Министерство образования и науки Российской Федерации

НОВОСИБИРСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

АНГЛИЙСКИЙ ЯЗЫК

АННОТИРОВАНИЕ И РЕФЕРИРОВАНИЕ

Часть 1

Методические указания для магистрантов технических специальностей

НОВОСИБИРСК
2013

ББК 81.432.1-923
А 647

Настоящие методические указания предназначены для магистрантов технического профиля, обучающихся по направлениям «Электроэнергетика и электротехника», «Материаловедение и технологии материалов», «Радиотехника».

Цель пособия – развитие навыков аннотирования и реферирования на английском языке.

Методические указания включают раздел «Теоретические основы аннотирования и реферирования», четыре раздела, содержащих тексты общетехнического характера и по направлениям «Электроэнергетика и электротехника», «Материаловедение и технологии материалов», «Радиотехника», упражнения, направленные на овладение вторичными жанрами аннотации и реферата, приложения, словарь-минимум.

В зависимости от целей, поставленных преподавателем, указания могут быть использованы для аудиторной и самостоятельной работы обучающихся.

Составитель *Ю.В. Ридная*

Рецензенты:

д-р пед. наук, доц. *Н.И. Колесникова*
канд. пед. наук, доц. *Н.А. Сапченко*

Работа выполнена на кафедре иностранных языков ТФ НГТУ

СОДЕРЖАНИЕ

Предисловие.. 5

Раздел I. Теоретические основы аннотирования и реферирования (Theoretical Review) 7

1.1. Основные понятия 7

1.2. Рекомендации по написанию реферата и аннотации 12

1.3. Стилевые и языковые характеристики реферата и аннотации 16

Раздел II. Тексты общетехнического характера (General Engineering) 19

Text 1. Classical and Modern Physics 19

Text 2. Learning about Electronics... 21

Text 3. Generation of Electricity 22

Text 4. Resistance.. 23

Text 5. Ohm’s Law 24

Text 6. Electricity 26

Text 7. - - - - - 28

Text 8. Hard and Soft Magnetic Materials 29

Раздел III. Тексты по направлению «Электроэнергетика и электротехника» (Electro-power and Electrical Engineering) 32

Text 1. Conductors and Cables.. 32

Text 2. Transmitting Alternating Current.. 34

Text 3. Alternating-Current Motors... 36

Text 4. Types of Direct-Current Motors... 37

Text 5. - - - - - 39

Text 6. Difference between Alternating – and Direct – Current Generators40

Раздел IV. Тексты по направлению «Материаловедение и технологии материалов» (Engineering Materials and Materials Technology) 42
Text 1. Conductor 42
Text 2. Metals 43
Text 3. Resistivity 45
Text 4. Cadmium copper 46
Text 5. Aluminium and its Alloys 48
Text 6. Magnetic Materials 50
Раздел V. Тексты по направлению «Радиотехника» (Radio Engineering) 53
Text 1. Semiconducting Materials Engineering Progress 53
Text 2. Semiconductor 55
Text 3. Materials used in Semiconductor Manufacturing 56
Text 4. - - - - - 58
Text 5. Semiconductor Devices 59
Text 6. Special Types of Diode 63
Приложение 1. Список химических элементов 67
Приложение 2. Средства связи 70
Приложение 3. Список глаголов для реферирования 72
Приложение 4. Клише для аннотирования и реферирования 74
Приложение 5. Образец учебно-научного понографического реферата к статье 78
Словарь-минимум 84
Список литературы 95

Предисловие

Для подготовки к вступлению в мировое профессиональное сообщество, а также успешного в нем функционирования, начинающим специалистам необходимо владение иностранным языком, в частности английским, который сегодня берет на себя функции средства межкультурной коммуникации, является языком делового общения и инструментом получения новых знаний, что особенно важно для будущих специалистов, обучающихся в магистратуре.

Благодаря иностранному языку приобретаются специальные знания по отдельным предметам, происходит осмысление определенного набора понятий, запоминание и накопление адекватного терминологического аппарата и др. Большинство специалистов используют иностранный язык для извлечения из аутентичных источников необходимой в профессиональной деятельности информации.

Таким образом, развитие навыков аннотирования и реферирования на иностранном (английском языке), заключающихся в формулировании и фиксации главного содержания прочитанного текста в результате сложной аналитико-синтетической обработки информации, занимает особое место при обучении иностранному языку в рамках программы подготовки магистрантов. Кроме того, аннотирование и реферирование обладают огромным обучающим и контролирующим потенциалом при обучении работе с текстами по специальности обучающегося.

Основной задачей пособия является овладение магистрантами жанрами аннотации и реферата на основе компрессии первичного текста.

Методические указания включают раздел «Теоретические основы аннотирования и реферирования», разделы, содержащие тексты общетехнического характера, а также тексты по направлениям «Электроэнергетика и электротехника», «Материаловедение и технологии материалов», «Радиотехника» с упражнениями, направленными на овладение вторичными жанрами аннотации и реферата; приложения, словарь-минимум.

Упражнения к текстам пособия направлены на работу с заголовком и лексико-тематической сеткой текста, распознавание логической структуры субтекста и овладение его типологией, выявление в оригинале и использование средств межфразовой связи при создании вторичных текстов, определение динамики развития мысли в тексте, сегментацию текста, визуальное моделирование смысловой структуры целого текста посредством изображения информационного графа или логико-смысловой схемы текста, использование перефразирования и обобщения при формулирования основной мысли смыслового куска или подведении итогов.

В пособии использованы оригинальные научно-технические тексты, отобранные в соответствии с заявленными направлениями подготовки магистрантов.

В помощь обучающимся предлагается словарь-минимум.

Набор устойчивых выражений (клише), используемых при аннотировании и реферировании предложен в соответствии с компонентами схемы-модели вторичного жанра, описываемого в пособии.

В зависимости от целей, поставленных преподавателем, Указания, могут быть использованы для аудиторной и самостоятельной работы обучающихся.

РАЗДЕЛ I
(Section 1)

ТЕОРЕТИЧЕСКИЕ ОСНОВЫ АННОТИРОВАНИЯ И РЕФЕРИРОВАНИЯ (Theoretical Review)

1.1. Основные понятия

Аннотирование и реферирование являются творческими процессами, суть которых состоит в осмыслении, анализе и оценке содержания оригинального текста с целью извлечения необходимых сведений. В результате аналитико-синтетической обработки информации получается вторичный текст, содержащий основные идеи первоисточника. К вторичным текстам относятся жанры аннотации и реферата.

Остановимся на их описании.

Реферат и аннотация – жанры письменные, периферийные, вторичные, малые, научно-информативные, с относительно фиксированной структурой [4, с. 146–148].

Реферат – это сжатое изложение основной информации первоисточника на основе ее смысловой переработки, строящееся в основном на языке оригинала и включающее фрагменты из первоисточника.

По цели (назначению) рефераты подразделяются:

– на библиографические рефераты;

– на рефераты для научно-популярных журналов;

– на учебные рефераты.

Выделяют следующие виды библиографических рефератов:

– **в зависимости от глубины свертывания, степени компрессии (сжатия) информации первичного документа и характера представления материала**:

а) *информативный реферат* (реферат-конспект);

б) *индикативный реферат* (указательный – краткий реферат, сходный с аннотацией).

Некоторые исследователи относят реферат-конспект и указательный реферат к *репродуктивному* виду реферата, то есть воспроизводящему содержание первичного документа. К продуктивному виду реферата, содержащему критическое или творческое осмысление реферируемого источника, относят *реферат-обзор* и *реферат-доклад*. Реферат-доклад, помимо анализа информации, приведенной в первоисточнике, дает объективную оценку состояния проблемы.

Информативный реферат определяется как реферат, содержащий «в обобщенном виде все основные положения первичного документа, иллюстрирующий его материал, важнейшую аргументацию, сведения о методике исследования, используемом оборудовании, сфере применения» [3, с. 171]. Поскольку такой реферат способен «до некоторой степени заменять первичный документ» он оказывает большую помощь читателям, которые не могут воспользоваться оригиналом.

Индикативный реферат характеризуется отсутствием детальной фактографической информации, касающейся результатов и выводов исследования, и наличием множества ключевых слов и словосочетаний, отражающих названия разделов, глав, рубрик. Именно эта особенность индикативного реферата помогает читателю решить вопрос о целесообразности обращения к первоисточнику.

– **по цели реферирования** или по читательскому назначению:

а) *общий* (*универсальный*), рассчитанный на широкий круг читателей;

б) *специализированный*, ориентированный на специалистов определенной области знания.

– **по количеству реферируемых первичных документов:**

а) монографический реферат (по одному первоисточнику);

б) обзорный реферат (на одну тему по нескольким источникам);

В рамках программы подготовки магистрантов по английскому языку рекомендуется написание ***информативного монографического специального реферата*** (объем – 1/8 от первичного текста) на основе информационной переработки профессионально-ориентированного (научно-технического) текста.

Построение текста реферата может иметь следующую композиционно-смысловую структуру:

1. Библиографическое описание (название статьи, выходные данные, сведения об авторе (авторах);

2. Тема;

3. Изложение основных вопросов, проблем, положений о которых говорится в первоисточнике;

4. Анализ самых важных, по мнению автора реферата, вопросов, перечисленных выше;

5. Выводы автора первоисточника по проблеме.

Аннотация, в отличие от реферата, является текстом, содержащим лишь перечисление главных вопросов первичного источника, указание на его тематику и структуру, при этом не допускающим цитирования.

Аннотация – это «наикратчайшее изложение содержания первичного документа, дающее общее представление о теме» [3] и характеризующееся наличием языковых оценочных клише.

Аннотации классифицируют следующим образом:

– по содержанию:

а) справочные;

б) описательные (раскрывают тематику первичного текста, но не дают критической оценки);

в) рекомендательные (оценивают первоисточник с различных точек зрения);

– по полноте охвата содержания аннотируемого документа и читательскому назначению:

а) общие;

б) специализированные.

Разновидностью специализированной аннотации является и *аналитическая* аннотация, характеризующая определенный аспект содержания первоисточника. Выделяют также *обзорную аннотацию*, которая содержит обобщенную характеристику двух и более документов, близких по тематике.

– по адресату:

а) не для личного пользования;

б) для себя;

– по форме:

а) устные;

б) письменные;

– по объему:

а) краткие аннотации (обычно сводятся к характеристике первоисточника по одному аспекту);

б) развернутые аннотации (более подробно представляют первоисточник);

– по наличию автора:

а) неавторская аннотация, сопровождающая новую публикацию;

б) авторская аннотация, написанная известным, авторитетным лицом или автором, не известным широкому кругу читателей.

При аннотировании научно-технического текста магистрантами рекомендуется написание ***описательной общей аннотации***, представляющей собой 3–4 четких предложения, дающих представление о главной теме и перечне вопросов, затрагиваемых в тексте первоисточника.

В структуре аннотации выделяют следующие части:

1. Библиографическое описание (название статьи, выходные данные, сведения об авторе (авторах));

2. Тема;

3. Проблематика.

Таким образом, если **аннотация** лишь перечисляет вопросы, о которых идет речь в первичном тексте и отвечает на вопрос *«О чем говорится в первоисточнике?»*, то **реферат** не только перечисляет эти вопросы, но и раскрывает их существенное содержание, отвечая на вопрос *«Что говорится в первоисточнике?»*.

Наряду с традиционными жанрами вторичной информации – рефератом и аннотацией, рекомендуется написание так называемых ***резюме-выводов***, или сжатых выводов, содержащих 2–3 четких, кратких, выразительных предложений, отражающих вывод, к какому пришел исследователь после прочтения статьи (текста) по специальности.

Особое внимание следует уделить **учебно-научному информативному монографическому** реферату, написание которого характеризуется высокой степенью творческой аналитико-синтетической переработки информации. Процесс построения учебно-научного монографического реферата основывается на чтении научного текста, главным образом научной статьи по специальности с последующим написанием собственного вторичного текста, исключающего компиляцию – механическое переписывание отрывков первоисточника. Поскольку текст учебно-научного реферата является результатом информационной переработки английской научной статьи, его структура будет иметь компоненты, отраженные в схеме-модели учебно-научного монографического реферата.

Схема-модель учебно-научного монографического реферата

1. Библиографическое описание

1.1. Название статьи, выходные данные

1.2. Сведения об авторе (авторах)

2. Вступление (Introduction)

2.1. Тема, ее актуальность (Importance of the Study/ Paper)

2.2. Степень разработанности темы:

– история вопроса наиболее важные работы, посвященные данной теме, сведения об авторах (Background of Study);

– нерешенные вопросы (Lack of Knowledge)
– постановка цели исследования (Statement of Purpose)

3. Основная часть (The main body)

3.1. Изложение основных вопросов, проблем, положений о которых говорится в статье

– описание методов и методик (Description of Methods and Techniques);

– описание оборудования и материалов (Description of Equipment and Materials);

– описание условий хода эксперимента (Experimental Conditions and Procedure);

– описание полученных результатов (Presenting Results)

3.2. Анализ самых важных, по мнению автора реферата, вопросов, перечисленных выше

4. Заключение (Conclusion)

4.1. Вывод, описание значения результатов/исследования, сделанные автором статьи (Description of the Significance of Results/Study)

4.2. Обобщенный вывод о значении темы или проблемы статьи, сделанный автором реферата (General Conclusion)

Написание вторичных текстов на английском языке требует использование устойчивых выражение (клише). В помощь магистранту предлагается список наиболее часто употребляемых клише при аннотировании и реферировании в соответствии со структурой жанра (см. Прил. 4).

По причине отсутствия в отечественной и зарубежной методической литературе единого мнения относительно терминологии на английском языке, используемой для обозначения того или иного жанра [6, с. 30–32], в данном пособии принимаются следующие обозначения:

Abstract – описательная общая аннотация (объем – 3-4 предложения) (не следует путать с аннотацией к статье);

Summary (1) – *информативный монографический специальный реферат* (объем – 1/8 от первичного текста);

Summary (2) – резюме-выводы (объем 2-3 предложения);

Summary (3) – учебно-научный монографический реферат (объем – 1/5 от первичного текста), в зависимости от учебного плана специальности может иметь название **Course Paper** – Курсовая работа (см. Прил. 5).

1.2. Рекомендации по написанию реферата и аннотации

При реферировании и аннотировании работа ведется по следующим направлениям:

1) выделение основной (главной) и отсечение второстепенной и несущественной информации;

2) переработка (перефразирование) главной информации в краткую форму речевого произведения.

Для успешно выполнения поставленных задач следует придерживаться следующего ***алгоритма***:

1. Просмотрите бегло первичный документ, определите общий смысл текста, опираясь на заголовок, графики, рисунки;
2. Прочитайте текст внимательно во второй раз для целостного восприятия информации, определите значение незнакомых слов по контексту и по словарю;
3. Определите основную тему текста;
4. Проведите смысловой анализ текста, выделяя абзацы (смысловые блоки, субтексты), содержащие информацию, которая раскрывает или подтверждает заглавие текста (основную тему); определите композиционное построение – структуру абзацев (дедуктивную – deductive, индуктивную – inductive, рамочную – closed-in, стержневую – pivotal);

Примечание. Проследить динамику изложения материала поможет анализ структуры абзаца или субтекста.

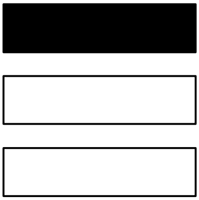
Абзац в научном тексте можно определить как относительно самостоятельный, графически выделенный посредством красной строки элемент текста, содержащий одну частную мысль или ее фрагмент. Классический абзац имеет абзацный зачин, главную абзацную фразу (обобщение), содержащую ключевые слова или предложение, комментирующую часть, раскрывающую утверждение главной абзацной части. Заканчивается абзац выводом. Иногда абзацный зачин является главной фразой, а комментирующая часть занимает два или более абзацев и вывод выделяется в отдельный абзац. В этом случае можно говорить о структуре субтекста.

Субтекст – компонент связного текста, развивающий одну из основных тем и обобщающий темы нескольких абзацев, входящих в его состав.

В зависимости от местонахождения в абзаце (субтексте) **обобщающего предложения** (key sentence) выделяют:

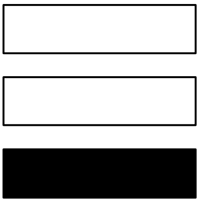
1) абзац (субтекст) с **дедуктивной** структурой – ключевое предложение находится на верхней границе абзаца (субтекста);

1) Модель *дедуктивного* (deductive) субтекста (абзаца)



2) абзац (субтекст) с **индуктивной** структурой – заключительное предложение или заключительный абзац, содержащие обобщение, подводят итог содержанию всего смыслового блока (куска) и находятся на нижней границе абзаца;

2) Модель *индуктивного* (inductive) субтекста (абзаца)

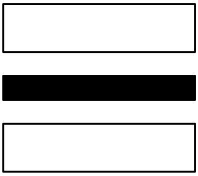


3) абзац (субтекст) с **рамочной** структурой – обобщение располагается в начале абзаца и в конце, при этом первое обобщение дублируется посредством перефразирования в конце смыслового куска;

3) Модель субтекста (абзаца) с *рамочной* **(**closed-in) структурой

4) абзац (субтекст) со **стержневой** структурой – ключевое предложение, содержащее обобщение, располагается в середине абзаца или в среднем абзаце субтекста;

4) Модель субтекста (абзаца) *со стержневой* (pivotal) структурой



В структуре текста можно выделить абзац, выполняющий функцию связки между абзацами (субтекстами). Такой абзац обычно состоит из одного предложения и называется **конструктивным.**

5. Установите средства межфразовой связи внутри абзаца (субтекста) для установления более точных его границ;

Примечание.
Предложения внутри абзацев могут быть связаны посредством:
а) повторений терминов (repetitions);
б) синонимов (synonyms);
в) антонимов (opposites);
г) местоимений (pronouns);
д) использования разных частей речи с общим корнем (например: to depend – dependence)
е) союзов, союзных слов, местоименных наречий и наречий (Connectives) (см. Прил. 2) и т. д.

6. Распределите материал текста первоисточника на три группы по степени важности:
а) наиболее важная информация;
б) второстепенная информация;
в) малозначительная информация, которую можно опустить;
7. Найдите ключевые предложения в абзацах (в начале, середине или конце), содержащих существенную информацию, составьте логический план (назывной, вопросный, тезисный) или информационный граф текста;

Примечание. Наиболее рациональной формой фиксации понятого главного содержания текста является составление плана.

План – краткая программа изложения содержания статьи (текста), содержащая последовательное изложение коротко сформулированных мыслей-заголовков, по которым можно получить представление о содержании и схеме построения первоисточника.

По структуре выделяют:

1) *простой план*;

2) *сложный план*, содержащий подпункты;

3) *развернутый*, содержащий не только перечисление основных идей, но и выдержки из текста;

По форме выделяют:

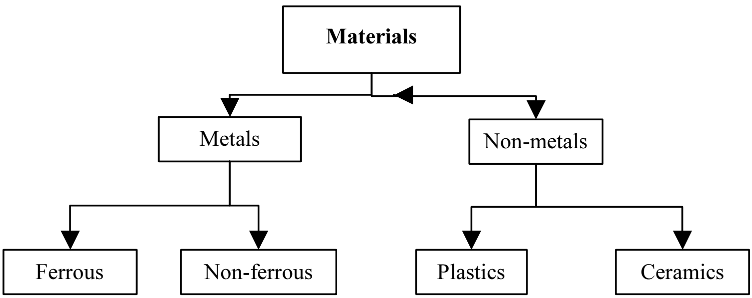
1) *назывной*, состоящий из назывных предложений (словосочетаний);

2) *вопросный*, в форме вопросов с использованием вопросительных слов;

3) *тезисный*, состоящий из утвердительных предложений.

Назывные предложения плана легче всего преобразовывать в реферативные предложения, формулирующие главную мысль каждого раздела.

Еще одним способом отражения структурной организации содержания первоисточника является составление информационного *графа* или графической репрезентации текста [1, с. 89–90], основанной на визуальном моделировании смысловой структуры целого текста. Например, текстовая схема (граф) текста, содержащего информацию о классификации материалов, может иметь следующий вид:



8. Перефразируйте, используя клише и слова с обобщенно-абстрактным значением, пункты плана в краткие (реферативные) предложения, формулирующие главную мысль каждого смыслового блока и важнейшие доказательства, подкрепляющие эту мысль;

Примечание. Перефразирование (реферирование) может осуществляться по предложенным образцам:

X is **a material** that …	=>	The author describes X **as a material** that …
		X is described **as a material** that …
X are **classified** into…	=>	The author gives the **classification** of X.
X are divided into …		
X fall into …		

X is **important** …	=>	The author points out to the **importance** of X.
X is made **thoroughly**…	=>	The author says about **thorough** X.
X **can** be described …	=>	It is said about the **opportunity** to describe X…
X is **bigger than** Y.	=>	The author **compares** X and Y.
X **consists of** … X **includes** … X **contains** … X **has**… **There is** … . … **is** also **present.**	=>	It is said about the **construction of X.** The author describes the **composition of X.** The **design** of **X** is presented.
X increases …	=>	The author says about **higher (increased) X**. It is said about an **increase in X/**
X decreases …	=>	The author points out to **lower (decreased) X.** It is pointed out to a **decrease in X.**
There is a X …	=>	The author says about **the availability of X** …
X is **used** for / in …	=>	It is said about the **use** of **X** for/in … The **use** of **X** for/in … is considered.
…	=>	…

9. Завершите обработку всех пунктов плана, соединив предложения при помощи средств связи (см. Прил. 2), в цельный, логично построенный в соответствии со схемой-моделью жанра вторичный текст.

1.3. Стилевые и языковые характеристики реферата и аннотации

Реферат и аннотация как жанры научного стиля имеют следующие стилевые характеристики:

– **обобщенно-отвлеченность** – в основе реферирования лежит использование приемов перефраза и обобщения:

а) *резюмирующего*, заключающегося в замене частного общим, видового понятия родовым, вскрытии общих признаков у ряда явлений для их объединения, сведении ряда явлений к их сущности, логическом развитии понятий, например замене одного признака другим, замене причины или следствие процессом и т. д.;

б) *выборочного*, означающего выделение одного наиболее типичного и показательного факта в качестве обобщенной характеристики положений материала;

– **логичность изложения** – в тексте прослеживается движение от простого к сложному, от старого знания к новому, от понятия к суждению и выводам. Кроме того, жанр реферата и аннотации имеют структуру, соответствующую модели жанра и соединение компонентов внутри текста достигается посредством многообразия средств межфразовой связи;

– **терминологичность** – термин – эмоционально-нейтральное слово (словосочетание), точно передающее название определенного понятия, относящегося к той или иной области науки и техники. Научно-технический текст содержит большое количество специальной терминологии, позволяющей наиболее четко и экономно излагать содержание данного предмета и обеспечивающей правильность понимания сути рассматриваемого вопроса. Отсюда вытекают такие особенности реферата и аннотации как, **однозначность, предельная краткость, ясность.**

Для языка и стиля реферата и аннотации характерно:

– преобладание слов с обобщенным, абстрактным значением (explanation-объяснение, description-описание, conditions-условия, estimation-оценка (результатов), etc.);

– наличие специального лексического аппарата – терминологии (AC generator-генератор переменного тока, electromotive force-электродвижущая сила, resistivity-удельное сопротивление, etc.);

– преобладание отглагольных имен существительных (determining-определение, implementing-внедрение, conducting-проведение, etc.);

– в глагольных формах преобладание настоящего простого (Present Simple), преимущественно в страдательном залоге; использование пассивных конструкций (The results of the experiment are presented. It is said about materials with high resistivity, etc.);

– активное использование повторений, лексических и грамматических, для обеспечения логико-смысловой связи между частями текста и отдельными фразами, например, личных, указательных, притяжательных и относительных местоимений; союзов и союзных слов и других средств связи (however-однако, besides-кроме того, thus-таким образом, etc.)

– употребление причастий и причастных оборотов;

– привнесение в текст клишированных конструкций, отсутствующих в первичном тексте (The experience of … is summarized in the article. The methodology of … is described in the paper., etc.);

– отсутствие субъективно-оценочной лексики.

Таким образом, соблюдение выше перечисленных особенностей помогает создавать тексты вторичных жанров аннотации и реферата в соответствии с требованиями, предъявляемыми к написанию текстов научного стиля, а, следовательно, эффективной текстовой деятельности.

РАЗДЕЛ II

ТЕКСТЫ ОБЩЕТЕХНИЧЕСКОГО ХАРАКТЕРА (General Engineering)

Text 1

1.1. What does physics deal with?
1.2. Read the text and find the answer to the question.

CLASSICAL AND MODERN PHYSICS

1. The earliest recorded efforts to systematically assemble knowledge concerning motion came from ancient Greece. In the system of natural philosophy set forth by Aristotle (384–322 B.C.), explanations of physical phenomena were deduced from assumptions about the world, rather than derived from experimentation. For example, it was a fundamental assumption that every substance had a "natural place" in the universe. Motion was ruled to be the result of a substance trying to reach its natural place. Because of the agreement between the deductions of Aristotelian physics and the motions observed throughout the physical universe, and because there was no tradition of experimentation that could overturn the ancient physics, the Greek view was accepted for nearly 2000 years. It was the Italian scientist Calileo Galilei (1564–1642) whose brilliant experiments on motion established for all time the absolute necessity of experimentation in physics and initiated the disintegration of Aristotelian physics. Within 100 years, Isaac Newton had generalized the results of Galileo's experiments into his three spectacularly successful laws of motion, and the natural philosophy of Aristotle was gone.

2. Experimentation during the next 200 years brought a flood of discoveries, inspiring the development of physical theories to explain them. By the end of the nineteenth century, Newton's laws for the motions of mechanical systems had been joined by equally impressive laws from Maxwell, Joule, Carnot, and others to describe electromagnetism and thermodynamics. The subjects that occupied physical scientists through the end of the nineteenth century – mechanics, light, heat, sound, electricity, and magnetism – are usually referred to as *classical physics*.

3. The remarkable success of classical physics led many scientists to believe that the description of the physical universe was complete. However, the discoveries of X rays by Roentgen in 1895 and of nuclear radioactivity by Becquerel in 1896 seemed to be outside the framework of classical physics. The theory of special relativity proposed by Albert Einstein in 1905 contradicted the ideas of space and time of Galileo and Newton. In the same year, Einstein suggested that light energy is quantized; that is, that light comes in discrete packets rather than being wavelike and continuous as had been assumed in classical physics. The generalization of this insight to the quantization of all types of energy is a central idea of quantum mechanics, one that has many amazing and important consequences. The application of special relativity and, particularly, quantum theory to such microscopic systems as atoms, molecules, and nuclei has led to a detailed understanding of solids, liquids, and gases and is often referred to as *modern physics*.

4. Except for the interiors of atoms and for motions at speeds near the speed of light, classical physics correctly and precisely describes the behavior of the physical world. Modern physics is itself built on the concepts of classical physics. For example, it is not possible to understand quantum theory without knowledge of such classical concepts as energy, momentum, angular momentum, wave functions, and standing waves.

1.3. a) What two parts can the text be divided into? Why do you think so? b) Find key sentences in each part.

1.4. Read the text again and complete the table:

Scientist	Aristotle, …
Discoveries	…, …, X rays, …
Periods of time	…, 1896, …
Physical phenomena	light, …

1.5. Find the means of connection within and between paragraphs 2, 3,4

1.6. Make up a complex nominative plan of the text.

1.7. What conclusion can you come to after reading the text?

1.8. Write a summary (2).

Text 2

2.1. What is electronics?
2.2. Read the text and find the answer to the question.

LEARNING ABOUT ELECTRONICS

Electronics is quite a complicated subject, taking in some physics, some chemistry, some mechanical engineering, and even some drawing. There is a lot to learn, but the most important part of learning the subject is understanding the underlying principles. Once you have mastered these, learning the rest of it is relatively easy.

It is possible to put a lot of mathematics into electronics, but it isn't necessary to an understanding of the subject. Of course, mathematics is necessary when calculating what voltages, currents and components your circuits use, but the calculations are really very simple: more 'arithmetic' than 'mathematics'.

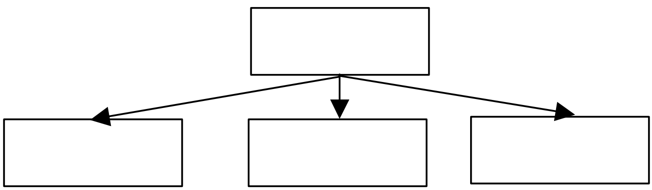
~~A study of electronics can be divided, broadly, into three rather separate disciplines: electricity, analogue electronics and digital electronics.~~

Electricity is basic to the whole thing; you need to know a certain amount about electricity before you can begin to understand anything about the way electronic devices work. And before you do much work with electricity, you must learn about safety.

Analogue electronics (or analog, which is the American spelling) is the study of systems in which electrical quantities vary continuously. Examples are radio, record and tape players, and television receivers.

Digital electronics is the more recent aspect of the subject, and deals with electrical quantities that vary in discrete steps instead of smoothly. Many digital systems deal with only two possible values. The most important example is digital computers.

2.3. Complete the graph of the text:



2.4. Divide the text into two subtexts. What are they? What is the function of the crossed sentence in the structure of the whole text?

2.5. Summarize the underlined sentences using the patterns:

X is **a material** that … => The author describes X **as a material** that …
X is considered **as a material** that …

2.6. Write a summary (1). Use Appendix 4.

Text 3

3.1. Look at the title of the text. What do you thing the text is about?
3.2. Read the text and fill in the gaps (1–4) with the sentences (A–D) below. Pay attention to the means of connection.

GENERATION OF ELECTRICITY

Historically, knowledge of electrical manifestation goes back to the early Greeks who noticed that amber, after being rubbed, had the power to attract feathers or small bits of straw. Through the ages many people have experimented with and studied the nature of this strange power, and by their efforts it has been brought under control and made one of man's most useful servants.

(1) ____.The explanations given here are made as simple and nontechnical as possible.

Electromotive force (emf) is the force or pressure that causes electric current to flow. The unit of measure of this force is the volt. Electromotive force is sometimes called "potential" or "voltage". Electric current will flow in a wire when sufficient voltage is present. (2) _________________ ___________________________. Volts and amperes are measured by dial instruments called voltmeters and ammeters.

The amount of electric power that is delivered by a generator or is consumed by a motor or other power device is the product of the pressure and the flow. (3)________________. The unit of measure of power is the watt. Therefore, watts = volts x amperes. Instruments for indicating or recording watts are called wattmeters. (4) _________________________________.

A. Thus, power = volts x amperes.
B. Before studying the way in which electrical power is generated, certain terms must be explained and certain manifestations must be discussed in order to make the study meaningful.
C. The unit of measurement of electric current flow is the ampere.
D. For designating large amounts of power the term "kilowatt" or kw, which means one thousand watts, is used.

3.3. Read the whole text, find keywords in the paragraphs and make up a plan.

3.4. What structure does the text have? Deductive, inductive, closed-in or pivotal? (See Section 1).

3.5. Give another title to the text.

3.6. Write a summary (1). Use Appendix 4/

Text 4

4.1. Match letters to the numbers:

1.) resistance	a) volt
2.) current	b) ohm
3.) voltage	c) ampere

4.2. What formula expresses the relationship between 1, 2, 3, from 4.1.?

4.3. Read the text and find this formula.

RESISTANCE

1. A. Resistance is the property of any material to oppose the flow of electricity through it. The unit of measure of this resistance is the ohm. B. The resistance of a conductor varies directly to its length and inversely to its cross-sectional area. Thus a long thin wire would have a high resistance in ohms and a short thick wire would have a low resistance.

2. C. The voltage required to make a current flow in a conductor depends upon the resistance. A pressure of 1 volt will make a current of 1 ampere flow through a resistance of 1 ohm. This relationship is expressed in the formula $I = V/R$, where I is the current in amperes, V – pressure in volts and R – resistance in ohms. D. This formula may be transposed $V = IR$ or $R = V/I$, so that when any two of the values in the formula are known the other may be found. This formula is known as Ohm's Law.

3. Electric conductors usually consist of wires or cables made of copper. Copper is used because it is the best conductor and relatively cheap. Every substance is a conductor to some degree, but the metals are the best.

4. Electric insulators are materials that allow almost no electricity to pass through them. These materials are also called nonconductors. Typical commercial insulators are rubber, silk, cotton, mica, porcelain, glass, dry paper and etc. Dry air and oils are good insulators too. Wire conductors are usually covered with insulation.

5. Electric circuits. – In order to use electric currents for transmitting power they must be sent through insulated conductors arranged to form complete paths. That is, the conductor must start at the generator, go to the motor, through it and return to the generator. If there is a break in the path, current will not flow. These paths are called electric circuits. Circuits may be series, shunt or compound.

4.4. a) Read paragraph 1 and 2. What means of connection are used within and between these paragraphs? b) Match the summarized sentences (1–4) below to the underlined ones (A–D) from paragraphs 1 and 2 and complete them.

1. The author underlines the dependence of the resistance of a conductor on … .
2. It is said about relationship between voltage and … .
3. The author gives the definition of … .
4. It is mentioned about the possibility of transposing the formula I = V/R as … .

4.5. a) Read paragraphs 3,4,5 and find the keywords within these paragraphs. b) Summarize the underlined sentences according to the patterns:

X is **a material** (that) …	=>	The author describes X **as a material** (that) …
		X is described **as a material** (that) …

4.6. Read the whole text again and divide it into two subtext. What are they about? Give subheadings to them. Make up a complex plan of the text.

4.7 Write a summary (1) and an abstract of the text.

Text 5

5.1. Give the formula expressing Ohm's law.

5.2. Read the text and check up if you are right.

5.3. Read the text again and complete the sentences (1–5) with the endings (A–E).

OHM'S LAW

The flow of electric current through a circuit depends on two factors: the e.m.f. (electromotive force) and the resistance of the circuit. (1) To get a visual picture of resistance, it is convenient ______________________ __________________. Figure 1. shows just such a comparison.

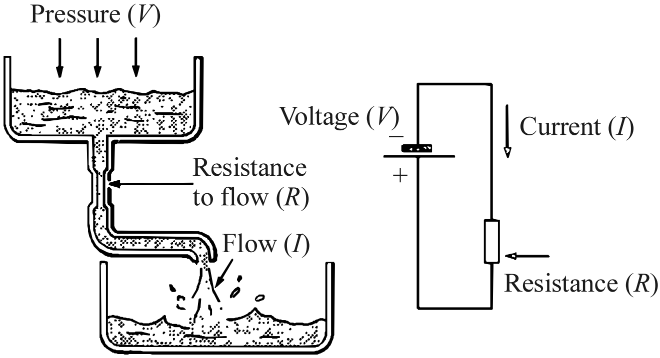


Figure 1. Plumbing analogy of an electric circuit: voltage, current and resistance all have their equivalent in the system

If the current flow is equivalent to a flow of water through the system, then the e.m.f. of the battery (in volts) is equivalent to the water pressure in the top tank (in kilograms per square metre). (2) The flow of current (in amperes) in the circuit is equivalent to ______________________. There is a restriction in the pipe that limits the flow. The amount of water that can flow out of the end of the pipe depends on the size of this restriction. If it is very thin, only a trickle of water will escape.

(3) In the electrical system, the equivalent of the restriction is _______________________________. The resistor has a greater resistance to the flow of current than the wires, just as the narrow part of the pipe 'resists' the flow of water more than the rest of the pipe. Without the resistor, a much larger current would flow in the circuit, just as more water would flow out of an unrestricted pipe. But notice that the amount of water would still not be unlimited; the pipe itself puts a limitation on the flow. (4) It is the same in the electrical circuit, for the wires and even __________________ ________________________________.

It is clear that, if the analogy holds good, there will be a relationship between pressure (e.m.f.), flow (current) and the size of the restriction (resistance). For example, if the water pressure were increased, you would expect a greater flow through the same restricted pipe. The relationship between current, voltage and resistance was first discovered by George Simon Ohm in 1827. It is called Ohm's law after him. (5) Ohm's law states ______________________________________. Ohm's law is usually written in the form V = IR In words, this says that the voltage (in volts) equals the current (in amperes) times the resistance (in ohms). The unit of resistance, the ohm (Ω), is of course, named in honour of Ohm's discovery.

A. … the battery exhibit a certain amount of resistance that would, in the absence of anything else, limit the current to some extent.

B. … the flow of water in the pipe (in litres per minute).

C. … that the current (I) flowing through an element in a circuit is directly proportional to the p.d. (V) across it.

D. … to think of the electric circuit as a plumbing system.

E. … a component called a resistor (because it resists the flow of electric current).

5.4. Complete the table

VERB	NOUN
resist	----------, ----------
----------	limitation, -----------
restrict	----------
discover	----------

5.5. Answer the questions:

a) What technique does the author of the text use to explain the phenomenon of resistance?

b) What conclusion is provided in the second paragraph?

c) What is the third paragraph about?

5.6. Which structure does each paragraph have? (Inductive, deductive, closed-in or pivotal?)

5.7. Find a key sentence in each paragraph and make up a thesis plan of the text.

5.8. Write a summary (1) and an abstract of the text.

Text 6

6.1. Look at the title of the text. What do you think the text is about.

6.2. Read the text and write down keywords.

ELECTRICITY

Although the spectacular advances have been in electronics, it would be wrong to underestimate the benefits that electricity has brought to communities everywhere. Electric power is now available in almost every corner of every nation, and has been responsible for great improvements in the living the living standards of millions of people. In most parts of the world reliable electric lighting is taken for granted; people are so used to it that they get quite angry if there are a lot of power cuts.

Electric power is easy to use, safe (if simple safety rules are followed properly), clean, and very flexible. It can be used for everything from lighting to railways. It can be generated from oil, gas, coal, falling water (hydroelectricity), atomic fission, waves, wind, or even sunlight.

There has been no 'revolution' in electric power, but there has been a steady improvement in the design, efficiency and reliability of electric appliances and machines. Electric motors, in particular, have improved almost beyond recognition in the last 50 years. Electric motors are more efficient (more power, less noise and heat) and – a given power output – about half the size they were 30 years ago. The basic principles are still the same, but there have been advances both in materials and in design. And, of course, electronics are now used in motor and power control.

<u>Electric lighting is also more efficient than it used to be (more light, less heat), thanks to advances in design and manufacturing technology.</u>

Domestic and industrial electrical installations are now much safer than they were. Better design and materials, better working practices (through proper training), and strict safety regulations in almost all countries have all helped to reduce the number of accidents.

If any area should be singled out as one in which there have been big advances in electrical – as opposed to electronic – technology, it is in batteries. A modern manganese-alkaline dry cell (for example, type MN1500) contains about ten times as much energy as its equivalent of 40 years ago. Rechargeable batteries of all types, from single cells to car and traction batteries, are much lighter, more efficient (less difference between the energy you put in and the energy you can take out), and have higher capacities.

6.3. What is the text about?

6.4. Give another title to the text.

6.5. How many subtexts can the text be divided into? Define their structure. (Are they deductive, inductive, closed-in or pivotal?) Find the means of connection within each subtext.

6.6. What do you think is the function of the underlined sentence?

6.7. Make up a complex plan of the text.

6.8. Write a summary (1) and an abstract of the text.

Text 7

7.1. a) Read the text and find the sentences that introduce a new idea. b) Divide the text into paragraphs. Find the means of connection in each paragraph.

7.2. Define the structure of each paragraph. (Are they deductive, inductive, closed-in or pivotal?)

We have always been curious about the world around us. Since the beginnings of recorded thought, we have sought ways to impose order on the bewildering diversity of events that we observe. This search for order has taken a variety of forms, and has given birth to religion, art, and science. Although the word "science" has its origins in a Latin verb meaning "to know," science has come to mean not simply knowledge in general, but more specifically, knowledge of the natural world. Most importantly, science is a body of knowledge organized in a specific and rational way. Today we think of science divided into separate fields, although this division occurred only in the last century or so. The separation of complex systems into smaller categories that can be more easily studied is one of the great successes of science. Biology, for example, is the study of living organisms. Chemistry deals with the interaction of elements and compounds. Geology is the study of the earth. Astronomy is the study of the solar system, the stars and galaxies, and the universe as a whole. Physics is the science of matter and energy, and includes the principles that govern the motion of particles and waves, the interactions of particles, and the properties of molecules, atoms, and atomic nuclei, as well as larger-scale systems such as gases, liquids, and solids. Some consider physics the most fundamental science because its principles supply the foundation of the other scientific fields. Physics is the science of the exotic and the science of everyday life. At the exotic extreme, black holes boggle the imagination. In everyday life, engineers, musicians, architects, chemists, biologists, doctors, and many others routinely command such subjects as heat transfer, fluid flow, sound waves, radioactivity, and stresses in buildings or bones to perform their daily work. Countless questions about our world can be answered with a basic knowledge of physics. Why must a helicopter have two rotors? Why do astronauts float in space? Why does sound travel around corners while light appears to travel in straight lines? Why does an oboe sound different from a flute? How do CD players work? Why is there no hydrogen in the atmosphere? Why do metal objects feel colder than wood objects at the same temperature? Why is copper an electrical conductor while wood is an insulator? Why is lithium, with its three electrons, extremely reactive, whereas helium, with two electrons, is chemically inert?

7.3. Read the text again and define what each paragraph is about.
7.4. Give a title to the text.
7.5. Make up a question plan of the text.
7.6. What is the text about?
7.7. What conclusion can you come to after reading the text?
7.8. Write a summary (2).

Text 8

8.1. What magnetic materials do you know? Where are they used?

8.2. Match numbers to the letters. Pronounce the names of chemicals properly. (See Appendix 1).

1) carbon	a) никель
2) tungsten	b) железо
3) chromium	c) титан
4) nickel	d) углерод
5) cobalt	e) медь
6) iron	f) алюминий
7) aluminium	g) вольфрам
8) copper	h) кобальт
9) titanium	i) хром

8.3. Find the meaning of the underlined words in the text. Use a dictionary.

8.4. Read the extracts (A-E) of the text "Hard and Soft Magnetic materials" and put them in the logical order to make up the text. Pay attention to the means of connection to link the extracts into the whole text.

HARD AND SOFT MAGNETIC MATERIALS

A.Hard ferrites are ferrimagnetic and considering the proportion of iron within the material have quite a low remanence (~400mT). The coercivity of these magnets (~250kAm-l). The magnets could also be exposed to moderate demagnetizing fields and hence could be used for applications such as permanent magnet motors. Permanent magnetic materials have a wide range of applications: automotive, telecommunications, data processing, consumer electronics, electronic and instrumentation, industrial, astro and aerospace, biosurgical.

B. Soft magnetic materials are those materials that are easily magnetized and demagnetized. They are used primarily to enhance and/or channel the flux produced by an electric current. The main parameter, often used as a figure of merit for soft magnetic materials, is the relative permeability (m_r, where m_r, = B/m_oH), which is a measure of how readily the material responds to the applied magnetic field. The other main parameters of interest are the coercivity, the saturation magnetization and the electrical conductivity. Soft materials are essentially composed of iron atoms and the industrial products include pure iron, the silicium-steels and iron-nickel alloys.

C. Hard magnets, also referred to as permanent magnets, are magnetic material that retain their magnetism after being magnetized. It is believed that permanent magnets have been used for compasses by the Chinese since ~2500 BC. However, it was only in the early twentieth century that high carbon steels and then tungsten / chromium containing steels replaced lodestone as the best available permanent magnet material. The present industrial permanent magnetic materials fall essentially in 3 groups: Alnico, Ferrite and Neodymium iron boron compounds.

D. The types of applications for soft magnetic materials fall into two main categories: AC and DC. In DC applications the material is magnetized in order to perform an operation and then demagnetized at the conclusion of the operation, e.g. an electromagnet on a crane at a scrap yard will be switched on to attract the scrap steel and then switched off to drop the steel. In AC applications the material will be continuously cycled from being magnetized in one direction to the other, throughout the period of operation, e.g. a power supply transformer. A high permeability will be desirable for each type of application but the significance of the other properties varies.

E. Alnico alloys are based mainly on the elements nickel, cobalt and iron with smaller amounts of aluminium, copper and titanium (Typical weight%: Fe-35, Co-35, Ni-15, Al-7, Cu-4, Ti-4). The alloy composition and processing were developed over the years and they are used today as they have a high Curie temperature (~850°C), and as a result can operate at higher temperatures as well as having more stable properties around room temperature than some of the more modern alloys. However, their main disadvantage is that they have low intrinsic coercivity (~50kAm-l) and as a consequence must be made in the form of horseshoes or long thin cylinders, which cannot be exposed to significant demagnetizing fields.

8.5. Find a key sentence in each paragraph.

8.6. Give a general word to each group of the words (word combinations) below:

a) Alnico, Ferrite and Neodymium iron boron compounds – ________________________.

b) Carbon, tungsten, chromium, nickel, cobalt, iron, aluminium, copper, titanium – __________.

c) High Curie temperature, low intrinsic coercivity, having more stable properties around room temperature, low remanence, easily magnetized and demagnetized, relative permeability, saturation magnetization, electrical conductivity – __________________.

d) Automotive, telecommunications, data processing, consumer electronics, electronic and instrumentation, industrial, astro and aerospace, biosurgical – _________________.

8.7. Make up a complex plan of the text.

8.8. Draw a graph of the text. (See Section 1).

8.9. Write a summary (1) and an abstract of the text.

Р А З Д Е Л III

ТЕКСТЫ ПО НАПРАВЛЕНИЮ «ЭЛЕКТРОЭНЕРГЕТИКА И ЭЛЕКТРОТЕХНИКА» (Electro-power and Electrical Engineering)

Text 1

1.1. What is a conductor? How are the terms “conductors” and “cables” linked?

1.2. Read the text and find the answer to the question.

CONDUCTORS AND CABLES

1. A conductor is a material that electric current will flow through quite easily. All metals are good conductors, as are some other materials such as carbon. Almost all plastics are very poor conductors – insulators, in fact. An insulator is simply a material that is a bad conductor of electricity. One of the best insulators is glass. Most ceramics are insulators, along with rubber, oil and wax.

2. A flow of electric current through a conductor consists of free electrons moving from atom to atom through the material. In order for there to be a useful amount of current, a very large number of electrons must flow. Accordingly, the basic unit of electric current flow is equivalent to around 6.28 $x10^{18}$ electrons per second moving past a given point in the conductor. This unit of electric current is called the *ampere* (often abbreviated to ‘amp’), and is named after André Marie Ampere, a French who did important work on electricity and electromagnetism. The ampere is given the symbol A.

3. We are all familiar with electrical wires. Figure 2 illustrates a cross-section through two different types. Look first at Figure 2 (a). The wire consists of a central conductor that is surrounded by flexible plastic insulation. The conductor is most likely to be made of tin-plated copper. Copper is one of the best conductors of electricity (only silver is better) and is also fairly flexible and relatively cheap. It is tin-plated to prevent the surface of the

surface of the copper from oxidizing; copper oxide is a poor conductor of electricity, which could give trouble if you used the cable with a screw-type connector. An oxidized surface is also difficult to solder.

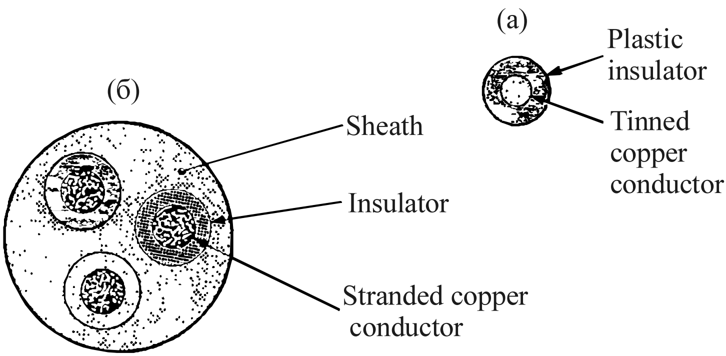


Figure 2. A cross-section through two types of cable.

4. The insulation surrounding the conductor is usually made of polyvinyl chloride (PVC), a flexible plastic with excellent insulating properties and an extremely long life in normal use. In the past, rubber insulation was used, but rubber eventually perishes and cracks .

5. Figure 2 (b) shows a typical cable used in house wiring. This cable has three cores, or conductors. There are two insulated conductors, with the insulation coloured red and black to indicate which is which. A third (earth) conductor is also present, but this does not have any insulation as it is not meant to carry current under normal circumstances. Mains three-core electricity cables always have the core colour-coded so you can tell which are which.

6. The *live* (dangerous!) core is coded *red*, or in some countries (including Europe), *brown*. The *neutral* core is coded either *black* or *blue*. The *earth* is either uninsulated or coded *green*; sometimes it has *green and yellow stripes*. A second layer of insulation, the *sheath*, covers the three cores. The current-carrying conductors are thus insulated by two layers of PVC. The sheath not only provides insulation, but also gives mechanical protection to the insulated cores inside.

7. The types of cable shown in Figure 2 will bend, although they are quite stiff. If a more flexible cable is needed, the cable to an electrical appliance for example, the conductor is manufactured with several strands

of thinner wire. This allows the cable to bend more easily and to be bent more often without danger of the cores fracturing.

Cables come in all sorts of different types. There are cables, ranging from simple insulated wires to multicored ‘ribbon cable’ used for carrying data signals.

1.3. a) How many subtexts can the text be divided into? What are they about? b) Which paragraphs do they include? Find the means of connection within and between paragraphs to prove your idea.

1.4. Read the text and find an odd word in each group:

a) carbon, plastics, silver, copper;
b) ceramics, rubber, oil, wax, copper;
c) current, electron, atom, physicist, conductor, electricity;
d) wire, conductor, ampere, insulator, copper;
e) red, brown, purple, black, blue, green, yellow.

1.5. Summarize the underlined sentences according to the patterns:

a) X is **a material** that …	=>	The author describes X **as a material** that …
		X is described **as a material** that …
b) X **consists of** …	=>	It is said about **construction of X**
X **includes** …		The author describes the **composition of X**
X **contains** …		The **design** of **X** is presented.
X **has**… **There is** … .		
… **is** also **present.**		

1.6. Find key sentences in the paragraphs and make up a complex nominative plan of the text.

1.7. Write a summary (1) and an abstract of the text. Use Appendix 4.

Text 2

2.1. What is a transformer? What is it used for?

2.2. Read the text and find the answer to the question.

TRANSMITTING ALTERNATING CURRENT

Alternating current is used more than direct current because it is best suited to long-distance transmission. Alternating current has the advantage over direct current in this because it may easily be generated at low voltages, raised to higher voltages suitable for transmission, and then reduced again by means of transformers to voltages suitable for general use.

High voltage is best for transmission over long distances because with high voltage more power may be carried over small wires. A transformer is a stationary device by which the voltage in an alternating-current system may be raised or lowered. It consists of an iron core surrounded by coils of insulated copper wire. There are two coils: the primary, to which current is supplied, and the secondary, from which current is led away. The voltage is “stepped up” or “stepped down” in exact proportion to the number of turns of wire in each coil. For instance, if the primary winding has 1,000 turns and is connected to a 2,200-volt supply, a secondary winding of 100 turns would give 220 volts (this would be called a "step down" transformer. See Figure 3 for a simple diagram of a single-phase transformer). Transformers are made single-phase and connected in groups of three for use with three-phase current, as shown in Figure 4, or they are made as special three-phase transformers.

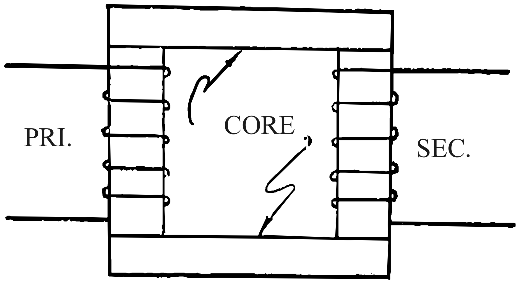


Figure 3. Diagram of transformer (single-phase)

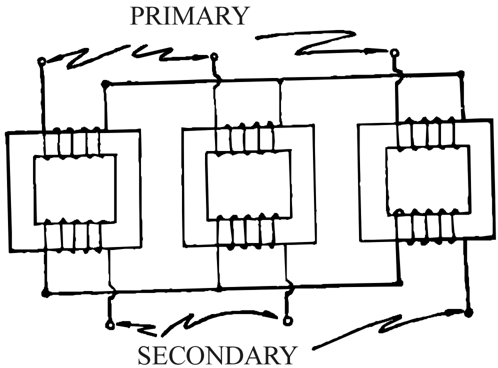


Figure 4. Diagram of three single-phase transformers (connected three-phase)

2.3. Read the text again and divide the text into several paragraphs. Pay attention to the key sentence to find a new fact or idea. Point out to the means of connection within a paragraph to define its boundaries.

2.4. Summarize the underlined sentences according to the patterns:

a) X is **bigger than** Y.	=>	The author **compares** X and Y.
b) X is a tool by which …	=>	The author describes X as a tool by which …
		X is described as a tool by which …
c) X **consists of** …	=>	It is said about the **construction of X**
X **includes** …		The author describes the **composition of X**
X **contains** …		The **design of X** is presented.
X **has**… **There is** a … .		
… is also **present.**		

2.5. Make up a plan of the text.

2.6. Write a summary (1). Use Appendix 4.

Text 3

3.1. What abbreviation for an alternating current motor is used?

3.2. What types are alternating current motors divided into according to the principle of operation?

3.3. Read the text and find the answer to the question from 3.2.

ALTERNATING-CURRENT MOTORS

Nearly all three-phase, alternating-current motors depend for their operation upon the production of the revolving magnetic field which is developed by the rotating part or rotor of the motor. (1) ________ __________ is set up by rising and falling currents in the three evenly distributed windings of the three-phase motor. When the (2) ____________ is rising in the first phase the magnetic field is produced only by the first winding. As the current decreases in the first phase and increases in the second the field shifts along until it is all produced by the second winding. A similar (3)__________ of field is produced when current rises in the third phase. The windings are so distributed that the shifting is uniform and continuous, and (4) _______ the rotating field is produced.

Alternating current motors may be divided according to the principle of operation into two general classes: synchronous and induction motors. A synchronous motor is one which rotates at the same speed as the generator. In (5) _______________, current from the generator is supplied to the windings of the stator or outer part and the windings of the rotor are "excited" by a source of direct current. Thus the magnetized (6) ___________ is pulled around by the revolving three-phase field. A three-phase generator will operate as a synchronous motor without any changes being made in its construction.

(7) ____________________ are usually made in very large sizes for service requiring constant speed. Very small synchronous motors such as those used in electric clocks and scientific instruments where constant speed is necessary are made similar to the large ones except that the rotor is made of a simple, toothed iron wheel and is not magnetized by an outside source of direct current. (8)____________________ is satisfactory where only very small amounts of power are needed.

3.4. Read the text again and fill in the gaps (1–8) with the words (nord-scompinations) below performing the function of connectives in the text.

a) shift
b) this type of motor
c) This revolving magnetic field
d) current
e) thus
f) This arrangement
g) rotor
h) Synchronous motors

3.5. Find the key sentences in each paragraph and define their structure. Are they deductive, inductive, closed-in or pivotal?

3.6. Make up a plan of the text.

3.7. Write an abstract of the text.

Text 4

4.1. What is the difference between motors and generators?

4.2. Read the text and find the answer to the question.

TYPES OF DIRECT-CURRENT MOTORS

Direct-current motors (which may be used as generators) are made in the same types as the generators, namely, series, shunt and compound. These all operate on the principle that is quite opposite to the principle of electromagnetic induction upon which the operation of the generator depends. This principle is that a current-carring conductor placed in a mag-

magnetic field will tend to move across that field. The direction of movement depends upon the direction of the current.

Motors of all types differ from generators in that all but the very small sizes require some form of control device for regulating the amount of current used in starting. These devices are called starters or starting-boxes. Starters are necessary to regulate the current fed into a motor when starting, because a motor has a much lower resistance when at rest than it has when running. This difference in resistance is due to the fact, that when running, the conductors on the rotor are cutting the magnetic field and the machine is really a generator at the same time as it is a motor. The voltage generated is of opposite polarity to that being led into the motor and consequently acts as a resistance to it. This generated voltage is called counter electromotive force.

Counter electromotive force really acts as an automatic speed control in shunt and compound direct-current motors. One may easily see that the faster a motor tends to run the more counter electromotive force it would generate. Thus more and more opposition to incoming current would be developed at the point where the motor would be obliged to slow down because of lack of current. Series motors, however, take less current with less load and so generate less and less counter electromotive force with the increasing speed that they develop when running free. Consequently these motors do not have automatic speed regulation.

4.3. Read the text and complete the table. What function do the words perform to make the text logical?

VERB	**NOUN**
move	----------
differ	----------
----------	starter
generate	----------

4.4. How many facts (ideas) are mentioned in the text. What are they? Which paragraph contains the key sentence? What another title of the text do you think can be?

4.5. What conclusion can you come to after reading the text. Find the sentence that expresses the conclusion. Formulate your own conclusion.

4.6 Write a summary (2) of the text.

Text 5

5.1. Read the text and captions to the pictures, find key words in the text. What are they?

5.2. What is the text about?

5.3. Give the title to the text.

5.4. Read the text again and fill in the gaps (1–6) with the sentences (A–F) after the text. Pay attention to the means of connection.

In a three-phase generator, three single-phase windings are combined on a single rotor and rotated in the same magnetic field. (1) ______________________________________ . The diagram in Figure 5 shows this.

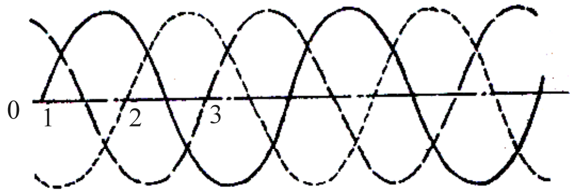


Figure 5. Distribution of phases in a three-phase generator

(2) ____. As a rule, the end of each phase winding is not brought out to a separate slip ring, but the windings are connected together inside of the machine and only three leads are brought out as shown in Figure 6.

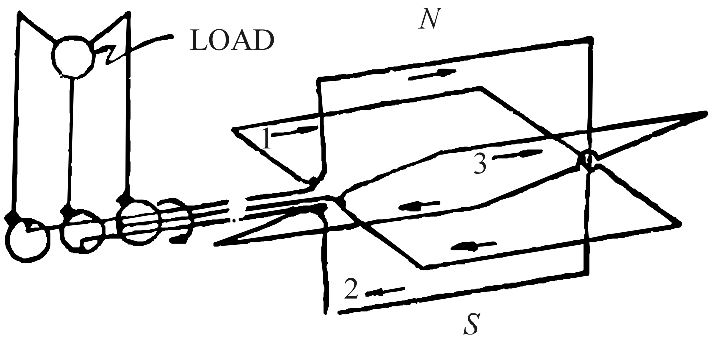


Figure 6. Diagram of three-phase revolving armature generator

This makes only three wires necessary for transmitting three-phase current. (3) ____.

In present-day commercial practice single-phase generators are very seldom used because three phase generators are more economical. (4) ______________________________.

Modern alternating-current generators are built with revolving fields, that is, the magnetic field is produced in the rotating part or rotor, and the conductors in which the current is generated are located in the stationary outer part which is called the stator. (5) ___________.

Practically all present-day alternating current generating systems operate to supply three-phase, 60-cycle power, at voltages of 110, 120 and 440. (6) _________________________.

A. Compare this diagram with the single-phase diagram.

B. When single-phase current is wanted it may be had by just using any two wires of the three that are led out of a three-phase generator.

C. This practice is followed because it means that only two slip rings may be used and they must carry only the low voltage "exciting" current.

D. The 110-volt power is usually taken off as single-phase.

E. The voltage in each winding alternates exactly one-third of a cycle after the one ahead of it, due to the arrangement of the windings.

F. Perhaps you have noticed some three-wire transmission lines.

5.5. Make up a plan of the text in the form of questions.

5.6. Write an abstract of the text.

Text 6

6.1. Look at the title of the text and say what you think the text is about. What is the difference between AC and DC generators?

6.2. Read the extracts (A-D) of the text "Difference between Alternating- and Direct-Current Generators" and find the one that contains the answer to the question.

DIFFERENCE BETWEEN ALTERNATING – AND DIRECT – CURRENT GENERATORS

(A) Keep in mind that the direct-current generator, like the alternating-current generator, is a device to convert mechanical power into electrical power, and that the direct-current motor like the alternating-current motor reverses this process. Just as the alternating-current generator may be used as a synchronous motor without any changes being made, the direct-current generator will operate as a motor. The difference here is that any direct-current generator will operate as a motor (and vice versa), whereas the al-

alternating-current generator will only operate as a synchronous motor. None of the other alternating-current motors will operate as generators.

(B) The answer to this in that there is usually what is called a little "residual magnetism" present in the field poles. This furnishes a weak field upon which the generator "builds up". If a field becomes completely demagnetized so that the generator will not build up, it is necessary to connect a battery or wires from another running generator to the terminals of the dead generator for an instant to furnish field excitation.

(C) One important difference between alternating- and direct-current generators is that the exciting current for the field of the direct-current generator is usually taken from its own rotor (since it is direct current) while the exciting current for the field of the alternating-current generator must always come from some outside source, usually a small direct-current generator. From this one may see that the direct-current generator is indispensable to the operation of the alternating current generator.

(D) One might ask where the direct-current generator gets the current to supply the field coils in the beginning.

6.3. Read the extracts (A-D) again and put them in the logical order to make up the text. Pay attention to the means of connection to link the extracts into the whole text.

6.4. Find key sentences in the paragraphs (A-D). Do all of them contain a key sentence ? What function does the paragraph (D) perform in the structure of the text?

6.5. What structure does the whole text have? (Inductive, deductive, closed-in or pivotal?)

6.6. Summarize the underlined sentences in the text using the beginnings below:

a) The author comes to the conclusion that …

b) Special attention is given to the fact that …

c) The author points out to the difference between … and … .

d) The necessity of ….-ing … is underlined.

6.7. Draw a graph and make a plan of the text.

6.8 Write a summary (1) and an abstract of the text.

РАЗДЕЛ IV

ТЕКСТЫ ПО НАПРАВЛЕНИЮ «МАТЕРИАЛОВЕДЕНИЕ И ТЕХНОЛОГИИ МАТЕРИАЛОВ» (Engineering Materials and Materials Technology)

Text 1

1.1. What is a conductor?
1.2. Read the text and find the answer to the question.

CONDUCTOR

In science and engineering, conductors are materials that contain movable charges of electricity. When an electric potential difference is impressed across separate points on a conductor, an electric current between those points appears in accordance with Ohm's law. While many conductors are metallic, there are many non-metallic conductors as well.

Under normal conditions, all materials offer some resistance to flowing charges, which generates heat. Thus, proper design of an electrical conductor includes an estimate of the amount of heat that the conductor is expected to endure without damage, as well as the quantity of electrical current. The motion of charges also creates an electromagnetic field around the conductor that exerts a mechanical force on the conductor. Consequently, a conductor of a given material and volume (length x cross-sectional area) has a limit to the current it can carry without being destroyed thermally or mechanically.

Non-conducting materials are insulators. A material can be an electrical conductor without being a thermal conductor, although a metal can be both an electrical conductor and a thermal conductor. Conducting materials are usually classified according to their electrical resistance; ranging from high to null resistance, there are semiconductors, ordinary metallic conductors (also called normal metals), and superconductors.

1.3. Read the text and find key sentences. Define the structure of the paragraphs (inductive, deductive, closed-in or pivotal). Find the means of connection within the paragraphs.

1.4. Make up a plan of the text and draw a graph of it.

1.5. Summarize the underlined sentences in the text using the patterns:

a) X is **a material** that …	=>	The author describes X **as a material** that …
		X is described **as a material** that …
b) X are **classified** into…	=>	The author gives the **classification** of X.

1.6. Write a summary (1) of the text. Use Appendix 4.

Text 2

2.1. What properties do metals have?

2.2. Read the text and complete the table;

Properties of metals	strength, …
Names of metals	copper, …
Heat treatment (procedures)	…, hardening, …

METALS

1. Why does man use metals still so much today when there are other materials, especially plastics, which are available? A material is generally used because it offers the required strength, and other properties, at minimum cost. Appearance is also an important factor. The main advantage of metals is their strength and toughness. Concrete may be cheaper and is often used in building, but even concrete depends on its core of steel for strength.

2. Plastics are lighter and more corrosion-resistant, but they are not usually as strong. Another problem with plastics is what to do with them after use. Metal objects can often be broken down and the metals recycled; plastics can only be dumped or burned.

3. Not all metals are strong, however. Copper, for example, is very malleable, aluminium is ductile and highly conductive. Copper and aluminium are both fairly weak – but if they are mixed together, the result is an alloy called aluminium bronze, which is much stronger than either pure copper or pure aluminium. Alloying is an important method of obtaining whatever special properties are required: strength, toughness, resistance to wear, magnetic properties, high electrical resistance or corrosion resistance.

4. The properties of a metal can be further improved by use of heat treatment. Heat treatment is the term given to a number of different procedures in which the properties of metals and alloys are changed. It usually consists of heating the metal or alloy to a selected temperature below its melting point and then cooling it at a certain rate to obtain those properties which are required. For example, hardening is used to make metals harder and more durable. Tempering makes them softer and less brittle. Annealing is carried out to make a metal soft so that it can be machined more easily. In this way, metallic materials can be produced to meet every kind of engineering specification and requirement.

5. When Concorde was built, a material was needed which could withstand extreme aerodynamic conditions and would have a life of at least 45,000 flying hours. To achieve this, a special aluminium alloy was developed which is tough and lightweight and is used in over 70 % of Concorde's structure. Another 16 % is made of high-strength steel, and titanium alloys are used in the engine surrounds to withstand temperatures of 4000 degrees centigrade.

6. Methods of extracting, producing and treating metals are being developed all the time to meet engineering requirements. This means that there is an enormous variety of metals and materials available from which to choose.

2.3. Read the text again and find key sentences.

2.4. Draw a graph of the text.

2.5. Summarize the underlined sentences using the patterns:

a) X is **a material** that …	=>	The author describes X **as a material** that … X is described **as a material** that …
b) X is **bigger than** Y.	=>	The author **compares** X and Y.
c) X **can be improved** by…		The author points out to **the opportunity of improving** X by …
d) There is an X …		The author says about the availability of X …

2.6. Write a summary (1) and an abstract of the text.

Text 3

3.1. What is the difference between the terms 'resistance' and 'resistivity'?

3.2. Read the text and find the definition of resistivity. Compare it with the definition of resistance (See Section 2, Text 4) to find out if you are right.

RESISTIVITY

Resistivity is the resistance in ohms offered by a unit cube of a substance to the flow of electric current.

Resistivity (also known as *specific resistance*) is a measure indicating how strongly a material opposes the flow of electric current. A low resistivity indicates a material that readily allows the movement of electrons. The SI unit for resistivity is the ohm metre.

The resistance of a conductor of a uniform cross-section varies directly as the product of the length and the resistivity of the conductor and inversely as the cross-sectional area of the conductors. (1) ____.

Resistivity is given the Greek symbol ρ (pronounced rho). The resistance of a material is usually defined by:

$$R = \rho l / A$$

where

ρ is the resistivity (measured in ohm metres)

(2) ____________________________________.

l is the length (measured in metres)

A is the cross-sectional area (measured in square metres)

Typical values for the resistivity of materials used in electrical engineering are given in Table 1. The materials manganin and constantan have high resistivity combined with a low temperature coefficient of resistance, and are widely used in ammeter shunts and in voltmeter multiplier resistors. (3) ___________________________________.

It should be noted that Table 1 may vary with temperature. (4) _____________________.

Table 1

Resistivity of metals at 0 °C

Material	*Resistivity* (Ω*m*)
Silver	1.47×10^{-8}
Copper	1.55×10^{-8}
Aluminium	2.5×10^{-8}
Zinc	5.5×10^{-8}
Nickel	6.2×10^{-8}
Iron	8.9×10^{-8}
Manganin	41.5×10^{-8}
Constantan	49.0×10^{-8}
Nichrome	108.3×10^{-8}

(5)____

Glass	$10^9 - 10^{12}$
Mica and mineral oil	$10^{11} - 10^{15}$
Plastic	$10^7 - 10^9$
Wood	$10^8 - 10^{11}$
Water (distilled)	$10^2 - 10^5$

Resistivity is the reciprocal of conductivity. (6)________________________.

A substance that has a high resistivity will have a low conductivity, and vice versa.

3.3. Read the text again and and fill in the gaps (1-6) with the sentences (A-F) after the text. Pay attention to the means of connection underlined.

A. Nichrome has a very high resistivity and is used as a conductor in heating elements in fires and ovens, and operates satisfactorily at temperatures up to 1100°C.

B. Insulators have much higher values of resistivity, typical values in Ωm being

C. Therefore, you can calculate the resistance of a conductor if you know the length, cross-sectional area and resistivity of the substance.

D. It is given the Greek symbol σ (*sigma*) and has the units siemens per metre (*s/m*).

E. R is the electrical resistance (measured in ohms)

F. For example, the resistivity of copper increases to 1.73×10^{-8} Ωm at 20°C, but the resistivity of constantan remains unchanged when the temperature changes from 0° to 20 °C.

3.4. Read the whole text and find key sentences.

3.5. Make up a plan of the text in the form of questions.

3.6 Write an abstract of the text.

Text 4

4.1. What do you know about cadmium copper? Where is it used?

4.2. Read the text and find the answer to the second question from 4.1.

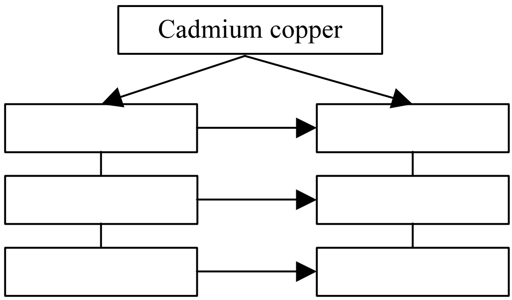
CADMIUM COPPER

Cadmium copper has greater strength than ordinary copper under both static and alternating stresses and it has better resistance to wear. It is particularly suitable for the contact wires in electric railways, tramways, trolley buses, gantry cranes and similar equipment, and it is also used in overhead telecommunication lines and transmission lines of long span. It retains its hardness and strength in temperatures at which high-conductivity materials would soften, and is used in electrode holders for spot and seam welding of steel, and it has also been used in commutator bars for certain types of motor. Because it has a comparatively high elastic limit in the work-hardened condition, it is also used in small springs required to carry current, and it is used as thin hard-rolled strip for reinforcing the lead sheaths of cables which operate under internal pressure. Castings of cadmium copper have some application in switchgear components and in the secondaries of transformers for welding machines. Cadmium copper can be soft soldered, silver soldered and brazed in the same way as ordinary copper, although special fluxes are required under certain conditions, and these should contain fluorides. Since it is a deoxidized material there is no risk of embrittlement by reducing gases during such processes.

4.3. Read the text again and find key words. What is the text about?

4.4. Find the repetition of the construction …**it is used ….** What is the construction used used for?

4.5. Complete the graph of the text:



4.6. What conclusion can you come to after reading the text?

4.7 Write a summary (2) of the text.

Text 5

5.1. Look at the title of the text. What do you thing the text is about?

5.2. Read the text and say what the text is about. Pay attention to the keywords in the text.

5.3. Give another title to the text.

ALUMINIUM AND ITS ALLOYS

I

For many years aluminium has been used as a conductor in most branches of electrical engineering. Several aluminium alloys are also good conductors, combining strength with acceptable conductivity. Aluminium is less dense and cheaper than copper, and its price is not subject to the same wide fluctuations as copper. World production of aluminium has steadily increased over recent years to overtake that of copper, which it has replaced in many electrical applications.

There are two specifications for aluminium, one for pure metal grade 1 E and the other for a heat-treatable alloy 91E. Grade IE is available in a number of forms which are extruded tube (E1E), solid conductor (CIE), wire (GlE) and rolled strip (D1E). The heat-treatable alloy, which has moderate strength and a conductivity approaching that of aluminium, is available in tubes and sections (E91E). The main application areas are as follows.

II

a)______________

Although aluminium has been used as busbars for many years, only recently has it been accepted generally. The electricity supply industry has now adopted aluminium busbars as standard in 400 kV substations, and they are also used widely in switchgear, plating shops, rising mains and in UK aluminium smelting plants. Sometimes busbars are tin-plated in applications where joints have to be opened and re-made frequently.

b)_____________

Aluminium is used extensively in cables rated up to 11 kV and house wiring cable above 2.5 mm is also available with aluminium conductor.

c)______________

The Aluminium Conductor Steel Reinforced (ACSR) conductor is the standard adopted throughout the world, although in USA Aluminium Conductor Aluminium alloy wire Reinforced (ACAR) is rapidly gaining acceptance; it offers freedom from bimetallic corrosion and improved conductance for a given cross section.

d)_______________

Aluminium is cast into the cage rotors of induction motors forming the rotor bars and end rings. Motor frames are often die-cast or extruded from aluminium, and shaft-driven cooling fans are sometimes of cast aluminium.

e)_______________

These are suitable for transformers, reactors and solenoids. They offer better space factor than a wire-wound copper coil, the aluminium conductor occupying about 90 per cent of the space, compared to 60 per cent occupied by copper. Heat transfer is aided by the improved space factor and the reduced insulation that is needed in foil windings, and efficient radial heat transfer ensures an even temperature gradient.

f)_______________

These have been developed in aluminium but they are not widely used at present. Applications include foil film wallpaper, curing concrete and possibly soil warming.

g)_______________

They are an ideal application for aluminium because of its high thermal conductivity and the ease of extrusion or casting into solid or hollow shapes with integral fins. They are used in a variety of applications such as semiconductor devices and transformer tanks. The low weight of aluminium heat sinks makes them ideal for pole-mounted transformers and there is the added advantage that the material does not react with transformer oil to form a sludge.

5.4. Read the second part of the text and fill in the gaps (a–g) with the subheadings (1–7) below:

1) *Motors*.
2) *Busbars*.
3) *Heat sinks*
4) *Foil windings*
5) *Cable*
6) *Heating elements*
7) *Overhead lines*.

5.5. Make up a complex plan of the text.

5.6. Write a summary (1) and an abstract of the text.

Text 6

6.1. What do you know about magnetic materials? What categories are they classified into?

6.2. Read the subheadings of the text and answer the second question from 6.1.

6.3. Read the underlined names of materials properly, consult Appendix 1.

MAGNETIC MATERIALS

All materials can be classified in terms of their magnetic behavior falling into one of five categories depending on their bulk magnetic susceptibility. The two most common types of magnetism are diamagnetism and paramagnetism, which account for the magnetic properties of most of the periodic table of elements at room temperature.

Materials respond differently to the force of a magnetic field. A magnet will strongly attract ferromagnetic materials, weakly attract paramagnetic materials, and weakly repel diamagnetic materials. The orientation of the spin of the electrons in an atom, the orientation of the atoms in a molecule or alloy, and the ability of domains of atoms or molecules to line up are the factors that determine how a material responds to a magnetic field. Ferromagnetic materials have the most magnetic uses. Diamagnetic materials are used in magnetic levitation and MRI.

Ferromagnetic materials

Ferromagnetic materials are strongly attracted by a magnetic force. The elements iron (Fe), nickel (Ni), cobalt (Co) and gadolinium (Gd) are such materials.

The reasons (1) ______ metals are strongly attracted are because their individual atoms have a slightly higher degree of magnetism due to their configuration of electrons, their atoms readily line up in the same magnetic direction, and the magnetic domains or groups of atoms line up more readily.

Iron is the most common element associated with being attracted to a magnet. Steel is also a ferromagnetic material. (2) ____ is an alloy or combination of iron and several other metals, giving it greater hardness than iron, as well as other specialized properties. (3) _____________ its hardness, steel retains magnetism longer than iron.

Alloys of iron, nickel, cobalt, gadolinium and certain ceramic materials can become "permanent" magnets, such that they retain their magnetism for a long time.

Strongly magnetic ferromagnetic materials like nickel or steel lose all their magnetic properties if they are heated to a high enough temperature. The atoms become too excited by the heat to remain pointing in one direction for long.

The temperature at which a metal loses its magnetism is called the Curie temperature, and it is different for every metal. (4)_________________ for nickel, for example, is about 350 °C.

Antiferromagnetism

In the periodic table the only element exhibiting antiferromagnetism at room temperature is chromium. Antiferromagnetic materials are very similar to ferromagnetic materials but the exchange interaction between neighbouring atoms leads to the anti-parallel alignment of the atomic magnetic moments. (5) _____________, the magnetic field cancels out and the material appears to behave in the same way as a paramagnetic material. Like ferromagnetic materials these materials become paramagnetic above a transition temperature, known as the Néel temperature, T_N. (Cr: T_N = 37 °C).

Paramagnetic materials

Paramagnetic materials are metals that are weakly attracted to magnets. Aluminum and copper are such metals. These materials can become very weak magnets, (6) ____ their attractive force can only be measured with sensitive instruments.

Temperature can affect the magnetic properties of a material. Paramagnetic materials like aluminum and copper become more magnetic when they are very cold.

The force of a ferromagnetic magnet is about a million times that of a magnet made with a paramagnetic material. Since the attractive force is so small, paramagnetic materials are typically considered nonmagnetic.

Diamagnetic materials

Certain materials are diamagnetic, which means that when they are exposed to a strong magnetic field, they induce a weak magnetic field in the opposite direction. (7)______________, they weakly repel a strong magnet. Some have been used in simple levitation demonstrations.

Two of the strongest diamagnetic materials are carbon graphite and bismuth. Other weaker diamagnetic materials include water, diamonds, wood and living tissue. Note that the last three items are carbon-based.

The electrons in a diamagnetic material rearrange their orbits slightly creating small persistent currents which oppose the external magnetic field.

(8)__________ the forces created by diamagnetism are extremely weak – millions of times smaller than the forces between magnets and ferromagnetic materials like iron, there are some interesting uses of those materials.

Ferrimagnetism

Ferrimagnetism is only observed in compounds, which have more complex crystal structures than pure elements.

6.4. Summarize the underlined sentences using patterns from Section 1.

6.5. Fill in the gaps (1–8) with the means of connection (a–h) below:

a) Because of
b) but
c) these
d) Therefore
e) Although
f) It
g) In other words
h) The Curie temperature

6.6. Read the text again and make up a plan of the text.

6.7. Draw a graph of the text.

6.8. Write a summary (1) and an abstract of the text.

РАЗДЕЛ V

ТЕКСТЫ ПО НАПРАВЛЕНИЮ «РАДИОТЕХНИКА» (Radio Engineering)

Text 1

1.1. What semiconducting materials do you know? Do you know the names of scientists who made great contribution to the study of semiconductor physics?

1.2. Read the text and find these names.

1.3. What do **Ge**, **Si** and **Se** stand for?

SEMICONDUCTING MATERIALS ENGINEERING PROGRESS

Semiconductors are used in a wide variety of solid-state devices including transistors, integrated circuits, diodes, photodiodes and light-emitting diodes.

Several elements in and around group IV of the Periodic Table show intrinsic semiconductor properties but of these Ge and Si (and to a lesser extent Se) alone have shown chemical and electrical properties suitable for electronic devices operating near room temperature.

Germanium and silicon were the first semiconductor materials in common use.

A great contribution to the study of semiconductor physics has been made by the prominent Soviet scientist A. F. Yoffe. It was in 1930 when Academician A.F. Yoffe and his co-workers started a systematic research in the field of semiconductors.

The diffusion theory of rectification on the boundary of the two semiconductors was elaborated by B. I. Davydov, a Soviet physicist, in 1938. Experimental support of his theory was of great importance in the investigation of processes occurring in *p-n* junctions.

Right after World War II, physicists John Bardeen, Walter Brattain and William Shockley, and many other scientists, turned full time to semiconductor research. Research was centered on the two simplest semiconductors – germanium and silicon.

Experiments in question led to new theories. For example, William Shockley proposed an idea for a semiconductor amplifier that would critically test the theory. The actual device had far less amplification than predicted. John Bardeen suggested a revision theory that would explain why the device would not work and why previous experiments had not been accurately foretold by older theories. In new experiments designed to test the new theory they discovered an entirely new physical phenomenon – the transistor effect. In 1948, W. Shockley patented the junction transistor. Junction transistors are essentially solid-state devices having three layers of alternately negative or positive type semiconductor material.

The early history of modern semiconductor technology can be traced to December 1947 when J. Bardeen and W. Brattain observed transistor action through point contacts applied to polycrystalline germanium. Germanium has become the material in common use. It was realized that transistor action occurred within the single grains of polycrystalline material.

G. Teal originally recognized the immense importance of single-crystal semiconductor materials as well as for providing the physical realization of the junction transistor. G. Teal reasoned in 1949, that polycrystalline germanium's uncontrolled resistances and electronic traps would affect transistor operations in uncontrolled ways. Additionally, he reasoned that polycrystalline material would provide inconsistent product yields and thus be costly. He was the first to define chemical purity, high degree of crystal perfection and uniformity of structure as well as controlled chemical composition (i.e. donor or acceptor concentration) of the single-crystal material as an essential foundation for semiconductor products.

The next decade witnessed the "universal" semiconductor material, silicon. Silicon gradually gained favour over germanium as the "universal" semiconductor material.

1.4. a) Read the text again and divide it into the parts that could be defined as 'Introduction', ' The main body' and 'Conclusion'. How did you learn it?

b) Give subheadings to the parts. Pay attention to the key sentences.

1.5. Complete the table using the information from ' The main body':

Scientist	**Contribution**

1.6. Make up a complex plan of the text.

1.7. Write an abstract of the text.

Text 2

2.1. What is a semiconductor? Where are semiconductors used?

2.2. Read the text and fill in the gaps with the correct word derived from the words in the box.

2.3. Read the text again to find the answers to the questions from 2.1.

conduct	various	suit	homogeneity	apply consume	rectify	
detect	characterize	consequence	exhibition			

SEMICONDUCTOR

A solid crystalline material whose electrical (1) __________ is intermediate between that of a metal and an insulator is a semiconductor. Semiconductors (2) __________ conduction properties that may be temperature-dependant, permitting their use as thermistors (temperature-dependant resistors), or voltage-dependant, as in varistors. By making (3) _______________ contacts to a semiconductor or by making the material suitably (4) ______________, electrical rectification and amplification can be obtained. Semiconductor devices, (5) ____________ and transistors have replaced vacuum tubes almost completely in low-power electronics, making it possible to save volume and power (6) ____________ by orders of magnitude. In the form of integrated circuits, they are vital for complicated systems. The optical properties of a semiconductor are important for the understanding and the (7) __________ of the material. Photodiodes, photoconductive (8) ____________ of radiation, injection lasers, light-emitting diodes, solar-energy conversion cel1s, and so forth are examples of the wide (9) ___________ of optoelectronic devices. From the standpoint of their use in electronics semiconductors are distinguished from other classes of materials by their (10) ____________ electrical conductivity σ. The electrical conductivity of materials vary by many orders of magnitude, and (11) __________ can be classified as: (a) the perfectly conducting superconductors; (b) highly conducting metals ($\sigma \approx 10^6$* mho/centimeter); (c) the somewhat conducting semimetals ($\sigma \approx 10^4$ mho/centimeter); (d) the semiconductors covering a wide range of conductivities ($10^3 \geq \sigma \geq 10^{-7}$** mho/centimeter); and (e) the insulators, also covering a wide range ($10^{-10} \geq \sigma \geq 10^{-20}$ mho/centimeter).

*** (**) Read the expressions properly:**

* $\sigma \approx 10^4$ – sigma approximately equals ten to the fourth (power);

** $10^3 \geq \sigma \geq 10^{-7}$ – sigma is equal to or less than ten to the third (power) *and* is equal to or greater than ten to the minus seventh (power).

2.4. How many parts can the text be divided into? What are they? Pay attention to the keywords and means of connection to define the boundaries of the parts (paragraphs).

2.5. Make up a plan of the text.

2.6. Summarize the underlined sentences using the patterns from Section 1.

2.7. Write a summary (1) and an abstract of the text.

Text 3

3.1. What semiconductor materials do you know?

3.2. Read the text and say what semiconductor materials are mentioned in the text. To pronounce the names of materials properly, consult Appendix 1.

MATERIALS USED IN SEMICONDUCTOR MANUFACTURING

I. Silicon, symbol Si, is the most commonly used basic building block of integrated circuits. (1)___________, silicon is a semiconductor, which means that its electrical behavior is between that of a conductor and an insulator at room temperature. With the proper addition of dopant elements, p-n junctions can be formed on silicon. Useful electronic components and integrated circuits can be built from p-n junctions. Aside from being used as semiconductor substrate, silicon is (2) _____widely used as dielectric in integrated circuits, usually in the form of silicon dioxide. (3)____________, dielectric layers are used to isolate conductive lines and the individual components in the circuit from each other. (4)__________ polycrystalline silicon, or polysilicon, is used for making resistors or conductors in integrated circuits.

(5) ____________silicon is widely used in semiconductor packaging, being the main ingredient of plastic encapsulants for integrated circuits. (6) ___________, it is used in die overcoats. Silicon is obtained by heating silicon dioxide (SiO_2), or silica, with a reducing agent in a furnace. Silicon dioxide is the main component of ordinary sand.

II. Aluminum, symbol Al, is a lightweight metal with silvery appearance. It is the most abundant metallic element on earth.

Aluminum is used in many aspects of semiconductor manufacturing. On the integrated circuit, Al metal lines are commonly used as the main conductor between components, mainly because of its low resistivity

(2.7 mohm-cm). As a thin film, it also has good adherence to silicon dioxide. When used for IC metallization, Al is usually very lightly doped with other elements such as Si and/or Cu to improve its characteristics and reliability.

In semiconductor assembly, ceramic packages are composed mainly of alumina. Aluminum is also used for wire bonding integrated circuits in ceramic packages.

III. Gold, symbol Au, is a soft metallic element that is bright yellowish in color. A good conductor of heat and electricity, it is also the most malleable and ductile of all metals.

Gold is used in many aspects of semiconductor manufacturing, particularly in the assembly or packaging processes. Its most widespread use is in wire bonding. Because of gold's excellent conductivity and ductility, it is extensively used in making wires for the connection of the integrated circuit to the leads of the package. Aside from manufacturability, the ductility of gold wires offers one more advantage when used in plastic-encapsulated devices, i.e., it makes the wires resistant to wire breaking during the encapsulation process.

3.3. Read Part I. of the text and fill in the gaps (1–6) with the connectives (a-f) below:

a) Moreover
b) For example
c) In addition
d) First of all
e) Finally
f) also

3.4. Complete the table:

Material	Uses

3.5. Make up a complex plan and draw a graph of the text.

3.6. Summarize the underlined sentences using the patterns:

X is **a material** that … => The author describes X **as a material** that …

X is described **as a material** that …

3.7. Find the sentences about materials application. Summarize them using the patterns:

It is mentioned about the use of ... for different purposes: ....

The author describes a wide range of ... application of ..., for example in ...

3.8. Write a summary (1) and an abstract of the text.

Text 4

4.1. a) Read the text and find the sentences that introduce a new idea. b) Divide the text into several paragraphs. Find the means of connection in each paragraph.

4.2. Define the structure of each paragraph. (Are they deductive, inductive, closed-in or pivotal?)

A printed circuit is an electrical circuit made by printing and bonding conducting material as a network of fine threads on a thin ceramic or polymer insulating sheet. This replaces the wiring used in conventional circuits. Other elements such as transistors, resistors and capacitors can be deposited onto the same base as the printed circuit. An integrated circuit is effectively a combination of many printed circuits. It is formed as a single unit by diffusing impurities into single-crystal silicon, which then serves as a semiconductor material, or by etching the silicon by means of electron beams. Several hundred integrated circuits (ICs) are made at a time on a thin wafer several centimetres in diameter, and the wafer is subsequently sliced into individual ICs called chips. In large scale integration (LSI), several thousand circuit elements such as resistors and transistors are combined in a 5 mm square area of silicon no more than 0.5 mm thick. Over 200 such circuits can be arrayed on a silicon wafer 100 mm in diameter. In very large scale integration (VLSI), hundreds of thousands of circuit elements fit onto a single silicon chip. Individual circuit elements on a chip are interconnected by thin metal or semiconductor films which are insulated from the rest of the circuit by thin dielectric layers. This is achieved by the formation of a silicon dioxide layer on the silicon wafer surface, silicon dioxide being an excellent dielectric. Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) are made using this technique. These transistors are used for high-frequency switching applications and for random access memories in computers. They have very high speed and low power consumption.

4.3. Read the text again and define what each paragraph is about.

4.4. Give a title to the text.

4.5. Make up a question plan of the text.
4.6. What is the text about?
4.7. What conclusion can you come to after reading the text?
4.8. Write a summary (2).

Text 5

5.1. What semiconductor devices do you know?
5.2. Read the subheadings of the text and say what semiconductor devices are mentioned in the text.

SEMICONDUCTOR DEVICES

There are a number of semiconductor devices – other than bipolar and unipolar transistors – that are in common use. This section gives short descriptions of what they do and what they are for.

Thyristors. The thyristor, also known as a silicon-controlled rectifier (SCR), is a component that has wide applications in the field of power control. In essence it is very simple, easy to use and easy to understand. The circuit symbol for the SCR is given in Figure 7.

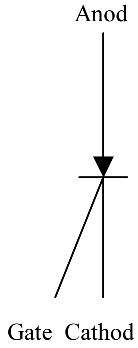


Figure 7. The circuit symbol for a thyristor (SCR)

As you can tell by looking at the symbol, the SCR is a form of diode. Under normal circumstances, however, it will not conduct current in either direction. If a voltage is applied to the SCR in such a way that, if it were on ordinary diode, would conduct (forward-biasing it), a small current made to flow between the gate and the cathode will make the SCR change abruptly from a non-conducting to a conducting state. It then has characteristics the same as those of a forward-biased silicon diode, with a somewhat higher forward voltage drop (typically 0.7–1.3 V).

Turn-on takes place extremely rapidly, within a few microseconds of the application of the gate current. Once it has been turned on, the SCR will stay in the conducting state even if the gate current is stopped. It will turn off again only when the current flowing through it is reduced below a certain (quite low) value. This minimum current required to maintain conduction is called the *holding current*, and is between a few microamps and a few tens of milliamps, according to the type of device.

SCRs can be made to withstand high voltages, and are readily obtainable for use with peak voltages from 50 V to tens of k V.

SCRs are power-control devices, and are made in a variety of current-carrying capacities, from small devices capable of handling a few hundred milliamps at 50 V to huge units designed to deal with hundreds of amps at hundreds of volts. Small SCRs used in electronic circuits likely to be encountered by the engineer range from T092 encapsulated 300 mA versions up to about 40 A. Voltages are usually in the range 50–1200 V, with 400 V types preferred for control of mains electricity at 220–240 V.

The size of the gate current – the minimum amount needed to trigger the SCR – can range from a few hundred microamps in sensitive low-voltage SCRs to a few tens of milliamps for the larger ones.

The fact that a thyristor, once triggered, remains on until the current flowing through it is interrupted does not necessarily mean it can't be used in d.c. circuits. The circuit in Figure 8 illustrates how it can be turned on and off to control a relay, motor or lamp. Momentarily connecting T_1 to the positive line switches the thyristor on by providing a gate current. When the thyristor is on, the 1 μF capacitor charges up through the 1 kΩ resistor, so that its left side (in the diagram) is positive.

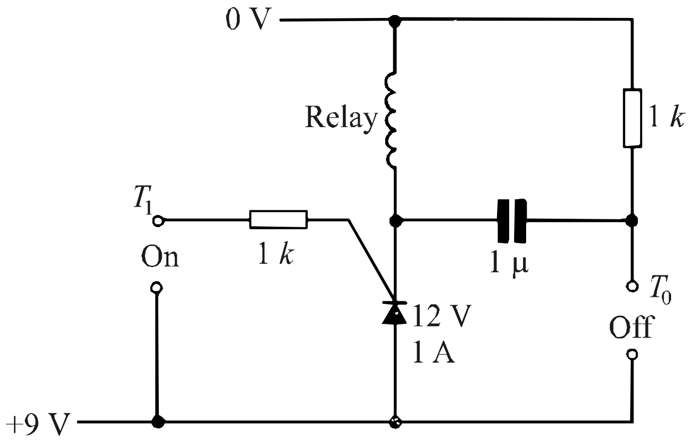


Figure 8. A thyristor circuit to give 'on' and 'off' contril

The thyristor can be turned off by momentarily connecting T_0 to the positive line. Until the capacitor has discharged (which takes less than a millisecond) this provides a voltage that opposes the direction of current flowing the thyristor, and the current drops to zero for long enough to turn it off.

This circuit will drive any suitable relay or lamp.

Triacs

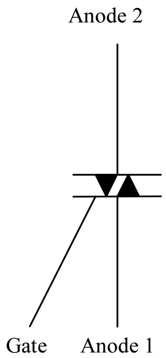


Figure 9. The circuit symbol for a triac

The triac, to give the more usual (but less informative) name for the bidirectional thyristor, is an SCR that will conduct in either direction, with the gate current flowing between anode 1 and the gate in either direction: a very accommodating component! The circuit symbol is given in Figure 9.

Like the SCR, the triac will remain on, once triggered, until the current passing through it falls below the level of the holding current. Triacs are often used with mains electricity, for controlling the brightness of electric lamps. When used with the mains a.c. supply, the triac will automatically turn off 100 times a second with a 50 Hz supply frequency.

Diacs

The diac is a specialised component, specifically designed for use with SCRs and triacs, though it has inevitably found its way into various other circuits. The 'long' name for the diac is the *bidirectional breakdown diode*, and its circuit symbol is given in Figure 10.

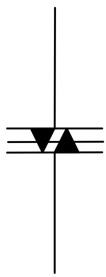


Figure 10. The circuit symbol for a diac.

A diac normally blocks the flow of current in either direction, but if the voltage across it is increased to the *breakover voltage*, usually about 30 V, the diac begins to conduct. It does in fact exhibit a phenomenon known as negative resistance, for as breakover occurs the voltage across the diac actually drops by a few volts. If the diac is connected in a circuit in which a steadily increasing voltage appears across it, it will, at breakover, allow a sudden current 'step' to flow in the circuit.

The diac is an ideal device for providing a suitable trigger pulse for an SCR or triac. The circuit in Figure 11 is a typical triac/ diac application: a circuit for a mains-lamp brightness controller.

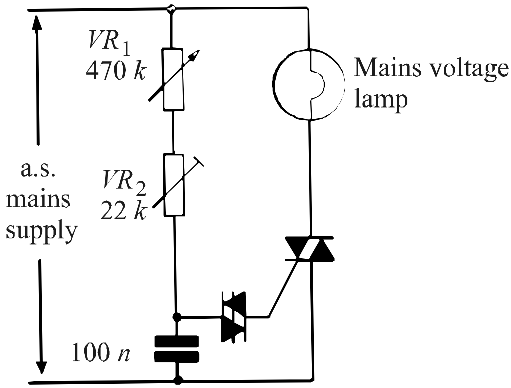


Figure 11. A simplified but functional circuit to control the brightness of an a.c. lamp.

The circuit works by means of what is loosely known as ‘phase control’. As the voltage across the circuit rises, following the sine wave of the mains electricity supply, the capacitor charges up at a rate controlled by VR_1 and VR_2. At a certain point in the a.c. half-cycle the voltage across the capacitor will reach the breakover voltage of the diac; the diac applies a pulse of current to the triac gate, triggering the triac into conduction and allowing current to flow through the load. At the end of the mains supply half-cycle the triac will switch off.

During the next half-cycle, the same sequence will occur, but with all the polarities reversed (unimportant, because all the circuit components will work with a voltage applied in either direction). Once again, the triac will trigger after a certain delay, allowing a current flow through the load.

If the resistor VR_1 is set to a high resistance, the capacitor will charge up slowly and the triac will be triggered near the end of each half-cycle. If the resistor VR_1 is set to a low resistance, the triac will be triggered near the beginning of each half-cycle, applying almost full power to the load. The amount of power flowing through the load is controlled by VR_1, so the brightness of a lamp can be regulated over a wide range. The graph in Figure 12 illustrates this. Because the circuit works by switching the power on and off, little heat is dissipated and the control is efficient in terms of power used. VR_2 is included in this circuit to set the maximum brightness level according to the characteristics of diac and triac.

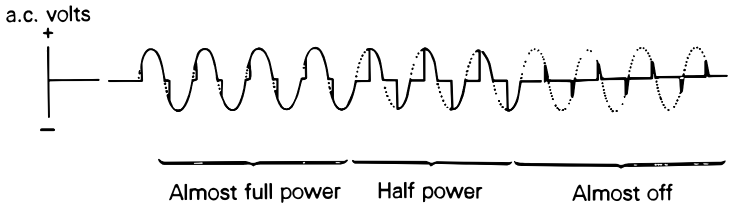


Figure 12. A graph illustrating the way in which the triac can be used with an a.c. supply to control the amount of power flowing through a load

5.3. Read the text and complete the table:

Semiconductor device	Function	Use

5.4. Summarize the underlined sentences using the patterns from Section 1.

5.5. Write a summary (1) of the text using information from the table above.

Text 6

6.1. What types of diode do you know?

6.2. Read the subheadings (1-4) after the text and say what types of diode are described in the text.

6.3. Read the text and fill in the gaps (a-d) with the sab headings (1-4) after the text/

SPECIAL TYPES OF DIODE

a) ________________

The Zener diode makes use of a form of breakdown to provide a constant 'reference' voltage, as required by many circuits. The circuit of Figure 13 shows the symbol for a Zener diode and also a suitable circuit to demonstrate its properties. In this circuit the diode is reverse-biased (Zener diodes are always used this way) and the meter is showing a drop of 2.8 V across it.

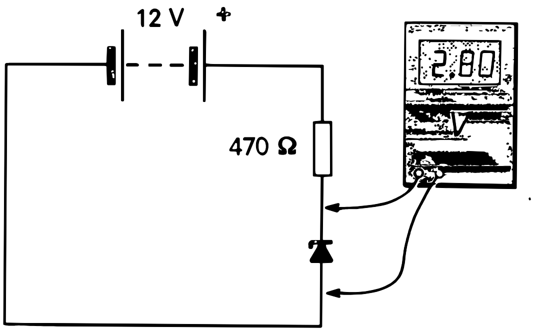


Figure 13. A Zener diode in a typical circuit

The voltage drop across a reverse-biased Zener diode will be substantially constant for all values of current up to the diode's limit, and for all values of p.d. higher than the Zener voltage.

A resistor is necessary to limit the current through the circuit. In this case the current is calculated by Ohm's law:

$$(12 - 2.8) / 470 = 19.6 \text{ mA}$$

If we were to double the battery voltage to 24 V, the current through the circuit would increase to

$$(24 - 2.8) / 470 = 45 \text{ mA}$$

but the voltage across the Zener diode still remains constant at 2.8 V. The Zener diode is therefore a valuable device for voltage regulation, giving a fixed reference voltage for a range of input voltages. According to the doping and the construction used, Zener diodes can be made with any of a range of forward voltage drops.

Zener diodes are named after C.M. Zener, who in 1934 described the breakdown mechanism involved. In fact, Zener's description applies only to diodes with a Zener voltage of less than about 3 V. Above this, a mechanism called *avalanche breakdown* begins to take over. However, both types are generally lumped together under the heading 'Zener diodes', and are available in a range of voltages from 2 to 70, and with power ratings from 500 mW to 5 W. The power dissipation of the Zener diode is calculated by the usual formula

$$P = V_z I$$

where V_z is the Zener voltage. By way of example, the Zener diode in Figure 13 is dissipating

$$2.8 \times 19.6 = 54.9 \text{ mW}$$

b) ________________

The junction of a reverse-biased diode has a measurable capacitance. The p-type and n-type regions form the plates of the capacitor, and the depletion region acts as a *dielectric*. You will remember that the capacitance of a capacitor depends (among other things) on the thickness of the dielectric, and it is this fact that makes the *pn* diode useful as a *variable capacitor* with no moving parts.

The diode is reverse-biased. If the biasing voltage is then increased, the difference in the energy levels of the *p* and *n* regions is made greater. As this happens, a greater thickness of the junction is depleted of charge carriers, increasing the width of the depletion regions. Effectively, the capacitor's dielectric has become thicker, and this lowers its capacitance.

A varicap diode (a composite word from *'variable capacitance'*) is a diode in which the change of capacitance with applied reverse voltage is enhanced as far as possible by the diode's physical construction. The maximum capacitance and the amount of change are both small, although they are sufficient to enable the varicap diode to be used in the tuning circuits of a television, for example.

c) ________________

A photodiode is structurally very similar to a normal *pn* junction diode, though there may be a mechanical difference brought about by the necessity to maximise the area of the junction that can be exposed to light. Photo diodes are used in *reverse-biased mode*, and the leakage current will then depend on the amount of light falling on the device. Photodiodes are useful for measurement applications, since the leakage current is directly proportional to the light intensity over a wide range.

Silicon is generally used for photodiodes, so the peak response to light is in the infrared region. The actual amount of current is also rather small. A typical photodiode might have a dark current of 1.5 μA, and an output current in bright sunshine of 3.5 μA. Substantial amplification is therefore required for most applications.

d) ________________

A light-emitting diode (LED) is an extremely useful device, and can be used instead of a miniature incandescent lamp in a whole range of appli-

applications. LEDs are usually ruby red, but green and yellow versions are available, although they are a little more expensive and therefore less common.

Like ordinary *pn* diodes, LEDs nave no inherent current limiting characteristics, and must be used with a resistor to limit the current flowing through them, generally to around 20 mA for a small LED indicator. LEDs are used in the forward-biased mode: indeed, they must be protected from reverse bias as they usually have a reverse breakdown voltage of only a few volts. If breakdown occurs, the LED is destroyed.

1. **The varicap diode**
2. **Light-emitting diodes**
3. **Photodiodes**
4. **The Zener diode**

6.4. Find key sentences in each part of the text. Define the structure of tne parts. (deductive, inductive, closed-in or pivotal)

6.5. Read the text again and complete the table

Type of diode	Use

6.6. Write down four sentences to characterize each type of diode using the patterns below. Use the information from the table above:

The author characterizes **X** as a … device that can be **used** for/in …

X is described as a … device that can be **used** for/in …

It is said that **X** is … device that has a variety of **uses** in …

6.7. Make up a complex plan of the text.

6.8. Write a summary (1) and an abstract of the text.

Приложение 1
(Appendix 1)

Список химических элементов*
(The list of chemical elements)

Ag	argentum	[a:'dʒentəm] = silver ['sɪlvə]	серебро
Al	aluminium	[ælju'mɪnɪəm]	алюминий
Ar	argon	['a:gɒn]	аргон
As	arsnic	['a:s(ə)nɪk]	мышьяк
Au	aurum	['ɔ:rəm] = gold [gould]	золото
B	boron	['bɔ:rɒn]	бор
Ba	barium	['beərɪəm]	барий
Be	beryllium	[bə'rɪlɪəm]	бериллий
Bi	bismuth	['bɪzməθ]	висмут
Br	bromine	['broumi:n]	бром
C	carbon	['ka:bən]	углерод
Ca	calcium	['kælsɪəm]	кальций
Ce	cerium	['sɪ(ə)rɪəm]	церий
Cd	cadmium	['kædmɪəm]	кадмий
Cl	chlorine	['klɔ:ri:n]	хлор
Co	cobalt	['koubɔ:lt]	кобальт
Cr	chromium	['kroumɪəm]	хром
Cs	caesium	['si:zɪəm]	цезий
Cu	copper	['kɒpə]	медь
F	fluorine	['flu(ə)ri:n]	фтор
Fe	ferrum	['ferəm] = iron ['aɪən]	железо
Ga	gallium	['gælɪəm]	галлий
Ge	germanium	[dʒə:'meɪnɪəm]	германий

H	hydrogen	['haɪdrədʒən]	водород
He	helium	['hi:lɪəm]	гелий
Hg	hydrargyrum	[haɪ'dra:dʒɪrəm] = mercury ['mə:kjurɪ]	ртуть
I	iodine	['aɪədi:n]	йод
Ir	iridium	[ɪ'rɪdɪəm]	иридий
K	kalium	['keɪlɪəm] = potassium [pə'tæsɪəm]	калий
Li	lithium	['lɪθɪəm]	литий
Mg	magnesium	[mæg'ni:zɪəm]	магний
Mn	manganese	[mæŋgə'ni:z]	марганец
Mo	molybdenum	[mə'lɪbdənəm]	молибден
N	nitrogen	['naɪtrədʒ(ə)n]	азот
Na	natrium	['neɪtrɪəm] = sodium ['soudɪəm]	натрий
Ne	neon	['ni:ɒn]	неон
Ni	nickel	['nɪk(ə)l]	никель
O	oxygen	['ɒksɪdʒ(ə)n]	кислород
P	phosphorus	['fɒsf(ə)rəs]	фосфор
Pb	plumbum	['plʌmbəm] = lead [led]	свинец
Pt	platinum	['plætɪnəm]	платина
Pu	plutonium	[plu:'tounɪəm]	плутоний
Ra	radium	['reɪdɪəm]	радий
Rb	rubidium	[ru:'bɪdɪəm]	рубидий
S	sulphur	['sʌlfə]	сера
Sb	antimony	['æntɪmənɪ]	сурьма
Sc	scandium	['skændɪəm]	скандий
Se	selenium	[si'li:nɪəm]	селен
Si	silicone	['sɪlɪkoun]	кремний
Sn	stannum	['stænəm] = tin [tɪn]	олово

Sr	strontium	['strɒntɪəm]	стронций
Te	tellurium	[tə'l(j)u(ə)rɪəm]	теллур
Th	thorium	['θɔ:rɪəm]	торий
Ti	titanium	[tɪ'teɪnɪəm]	титан
U	uranium	[ju'reɪnɪəm]	уран
W	wolfram	['wulfrəm] = tungsten ['tʌŋstən]	вольфрам
Zn	zinc	[zɪŋk]	цинк
Zr	zirconium	[zə:'kounɪəm]	цирконий

* В список входят наиболее распространенные химические элементы

Приложение 2
(Appendix 2)

Средства связи
(Means of connection)

	Значение	Средство связи
1	Указание на порядковую последовательность мыслей и действий (сначала, потом, наконец)	First, at first, first of all, at the beginning, to begin with – во-первых, сначала, прежде всего; second, secondly – во-вторых; next, further, then – далее, затем; finally, lastly, at last, in the end – (и) наконец
2	Присоединение к высказыванию нового предложения, содержащего дополнительные замечания, или развивающее мысли дальше (кроме того, помимо того)	in addition – в дополнение (к сказанному); consequently – следовательно, вследствие этого; accordingly – в соответствии с этим; therefore – поэтому moreover – кроме того, более того; furthermore – далее, более того, кроме того, к тому же; also – кроме того, более того, а также; likewise, similarly – точно так же, аналогичным образом; besides – кроме того what is more – более того
3	Выражение противопоставления	however – однако; still – однако, тем не менее; yet – однако, однако же; on the contrary, in (by) contrast – и наоборот, напротив, в противоположность этому; conversely, alternatively – с другой стороны; on the one hand – с одной стороны; on the other hand – с другой стороны; nevertheless – тем не менее, несмотря на это, однако; otherwise – иначе, противном случае although – хотя

Окончание таблицы

	Значение	Средство связи
4	Указание на следствие, суммирование сказанного ранее	hence – отсюда; therefore – поэтому consequently, as a consequence thus – таким образом; as a result – в результате этого; in brief, in short, briefly, in a few words вкратце короче говоря; – вкратце; in sum, to sum up, to summarize – итак, суммируя сказанное выше, можно сказать, что…
5	Выражение ссылки на что-либо	according to, with reference to – согласно …, в соответствии с … as for – что касается… with respect to, with regard to, regarding – относительно …
6	Выражение причины	because of, owing to, due to – из-за, благодаря; for this reason – по этой причине
7	Приведение примеров	for example, for instance – например as an example – в качестве примера

Приложение 3
(Appendix 3)

Список глаголов для реферирования

account for – объяснять
agree with – соглашаться (с)
analyze – анализировать
argue – доказывать
assume – допускать
be concerned with – касаться
believe считать, полагать
compare – сравнивать
concentrate on – сосредоточиваться
concern – касаться
conclude – делать вывод
confirm – подтверждать
consider – рассматривать
contradict – противоречить
deal with – иметь дело (с)
define – определять
design – сконструировать
determine – определять
develop – развить, разработать (теорию, идею, метод)
disagree with – не соглашаться (с)
discover – открыть, сделать открытие
discuss – обсуждать
distinguish – различать
draw attention to – обратить внимание
emphasize – подчеркивать
evaluate – оценивать
examine –исследовать
explain – объяснять
find – найти, обнаружить, становить
illustrate – иллюстрировать
indicate – указывать
interpret – объяснить, интерпретировать
investigate – исследовать
lead to – вести (к)

pay attention to – обратить (свое) внимание на что-либо
point out – указать на что-либо
predict – предсказать
present – излагать, представить
produce – вызывать
provide – обеспечивать
recognize – признавать
refer to – сообщать
regard – считать
report – сообщать
respond to – реагировать, отвечать на
reveal – раскрывать
review – рецензировать, делать обзор
show – показать
solve – решить (проблему, уравнение, задачу)
suggest – предложить
touch upon – затрагивать
treat smth. as – считать, трактовать что-то как

Приложение 4
(Appendix 4)

Клише для аннотирования и реферирования

(В соответствии со схемой – моделью учебно-научного монографического реферата)

Субжанры	Тематические предложения	Клише
1. Библиографическое описание	1.1. Название статьи, выходные данные	The paper is entitled … is called … is named … The title of the paper is … The paper is published in…
	1.2. Сведения об авторе (авторах)	The author (s) of the paper is (are)… The article is written by …
2. Вступление (Introduction)	2.1. Тема, ее актуальность (Importance of the Study/ Paper)	The present paper deals with… The paper under discussion (consideration) is concerned with … is devoted to … The paper considers … discusses … describes … gives a brief account of … contains a survey of …

		presents a picture of …. provides information on … reviews briefly … touches upon the issue of... is about … centers round the problem of... presents some data on … contains information on … The paper is intended (aims) to describe (explain, characterize) …
	2.2. Степень разработанности темы: – история вопроса наиболее важные работы, посвященные данной теме, сведения об авторах (Background of Study); – нерешенные вопросы (Lack of Knowledge); – постановка цели исследования (Statement of Purpose)	In recent years there have been some new developments in the field of … During the past few years much progress has been made in … During the last decade a great number of researchers have been involved in the study of … In the last ….years we have witnessed remarkable progress in … At present intensive investigation is being carried on in the field of … The problem of … is being widely discussed in ... Lately interest has been centered around the problem of … But …has not been developed However…is required Thus …is proposed.
3. Основная часть (The main body)	3.1. Изложение основных вопросов, проблем, положений о которых говорится в статье	The paper under consideration is mainly focused on … issues:… considers (describes) the following main issues: … First/ firstly, …. is/are discussed (described, shown, considered) in the paper.

Продолжение таблицы

Субжанры	Тематические предложения	Клише
	– описание методов и методик (Description of Methods and Techniques); – описание оборудования и материалов (Description of Equipment and Materials); – описание условий хода эксперимента(Experimental Conditions and Procedure); – описание полученных результатов (Presenting Results)	The paper begins with the discussion of … The first part deals with … In the first part the problem of … is considered in detail. The first part concentrates (focuses) on … The introductory part reviews … Then/ Secondly … is/ are analyzed (considered, reviewed). The author goes on to show that … Also/ In addition the problem of … is considered. Besides, some comments on … are given. Then the author makes an attempt to show that … The paper also presents some data on … The paper also mentions the fact that … The paper also contains … Besides, the paper touches upon the problem of … The mechanism of ... was/has been investigated using the method / technique of ... The structure of ... was/has been studied by (the method of) ... The phenomenon of … was/has been analyzed (by means of) .... The process of ... was/has been examined making use of technique of ... The function of ... was/has been analyzed by ... Finally, the relationship between …was/has been established. the interaction between … was/has been determined. the parameters of ... were/have been calculated. some information concerning ... was/has been obtained. the properties of ... were/have been evaluated.

		It was/has been found that … It was/has been shown that … It was/has been suggested that … It was/has been concluded that …
	3.2. Анализ самых важных, по мнению автора реферата, вопросов, перечисленных выше	Special attention is paid (given, called) to… … is/ are of special importance (significance, interest) It is stressed (underlined, emphasized) that … Much attention is focused on … … is/are emphasized (underlined, stressed, pointed out)
4. Заключение (Conclusion)	4.1. Вывод, описание значения результатов/ исследования, сделанные автором статьи (Description of the Significance of Results/Study)	Summing up, the author points out that … Summing up the discussion, the author emphasizes that … Summarizing, the author says that … To summarize, the author says that … In conclusion, the author emphasizes that …
	4.2. Обобщенный вывод о значении темы или проблемы статьи, сделанный автором реферата (General Conclusion)	Having analyzed the information it is possible to say that … All things considered we can come to the conclusion that … In conclusion, it should be emphasized that … In conclusion, I should like to point out that … To summarize the discussion, I should like to underline that … Summing up the discussion, it should be pointed out that … To sum up, the paper under discussion provides us with …

Приложение 5
(Appendix 5)

Образец учебно-научного монографического реферата к статье (Первичный текст прилагается)

The title of the paper is “High-performance perfluorinated polymer electret film for micro power generation”. The authors of the paper are Yoshihiko Sakane, Yuji Suzuki and Nobuhide Kasagi, Japan.

The present paper describes the development of a new high-performance polymer electret material for electret power generator. In recent years much interest has been centered on the use of micro power generation systems as the alternatives of conventional secondary batteries. Since the vibration-driven energy harvesting devices are applied to RFIDs and mobile sensors networks consuming a low electrical power, electret power generators with higher performance should be used. According to the data presented by the authors in their previous reports, CYTOP™ CTL-M (Asahi Glass Co., Ltd.), MEMS-friendly amorphous perfluorinated polymer, can possess high surface charge density, which is stable enough for electret material. However higher surface charge density is required for better performance. Thus a novel electret material based on CYTOP™, type CTL-NMD, is proposed.

The paper under consideration is mainly focused on three issues: the design of the electret power generator, polymer electret material and power generation experiment.

Firstly, the design and operation of the micro electret generator developed in the authors’ previous study are presented. Also, referring to the information presented by Boland et al. in 2003 the authors come to the conclusion about the factors that have large impact on the generator performance. So it was concluded that the maximum output power is proportional to the squared surface change density and is increased with the thickness of electret.

Further the requirements for materials to be dielectric for electret are discussed. These requirements are as follows: compatibility with MEMs fabrication technique, easiness to be formed into thick films and having high dielectric strength. It is proved that CYTOP™ meets the requirements described. In other words it is compatible with MEMs fabrication process; it is soluble in perfluorinated solvents, and thus thick films can be obtained by multiple spin-coating. In addition the unique properties of CYTOP™ as the perfluorinated polymer are enumerated.

Then different types of CYTOP™ were examined and compared. The performance of the electret materials based on CYTOP™ was evaluated by means of measuring temporal change of the surface charge density. Also the thermal stability of charged electret was examined by performing the open circuit thermally-discharged (TSD) measurement. As result it was defined that a new material developed, CYTOP™, type CTL-NMD, has the highest surface charge density, moreover, the thermal stability of charges can be improved with the doping of silane coupling reagent.

Finally the experimental set up for power generation is considered. It is pointed out that corona charging technique was applied to acquire surface potential of more than –550V. Besides, it is underlined that peak power output that is about twice of the previous data was obtained.

In conclusion, the authors underline that as a consequence of examining MEMs-friendly perfluorinated polymer CYTOP™ with different functional end groups for electret generator applications, the aminosilane end group provides better surface charge density and thermal stability. Hence a novel high-performance polymer electret material has been developed.

All things considered we can come to the conclusion that the results obtained in the study can be of great importance for further development in micro power generation systems.

HIGH-PERFORMANCE PERFLUORINATED POLYMER ELECTRET FILM FOR MICRO POWER GENERATION

Yoshihiko Sakane[1*], Yuji Suzuki[2], and Nobuhide Kasagi[2]
[1]Chemicals Company, Research & Development Div., Asahi Glass Co., Ltd.
Hazawa-cho 1150, Kanagawa-ku,Yokohama, Kanagawa, 221-8757, JAPAN
[2]Department of Mechanical Engineering, The University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, JAPAN

Abstract: The development of a new high-performance polymer electret material with high surface charge density, stability, and high thermal resistibility of electric charge was studied. Previously, we found that MEMS-friendly perfluorinated polymer CYTOP™ CTL-M (Asahi Glass Co., Ltd.) shows excellent electret properties. In the present study, it is reported that the electret property and the thermal stability of CYTOP™ electret are markedly improved by doping silane coupling reagent into polymer. The charge density of 1.5 mC/cm^2, which is 1.6 times larger than that of the undoped CYTOP™, has been obtained on 16 μm-thick film. In addition, the power generation of 0.585 mW, which is about twice of our previous data, has been achieved at a low seismic frequency of 20Hz.

Key words: Electret, Energy harvesting, Micro power generation, Perfluorinated polymer, CYTOP

1. INTRODUCTION

Recently, the micro power generation systems as the alternatives of conventional secondary batteries attracted much attentions. It is known that the devices applying to RFIDs and mobile sensor networks consume a low electrical power. The vibration-driven energy harvesting devices are proposed for these applications [1-3]. Since the frequency range of vibration existing in the environment is below a few tens of Hz, electret power generators should have higher performance than electromagnetic ones [4-8].

We recently reported that CYTOP™ CTL-M (Asahi Glass Co., Ltd.), MEMS-friendly amorphous perfluorinated polymer, can possess high surface charge density, which is stable enough for electret material [7,8]. We also found that up to 0.28 mW can be obtained with the CYTOP™ electret at an oscillation frequency as low as 20Hz. However, higher surface charge density is required for better performance, and charge stored in CTL-M becomes unstable at relatively low temperature. In the present study, a novel electret material based on CYTOP™ is proposed for higher surface charge density and thermal stability, and its electret properties are systematically investigated.

2. ELECTRET POWER GENERATOR

Figure 1 shows a schematic of the micro electret generator designed in our previous study [7]. When the in-plane vibration is generated, the seismic mass with the electret brings about a relative motion to the counter electrode on the bottom substrate. Thus, the amount of induced charge on the counter electrode is changed corresponding to the overlapping area. Consequently, electric current is generated in the external circuit. The seismic mass is supported by high-aspect-ratio soft springs made of Parylene [9], which enables large amplitude of vibration and low resonance frequency.

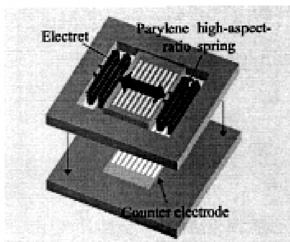


Fig. 1: Schematic of micro seismic electret power generator.

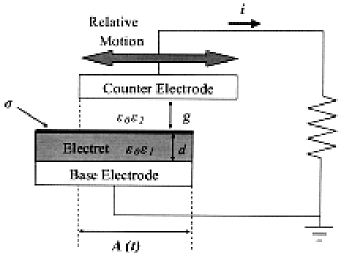


Fig. 2: Model of electret power generator.

Figure 2 shows a schematic of the simplified generator structure, where σ, *d*, *g*, and *A* are respectively the surface charge density, the thickness of electret, the gap between the electret and the counter electrode, and the overlapping area. Boland et al. [5] show that the maximum output power P_{MAX} is proportional to the squared surface charge density (σ^2), and is increased with the thickness of electret (*d*). On the other hand, the optimal external load R_{MAX} is independent of σ, but linearly dependent on *d* and *g*. P_{MAX} is also proportional to the time derivative of the overlapping area $dA(t)/dt$. Thus, the vibration frequency, the amplitude of vibration, and the number of poles should also have large impact on the generator performance.

3. POLYMER ELECTRET MATERIAL

Various kinds of materials have been examined for electrets [10]. Among them, polymer dielectric materials, especially fluorinated polymers such as PTFE, are generally employed. Hsieh et al. [11] use Teflon® AF (Du Pont) as the electret material for their MEMS microphone.

In our previous work [12], we found that CYTOP™ CTL-809M (Asahi Glass Co., Ltd.), which is amorphous perfluorinated polymer, can be also used for electrets. The candidates of dielectric for electret need to meet the following three requirements;

(a) Compatible with MEMS fabrication technique
(b) Easy to be formed into thick film
(c) Having high dielectric strength

CYTOP™ is compatible with MEMS fabrication process; it is soluble in perfluorinated solvents, and thus thick films can be obtained by

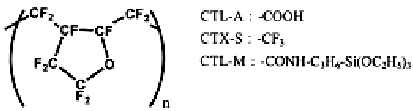


Fig. 3: The molecular structure and the end groups of CYTOP™.

multiple spin-coating. In addition, coated films can be patterned easily with photolithography process and O_2 plasma etching.

Tsutsumino et al. [7] found that the surface charge density of CYTOP™ is three times larger than that of Teflon® AF. Since power output of electret generator is proportional to the square of the surface charge density, electret generators with CYTOP™ can produce electricity nine times larger than generators with Teflon® AF.

The molecular structure of CYTOP™ is shown in Fig. 3. CYTOP™ is the perfluorinated polymer, so there are no hydrogen atom in the main chain, and that leads to unique properties as follows; (i) high chemical stability in any acids, alkalis, and organic solvents except for perfluorinated solvents, (ii) low surface energy (17 dyne/cm), (iii) high thermal stability (thermal decomposition temp is over 350 °C), (iv) low dielectric constant (2.1), (v) high volume resistivity (>10^{17}Ωcm). There are three different types of CYTOP™, which end groups are different respectively; the carboxylic acid type (CTL-A), trifluoromethyl type (CTL-S), and aminosilane type (CTL-M) [13].

To evaluate the performance of the electret material, we have measured temporal change of the surface charge density σ by using a surface voltmeter (Model279, Monroe Electronics). 16 -μm-thick CYTOP™ was spin-coated on 0.3-mm-thick copper substrate with area of 30x30 cm^2. The sample was charged by corona charging with -8 kV needle voltage for 3 minutes at 120 °C.
Figure 4 shows the surface charge density data obtained for CTL-S, CTL-A, CTL-M, and CTL-NMD, which is a new material developed in the present study. Samples were stored at 23 °C and 60 % humidity. This figure shows that 'pure' CYTOP™ CTL-S is the least stable, and the surface charge density is reduced to about 30% of its initial value in 1500 hours. On the other hand, small amount of functional end groups like

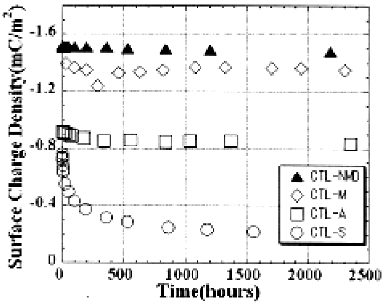


Fig. 4: Time trace of the surface charge density of Perfluorinated polymer electret films.CYTOP™ CTL-S, CTL-A, CTL-M and CTL-NMD.

carboxylic acid or aminosilane significantly enhance the electret performance; the surface charge density becomes higher, and the charge decay is suppressed. Especially, aminosilane end group (CTL-M) has the best performance to promote the surface charge density. To introduce more aminosilane into the CYTOP™ electret, we doped silane coupling reagent to CTL-A, accomplished the highest surface charge density of 1.5 mC/cm^2 (CTL-NMD)

To examine the thermal stability of charged electret, the open circuit thermally-discharge (TSD) measurement [14] has also been performed. Different TSD spectra peaks correspond to different charge trap mechanisms in dielectric materials [10, 14]; the peak corresponding to the dipole appears at the lowest temperature near the glass transition temperature (T_g=*108* °C). Peaks at the higher temperatures correspond to the surface and bulk traps. Therefore, TSD spectra are very useful for optimizing charging conditions and materials for more stable electrets.

The electret sample (e.g. copper substrate) and a facing probe were connected as shown in Fig.5, and heated up at the rate of 1 °C/min. Since the temperature increased, thermal energy was applied to electret and the trapped charges were released. The discharged current was measured with an electrometer (Model 6517A, Keithley Instruments) set into the circuit. As shown in Fig. 6, TSD spectra of CTL-S has a peak at 135 °C,

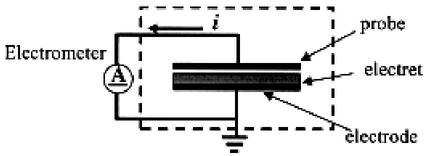


Fig. 5: Experimental setup of Thermally-stimulated-discharge (TSD) measurement.

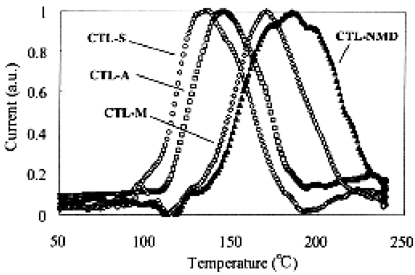


Fig. 6: Thermally-stimulated-discharge (TSD) spectra of CYTOP™ electret films.

which is the lowest among four samples examined. The peak shifted to higher temperature, when the functional end group is introduced into the chemical structure of CYTOP™. Especially, aminosilane promotes the thermal stability of trapped charge effectively, and the peak temperature of CTL-NMD TSD spectra has been improved to 185 °C, which is even higher than that of CTL-M and CTL-A. Therefore, not only the surface charge density, but also the thermal stability of charges can be improved with the doping of silane coupling reagent.

4. POWER GENERATION EXPERIMENT

Figure 7 shows the experimental setup for power generation, which consists of a patterned electret, a counter electrode, an alignment XYZ stage, and an electromagnetic shaker [7,8]. The electret and the counter electrode were microfabricated with standard lithography process. By using multiple spin coating technique, 16 μm-thick electret film was obtained after curing, followed by O_2 plasma etching for patterning.

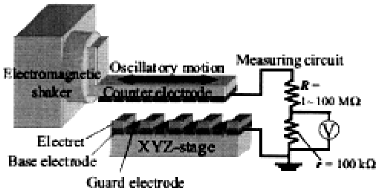


Fig. 7: Schematic of power generation experiment setup.

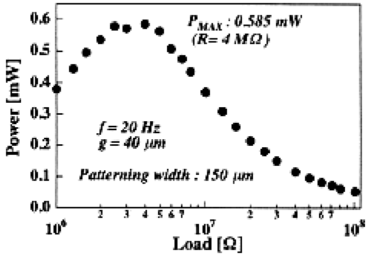


Fig. 8: Power output versus external load.

Finally, corona charging technique was applied to acquire surface potential of more than -550V. Total area of the electret was 20 x 20 mm^2 with an interdigital electrode configuration, where the line/space is 150 μm.

Figure 8 shows the output power with the CTL-M electret thus fabricated versus the external load for the oscillation amplitude of 1.2 $mm_{p\text{-}p}$ at 20Hz. Peak power output of 0.595 mW, which is about twice of our previous data [8], has been obtained at the external load of 4 MΩ. Power generation experiment using the new electret material is now undertaken.

5. CONCLUSION

We examined MEMS-friendly perfluorinated polymer CYTOP™ with different functional end groups for electret generator applications through measurements of surface charge density and thermally-stimulated discharge. We have found that the aminosilane end group provides better surface charge density and thermal stability, and developed a novel electret material with the doping of silane coupling reagent. We also have obtained 0.59 mW at a low seismic frequency of 20Hz in our prototype power generator, which is about twice of our previous data.

ACKNOWLEDGMENT

We thank Dr. C. Kamezawa, and Messrs T. Tsutsumino and M. Edamoto for their extensive corporation for this research. This work is partially supported through Strategic Informetion and Communications R&D Promotion Programme (SCOPE) of JAPAN.

REFERENCE

[1] C. B. Williams, and R. B. Yates, *Sensors Actuators*, A, vol.52, pp. 8-11, 1996
[2] S. Roundy, P. K. Wright, and J. Rabaey, *Comp. Comm.*, vol. 26, pp. 1131-1144, 2003
[3] J. A. Paradiso, and T. Starner, IEEE Pervasive Comp., vol. 4, pp. 18-27, 2005
[4] Y. Tada, *IEEE Trans. Electrical Insulation*, vol. 21, pp. 457-464, 1986
[5] J. Boland, C.-H. Chao, Y. Suzuki, and Y.-C. Tai, *Proc. 16th IEEE Int. Conf. MEMS*, Kyoto, pp. 538-541, 2003
[6] J. S. Boland, J. D. M. Messenger, H. W. Lo, and Y.-C. Tai, *Proc. 18th IEEE MEMS 2005*, Miami, pp. 618-621, 2005
[7] T. Tsutsumino, Y. Suzuki, N. Kasagi, and Y. Sakane, *Proc. 19th IEEE MEMS 2006*, Istanbul, pp. 98-101, 2006
[8] T. Tsutsumino, Y. Suzuki, N. Kasagi, K. Kashiwagi, and Y. Morizawa, *Proc. PowerMEMS 2006*, Berkeley, pp. 279-282, 2006.
[9] Y. Suzuki, and Y.-C. Tai, *J. MEMS*, vol. 15, pp. 1364-1370, 2006
[10] G. M. Sessler, *"Electrets 3rd Edition,"* Laplacian Press, 1998
[11] W. H. Heisch, T. J. Yao, and Y.-C. Tai, *Int. Conf. Solidstate Sensors Actuators (Transducers'99)*, Sendai, pp. 1064-1067, 1999
[12] Y. Arakawa, Y. Suzuki, and N. Kasagi, *Proc. PowerMEMS 2004*, Kyoto, pp. 187-190, 2004
[13] *CYTOP™ Technical Bulletin,* ASAHI GLASS Co., LTD.
[14] H. Seggern, *J. Appl. Phys.*, vol. 50, pp. 2817-2821, 1979

Словарь-минимум

A

AC (a.c.) – alternating current (n.)	–	переменный ток
adherence (n.)	–	сцепление
advance (n.)	–	продвижение вперед, прогресс
alignment (n.)	–	расположение на одной прямой, выстраивание вряд
alkaline (adj.)	–	щелочной
alloy (n.)	–	сплав
alnico (n.)	–	альнико (магнитный железоникелькобальталюминиевый сплав)
alternating current motor (n.)	–	двигатель переменного тока
amber (n.)	–	янтарь
amount (n.)	–	количество, сумма; величина
ampere (n.)	–	ампер
amplification (n.)	–	усиление, коэффициент усиления; увеличение, расширение
amplifier (n.)	–	усилитель
angular momentum (n.)	–	момент количества движения, кинетический момент, угловой момент, момент импульса
annealing (n.)	–	отжиг, отпуск; обжиг(стекла)
antiferromagnetism (n.)	–	антиферромагнетизм
appearance (n.)	–	наружный, внешний вид
appliance (n.)	–	прибор, приспособление, устройство
array (v.)	–	выстраивать в порядок
available (adj.)	–	полученный, доступный, годный, имеющийся в наличии, применимый

B

bewildering (adj.)	–	смущающий, ставящий в тупик, сбивающий с толку
bidirectional breakdown diode (n.)	–	диод с двусторонним ограничение

bimetallic (adj.)	–	биметаллический
braze (v.)	–	паять твердым припоем
breakover voltage (n.)	–	напряжение переключения (включения) тиристора
brittle (adj.)	–	хрупкий
build up (v.)	–	поднимать (напряжение, давление)
busbar (n.)	–	шина (эл.), собирательная шина

C

cage rotor (n.)	–	короткозамкнутый ротор, ротор с «беличьей клеткой»
capacitance (n.)	–	емкость, емкостное сопротивление
capacitor (n.)	–	конденсатор
capacity (n.)	–	емкость, объем; производительность, выработка, мощность; электрическая емкость; способность
casting (n.)	–	отливка
cell (n.)	–	элемент (эл.)
charge (n.)	–	заряд
(v.)	–	заряжать
circuit (n.)	–	цепь, контур, схема (эл.)
coercivity (n.)	–	коэрцитивная сила
coil (n.)	–	катушка; виток, намотка, обмотка
commutator bar (n.)	–	пластина коллектора
compound (adj.)	–	смешанное (соединение)
compound (n.)	–	соединение (хим.)
compound generator (n.)	–	генератор со смешанным возбуждением
compound motor (n.)	–	двигатель со смешанным возбуждением
conduct (v.)	–	проводить
conductor (n.)	–	проводник (эл.)
constantan (n.)	–	константан (сплав)
cooling (n.)	–	охлаждение
core (n.)	–	жила (кабеля); сердечник (трансформатора)
corrosion-resistant (adj.)	–	устойчивый против коррозии, коррозиеустойчивый

counter electromotive force (n.) – противоэлектродвижущая сила

crack (v.) – треснуть, трескаться

cross-sectional area (n.) – площадь поперечного сечения

current (n.), – ток (эл.), поток;
(adj.) – современный, настоящий, данный

concrete (n.) – бетон

D

DC (d.c.) – direct current (n.) – постоянный ток

dense (adj.) – густой, плотный, компактный, непроницаемый

depletion (n.) – уменьшение, истощение

designate (v.) – назначать, обозначать, маркировать, называть

diac (n.) – динистр, переключающий диод

dielectric (n.) – диэлектрик
(adj.) – диэлектрический

diffuse (v.) – рассеивать (свет); распылять; диффундировать

direct-current motor (n.) – двигатель постоянного тока

discrete (adj.) – дискретный, прерывный, прерывистый, разрывный

domain (n.) – область

dopant element (n.) – примесь, легирующий элемент, допант

dope (v.) – легировать (полупроводник)

ductile (adj.) – пластичный; вязкий, тягучий; дуктильный, ковкий

ductility (n.) – пластичность; вязкость, тягучесть; дуктильность, ковкость

durable (adj.) – долговечный

E

efficiency (n.) – производительность, эффективность; коэффициент полезного действия (к.п.д.). продуктивность

efficient (adj.)	–	эффективный, действенный, продуктивный, экономичный
elaborate (v.)	–	разрабатывать. уточнять
electromagnetic induction (n.)	–	электромагнитная индукция
electromotive force (emf) (n.)	–	электродвижущая сила
embrittlement (n.)	–	хрупкость, придавание хрупкости
encapsulant (n.)	–	герметик
endure (v.)	–	выносить, терпеть,
enhance (v.)	–	увеличить, увеличивать
estimate (n.)	–	оценка
etching (n.)	–	травление
excitation (n.)	–	возбуждение; намагничивание током, магнитодвижущая сила, намагничивающая сила
excite (v.)	–	возбуждать (эл.)
exert (v.)	–	оказывать, оказать
exhibit (v.)	–	показывать, проявлять
expose (v.)	–	подвергать
extracting (n.)	–	извлечение
extrude (v.)	–	выдавливать, прессовать, штамповать; выталкивать, вытеснять
extrusion (n.)	–	выталкивание, вытеснение; прессование (через матрицу); выдавленное или прессованное изделие

F

fan (n.)	–	вентилятор, лопасть вентилятора
feed (v.)	–	подавать, питать, нагнетать, снабжать
ferromagnetic (adj.)	–	ферромагнитный
fission (n.)	–	деление, расщепление (атомного ядра)
fluctuation (n.)	–	пульсирование, колебание, качание; отклонение (от заданного режима или параметра)
fluoride (n.)	–	фтористое соединение
flux (n.)	–	поток (магнитный)

forward-biased	–	прямосмещенный, с положительным смещением
fracturing (n.)	–	растрескивание, излом, разрыв, перелом
furnish (v.)	–	поставлять, снабжать

G

gadolinium (Gd) (n.)	–	гадолиний

H

hardening (n.)	–	увеличение жесткости, упрочнение, закалка
heat (n.)	–	тепло
(v.)		нагревать
heat sink (n.)	–	сток тепла
heat treatment (n.)	–	термическая обработка
heating (n.)	–	нагрев, нагревание
holding current (n.)	–	ток удержания, удерживающий ток
hydrogen (n.)	–	водород

I

impurity (n.)	–	примесь
indispensable (adj.)	–	необходимый
injection (n.)	–	инжекция (носителей заряда); введение, ввод; впрыскивание
installation (n.)	–	установка, устройство; оборудование, монтажные приборы и принадлежности,
installations (n.)	–	сооружения
insulator (n.)	–	изолятор; изоляционный материал
interior (n.)	–	внутренняя область, внутренняя часть, внутренность, внутреннее строение
inversely (adv.)	–	обратно, противоположно

J

junction transistor (n.)	–	плоскостной транзистор, плоскостной полупроводниковый триод

L

lead (n.)	–	проводник (эл.), питающий провод; подводящий кабель; ввод, вывод; опережение по фазе (эл.);

lead (n.) – свинец
leakage current (n.) – ток утечки; переменный ток, не выпрямленный выпрямителем; обратный ток в выпрямителе
length (n.) – длина
levitation (n.) – всплывание
light-emitting diode (n.) – светоизлучающий диод
lightweight (adj.) – легкий, легковесный
load (n.) – нагрузка; заряд
lodestone (n.) – природный магнит, магнитный железняк

M

machine (v.) – обрабатывать
mains (n.) – электрическая сеть
malleable (adj.) – ковкий, тягучий; способный деформироваться в холодном состоянии
manganin (n.) – манганин (медномарганцевоникелевый высокоомный сплав)
master (v.) – справляться, овладевать, преодолевать
meaningful (adj.) – значительный
measure (v.) – измерять
measurement (n.) – измерение
measurements (n.) – размеры
melting (n.) – плавка, плавление, расплавление
mica (n.) – слюда, миканит
miniature incandescent lamp (n.) – малогабаритная лампа накаливания
moderate (adj.) – умеренный, средний
momentum (n.) – количество движения, импульс; импульс силы
motion (n.) – движение
motor (n.) – двигатель, мотор; электродвигатель

N

neodymium (n.) – неодим
nichrome (n.) – нихром (сплав)

nuclear (adj.)	–	ядерный
nuclei – pl. от nucleus		
nucleus (n.)	–	ядро
null (n.)	–	нуль

O

ohm (n.)	–	ом
operation (n.)	–	работа, приведение в действие; процесс; разработка, эксплуатация; режим
oppose (v.)	–	противодействовать, препятствовать
oxide (n.)	–	окись
oxidize (v.)	–	окислять, окисляться

P

perish (v.)	–	портиться
permeability (n.)	–	магнитная проницаемость
pipe (n.)	–	труба, трубка, трубопровод
plating shop (n.)	–	гальванический цех
plumbing (n.)	–	водопровод
pn junction diode (n.)	–	*p-n*-контактный (кристаллический диод)
pole-mounted transformers (n.)	–	столбовой (мачтовый) трансформатор
porcelain (n.)	–	фарфор
potential (n.)	–	потенциал, напряжение (эл.)
potential difference (n.)	–	разность потенциалов; напряжение (эл.)
power (n.)	–	сила, мощность, энергия; способность; производительность
power supply (n.)	–	электроснабжение
power supply (n.) transformer (n.)	–	силовой трансформатор
practice (n.)	–	практика, технология
precisely (adv.)	–	точно
pressure (n.)	–	давление, прессование; напряжение (эл.)
procedure (n.)	–	операция, процедура, порядок действия; метод, методика; технологический процесс
propose (v.)	–	предлагать, предполагать
pure (adj.)	–	чистый

Q

quantity (n.)	–	количество, размер, величина (мат.), параметр
quantization (v.)	–	квантование
quantized (adj.)	–	квантованный
quantum (n.)	–	квант

R

random access memories (RAM) (n.)	–	запоминающее устройство с произвольным порядком выборки
rate (n.)	–	темп, скорость; величина, расход; производительность; отношение, пропорция
readily (adv.)	–	легко
reciprocal (n.)	–	обратная величина
rectification (n.)	–	исправление; выпрямление (эл.); детектирование (рад.)
rectifier (n.)	–	выпрямитель (эл.); детектор (рад.)
reducing agent (n.)	–	восстановитель
relativity (n.)	–	относительность, теория относительности
remanence (n.)	–	остаточный магнетизм
repel (v.)	–	отталкивать, отбрасывать, отражать
resist (v.)	–	сопротивляться, противостоять ; отталкивать,
resistance (n.)	–	сопротивление (эл.)
resistance to wear (n.)	–	износостойкость, сопротивление износу
resistivity (n.)	–	удельное сопротивление
restrict (v.)	–	ограничивать
restriction (n.)	–	ограничение
reverse-biased (adj.)	–	обратносмещенный, с отрицательным смещением
revolve (v.)	–	вращаться, вертеться
ribbon-cable (n.)	–	ленточный кабель
rising mains (n.)	–	стояк (электропроводки)
rolled strip (n.)	–	холоднокатная лента
rotate (v.)	–	вращаться, обращаться вокруг центра

rotor (n.)	–	ротор
rub (v.)	–	тереть, натирать; полировать, шлифовать
rubber (n.)	–	резина, каучук

S

saturation (n.)	–	насыщение
screw (n.)	–	винт, завинчивать, закреплять винтом
seam welding (n.)	–	роликовая сварка
secondary (n.)	–	вторичная обмотка (трансформатора)
semiconductor (n.)	–	полупроводник
series (adj.)	–	последовательное (соединение)
series motor (n.)	–	двигатель с последовательным возбуждением
sheath (n.)	–	защитная оболочка кабеля
shunt (adj.)	–	параллельное (соединение)
shunt motor (n.)	–	двигатель с параллельным возбуждением
solder (v.)	–	паять, спаивать
solenoid (n.)	–	соленоид
solid (n.)	–	твердое тело
Solid (adj.)	–	твердый; пространственный, трехмерный; сплошной, прочный
solid-state device (n.)	–	полупроводниковое устройство (прибор)
spin (n.)	–	спин, собственное вращение
spot welding (n.)	–	точечная сварка
spring (n.)	–	пружина, рессора
starter (n.)	–	пускатель, стартер; пусковое устройство
’step down’ transformer (n.)	–	понижающий трансформатор
strand (n.)	–	проволока, пучок многожильного кабеля; стренга, прядь, жила
strength (n.)	–	прочность, крепость
strip (n.)	–	полоса, лента
strong (adj.)	–	прочный, крепкий, жесткий
substation (n.)	–	подстанция
superconductor (n.)	–	сверхпроводник

supply (n.) – снабжение, подача, питание; снабжать, подавать, питать
switchgear (n.) – распределительное устройство, коммутационное устройство

T

take for granted (v.) – допускать, считать доказанным, не требующим доказательства; считать само собой разумеющимся
tempering (n.) – отпуск; закалка с последующим отпуском (металла)
terminal (n.) – зажим, клемма; ввод, вывод
thermistor (n.) – термистр
thyristor (n.) – тиристор
tin-plated (adj.) – луженный гальваническим способом
toothed wheel (n.) – зубчатое колесо
tough (adj.) – жесткий, прочный, твердый
toughness (n.) – жесткость, прочность. крепость
transmission (n.) – передача (энергии)
transpose (v.) – преобразовать, трансформировать
trap (n.) – ловушка, улавливатель; заграждающий фильтр, фильтр-пробка;
treat (v.) – обрабатывать, подвергать обработке
triac (n.) – симистор, симметричный триодный тиристор

V

variable capacitance (n.) – переменная емкость
variable capacitor (n.) – переменный конденсатор
varicap diode (n.) – варактор
varistor (n.) – варистор, реостат, регулируемое сопротивление
vice versa (adv.) – наоборот
volt (n.) – вольт
voltage (n.) – напряжение
volume (n.) – объем, масса; емкость вместимость

W

wafer (n.)	–	подложка
watt (n.)	–	ватт (эл.)
wave (n.)	–	волна, колебание, сигнал
wave standing wave (n.)	–	стоячая волна
wax (n.)	–	воск, парафин, озокерит
winding (n.)	–	обмотка (эл.)
wire (n.)	–	проволока, проволочная сетка, провод
wire bonding (n.)	–	проводное соединение
wiring (n.)	–	электропроводка, электрическая монтажная схема
withstand (v.)	–	выдерживать

Z

Zener diod (n.)	–	стабилитрон

СПИСОК ЛИТЕРАТУРЫ
(References)

1. *Вейзе А.А.* Чтение, реферирование и аннотирование иностранного текста: учеб. пособие / А. А. Вейзе. – М.: Высш. шк. 1985. – 127 с.

2. *Евсеева А.М.* Английский язык: учеб. пособие по профессиональному иностранному языку, модуль «Электротехническое материаловедение» / А.М. Евсеева, В.С. Ким, С.В. Жаркова; Национальный исследовательский Томский политехничесикй университет. – Томск: Изд-во Томского политехнического университета, 2010. – 128 с.

3. *Колесникова Н.И.* От конспекта к диссертации: учеб. пособие по развитию навыков письменной речи. / Н.И. Колесникова. – 2-е изд. – М.: флинта: Наука, 2003. – 288 с.

4. *Колесникова Н.И.* Лингводидактическая концепция формирования жанровой компетенции учащихся в системе непрерывного языкового образования: монография / Н.И. Колесникова. – Новосибирск: Изд-во НГТУ. – М.: Флинта; Наука, 2009. – 408 с.

5. *Кушникова Г.К.* Electrical Power. Обучение профессионально-ориентированному чтению: учеб. пособие / Г. К. Кушникова. – 3-е изд., испр. – М.: Флинта: Наука, 2007. – 104 с.

6. *Матулевич Т.Г.* Чтение. Реферирование. Аннотирование: учебно-метод. пособие по английскому языку = Reading. Summary Writing. Abstracting: student Guide / Т.Г. Матулевич; Новосиб. гос. техн. ун-т. – Новосибирск, 2007. – 156 с.

7. Proceedings of the 7th Int. Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMs 2007), Freiburg, 2007, pp 53–56.

8. *Tipler P.* Physics for Scientists and Engineers. Fourth edition. – New York. W.H. Freeman and Company. 1999

9. *Watson J.* Practical Electricity and Electronics. – Macmillan. 1994.

АНГЛИЙСКИЙ ЯЗЫК

АННОТИРОВАНИЕ И РЕФЕРИРОВАНИЕ

Часть 1

Методические указания

В авторской редакции

Выпускающий редактор *И.П. Брованова*
Компьютерная верстка *Л.А. Веселовская*

Подписано в печать 30.01.2013. Формат 60 × 84 1/16. Бумага офсетная. Тираж 50 экз.
Уч.-изд. л. 5,58. Печ. л. 6,0. Изд. № 343. Заказ № 258. Цена договорная

Отпечатано в типографии
Новосибирского государственного технического университета
630073, г. Новосибирск, пр. К. Маркса, 20