微电子专业规划教材

Microelectronic Technology / English

微电子技术专业英语

王 波 谈向萍 主编

肖国玲 主审

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本书涉及半导体器件、半导体工艺、集成电路、微型机电系统（MEMS）等微电子技术的基础知识，旨在逐步提高学生的阅读、理解和翻译微电子技术专业书刊资料的能力，为学生今后能够以英语为工具，获取和交流专业技术信息打下较好的基础。

本书注重选用不同类型的各种资料，有教材、科普资料、设备说明书等，并附上了很多插图，力求达到较好的教学效果。

本书适合作为本科院校、函授学院、高等职业院校的微电子技术专业教材，也可作为其他电类专业学生的参考用书。

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前 言
FOREWORD

专业英语的教学目的是为了指导学生阅读与自己专业相关的英语书刊和科技资料，使学生能以英语为工具，获取更多与专业相关的信息。

微电子技术是随着集成电路，尤其是超大规模集成电路而发展起来的一门新的技术。微电子技术包括系统电路设计、器件物理、工艺技术、材料制备、自动测试以及封装、组装等一系列专门的技术，微电子技术是微电子学中的各项工艺技术的总和。微电子学是一门发展极为迅速的学科，高集成度、低功耗、高性能、高可靠性是微电子学发展的方向。本书的教学对象是高等院校和高等职业院校微电子专业的学生，也可作为其他电类专业学生的参考书。

本书内容分为 6 个单元。第 1 单元为微电子技术介绍。第 2 单元为半导体器件，主要内容包括双极型器件、MOS 器件、微波与光电子器件。第 3 单元为半导体工艺，主要内容包括晶体生长、薄膜生长、光刻、腐蚀、扩散、注入等基本半导体工艺，双极型集成电路工艺，MOS 集成电路工艺。第 4 单元为集成电路设计，主要内容包括设计方法、设计工具、综合与仿真。第 5 单元为 MEMS，主要内容包括 MEMS 概念与特点，MEMS 工艺、器件与材料等。第 6 单元为科技文献范例，主要介绍实际微电子设备的操作方法。

本书由无锡职业技术学院王波、谈向萍任主编，平毅、吴孔培也参与了编写。其中平毅编写第 3 单元，吴孔培编写第 5 单元，谈向萍编写第 6 单元，王波编写第 1、2、4 单元及附录。全书由王波、谈向萍统稿。

无锡职业技术学院肖国玲主审了本书，并提出宝贵意见，编者在此表示衷心的感谢。书中内容力求选材精良，为了有利于教学和阅读理解、帮助学生更好地理解原文，每章后面给出了主要专业词汇及难句注释，并在全书后面列出了有关参考文献。在此，对这些参考文献的作者和出版单位表示感谢。

由于水平有限，书中不足之处在所难免，敬请读者批评指正。

编者

2011 年 2 月

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Unit 1
A Brief Introduce to Microelectronic Technology

1.1 History About Microelectronics

pre-reading

Read the following passage, paying attention to the questions.

① *What is microelectronic technology?*

② *How many courses are included in microelectronics?*

③ *Who discovered X-rays?*

④ *What does microelectronics can be used to?*

Text

1.1.1 Introduction of Microelectronics

Microelectronics is an important course in information field. In the field of information, microelectronics research and realize the information acquisition, storage, processing, transmission and output. Microelectronics is the science of information carrier researching and is the foundation of information science.

Microelectronics is a comprehensive strong edge disciplines, including the semiconductor physics, integrated circuit technology, integrated circuits, systems design, and testing etc. It also involves the solid physics, quantum mechanics, thermodynamics, statistical physics, materials science, electronic circuit, signal processing, computer aided design, testing and processing, graph theory and chemical etc.

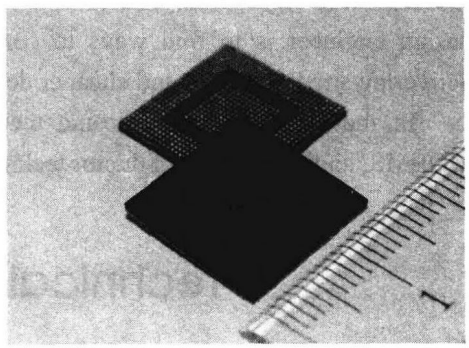

Fig 1.1 Microelectronic chip

Microelectronics is an extremely fast development of discipline. High levels of integration, low power consumption, high performance, high reliability, are the development directions of microelectronics. Because of microelectronics, it can be quite combined with

other disciplines and produce a series of new cross-disciplinary, for example, and machinery, optical combination resulted in micro-electromechanical systems (MEMS). Microelectronics combined with biological sciences and then biological chip was born.

1.1.2 History of Microelectronics

Microelectronics technology development is based on the theory of modern physics from late 19th century to 1930s. During the period, there are many important discoveries, including Wilhelm konrad rontgen, a German scientist, discovered X-rays in 1895; Henry Becquerel found radioactivity in 1896; Mrs Curie discovered radium in 1898 and so on. This series of invention and discovery revealed the basic law of microcosm. Hence, Heisenberg and Schrodinger to establish the quantum mechanics theory system, for the modern electronic information technology revolution laid a theoretical foundation.

ENIAC, the first computer in the word, was made in the Moore engineering college. It was made with 19000 vacuum tubes and thousands of resistors and capacitors. But vacuum tubes have a series of shortcomings. John Bardeen, Walter Bratti and William Shockley discovered transistor-effect. And then transistor is born. Transistor is one of the greatest inventions in human society in the 20th century. It produces profound influence in all fields, including life and production, and war. Since 1947, semiconductor industry continuously developed at a very high speed.

Microelectronics is a subfield of electronics. Microelectronics, as the name suggests, is related to the study and manufacture, or microfabrication, of electronic components which are very small (usually micrometer-scale or smaller, but not always). These devices are made from semiconductors. Many components of normal electronic design are available in microelectronic equivalent: transistors, capacitors, inductors, resistors, diodes and of course insulators and conductors can all be found in microelectronic devices.

Digital integrated circuits (ICs) consist mostly of transistors. Analog circuits commonly contain resistors and capacitors as well. Inductors are used in some high frequency analog circuits, but tend to occupy large chip area if used at low frequencies; gyrators can replace them in many applications.

As techniques improve, the scale of microelectronic components continues to decrease. At smaller scales, the relative impact of intrinsic circuit properties such as interconnections may become more significant. These are called parasitic effects, and the goal of the microelectronics design engineer is to find ways to compensate for or to minimize these effects, while always delivering smaller, faster, and cheaper devices.

In the future, microelectronic technology will develop in several aspects, such as SOC, MOEMS, and other semiconductor technologies.

Technical words and Phrases

microelectronics ['maikrəui,lek'trɔniks] *n.* 微电子学

acquisition	[ˌækwi'ziʃən]	*n.* 获得，得到；获取
transmission	[trænz'miʃən]	*n.* 传输，传送，传播
discipline	['disiplin]	*n.* 纪律，处分，处罚；学科 *v.* 处罚，惩罚
quantum	['kwɔntəm]	*n.* <物>量子；定量，总量
thermodynamics	[ˌθə:məudai'næmiks]	*n.* 热力学
statistical	[stə'tistikəl]	*a.* 统计的，统计学的，以数据表示的
subfield	['sʌbfi:ld]	*n.* 子域
microfabrication	[ˌmaikrəfæbri'keiʃən]	*n.* 微细加工
gyrator	['dʒaiəreitə]	*n.* 回转器,回旋器,旋转子
intrinsic	[in'trinsik]	*a.* 固有的,内在的,本质的,本身的
significant	[sig'nifikənt]	*a.* 重要的,重大的,可观的；显著的，有效的；意味深长的 *n.* 有意义的事物；象征，标志
parasitic	[ˌpærə'sitik]	*a.* 寄生的，寄生虫的；由寄生虫引起的
be related to		与…相关；与…有联系
be available		随处可见的，可供使用
compensate for		补偿，弥补

Notes to the text

micro-electromechanical systems (MEMS) 微机电系统
MOEMS（microoptoelectromechanical system）微光电子机械系统

Exercises

1. Put the following phrases into English.

（1）信息领域
（2）信息获取
（3）信息传输
（4）信息基石
（5）边缘学科
（6）系统设计
（7）固态物理
（8）量子理论
（9）材料科学
（10）高可靠性
（11）寄生效应
（12）相对影响
（13）微电子技术
（14）功耗
（15）半导体集成电路
（16）计算机辅助设计
（17）高性能
（18）高集成度
（19）信息处理
（20）综合性学科

2. Put the following phrases into Chinese.

（1）information storage
（2）carrier researching
（3）semiconductor physics
（4）integrated circuit technology
（5）signal processing
（6）theoretical foundation
（7）statistical physics
（8）graph theory
（9）the science of information
（10）vacuum tube
（11）profound influence in all fields
（12）developed at a very high speed
（13）micrometer-scale
（14）modern electronic information technology
（15）law of microcosm
（16）microelectronic device
（17）intrinsic circuit properties
（18）comprehensive discipline
（19）quantum mechanics theory system
（20）transistor-effect

3. Sentence translation.

（1）In the field of information, microelectronics research and realize the information acquisition, storage, processing, transmission and output.

（2）Microelectronics is a comprehensive strong edge disciplines, including the semiconductor physics, integrated circuit technology, integrated circuits, systems design, and testing etc.

（3）High level of integration, low power consumption, high performance, high reliability, are the development directions of microelectronics.

（4）This series of invention and discovery revealed the basic law of microcosm. Hence, Heisenberg and Schrodinger to establish the quantum mechanics theory system, for the modern electronic information technology revolution laid a theoretical foundation.

（5）It produces profound influence in all fields, including life and production, and war. Since 1947, semiconductor industry continuously developed at a very high speed.

（6）Microelectronics, as the name suggests, is related to the study and manufacture, or microfabrication, of electronic components which are very small.

（7）Inductors are used in some high frequency analog circuits, but tend to occupy large chip area if used at low frequencies; gyrators can replace them in many applications.

（8）Because of microelectronics, it can be quite combined with other disciplines and produce a series of new cross-disciplinary, for example, and machinery, optical combination resulted in micro-electromechanical systems (MEMS).

（9）Many components of normal electronic design are available in microelectronic equivalent: transistors, capacitors, inductors, resistors, diodes and of course insulators and conductors can all be found in microelectronic devices.

（10）It also involves the solid physics, quantum mechanics, thermodynamics, statistical physics, materials science, electronic circuit, signal processing, computer aided design, testing and processing, graph theory and chemical etc.

1.2 Introduction To Some Courses

pre-reading

Read the following passage, paying attention to the questions.

① *What courses will a student majoring in the microelectronic technology study?*

② *What careers a student majoring in the microelectronic technology will follow?*

Text

As a student majoring in microelectronic technology, you will study many courses such as:

① Electronic circuits

This course introduces the fundamental theory of passive devices (resistor, capacitor and inductor) and electrical networks supplied by a DC source, and then an introduction to the effects of alternating voltage and current in passive electrical circuits is given. This unit also mentioned machines, three phase machines and transformers. Ohm's Law and Kirchhoff's Law are also introduced in this course.

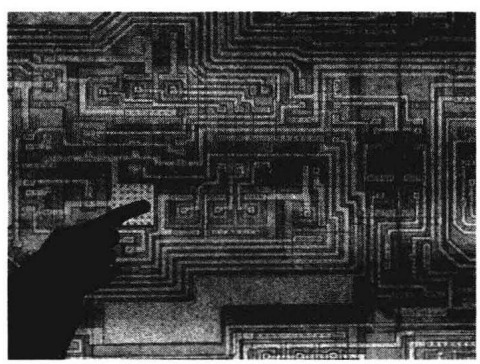

Fig 1.2 Layout design of IC

② Semiconductor physics

This course covers the theory of basic semiconductor physics and a wide range of important phenomena in semiconductors. Students are assumed to have a basic command of mathematics and some elementary knowledge of solid state physics. This module also covers construction of semiconductor, optical transition, electron phonon interactions, electron mobility, photoelectric effect, thermoelectric effect.

③ Semiconductor materials

This module introduces basic characteristics of semiconductor and the way to preparation of semiconductor. The following specific topics are coved. Semiconductor materials: Si, Ge and its chemical compound. The way to preparation of semiconductor: crystal growth, epitaxy, etc.

④ Semiconductor devices

This module the following topics are coved. Semiconductor diodes: PN junction diodes, special purpose diodes. Transistors: bipolar and field-effect transistors. Photonic devices: photo diode, photo triodes and other photonic devices.

⑤ Micro-electronic technology

This course introduces basic laws of semiconductor and semiconductor industry. It also covers manufacturing process of semiconductor. The process is composed of four steps including crystal growth, film preparation, lithography, doping. This module also introduces several manufacturing

process of TTL integrated circuits and MOS devices.

⑥ Design of integrated circuits

In this unit, the following topics are covered: basic concepts of Integrated circuits, combinational circuits, sequential circuits, introduction to CMOS circuits and design method of Integrated circuits. This module also covers tools of IC design, such as cadence.

⑦ Computer Programming

It is important for a student majoring microelectronics to have more advanced programming techniques. The language C will be used for teaching purpose. Emphasis is towards the use of programming for electronics application and problem solving.

⑧ Microcomputer principle

This course is a professional course for student not majoring in computer engineering to study. This module covers concept of microcomputer system, basic microcomputer system, design of microcomputer interface and integrated applications of microcomputer system etc. learning of microcomputer principle will provide a sound foundation for students to learn other development courses such as testing control etc.

⑨ Application of microelectronics

The use of microelectronics is now found in every field of electronic industry. This use will continue to grow at a rapid pace. It is important for students to master these new technologies. This module enables the student to understand and master these new technologies.

Above all, the microelectronic technology will provide a sound educational foundation to enable graduates to follow a career in: engineering; layout design; microelectronics etc.

Technical words and Phrases

source	[sɔːs]	*n.* 源极，信号源，电源；源头
phase	[feiz]	*n.* 阶段，时期；相位
phenomena	[fi'nɔminə]	*n.* 现象（单数为 phenomenon）
optical	['ɔptikəl]	*a.* 光学的，光的；视觉的，视力的
phonon	['fəunɔn]	*n.* 声子
mobility	[məu'biliti:]	*n.* 流动性;移动性；迁移率
photoelectric	[ˌfəutəui'lektrik]	*a.* 光电的
characteristic	[ˌkæriktə'ristik]	*a.* 特有的，典型的；有特色的 *n.* 特征，特色
thermoelectric	[ˌθəːməui'lektrik]	*a.* 热电的
preparation	[ˌprepə'reiʃən]	*n.* 准备，制备
crystal	['kristəl]	*n.* 水晶，结晶体
epitaxy	['epitæksi]	*n.* （晶体）取向附生，外延附生，外延

concept	['kɔnsept]	*n.* 概念，观念，想法
interface	['intəfeis]	*n.* 界面，接口
		v. （使通过界面或接口）连接，接合
major in		（在大学里）主修
be given		给出
be assumed to		假设为

Notes to the text

Microcomputer	微型计算机，微机

Exercises

1. Put the following phrases into English.

（1）直流电源　（2）交流电源
（3）三相电机　（4）半导体物理学
（5）半导体材料学　（6）半导体工业
（7）固态物理　（8）光电效应
（9）组合逻辑电路　（10）时序逻辑电路
（11）微型计算机接口　（12）微型计算机系统
（13）欧姆定律　（14）基尔霍夫定律
（15）集成电路设计　（16）有源器件
（17）无源器件　（18）电子网络
（19）计算机编程　（20）微电子应用

2. Put the following phrases into Chinese.

（1）fundamental theory　（2）passive electrical circuits
（3）elementary knowledge of solid physics　（4）optical transition
（5）electron phonon interaction　（6）electron mobility
（7）thermoelectric effect　（8）basic characteristics of semiconductor
（9）preparation of semiconductor　（10）photonic device
（11）manufacturing process of semiconductor　（12）TTL integrated circuits
（13）computer programming　（14）a sound foundation
（15）testing control　（16）advanced programming techniques
（17）construction of semiconductor　（18）programming for problem solving
（19）basic command of mathematics　（20）semiconductor materials

3. Sentence translation.

（1）This course introduces the fundamental theory of passive devices(resistor, capacitor and

inductor) and electrical networks supplied by a DC source, and then an introduction to the effects of alternating voltage and current in passive electrical circuits is given.

(2) This module also covers construction of semiconductor, optical transition, electron phonon interactions, electron mobility, photoelectric effect, thermoelectric effect.

(3) This module introduces basic characteristics of semiconductor and the way to preparation of semiconductor. The following specific topics are coved.

(4) The process is composed of four steps including crystal growth, film preparation, lithography, doping.

(5) In this unit, the following topics are covered: basic concepts of Integrated circuits, combinational circuits, sequential circuits, introduction to CMOS circuits and design method of Integrated circuits.

(6) Emphasis is towards the use of programming for electronics application and problem solving.

(7) This module covers concept of microcomputer system, basic microcomputer system, design of microcomputer interface and integrated applications of microcomputer system etc.

(8) It is important for a student majoring microelectronics to have more advanced programming techniques.

(9) Above all, the microelectronic technology will provide a sound educational foundation to enable graduates to follow a career in: engineering; layout design; microelectronics etc.

(10) learning of microcomputer principle will provide a sound foundation for students to learn other development courses such as testing control etc.

1.3 Reading Materials

Photonics

1.3.1 History of Photonics

The science of photonics includes the generation, emission, transmission, modulation, signal processing, switching, amplification, detection and sensing of light. The term photonics thereby emphasizes that photons are neither particles nor waves—they are different in that they have both particle and wave nature. It covers all technical applications of light over the whole spectrum from ultraviolet over the visible to the near-, mid- and far-infrared. Most applications, however, are in the range of the visible and near infrared light. The term photonics developed as an outgrowth of the first practical semiconductor light emitters invented in the early 1960s and optical fibers developed in the 1970s.

The word 'photonics' appeared in the late 1960s to describe a research field whose goal was to use light to perform functions that traditionally fell within the typical domain of electronics, such as telecommunications, information processing, etc.

Photonics as a field began with the invention of the laser in 1960. Other developments followed: including the laser diode in the 1970s, optical fibers for transmitting information, and the Erbium-doped fiber amplifier. These inventions formed the basis for the telecommunications revolution of the late 20th century and provided the infrastructure for the Internet.

Historically, the term photonics, though coined earlier only came into common use in the 1980s, as fiber-optic data transmission was adopted by telecommunications network operators. At that time, the term was used widely at Bell Laboratories. Its use was confirmed when the IEEE Lasers and Electro-Optics Society established an archival journal named Photonics Technology Letters at the end of the 1980s.

During the period leading up to the dot-com crash circa 2001, photonics as a field focused largely on telecommunications. However, photonics covers a huge range of science and technology applications, including: laser manufacturing, biological and chemical sensing, medical diagnostics and therapy, display technology, and optical computing.

Various non-telecom photonics applications exhibit strong growth, particularly since the dot-com crash, partly because many companies have been looking for new application areas. Further growth of photonics is likely if current silicon photonics developments are successful.

1.3.2 Microelectronics and Computer Technology Corporation

Microelectronics and Computer Technology Corporation (MCC) was the first, and - at one time - was one of the largest, computer industry research and development consortia in the United States.

MCC did research and development in the following areas:

- System Architecture and Design (optimize hardware and software design, provide for scalability and interoperability, allow rapid prototyping for improved time-to-market, and support the re-engineering of existing systems for open systems).
- Advanced Microelectronics Packaging and Interconnection (smaller, faster, more powerful, and cost-competitive).
- Hardware Systems Engineering (tools and methodologies for cost-efficient, up-front design of advanced electronic systems, including modeling and design-for-test techniques to improve cost, yield, quality, and time-to-market).
- Environmentally Conscious Technologies (process control and optimization tools, information management and analysis capabilities, and non-hazardous material alternatives supporting cost-efficient production, waste minimization, and reduced environmental impact).
- Distributed Information Technology (managing and maintaining physically distributed corporate information resources on different platforms, building blocks for the national information infrastructure, networking tools and services for integration within and between companies, and electronic commerce).
- Intelligent Systems (systems that "intelligently" support business processes and enhance performance, including decision support, data management, forecasting and prediction). In late 1982, several major computer and semiconductor manufacturers in the United States banded