could obtain more precise results.
16. The discoverers conclude by analogy with their recent binding that vanadium - aluminium should we ever manage to crystal­lize it in the same structure, would be a very high superconductor.

II. Silently read the text and be ready to answer the followingquestions:

1. What problem does the text deal with?
2. What technique is des­cribed in the text?
3. Why should the problems of target prepara­tion attract increased attention?
4. What conclusion does the author make having analysed a wide range of samples?
5. What does the choi­ce of target preparation techniques depend upon?
6. Can you define a thick target?
7. Why have thick target analyses been criticized?
8. What other problems are mentioned in the text?
9. What results are presented in the final paragraph of the article?
10. In what cases and why should we use thick targets instead of thin?

III.Look up the text again and say whether the following statementstrue or not:

1. The FIXE technique has attracted great attention because of in­creased accuracy, sensitivity and decreased cost per analysis.
2. The authors analyze samples including human tissues only.
3. Any sample in which the proton beam stops completely in the target is considered to be a thin target.
4. The authors investigate the com­parative merits of thick and thin targets.
5. Thick target analyses have many advantages.
6. The authors conclude that thick targets may be used for qualitative trace element determinations with PIXE.

IV. Discuss the following statements. Supply facts from the text.

1. The PIXE technique has found widespread success.
2. The choiceof a target preparation technique is determined by many factors.
3. Thick target analyses have been criticized on some grounds.
4. The experimental comparisons of thick pellets and thin ashed depo­sits are presented in the article.

V.Find in the text:

1. the definition of a thick target;
2. thegrounds on which thick target analyses have been criticized;
3. ad­vantages and disadvantages of thick and thin targets.

VI.Write a summary of the article.

Text 4

## Structural Disorder and Electronic Properties of Amorphous Silicon

The theoretical study of the electronic density of states of amorphous group-IV semiconductors has advanced quite rapidly in the past few years.

The use of continuous random tetrahedral networks (CRTN) to rep­resent the amorphous material enables us to specify the positions of the atoms in the solids, making it possible to perform theoretical studies at a microscopic level. In the pioneer works the tetrahedrally coordinated structure is described by ea simple model Hamiltonian where four basis functions (corresponding to the four tetra­hedral bonds) are associated with each atom. The only nonvanishing matrix elements of the Hamiltonian are known to consist of a cons­tant matrix element between two different basis functions on the same atom, and another constant element between two basis functions of the same bond. Interactions between orbitals on unbonded pairs of atoms being neglected,the spectrum of this Hamiltonian is dicta­ted by the bond pattern, i.e. by the topological disorder.

Positional disorder or structural disorder per sec. is impor­tant only indirectly through the topological disorder that produc­ed it. Asa result, a CRTN is primarily characterized by its ring statistics, less attention being directed to the effects of bond-length and bond-angle distortion. However, to acquire a more quantitative understanding of electronic properties, calculations based on more realistic Hamiltonians are necessary.

Using the method of orthogonalised linear combinations of atomic orbitals (OLCAO) recently developed for band-structure calcula­tion it was possible to take into account the detailed positional disorder, and thus to characterize the electronic properties of an amorphous solid realistically. Of course, structural disorder and topological disorder are not independent of each other. Nevertheless, we regard the structural disorder to be more fundamental way of characterizing the CRTN.

There exist two classes of CHTN structural models of a-Si. We know finite networks, containing typically 200-500 atoms, to have been built by hand, sometimes with computer assistance. In the existing models construction has stopped at a point where a large frac­tion of the atoms ia still close to the surface, with effects on the properties that may be large and are difficult to estimate.

In the other class of CRTN, designed to eliminate surface effects, a certain number of atoms is disposed within a unit that satisfies periodic boundary conditions, i.e., repeats indefinitely in three (usually orthogonal) directions. The first of these to be made is due to Henderson and Herman, later modified by Henderson. More recent­ly a prescription has been given for systematic construction of such periodic CRTN by computer simulation. Briefly this method is to start from a finite region of a crystal, to join each atom ran­domly to four others so as to satisfy periodic boundary conditions, and then to modify the bond pattern progressively in order to lower the strain energy as much as possible. An example has been produc­ed in this way, starting from a cubical region containing 27 unit cells of the body-centered-cubic lattice (54 atoms).

In addition to the two kinds of CRTN referred to in the preced­ing paragraphs, the crystalline structures of polymorphs ofSi and Feappear to have been suggested as possible structural models for a-Si. The use of CRTN to describe the structure ofa-Si and other amorphous group-IV semiconductors in terms of the position coordi­nates of the individual atoms has proved to be very successful in resent years. Based on a CRTN description it is now possible to perform first-principles calculations of the electronic energy sta­tes of a-Si by means of the OLCAO method. A first-principles appro­ach that takes into account the full positional disorder is certain to give a more basic view and reliable results.

ASSIGNMENTS

I. Refresh your grammar. Analyse and translate the following sentences paying attention to the Infinitive:

1. Because the electrons and holes are very light they will probably retain enough random motion to prevent the liquid from freezing no matter how much the temperature is reduced.
2. We know enough by now to realize that the law of conservation of energy demands that any energy acquired by an atom must eventually be given off.
3. To study the solid state we first must have a sample, preferably a pure single crystal of a relatively simple element or compound.
4. To avoid this difficulty, we shall often refer to the symmetry group of a molecule, the orientation of which is such that the molecular axis coincide with the crystal axis.
5. We shall use this basis to describe the dynamics of molecular orientation.
6. In order to stu­dy the intersections it is convenient to classify crystals in the following groups.
7. A carbon atom has electrons sufficient to form four covalent bonds by sharing four electrons with four neighbouring atoms.
8. Other measurements are needed to enable a complete descrip­tion of the materials to be made.
9. This theory enables the dipole moment to be calculated.
10. Sufficient crystallographic data have now been obtained to permit an estimate to

be made of the relative ions radii in these compounds.

1. Rochelle salt was the first ferroelectic to be discovered.
2. There are situations to be discussed below where these effects are dominant.
3. Most of the systems to be investigated involve magnetic ions localized at crystal-sites and interacting with short-range forces.
4. The physical processes to be described are particle scattering processes taking place in infinite time.
5. There are a number of advantages to be gained from using a liquid as the active medium in a laser rather than a solid or a gas.
6. They find the coefficient be negative, as well as too small.
7. We may expect binary compounds to possess diamond-like lattices whenever the average number of external orbital elect­rons per atom is four.
8. We assume the crystal to be homogeneous and isotropic and to have a distinct cleavage plane.
9. Ions in crys­tals are believed to exist in states not much modified from those of free ions.
10. The interactions between ions are assumed to be pri­marily the electrostatic interactions between spherical charge dist­ributions.
11. The distinction between crystalline and amorphoussubstances was thus thought to be a fundamental one.
12. We propose an arrangement of the 122 point groups, which we call the periodic table, because it turns out to have a number of analogies with the Periodic Table of chemical elements.
13. The resulting material appears to be electrically inactive and has not, there­fore, been widely used in investigations.
14. Such differences are believed to arise mainly from slight changes in experimental conditions which proved to be necessary.
15. Actually, both effects are closely related and when one is large the other is likely to be large too.

II. Read the text and be ready to answer the following questions:

1. What problems does this text deal with?
2. What helps us to define the positions of theatoms in the solids?
3. What two kinds of disorder are mentioned in the text?
4. How many classes of CRTN structural models of a-Si does the author describe in the text?
5. What method has been recently developed for band-structure cal­culations?

III. Read paragraph 2 over again and be ready to answer the following questions:

1. By means of what method is the tetrahedrally coordinated structure described?
2. Is this model known to you? What can you tell us about it?
3. What are four basis functions connected with?
4. What do the only nonvanishing matrix elements consist of?
5. What is topological disorder?

IV. Read paragraph 3,4 over again and say whether the following statements are true or not:

1. When applying continuous random tetrahedral networks more at­tention is paid to the effects of bond-length distortion.
2. To get a more quantitative understanding of electronic properties, it is necessary that more realistic Hamiltonians should be done.
3. By means of the method of orthogonalised linear combinations it was possible to take into account the detailed structural dis­order.
4. Structural disorder and topological one are quite inde­pendent of each other.

V. Substitute the underlined words by their synonyms or thewords from the text:

1. There are two classes of CRTN structural models of a-Si.
2. Finite networks consist of typically 200-500 atoms.
3. Finite net­works are built by hand with computer aid.
4. Construction has stopped at a point where most of the atoms are situated near the surface.
5. The use of continuous random tetrahedral networks per­mits us to define the positions of the atoms in the solid.
6. The theoreticalstudy of the electronic density of states of amorphous group-IV semiconductors has progressed rapidlyduring the past few years.
7. We consider the structural disorder to be more important way of characterizing the CRTN.
8. The use of CRTN appears to be ve­ry successful.
9. With the help of OLCAO method itis possible to perform first-principlescalculations of the electronic energy states of a-Si.

VII. Write a summary of the article

СБОРНИК НАУЧНЫХ ТЕКСТОВ НА АНГЛИЙСКОМ ЯЗЫКЕ

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