Государственный комитет СССР по народному образованию

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МЕТОДИЧЕСКИЕ УКАЗАНИЯ

ПО ОБУЧЕНИЮ ЧТЕНИЮ ТЕХНИЧЕСКИХ ТЕКСТОВ НА АНГЛИЙСКОМ ЯЗЫКЕ ПО СПЕЦИАЛЬНОСТИ «КОНСТРУИРОВАНИЕ И ТЕХНОЛОГИЯ ЭЛЕКТРОННО-ВЫЧИСЛИТЕЛЬНОЙ АППАРАТУРЫ»

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Шишкина Е.Н., Е. И. Румянцева. Методические указания по обучению чтению технических текстов на английском языке по специальности "Конструирование и технология электронно-вычислительной аппаратуры". Ч.1. — М.: Изд-во МГТУ. — 28 с.

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Пособие состоит из текстов для чтения и перевода по специальности ИУ-4, текстов на развитие различных видов чтения и для самостоятельной работы студентов. Пособие включает упражнения на закрепление и активизацию грамматического материала и упражнения по различным видам чтения.

Предназначено для студентов III курса.
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Редакция заказной литературы

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Методические указания по обучению чтению технических текстов на английском языке по специальности "Конструирование и технология электронно-вычислительной аппаратуры".
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Unit I. Texts A. "Preliminary Operations" B. "Epitaxy" C. "Thermal Oxidation"
Grammar Revision: 1. Functions of "that"
2. Degrees of Comparison

Terminology:

1. technology — техника, технология
technique [tek'ŋi:k] -метод, технический прием semiconductor Integrated circuit (IC) technology — технология полупроводниковых интегральных схем (ИС)
2. melt n. — плавка, плавление, расплав
v. - плавиться, расплавляться
3. seed n. — затравка
v. — использовать затравку
4. pull a. — тяга; натяжение, растяжение
v. — тянуть, растягивать crystal pulling — выращивание кристалла методой вытягивания
5. ingot ['ingət] — (полупроводниковый) слиток
single crystal ingot — монокристаллический слиток
6. rod — стержень
single-crystal rod — монокристаллический стержень
7. wafer ['weifə] — пластина, плата, подложка
silicon wafer — кремневая пластина
8. substrate — подложка, основание
blank substrate — необработанная подложка
9. saw (sawed — sawn) — распиливать
diamond saw blade — диск с алмазной режущей кромкой
10. lap — шлифовать, полировать
11. suspension — подвеска
12. grain — зерно
crystal grain — кристаллит
13. etching — травление
14. crystal face — грань кристалла
15. layer — слой, наносить слой
16. film — пленка, тонкий слой
17. solvent — растворитель

Preliminary exercises

I. Прочитайте и переведите без словаря:

process ['prəusəs], procedure [prə'si:dʒə], fabrication, typical, cycle, manufacturing, popular, rotate, orientation, section, stage, diameter [dai'æmitə], mechanical [mi;kænikl], physical, chemical ['kemikl], parallel, characterise, micrometer, cantimeter, maximum ['mæksiməm]

II. Назовите прилагательные, от которых образованы следующие слова. Переведите исходные и производные слова.

slowly, simply, generally, gradually, commonly, rigidly, specifically, actually

III. Образуйте от пени сравнения от следующих прилагательных и переведите их: low, important, thin, fine, popular, slow IV. Переведите следующие слова, исходя из значения их антонимов.

unven, uneveness (even — ровный), invisible (visible — видимый), unattainable (attainable — достижимый), unachievable (achievabie — достижимый), impurity — (purity — чистый), decrease (increase — увеличивать)

V. Прочитайте текст А и ответьте на вопросы:

I) Как развивалась технология полупроводниковых ИС. 2) Какие подготовительные операции лежат в основе полупроводниковой технологии.

Preliminary Operations

1. Semiconductor integrated circuit technology is a logical extension of the development of transistor planar technology which embodied the prior experience gained in the production of semiconductor devices, for better understanding of the procedures of IC fabrication, therefore, we should be familiar with typical manufacturing steps of the entire technological cycle. Hybrid

technology has its historical roots too. It generalised and perfected the film deposition techniques used earlier in radio engineering, macnine-building industry, and optics.

2. Single crystals of silicon and also other semiconductors are generally produced by the techniques of crystal growth from the melt, the most propular being the technique of crystal pulling. For a crystal to be grown, a silicon seed crystal attached to the polling rod is lowered into contact with the melt and then slowly raised and rotated. The liquid column suspended from the seed gradually solidities into a single crystal ingot.

3. The crystallographic orientation of the ingot in its cross section is defined by that of the seed. The standard diameter of crystal rode is at present 80 mm; the maximum diameter can be 120 mm and over. The length can be 1 to 1.5 m, but commonly the rods measure only fractions of this sice. Silicon ingots are first sawed into wafers, or slices, 0.4 or 0.3 mm in thickness.

4. The surface of blanks is rather uneven; scratches, projections, and pits are far larger in sise than the potential integrated elements. Before starting with basic technological steps, therefore, blanks need be repeatedly lapped and polished to produce the smooth and shiny surface. Apart from removing mechanical defects, the aim of the first stage of lapping made on special turntables is to bring the blanks to the desired thickness, 200 to 500 mkm unattainable in sawing, and render the faces parallel to each other. The lapping agent is the suspension of micropowders chosen for each cycle of lapping in order of decreasing grain size, down to 1 or 2 mkm.

5. The wafers lapped in this stage still have a mechanically disrupted surface layer, a few micrometers thick, which covers a yet thinner, physically disturbed layer characterised by "invisible" crystal distortions and mechanical stresses induced in the course of polishing.

6. Finishing polishing is aimed at removing the two disturbed layers and decreasing the surface unevenness to a level characteristic of optical systems — down to hundredths of a micrometer. This polishing can be of the mechanical type (polishing with yet finer grained suspensions) and of the chemical type (etching, of the surface layer with suitable solvents).

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Words to be learnt:

1. to gain experience — приобретать опыт
2. to be familiar with — ознакомиться
3. to attach to — прикреплять к
4. to suspend — подвешивать
5. to define — определять
6. to attain — достигать 7. solid — твердое вещество to solidify — затвердевать
8. to disrupt — нарушать
9. to cover — покрывать

covering — покрытие

10. to disturb — нарушать, мешать
11. induce — вызывать, возникать

Exercises

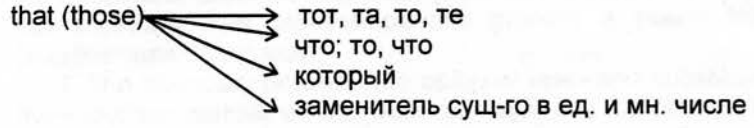
VI. Переведите следующие определительные блоки существительных:

semiconductor integrated circuit technology; typical manufacturing steps; entire technological cycle; diamond saw-blade silicon seed crystal; the blanks of the desired crystallographic orientation; the aim of the first stage of lapping; etching of the surface layer; physically disturbed layer.

VII. Переведите следующие; словосочетания на английский язык:

процессы производства ИС, монокристаллы кремния, выращивание кристалла методом вытягивания, стержень с затравкой, монокристаллический слиток, кремниевая пластина, грань кристалла, диск с алмазной режущей кромкой, шлифовать поверхность, удаление двух нарушенных слоев, травление поверхностного слоя растворителями.

VIII Переведите предложения, обращая внимание на функции " that "



1. The main task is that the blanks should be repeatedly lapped
and polished to produce the smooth and shiny surface.
2. The wafers have mechanically disrupted surface layers that are characterized by invisible crystal distortion.
3. That silicon is used in most integrated circuit devices is a well-known fact.
4. This phenomenon is indicated with that mentioned above.
5. Hybrid technology has perfected the film deposition techniques that «ere used earlier in radio-engineering.
6. It is important that the ingot is fixed at right angles to the diamond saw blade.
7. It is known that a computer is nothing more than a collection of circuits that do a few simple tasks, one at a time.

IX. Переведите прилагательные обращая внимание на степени
сравнения:
more preferable — much more preferable; more popular — much more popular; more important — much more important; larger — far larger; thinner — yet thinner; finer — yet finer.

X. Ответьте на следующие вопросы:
1. How is the single crystal of silicon generally produced? Describe this process.
2. What is the method of defining the crystallographic orientation?
3. What is the size of crystal rod?
4. What operations should be done before starting with basic technological steps?
5. What is finishing polishing aimed at ?
6. What are the types of polishing?

XI. Переведите микротекст.
Монокристаллические слитки кремния получают путем кристаллизации из расплава. Кристаллографическая ориентация слитка определяется кристаллографической ориентацией затравки. Слитки кремния разрезают на множество тонких пластин (толщиной 0,4-0,5 т). на которых затем изготовляют интегральные схемы или другие приборы. XII. Составьте аннотацию текста:
Выделите наиболее значимую информацию из каждого абзаца, обобщите полученные сведения, используйте слова-клише (сообщается о..., излагается, приводится... и т.п.), избегайте сложных предложений.

XIII. Расскажите о подготовительных операциях, используемых в технологических процессах изготовления полупроводниковых ИС.

XIV. Прочитайте текст В за 4-5 минут и ответьте на вопросы:
1. Что такое эпитаксия?
2. Что затрудняет создание сверхтонких и многослойных эпитаксиальных структур?
3. Какие вида эпитаксии применяются в промышленности?

Epitaxy
1. Epitaxy is the process of growing single crystal layers on substrate, with the crystallographic orientation of the layer repeating that of the substrate material.
2. At present epitaxial growth techniques are generally used for depositing thin working layers of a homogeneous semiconductor on a comparatively thick substrate that serves as a bearing structure. An epitaxial film may differ from the substrate in chemical composition. The process of growing such films is called heteroepitaxy in contrast to homoepitaxy. Of course, the heteroepitaxial process, too, must produce the films whose crystal lattice Is the same as that of the substrate. The process permits growing a silicon film on, say, a sapphire substrate (сапфировая подножка).
3. The boundary between the epitaxial layer and substrate cannot be ideally abrupt because the impurities partially diffuse from one layer into the other in the course of epitaxy. This involves

difficulties in depositing superthin (less than 1mm) and multilayer epitaxial structures. It is the single-layer epitaxial growth that plays the leading role at present. This technique has greatly widened the scope of semiconductor technology: epitaxy can produce homogeneous layers as thin as 1 to 10 mm, unachievable so far by any other techniques.

4. Let us note that along with vapor phase (gas phase) epitaxy, industry uses liquid phase epitaxy — the process of growing single crystal layers from the liquid phase, that is, from the solution containing requisite (необходимые) components.

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XV. Переведите текст С со словарем за 15 минут.

Thermal Oxidation

1. Silicon oxidation is one of the most typical processes In modern IC technology. The process provides the film of silicon dioxide, SiO2, which serves a few important functions, such as (a) protection of the surface; (b) a mask defining the windows for introduction of dopants; (c) a thin insulator under the gate of a MOS transistor.

2. The wide opportunities offered by SiO2 are one of the reasons why silicon has become the main material for the fabrication of semiconductor ICs.

3. The surface of silicon is inherently coated with an oxide film resulting from natural oxidation at low temperatures. But this film is too thin (about 5 mm) to be able to perform any of the above functions, and therefore SiO2 films are grown artificially at high temperatures from 1000 to 1200°C.

4. Thermal oxidation is conducted in the atmosphere of pure oxygen (dry oxidation), in the mixture of oxygen and water vapors (wet oxidation), or just in water vapors.

5.There are two mechanisms of oxidation. The first includes the following stages: (1) diffusion of silicon atoms through the natural oxide film to the surface, (2) adsorption of oxygen molecules by the surface from the gas phase, (3) the oxidation proper, or chemical reaction, which causes a film to grow over the initial silicon surface. The second mechanism Involves (1) adsorption of oxygen by the surface of the natural oxide film, (2) diffusion of oxygen through the oxide to silicon, and (3) the oxidation proper. With the second mechanism, the grows from the surface into the bulk (вглубь) of silicon. In practice, both mechanisms act In combination, but the second prevails.

1500

Unit II Texts A. "Diffusion methods"
B. "The process of doping in diffusion furnaces".
C. "Ion Implantation"

Grammar Revision: функции глаголов "to be", "to have".

Terminology

1. diffusion a. — рассеивание, распространение
diffuse — v. распылять, распространять, диффундировать
the double or the triple type of diffusion — Двойная или тройная диффузия
multiple diffusion — многократная диффузия
diffusant — диффузант, диффундирующая примесь
2. slice n. — тонкий слой, полупроводниковая пластина, кристалл (ИС)
v. — резать на тонкие слои
5. mask n. — фотошаблон, маска, маскирующий слой
v. — маскировать
4. bulk — масса, основная часть, объем, подложка
5. to dope — легировать
doping — легирование
dopant — легирующая прииеог.
6. junction — соединение, переход (p-n)
7. acceptor — акцептор
acceptor impurity — акцепторная примесь в. solubility — растворимость

solid solubility — растворимость в твердой фазе

Preliminary exercises

I. Прочитайте и переведите следующие слове: total, local, portion, vertical, factor, starting, material, parameter, temperature, limit, maximum, critical, structure, parralel.

II. Определите, к каким частям речи относятся следующие слова, переведите их:

impurity, selective, layer, lateral, performed, stage, conducting, concentration, solubility, infinitely, chosen, available, succession, limited, definite, diffused, conductivity

III. Образуйте от следующих глаголов существительные и дайте их перевод: to introduce, to produce, to differ, to distribute, to penetrate, to protect, to relate, to dope, to concentrate, to determine, to limit, to define.

IV. Переведите следующие определительные блоки существительных:

silicon oxide film; thin diffused layer; wafer bulk; wafer plane; diffusion layer thickness; starting n-type slice; three — layer structure; preceding impurity concentration; chosen impurity; maximum critical solubility

V. Прочитайте текст А и ответьте на вопросы:

1) Какие существуют типы и виды диффузий?

2) Назовите источники диффузантов.

Diffusion Methods

1. The introduction of impurities into the starting material (a wafer or epitaxial layer) by diffusion at high temperatures is still the basic method of doping of semiconductors aimed at creating diode and transistor structures. Diffusion can be total, or overall, and selective or local. In the first case, diffusion occurs over the entire surface of the slice, and in the second case only in the definite portions of the slice through the windows in the mask such as the silicon oxide film. 2. Overall diffusion produces, a thin diffused layer on the wafer surface that differs from the epitaxial layer by the inhomogeneous distribution of an impurity in depth.

3. In local diffusion, the impurity penetrates not only into the wafer bulk at right angles to the wafer plane but also spreads over parallel to the wafer plane that is, under the mask. As a result of this lateral diffusion, the p-n junction portion that extends outward becomes protected by the oxide. The relation between the depths of lateral and "vertical" diffusions depends on a number of factors, including the diffusion layer thickness L. The lateral diffusion depth is generally equal to 0.7 L.

4. Diffusion can be performed once and repeatedly. For example, in the first stage of diffusion, it is possible to dope the starting n-type slice with an acceptor impurity to produce a p-layer and then, ia the second stage, to drive a donor impurity into the p layer to a smaller depth and thus form a three-layer structure. So diffusion can be of the double and the triple type.

5. In conducting multiple diffusion, one must see tnat the concentration of every new impurity being introduced exceeds the preceding impurity concentration, otherwise the type of conductivity will remain the same and, hence, the p-n junction will not be formed. One the other band, the impurity concentration in eilicon or any other starting material cannot be infinitely large: it has an upper limit determinated by the parameter called the solid solubility of an impurity.The solid solubility reaches it's maximum, Nmax, and then starts to fall of.

"6. In the last stage of multiple diffusion, therefore, the chosen impurity must have a maximum critical solubility. Since the range of available impurity materiels is limited, it is not possible to carry out more than three diffusions in succession.

The dopants such as boron, phosphorus, and others introduced by diffusion are called diffusants whose sources are chemical compounds. These can be liquids, solids and gases.

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Words to be learned:

1. to occur — происходить
2. to spread over — распространяться по
3. to determine — определять
4. to distribute — распространять

5. to reach — достигать
6. Служебные слова: that is — то есть
otherwise — в противном случае
such as — такой, как;
hence — следовательно
on the one hand — с одной стороны;
on the other hand — о другой стороны
since — тах как; с тех пор, как
therefore — поэтому
however — однако

VI. Переведите следующие словосочетания на английский язык:

общая диффузия, локальная диффузия, боковая диффузия, неоднородное распределение примеси, под маску, через окна в маске, участок p-n перехода; глубина диффузионного своя, получить p-n слой, проводить многократную диффузию, превышать концентрацию предыдущей примеси, исходный материал, предельная растворимость примеси, максимальная предельная раотворимость примеси, обеспечение более трёх последоваетльных диффузий.

VII. Найдите в тексте словосочетания, противоположные по значению данным, и переведите их:

total diffusion, homogeneous distribution, the introduction of purities, at low temperatures, indefinite portion, a thick layer once, triple type, to remain the same, above the mask, the lower limit, to fall off, the last stage, liquids.

VIII. Закончите предложения, ориентируясь на текст, и переведите их.

1) Diffusion occurs only in the definite portions of the slice through the windows in the mask such as...
2) The impurity penetrates not only into the wafer bulk at right angles to the wafer plane but also spreads over...
3) It is possible to dope the starting n-type slice with an acceptor impurity to produce a ...
4) The concentration of every new impurity exceeds the preceding impurity concentration, otherwise...
5) The impurity concentration in silicon has an upper limit determined by....
6) At a certain temperature, the solubility reaches its maximum and then....

IX. Переведите речевые отрезки. Обратите внимание на перевод сказуемого, первым компонентом которого является личная форма глагола "to be ":

1) the impurity is penetrating to; 2) the impurity is able to penetrate to; 3) the impurity is supposed to penetrate to; 4) the impurity is to penetrate to; 5) the impurity is introduced; 6) the impurity is presently in wide-spread use; 7) this impurity is being applied to; 8) the impurity is to be applied to.

X. Переведите речевые отрезки. Обратите внимание на перевод сказуемого, первым компонентом которого является личная форма глагола "to have".

1) the junction has a form of; 2) the junction has formed; 3) the junction has been formed; 4) the junction has been supposed to form; 5) the junction has to be formed; 6) we have to study the properties of; 7) the properties have been studied.

XI. Переведите следующие предложения, обращая внимание на служебные слова:

1. An integrated circuit is a special kind of microelectronics and at our current level of IC development however we must face several problems.
2. Microelectronics is a name tor extremely small electronic components and hence for circuit assemblies made by thin film, thick film or semiconductor techniques.
3. An Integrated circuit has been fabricated as an assembly of electronic elements in a single structure, that is it cannot be divided without destroying its electronic function.

4. Integrated electronics will develop further. It will move not only towards more functions per slice, but toward new types of functions.

5. Since the range of materials is limited it is impossible to carry out more than three diffusions in succession.

6. Semiconductors are used in a wide variety of solid-state devices, such is transistors, integrated circuits, diods and so on.

7. Silicon has been the backbone (основа) of the semiconductor industry since the production of commercial transistors.

XII. Ответьте на вопросы по тексту.

1. 'What is the difference between local and overall diffusion?
2. What does the relation between the lateral and "vertical" diffusion depend on?
3. What types of diffusion do you know?
4. Why should the concentration of every new impurity exceed the preceding impurity concentration?
5. What parameter determines the upper limit of tbe impurity concentration?
6. What does the solid solubility depend on?
7. Is is possible to carry out more than three diffusions in succession?
8. What are the sources of diffusants?

XIII. Дайте определение следующих терминов:

overall diffusion; local diffusion; the first stage of diffusion; the second stage of diffusion; multiple diffusion; the solid solubility of an impurity; the diffusant.

XIV. Составьте аннотацию к тексту.

XV. Расскажите о методах диффузии.

XVI. Прочитаете текст В за 4- 5 мин. и ответьте на следующие вопросы:

1. В каких целях используются однозонные и двухзонные печи?
2. Какие виды источников диффузанта используются в диффузионных печах?
3. Какую функции выполняет стекло при использовании жидких источников диффузанта?

The Process of Doping in Diffusion Furnaces

1. As with epitaxial growth and thermal oxidation, the process of doping involves gas-transport reactions carried out in single-zone or double-zone diffusion furnaces. 2. A double-zone furnace consists of two high-temperature zones, one for decomposing the solid source of a diffusant and the other for performing tbe diffusion proper.

3, Liquid and gaseous sources of a diffusant do not need high temperature for evaporation, and so they allow the use of single-zone furnaces; a diffusant source is forced into the furnace tube in the gaseous state.

4. If liquid sources of a dopant are used, the diffusion is performed in the oxidizing atmosphere by adding oxygen to the carrier gas. Oxygen combines chemically with the surface atoms to form the oxide SiO_2, which is in essence a glass. At a temperature above 1000°C these glasses are in the liquid state. They coat the silicon surface with a thin film, so that the diffusion takes place, strictly speaking, from the liquid phase. The glass solidifies to produce a sealing (защитный) layer that protects the silicon surface at the spots of diffusion, that is, in the windows of the oxide mask. With the use of solid diffusant surfaces (oxides), the glass layer forms in the process of diffusion without the addition of oxygen.

1050

XVI. Прочитайте текст С со словарем.

Сравните диффузионные методы с методом ионной имплантации. Какие существуют сходства и различия, преимущества и недостатки того или иного метода?

Ion Implantation

1. This is the method of doping of a slice (or an epitaxial layer) by bombarding it with impurity ions accelerated to an energy enough to enable the ions to penetrate rather deep into the slice bulk.

2. Special installations similar to charged-particle accelerators employed in nuclear physics provide for ionisation of impurity atoms, ion acceleration, and focusing of the ion beam. The dopants are the same as those used in the diffusion process.

3. Ion implantation, like diffusion, can be overall and local (selective). An important merit of ion implantation is that ions, travelling along the straight line, penetrate only into the slice bulk at right angles to the surface and do not affect the regions under the mask. In other words, the process analogous to lateral diffusion does not exist here.

4. As with diffusion, multiple ion implantation for "driving" one layer into the other is in principle possible. However, it is difficult to compromise between the ion energy, exposure time, and annealing conditions required for multiple ion implantation. For this reason ion implantation enjoys popularity mainly in growing thin single layers.

5. The main advantages of ion implantation are a low temperature needed tor the process and it's good controllability. The first feature offers the possibility of performing ion implantation at any stage of the technological cycle, thereby dispensing with the additional diffusion of impurities into the layers prepaired earlier.

1400

Unit III. Text A Masking Text B Grammar Revision — Participle I,II

Terminology
Photolithography — фотолитография
photoresist — фоторезист
oxide — окись
oxidate — окислить
oxidation — окисление oxide layer — окисный слой
oxide film — окисная пленка
polymer — полимер
—||— chain — полимерная цепочка

Preliminary exercises:
Ex. 1. Вспомните значение префиксов -un-; non-; re-; semi-;
Образуйте с их помощью производные от следующих слов и дайте их перевод:
un-: exposed, coated, equal, covered, common
non-: transparent; effective
re-; move, place, do, read semi-: conductor, circle

Ex 2. Переведите однокоренные слова, обращая внимание на значение суффиксов и префиксов.

process, v — (обрабатывать) process, processing, processor

move, v (двигать(ся)) remove, removal, removed coat, v (покрывать) — coating, coated apply, v (применять) — applied, application, applicable vary, v (различаться) — variety, variable, variability, variation, various

dissolve, v (растворять) dissolvable, dissolvent, solution

Ex. 3. Прочитайте и переведите следующие слова без словаря, учитывая их интернациональную основу.

photographic, photoresist, film, polymer, polymerize, quartz, lamp

Ex. 4. Прочитайте первые три абзаца текста А и скажите, в чем состоит задача литографии.

Text A Masking

1. Masks hold an important place in the technology of semiconductor devices. They serve to ensure the local character of deposition, doping, etching, and, in some cases, epitaxial growth. Of all the techniques used for mask fabrication photolithography heads the list. Photolithography, also called photomasking or photoengraving uses photoresists which are a variety of photoemulsions applied in conventional photography. Photoresists are sensitive to ultraviolet light and hence they can be processed in a slightly darkened room.

2. Photoresits come in negative-acting and positive-acting types. The first polymerize under light and become stable to etchants (acidic or alkaline solutions); after selective exposure to light the unexposed portions will be soluble as is the case for a common photographic negative. On the contrary, in positive photoresists the light destroys polymer chains so the etch will dissolve the exposed portions.

3. The structure containing the pattern of the future oxide mask is known as a photomask. This is a thick glass plate one side of which is coated with a thin non-transparent film having the desired circuit pattern in the form of transparent openings. These openings or pattern elements are equal in size to the desired integrated elements, which can be as small as 20 to 50 mkm. от even 2 or 3 mkm.

4. The photolitho technique for opening windows in the SiO2

mask that covers a silicon wafer consists of a number of steps. A small drop of photoresist (PR) is placed on the oxidized surface and the wafer is rotated to spread the photoresist over its surface in an even film about 1 mkm thick. The film is then left to dry hard. Next the photomask (FM) with its pattern facing the photoresist is placed over the wafer and exposed to the light of a quartz lamp. The photomask is then taken off.

5. If the process makes use of a positive photoresist then after its development and fixing (hardening and heat treatment) the photoresist layer will have windows in the areas which correspond to the transparent portions on the photomask. We thus have transferred image of the pattern from the photomask to the photoresist. The photoresist layer is now the mask that tightly adheres to the oxide layer.

6. In the next step an etchant is applied to remove the oxide layer through the windows in the photoresist mask as far as the silicon surface (which is resistant to the etchant used) and thus to open the windows in the oxide thereby transferring the pattern from the photoresist to the oxide layer. The final step involved in the photomasking process comes to etching away the remaining photoresist leaving intact the oxide mask with window. The wafer is now ready for such operations as diffusion or ion implantation etching and so forth until the integrated circuits are completed.

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Ex. 5. Прочитайте и переведите текст A, обращая внимание на функции и перевод Participle I, II:

Words to be remembered

1. to ensure — обеспечивать
2. to be sensitive — быть чувствительным к чему-либо 3. to process — обрабатывать
4. to be stable to — быть устойчивым к чему-либо.
5. a variety of — разнообразие
6. to expose — выставлять, подвергать действию
7. exposure — выставление на...
8. to coat, to cover — покрывать, наносить слой
9. to contain — содержать 10. to spread — распространять 11. to adhere — прилипать 12. to be resistant — быть Прочным, стойким 13. even, adj.- даже

Ex. 6. Переведите следующие словосочетания:

to apply in conventional photography; to be sensitive to ultraviolet light; to become stable to etchants; selective exposure to light; to destroy polymer chain; to dry hard; desired circuit pattern; transferred image; to remove the oxide layer.

Ex. 7 Найдите в тексте следующие словосочетания:

тонкая непрозрачная пленка; ультрафиолетовое излучение; полимеризует фоторезист; окна в слое окисла; ровная тонкая пленка; растворять незащищенные участки; плотно прижимать к поверхностному слою.

Grammar Revision

Ex. 8. Образуйте от следующих глаголов все формы причастия, дайте их перевод. Вспомните синтаксические функции причастий

to apply; to use; to read; to compare; to reduce; to desire; to accumulate; to form; to move.

Ex. 9. Прочитайте и переведите предложения, обращая внимание на функции причастия в предложении.

1. Microsystem electronics is a term defining work applicable towards achieving smaller electronic equipment.
2. Improved reliability by the introduction of circuit redundancy is possible only through reduced size of circuit components.
3. The emitter diffusion using a phosphorus compound is carried out with the oxide again masking all but desired region.
4. Coat reduction is to be a by-product of improved mechanized construction and assembly technique.
5. The diffusion technology was not only adapted to existing processes, it also led to new device structure.
6. Discussing the advantages of this new method, the lecturer gave the audience all the necessary explanations.
7. Having made use of W.Mayer conclusions, Welker went further and attempted to predict the electrical properties of the III-Y components.

Ex. 10, Прочитайте и переведите предложения, обращая внимание на значения служебных слов.

1. Also as in macrocircuits, power must be expended to overcome the tolerance of all circuit components.
2. As long as we use this technique the cost will be very high.
3. As early as the beginning of the 50th the subject of microminiaturization become one of the "controversial" topics in the electronic field;
4. The 2 approaches necessarily complement each other as they are different means of describing the same physical phenomena.
5. Hence, completely new electronic function approaches chosen specifically for low-power operation will often be required.
6. Thus it has been possible to approach miniaturization in a functional manner.
7. Since all components exhibit a "spread" in values around their nominal ratings, the circuit designer never works with ideal components.

Ex. 11. Ответьте на вопросы к тексту А.

1. What is photolithography used for?
2. What are the main properties of photoresists? 5. What is a photomask?
4. How many steps does the photolitho technique consist of? What are they?

Ex. 12. Напишите аннотацию к тексту.

Ex. 13. Передайте основное содержание текста А.

Ex. 14. Прочитайте текст В и ответьте на вопросы;

а) Каковы недостатки фотолитография?

б) Каковы новые направления развития фотолитографии?

1. Whatever the present significance of photolithography, it is not free from limitations.

One of the principal limitations relates to resolution, which defines the fineness of detail in the

produced pattern of the mask. The feet is that the wavelengths of ultraviolet light range between 0.2 and 0.3 mkm . However small the window in the photomask pattern, the size of its image in the photoresist cannot be as small as the values given above due to diffraction.

2. A most obvious approach to increasing resolution in lithography is to use short-wave radiations in exposure, for example, soft X-radiation with a wavelength of 1 or 2 nm. This approach is still in the stage of research.

3. However the use of short-wave radiation in itself cannot solve either the problem of decreasing the size of circuit elements or the problem of pattern alignment. What is needed here is a new technique for the fabrication of masks with submicronic pattern elements. Also, there is a need for new resists of increased resolution and appropriate chemicals for their treatment. Last, a basic problem that awaits its solution is to choose or develop an adequate source of X-radiation. One of the variants is a synchrotron, an installation applied in nuclear engineering. However this unique installation is too costly for use in industry on a large scale.

4. Even after bringing the above problems under control, it is out of the question to expect to have integrated elements with dimensions lying in the nanometer range. There are a number of factors which stand in the way of reaching this range, such as undercutting of a resist and silicon dioxide, lateral diffusion, or spreading of ions under the mask in ion implantation. 5. The trend aimed at decreasing the size of circuit elements, using in particular, X-radiation and electron beams has received the name nanoelectronics (submicronic technique).

6. One of the weak spots in classical photolithography is mechanical contact between the photomask and substrate coated with the photoresist. This contact cannot be too perfect, so it leads to various kinds of distortion of the pattern. The competing technique is projection photolithography in which the pattern on the photomask is projected on the substrate with the and of a special optical system.

Ex. 15 Составьте 4-5 вопросов к тексту B, охватывающих основное содержание.

Ex. 16. Придумайте заглавие к тексту B.

Ex. 17. Найдите в тексте B основные положения.

Прочтите их вслух, соединяя различными средствами связи, приведенными ниже, таким образом, чтобы получился связный текст, охватывающий основное содержание текста.

as far as, whatever, since, moreover, hence, thus, because of, due to, thanks to.

Ex. 18. Разделите текст B на абзацы и озаглавьте их. Используйте заголовки в качестве плана для пересказа текста

Ex. 19. Докажите правильность или ошибочность суждений.

Используйте следующие выражения.

It goes without saying... That's right I'm not sure....

I don't agree with it, The point is that ... I can also add.... On the contrary....

1. One of the main limitations of photolithography is imperfect contact between the photomask and substrate, which leads to various destortion of the pattern.

2. The use of short wave radiation in itself can solve both the problem of decreasing the site of circuit elements and the problem of pattern alignment. 3. X-radiatlon lithography is presently in wide spread use in the semiconductor technology. 4. Nanoelectronics is the most forward-looking of several modern approaches to the development of small, reliable electronic systems. 5. It is out of the question to expect to have integrated elements with dimensions lying in the nanometer range.

Ex. 20. Переведите письменно текст за 10 минут.

Last years have seen the emergency of electron beam lithography. The essence of the technique is the following. A focused electron beam of computer-controlled intensity scans, line by line, the substrate surface coated with a resist. At the points which must be "exposed" the current of the beam is the highest, and at the points which must be "unexppsed" 'the current is the

smallest or equal to zero. The electron beam diameter is directly dependent on the beam current: the smaller the beam diameter, the lower the current. However, the exposure time grows with a decreasing current. Therefore an increase in resolution (decrease in the beam diameter) tends to lengthen the process.

Unit IV.

Text A — Thin Film Deposition
Text B — Electrolytic deposition

Grammar Revision — Gerund

Terminology
Vacuum evaporation — вакуумное напыление
rarefied gas — разреженный газ
cathode sputtering — катодное распыление
ion — plasma sputtering — ионное осаждение
chemical vapor deposition — химическое осаждение газовой фазы
anodyzing — анодирование
anodic oxidation — анодное окисление
thin film deposition — осаждение тонких пленок

Preliminary exercises.

Ex. 1. Образуйте и переведите:
а.) существительные от данных глаголов: .
to contain, to process, to evaporate, to deposit, to accumulate , to depend, to require, to determine в) антонимы следующих слов:
charge (v), appear (v), possible, simple, difference, necessary, advantage, increase

Ex. 2. Прочитайте данные слова в переведите их без-словаря, учитывая их интернациональную основу:
vacuum setup, cathode, method, absorb, condense, resistor, positive ions, electrode, anode, hybrid, integration, dielectric
Ex. 3. Прочитайте текст А и перечислите приведенные в тексте основные методы осаждения тонких пленок.

Thin Film Deposition
1. One of the basic stages in the fabrication of integrated circuits is the process of deposition of thin films. In semiconductor integrated circuits, thin films deposited on the oxids coat of a silicon slice to interconnect individual components, blocks, and devices and also serve as termination areas, i.e. contact or bonding pads for connection to IC leads.
2. A few methods are available for the deposition of thin films.
Vacuum evaporation. This method uses the same vacuum setups as the method of cathode sputtering, except that in the latter the cathode replaces the heater. Both methods are very popular. The proces is run in a vacuum chamber evacuated to a very high
vacuum. The essence of the process is the following. An electron beam or any other heating source melts down a metal which evaporates and adsorbs (condenses) on the surface of a substrate placed nearly, thus coating the substrate with a thin layer of the evaporant. By replacing the evaporant and masks through which the material adheres to the substrate it is possible to produce in the single cycle of operations a large number of conductors, resistors and capacitors, i.e. to fabricate integrated circuits.
3. Cathode sputtering. The source material for the film serves hpre as a cathode bombarded by positive ions of a rarefied gas. The ions falling on the cathode give up energy to the atoms and molecules of the material and thus knock out the atoms from the cathode. The knockout atoms

move toward the high-potential positive electrode (anode), which is the substrate on which the atoms accumulate to form a thin film.

4. To sputter insulating and semiconducting materials, a high-frequency field is built up between the electrodes. By changing the potential of the hf field it is possible to sequentially bombard the target (cathode) with positive ions and to cancel the stored positive charge with highly mobile electrons.

5. Ion-plasma sputtering. This method does not in principle differ from the method of cathode sputtering. The only difference is that a glow discharge is built up In the gap between ca'thode and anode. The process begins after initiating the discharge and applying voltage to the coil of the heater containing the source material. The rate of deposition grows until, the velocity of reactively sputtered ions reaches the velocity of ions near the substrate. The process gives a film that adheres more strongly to the substrate than in the case with cathode sputtering. It finds use for the deposition of films of chemical compounds, such as silicon nitride.

6. Chemical vapor deposition. This method relies on chemical reactions between two or more substances or on chemical decomposition. Chemical deposition from the vapor phase can produce all the three types of thin film, namely, insulator (silicon oxide), conductor end semiconductor.

7. Anodizing. Anodic oxidation is the most popular method of anodizing for obtaining thin films of hybrid circuits. Formation on a tantalum film of the tantalum oxide that acts as a capacitor dielectric can be taken as one of the examples. On applying voltage to the anode (the tantalum film), tantalum begins to oxidize forming an oxide layer of the desired thickneas determined by the drop of voltage on the anode since the oxide is a dielectric. The solution of, say, acetic acid serves as an electrolyte.

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Ex. 4. Переведите текст А, отмечая все случаи употребления герундия

Words to be remembered

1. essence — сущность, существо
2. to knock out — выбивать
5. sequentially — последовательно
4. target — цель, мишень
5. to cancel — нейтрализовать, уравновешивав
6. to store — хранить, накапливать
7. a glow — свечение
8. to initiate — начинать
9. coil n.v. — катушка, змеевик, наматывать, обматывать 10. heater — радиатор, калорифер, обогреватель катода
11. to contain — содержать, вмещать
12. to rely on — полагаться на ч.-д.

Ex. 5. Переведите следующие словосочетания:

oxide coat of silicon slice; termination areas; vacuum setups; the process is run in; heating sourcei single cycle of operations; to cancel the stored positive charge; the rate of deposition; vapor phase; absorb on the surface.

Ex. 6. Найдите в тексте следующие словосочетания:

контактные площадки, большое число проводников, сопротивление плоскостей, разреженный газ, выбивать атомы, выбитые частицы, высокий потенциал, скорость ионов подложки, химическое разложение; гибридные схемы

Ex. 7. Найдите в тексте синонимы следующих слов:

to begin; to accumulate; speed, n; significance, n; to get, to use, to carry out; to gain

Ex. 8. Вспомните функции герундия и переведите следующие предложения:

1. Allowing 2 similar materials reduces thermal conductivity without materially affecting

electrical conductivity.

2. By developing optical systems capable of resolving finer structures, the size of a typical transistor has been reduced.

3. The method of processing as well as available peripheral devices define computer generations.

4. It Is possible to obtain the films of MO and W by decomposing their halogen or carbonye compound.

5. On applying voltage to the anode, tantalum begins to oxidize, forming an oxide layer.

6. It is impossible to speak about further development of semiconductor technology without mentioning the x-radiation lithography.

7. After reading the text, the students made a summary of it.

Ex. 9, Ответьте на вопросы к тексту A:

1. What are the main methods for the deposition of thin films?

2. Is it possible to fabricate integrated circuits in the single cycle of operations in vacuum deposition? How can it be done?

3. What is the essence of cathode sputtering?

4. What is the difference between cathode sputtering and ion-plasma sputtering?

5. What types of thin films can be produced by chemical deposition?

6. What is the most popular method of anodizing for obtaining thin film of hybrid circuits?

Ex. 10. Напишите аннотацию текста A.

Ex. 11. Дайте определения основных методов осаждения тонких пленок, описанных в тексте A.

EX. 12. Составьте план текста, используя следующие выражения:

The first paragraph introduces ...

The second paragraph deals with... The text goes on to...

In conclusion the text advances the idea...

Ex.13. Прочитайте текст B и расскажите:

1) Чем отличается этот метод от методов, описанных в тексте A.

2) В чем его преимущество над распылением.

Electrolytic deposition

This method differs from the methods discussed above in that the working medium of the process is a liquid. But the character of the process resembles that of ion-plasma sputterng because both the plasma and electrolyte are quasineutral mixtures of ions with unionised molecules or atoms. And above all, the deposition here occurs gradually, layer by layer, as does sputtering, thereby enabling the growth of thin films.

Electrolytic deposition originated much earlier than any of the methods discussed, back in the 19th century. It came to be popular tens of years ago in machine-building industry for electrodepositing (nickel plating, chrome plating, and so on) of various kinds of thin coating. In microelectronics, electrolytic deposition is not an alternative of vacuum evaporation or ion-plasma sputtering: it complements each and all go together.

A great advantage of electrolytic deposition over sputtering is a much higher rate of plating, the added advantage being that the plating rate is easy to control by changing the current. The electrolytic process is mainly used for despositing comparatively thick films, 10 to 20 mkm and above. The quality (structure) of these films is inferior to sputtered films, but they prove quite acceptable for use in a number of applications.

Ex. 14. Докажите правильность или ошибочность данных суждений. Дайте расширенный ответ.

1. In microelectronics electrolytic deposition is an alternative of vacuum evaporation.

2. Ion-plazma sputtering differs fundamentally from the method of cathode sputtering. 3. There is a continuous demand for improved metallurgical contacts in semiconductor devices.

4. The dominant role of silicon as a material for microelectronic circuits is attributable to the properties of its oxide.

Ex. 15. На основе информации, изложенной в текстах А и Б, и используя приведенную ниже логико-структурную схему, расскажите об основных методах осаждения тонких пленок, применяемых в качестве тонкопленочных элементов гибридных микросхем.