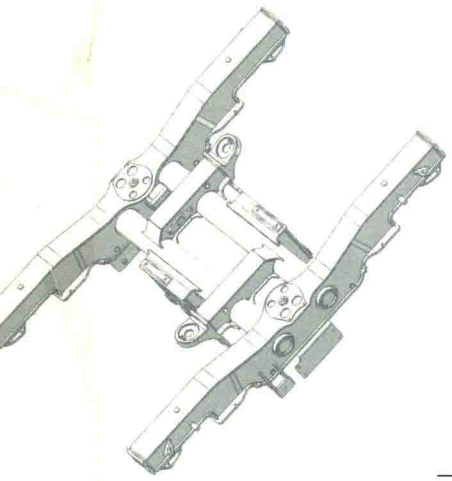
交通类复合型人才培养专业英语丛书

机械工程专业英语

English for Mechanical Engineering

兰惠清◎主编
史红梅◎主审



中国铁道出版社有限公司
CHINA RAILWAY PUBLISHING HOUSE CO., LTD.

交通类复合型人才培养专业英语丛书

机械工程专业英语

English for Mechanical Engineering

兰惠清　主编
史红梅　主审

中国铁道出版社有限公司
CHINA RAILWAY PUBLISHING HOUSE CO., LTD.

内 容 简 介

本书旨在使读者掌握机械工程专业英语术语及用法，培养并提高读者阅读和翻译专业英语文献资料的能力。内容新颖，与时俱进，较常规的机械工程专业英语书有重大突破，交通特色鲜明。主要内容结合交通应用背景，以现代机械工程为主线，包括机械工程简介、机械工程相关的热点话题、机械制造、机械设计及理论、机械电子工程、车辆工程、材料科学与技术等相关知识点，介绍了工业 4.0、高铁、机器学习等热点前沿技术。编写形式有较大创新，充分利用现代数字技术，打造立体化新形态图书，正文相关知识配英文视频、微课等拓展知识二维码。

本书适合作为交通类高等院校机械工程类专业本科生和研究生的专业英语教材，也可作为“一带一路”人才培养的培训教材，还可供涉外相关工程技术人员参考使用。

图书在版编目（CIP）数据

机械工程专业英语/兰惠清主编. —北京：中国铁道出版社有限公司，2019.8
（交通类复合型人才培养专业英语丛书）
ISBN 978-7-113-25901-3

Ⅰ.①机… Ⅱ.①兰… Ⅲ.①机械工程-英语-高等学校-教材 Ⅳ.①TH

中国版本图书馆 CIP 数据核字(2019)第 152532 号

书　　名：机械工程专业英语
作　　者：兰惠清

策　　划：田银香　　**编辑部电话：**010-63589185 转 2053　　**电子信箱：**403195044@qq.com
责任编辑：田银香
封面设计：刘　颖
责任校对：张玉华
责任印制：郭向伟

出版发行：中国铁道出版社有限公司（100054，北京市西城区右安门西街 8 号）
网　　址：http://www.tdpress.com/51eds/
印　　刷：三河市航远印刷有限公司
版　　次：2019 年 8 月第 1 版　2019 年 8 月第 1 次印刷
开　　本：850 mm×1 168 mm 1/16　**印张：**18.75　**字数：**396 千
书　　号：ISBN 978-7-113-25901-3
定　　价：48.00 元

前　言

据统计，全球有超过40%的人在学习和使用英语；超过85%的科技资料（如书籍、期刊、专利说明书和内部技术报告等）运用英语语言；不论在哪个国家召开国际学术会议，所规定使用的工作语言一般也都是英语。因此，英语既是人们交流的主要工具，也是开展科学研究的重要工具。

伴随“一带一路”的建设和中国高铁“走出去”战略的实施，海外高铁项目建设、装备制造等国际交流合作愈发紧密，这就要求机械工程类专业学生既要精通技术知识，又要熟练应用专业英语，要成为具备国际技术交流能力的复合型人才。

目前，各高校纷纷开设专业英语课程。本书的编写是为满足机械工程专业英语课程教学需要和涉外人员的自学参考要求。内容结合高铁等交通应用背景，以现代机械工程为主线，借助英语工具开展机械工程在交通领域的应用实践，而不是通过专业实践去巩固英语知识，最终要提升读者运用英语进行交通背景下机械工程专业活动的整体水平，能够进行国际交流研讨、专业英语文本写作、了解国际科技创新、在国外顺畅进行施工交流等实践，使其将专业能力、英语能力与应用能力三者有机融合。

本书共分7章，包括机械工程简介、机械工程相关的热点话题、机械制造、机械设计及理论、机械电子工程、车辆工程、材料科学与技术等相关知识点。内容较常规的机械工程专业英语书都有重大突破，交通特色鲜明。首先，内容新颖、与时俱进，介绍工业4.0、高铁、机器学习等热点前沿技术；其次，覆盖面广、体系完整，涵盖机械工程一级学科下所有的二级研究方向，尤其是车辆工程为独立一章；第三，学科知识与交通背景结合，例如，介绍钢轨打磨、钢轨在线监测、轨道交通材料、复合材料等内容。另外，编写形式有较大创新，充分利用现代数字技术，打造立体化新形态图书，正文相关知识配二维码，添加用英文讲解的机械工程视频、前沿技术英文微课等拓展素材。

本书由北京交通大学的相关专家和技术人员编写。兰惠清任主编，负责全书的构思、组稿和统稿。各章编写分工如下：第1章和第2章由兰惠清编写，第3章由曹建国、房善想和张勤俭编写，第4章由张朝辉编写，第5章由董立静和陈光荣编写，第6章由陈星宇编写，第7章由杜云慧编写。全书由史红梅主审，李聪协助完成统稿工作。

在本书的编写过程中，编者参考了国内外专家学者的最新研究成果和资料，在此向这些专家学者表示诚挚的感谢。

机械工程所涉及的内容广泛，学科跨度大，新材料、新技术发展迅速，加之编者水平有限，书中难免有不足之处，恳请广大读者提出宝贵意见。

编　者

2019年5月

CONTENTS
目　录

Chapter 1 Introduction of Mechanical Engineering

1.1 Definition and History of Mechanical Engineering

1.1.1 Definition of Mechanical Engineering

Mechanical engineering (ME) is the discipline that applies engineering, physics, engineering mathematics, and materials science principles to design, analyze, manufacture, and maintain mechanical systems. It is one of the oldest and broadest of the engineering disciplines.

Definition of mechanical engineering

The mechanical engineering field requires an understanding of core areas including mechanics, dynamics, thermodynamics, materials science, structural analysis, and electricity. In addition to these core principles, mechanical engineers use tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), and product life cycle management to design and analyze manufacturing plants, industrial equipment and machines, heating and cooling systems, transport systems, aircraft, watercraft, robotics, medical devices, weapons, and others. It is the branch of engineering that involves the design, production, and operation of machinery.

1.1.2 History of Mechanical Engineering

The application of mechanical engineering can be seen in the archives of various ancient and medieval societies. In ancient Greece, the works of Archimedes influenced mechanics in the Western tradition and Hero of Alexandria created the steam engine—Aeolipile. In China, Zhang Heng improved a water clock and invented a seismometer, and Ma Jun invented a

chariot with differential gears. The medieval Chinese horologist and engineer Su Song incorporated an escapement mechanism into his astronomical clock tower two centuries before escapement devices were found in medieval European clocks. He also invented the world's first known endless power-transmitting chain drive.


History of mechanical engineering

During the 7th to the 15th century, some inventors made remarkable contributions in the field of mechanical technology. Al-Jazari, who was one of them, wrote *Book of Knowledge of Ingenious Mechanical Devices* in 1206 and presented many mechanical designs. He is also considered to be the inventor of such mechanical devices which now form the very basic of mechanisms, such as the crankshaft and camshaft.

During the 17th century, important breakthroughs in the foundations of mechanical engineering occurred in England. Sir Isaac Newton formulated Newton's Laws of Motion and developed Calculus, the mathematical basis of physics. Newton was reluctant to publish his works for years, but he was finally persuaded to do so by his colleagues, such as Sir Edmond Halley, much to the benefit of all mankind. Gottfried Wilhelm Leibniz is also credited with creating Calculus during this time period.

During the early 19th century industrial revolution, machine tools were developed in England, Germany, and Scotland. This allowed mechanical engineering to develop as a separate field within engineering. They brought manufacturing machines and the engines to power them. The first British professional society of mechanical engineers Institution of Mechanical Engineers was formed in 1847; thirty years after the civil engineers formed the first such professional society Institution of Civil Engineers. On the European continent, Johann von Zimmermann (1820–1901) founded the first factory for grinding machines in Chemnitz, Germany in 1848.

In the United States, the American Society of Mechanical Engineers (ASME) was formed in 1880, becoming the third such professional engineering society, after the American Society of Civil Engineers in 1852 and the American Institute of Mining Engineers in 1871. The first schools in the United States to offer an engineering education were the United States Military Academy in 1817, an institution now known as Norwich University in 1819, and Rensselaer Polytechnic Institute in 1825. Education in mechanical engineering has historically been based on a strong foundation in mathematics and science.

Words and Expressions

mechanics [mɪ'kænɪks] the branch of physics that deals with the action of forces on material objects with mass	*n.* 力学（这里指静力学）

dynamics [daɪˈnæmɪks] the branch of mechanics that is concerned with the effects of forces on the motion of objects	*n.* 动力学
thermodynamics [ˌθɜːməʊdaɪˈnæmɪks] the science of the conversions between heat and other forms of energy	*n.* 热力学
computer-aided design (CAD) [kəmˈpjuːtə eɪdɪd dɪˈzaɪn]	计算机辅助设计
computer-aided manufacturing (CAM) [kəmˈpjuːtə eɪdɪd ˌmænjuˈfæktʃərɪŋ]	计算机辅助制造
product life cycle management [ˈprɒdʌkt laɪf ˈsaɪkl ˈmænɪdʒmənt]	产品生命周期管理；全生命周期管理
aircraft [ˈeəkrɑːft] a vehicle capable of atmospheric flight due to interaction with the air, such as buoyancy or lift	*n.* 航空器
watercraft [ˈwɔːtəkrɑːft] a boat, ship, sea scooter, or similar vehicle	*n.* 船舶
seismometer [saɪzˈmɒmɪtə] a device used by seismologists to detect and measure seismic waves and therefore locate earthquakes	*n.* 测震仪
chariot [ˈtʃæriət] a two-wheeled horse-drawn vehicle, used in Bronze Age and Early Iron Age warfare	*n.* 双轮敞篷马车（古代用于战争）
horologist [ˈhɒrɒlədʒɪst] someone who makes or repairs watches or clocks	*n.* 时计学者
escapement mechanism [ɪˈskeɪpmənt ˈmekənɪzəm]	*n.* 擒纵机构
endless power-transmitting chain drive [ˈendləs ˈpaʊə trænsˈmɪtɪŋ tʃeɪn draɪv]	无级动力传动链传动
American Society of Mechanical Engineers (ASME) [əˈmerɪkən səˈsaɪəti əv məˈkænɪkl ˌendʒɪˈnɪəz]	美国机械工程师协会

Questions for Discussion

1. Give a definition of mechanical engineering.
2. What branches does mechanical engineering mainly include?
3. What functions does mechanical engineering have?

1.2 Fields of Mechanical Engineering


Fields of mechanical engineering

The discipline of mechanical engineering is the science of the theory, method and technology of the performance, design and manufacture of mechanical systems and products, including two major fields of mechanics and manufacturing science.

Mechanics is a science that studies the mechanical structure and system performance and its design theory and method, including the mechanism, transmission, dynamics, strength, tribology, design, bionics, micro mechanics and interface mechanics involved in the manufacturing process and the mechanical system.

Manufacturing science is a science about manufacturing processes and systems. It covers product design, forming and manufacturing (casting, plastic forming, joint forming, mold manufacturing, surface engineering, etc.), processing and manufacturing (ultra-precision machining, efficient processing, non-traditional machining, complex surface processing, measurement and instrument, equipment design and manufacturing, surface functional structure manufacturing, micromanufacturing, nanomanufacturing, biomimetic and raw material production), and operation and management of the manufacturing system and other science.

According to Ministry of Education of the People's Republic of China, there are four classical second-class disciplines belong to the first-class discipline of Mechanical Engineering: mechanical manufacture and automation, mechanical design and theory, mechatronic engineering, and vehicle engineering.

1.2.1 Mechanical Manufacture and Automation

Mechanical manufacture and automation is one of the engineering disciplines studying mechanical manufacturing theory, manufacturing technology, automated manufacturing system and advanced manufacturing mode. The discipline combines the latest development of related disciplines, making manufacturing technology, manufacturing systems and manufacturing models showing a new look. The goal of mechanical manufacture and automation is very clear, which combines mechanical equipment and automation through the way of computer to form a series of advanced manufacturing technologies, including CAD (computer aided design), CAM (computer aided manufacturing), FMS (flexible manufacturing system) and so on. Finally, large-scale computer integrated manufacturing system (CIMS) is formed, which makes the traditional machining process get a qualitative leap. Specific applications in industry include computer numerical control (CNC) machine tools, machining centers and so on.

1.2.2 Mechanical Design and Theory

Mechanical design and theory is a basic technical discipline to analyze, synthesize, quantitatively describe and control the performance of the machinery. It is a brief introduction to the detailed work processes and procedures of the mechanical engineering. Therefore, work principles, motion and dynamic properties, strength and life, vibration and noise, friction, wear and lubrication, mechanical innovation and design, and modern design calculation methods of various machines, mechanisms and parts are mainly studied.

1.2.3 Mechatronic Engineering

Mechanical and electronic engineering, commonly known as mechatronics, is a kind of mechanical engineering and automation. The majors of mechanical and electronic engineering include basic theoretical knowledge and mechanical design and manufacturing methods, the application ability of computer software and hardware, and the ability to design, manufacture, testing and developing various kinds of mechanical and electrical products and systems. Mechanical and electronic engineering is the product of high-speed development of science and technology and interlinking of disciplines. It breaks the traditional classification of disciplines and integrates many technical characteristics. It represents the emergence of new technologies, new ideas, new research methods and new research objectives.

1.2.4 Vehicle Engineering

Vehicle engineering is one of engineering technology field studying theory, design and manufacturing technology of mobile machines on the land, such as automobiles, tractors, locomotives, military vehicles and other engineering vehicles.

Vehicles are widely used in modern society. They are related to the revitalization and development of the automobile industry and transportation industry, one of the pillar industries of China's economic construction, and has a great influence on the modernization of agriculture and the modernization of national defense equipment. From the early stages of vehicle engineering, it involves mechanics, mechanical design, material, fluid mechanics, chemical industry, and extends to the interpenetrating and interrelated subjects such as mechatronic engineering, mechanical design and theory, computer, electronic technology, measurement technology, control technology and other disciplines, and further touches on wide fields such as: medicine, physiology and psychology, forming a comprehensive discipline and engineering technology covering a variety of new and high technologies.

According to the characteristics of the industry, this field covers design and manufacture of automobiles and tractors, military vehicles, locomotive vehicles, engineering vehicles, energy power and so on.

According to the working nature of engineering technicians, the scope of the field can be divided into: research and development of vehicles; manufacturing and processing of vehicles; performance testing, testing and analysis of vehicles; use, management and maintenance of vehicles, equipment related to production testing vehicles, the development of testing apparatus, etc.

Words and Expressions

mechanical manufacture and automation [məˈkænɪkl ˌmænjuˈfæktʃə ænd ɔːtəˈmeɪʃən]	机械制造及自动化
mechanical design and theory [məˈkænɪkl dɪˈzaɪn ænd ˈθɪəri]	机械设计及理论
mechatronic engineering [məkæˈtrɒnɪk endʒɪˈnɪərɪŋ]	机械电子工程
vehicle engineering [ˈviːəkl endʒɪˈnɪərɪŋ]	车辆工程

Questions for Discussion

What field of mechanical engineering attracts you the most? Why?

1.3 Advantages of Mechanical Engineering in China

In recent years, a series of outstanding progresses and original innovations have been achieved in the fields of mechanical engineering, which provide a large number of novel theories, technologies and methodologies for our country's economic construction and mechanical engineering.

1.3.1 Tribology


Tribology

Tsinghua University has made important progress in the field of nanotribology and its technology. In the study of superfine chemical mechanical polishing on the surface of the computer hard disk, the behavior mechanism of super fine surface nanoparticles was put forward. The equilibrium law of chemical and mechanical action was found, and a new technology and advanced polishing process of the superfinishing surface of the hard disk substrate were explored. The roughness of the surface wave after polishing were lower than that of nanoscale. Combined with the study of wheel-rail interaction in high speed railway, Southwest Jiaotong University reproduced the wheel-rail corrugation for the first time, and analyzed the formation mechanism of wheel-rail corrugation from the theory and test. Lanzhou Institute of Chemical Physics has played an important role in the research of

nanosolid lubrication technology applied to Chinese aerospace engineering. Tribology has become one of the most influential subjects in Chinese mechanical engineering discipline in the international academia.

1.3.2 Robotics

Yanshan University, Shanghai Jiaotong University, etc., put forward a universal method and the general formula for calculating the degree of freedom of less freedom and parallel structure, and the theory of principal helix analytic recognition model with the helix theory, Lie group, and set theory as mathematical tools[1]. Moreover, using the above theory dozens of new mechanisms, force sensors, micromanipulation robots, and earthquake simulators had been developed. Tianjin University and Tsinghua University put forward a universal modeling method of the Jacobi matrix based on a linear space theory, and developed a large number of engineering equipment, such as the large gantry hybrid machine tool, the high-speed packaging robot and so on.


Robotics

1.3.3 Mechanical Dynamics

Nonlinear dynamics, fault prediction and intelligent maintenance of complex mechatronic systems are frontier research fields of mechanical dynamics. Northeastern University has proposed theory of probability and screen with constant bed thickness, vibration synchronization and control synchronization theory, and has designed dozens of engineering vibration machines. Nanjing University of Aeronautics & Astronautics proposed a control system dynamics with time delay, a bifurcation mechanism and control method of the vibration control system with elastic constraints, as well as modeling and control method of the hysteresis damping vibration control system. American control experts evaluate the system as “a refreshing system method”. A coupling dynamics model of locomotive vehicle and track system has been developed by Southwest Jiaotong University, and the dynamic simulation system of locomotive vehicle and track coupling dynamics and the evaluation system of safety field test are developed.

1.3.4 Mechanical Transmission

Ultrasonic Motor Research Center of Nanjing University of Aeronautics & Astronautics has put forward theory and design method of movement mechanism, electromechanical coupling model, drive and control technology for a new ultrasonic motor. Moreover, it has invented dozens of ultrasonic motors and drivers with unique traveling wave and standing wave. In the high-speed and ultra-precision motion control research, Huazhong University of Science and Technology found and clarified the mechanism of the cyclonic phenomena of air bearings. Chongqing University invented a water-lubricated rubber alloy bearing with the

organic combination of multi-surface and linear circular arc groove. This bearing saved a lot of precious metals and has been widely used in the transmission system of ships at home and abroad.

1.3.5 Biomimetic Machinery and Biological Manufacturing

Biomimetic machinery and biological manufacturing

Jilin University has made important progress in the research of bionic flexible dynamic drag reduction and biomimetic electroosmotic desorption theory. It has created and developed a mechanical bionics discipline and invented a series of ground mechanical desorption and drag reduction bionics technology, and successfully applied it to agricultural machinery and national defense engineering. In the study of artificial bone biomimetic manufacturing, Xi'an Jiaotong University established a model of bone tissue, proposed a composite structure repair method of bone defect, and made the structural frame of artificial bone by rapid prototyping, and succeeded in repairing the bone defect of the animal.

1.3.6 Advanced Electronic Manufacturing

Central South University has put forward a concept of "extreme manufacturing". The research on the key scientific problems in hard disk drive and chip manufacturing is carried out by Shanghai Jiaotong University and Tsinghua University. A single abrasive grinding method with controllable nanoscratch depth and length is proposed. A critical depth model of the grinding wheel in self-rotating grinding of silicon wafer has been established to reveal the wide frequency of the high acceleration motion system. The design theory and control method of high acceleration, high precision and high reliability precision driving platform are put forward. The rapid diffusion mechanism of atoms at ultrasonic bonding interface is clarified, the "stick-slip" motion characteristic of bonding interface is discovered, and the variable parameter loading process is put forward.

1.3.7 Digital Manufacturing

A new method of geometric reasoning based on visual cone and the unified discrimination of the contour error of complex surfaces have been put forward by Huazhong University of Science and Technology. The software system of digital modeling and manufacturability analysis for complex products is developed, and a system platform of integrated rapid measurement, digital modeling and manufacturing oriented design is established. It is applied to rapid development of complex curved surface parts, such as cylinder heads and blades. Wuhan University of Technology had put forward a digital manufacturing modeling theory, digital manufacturing resource sharing based on manufacturing grid, a theory model of agile supply chain under digital manufacturing environment, and a theory and algorithm of intelligent scheduling in digital manufacturing

workshop. Moreover, it had established a remote operation, monitoring and diagnosis platform of virtual NC machining system equipment under digital manufacturing environment. Shanghai Jiaotong University had applied a distance function and pseudo-distance function theory into a qualitative and quantitative geometric reasoning of force and motion spin space. Therefore, a qualitative and quantitative analysis and evaluation index system for the sealing and stability of clamp and holding mechanism can be established.

1.3.8 Mechanical Measurement

Tianjin University has invented an on-site calibration method and device for space dimension measurement, which has solved the problem of on-site calibration and its installation urgently needed in modern manufacturing. Tsinghua University has invented a "laser nanometers" with frequency difference greater than birefringent dual-frequency lasers and displacement measurements. Harbin Institute of Technology has invented a high performance series of straight line and rotary motion datum, and a series of confocal scanning measuring devices and microscopes, which made the level and vertical resolution reach the sub nanometer scale for China to develop the first cylindrical and micro deep hole measuring instrument standard installation, so that China has ability to disseminate and trace the value in this field [2]. Chongqing University has put forward a concept and principle of "intelligent virtual control", established a unified model of signal transformation, and developed thousands of unique virtual instrument development systems. Chongqing Institute of Technology put forward an idea of "time-space transformation" of the precision displacement measurement, and invented a time-grating displacement sensor and its testing system.

1.3.9 Processing and Manufacturing

Dalian University of Technology has put forward a precision manufacturing technology and equipment of hard and brittle material complex curved radome. In view of special requirements of the electrical performance of the radome, a precision grinding theory for compensating the electrical performance of the radome is put forward. A theoretical model of the relation between the comprehensive electrical performance error of the radome and the compensation of the geometric parameters is established. The digital repair equipment has been invented, which solved a major scientific and technological problem in the defense engineering. In the research field of high-speed precision grinding, Hunan University has put forward "four point constant line speed method", which makes the grinding defects improved and the surface quality is obviously improved. Huazhong University of Science and Technology proposed a formation mechanism, theoretical model, parameter optimization and

Piston manufacturing process

control strategy of grinding surface burn, and solved the problem of grinding burn.

1.3.10 Ultra-Precision Machining


Precision machining

Harbin Institute of Technology have been studied deeply in the study of the machining mechanism of micro- and nano-cutting process, the mechanism of tool wear and tear and the mechanism of ultra-precision cutting removal of brittle materials. Many special equipment for ultra-precision cutting are developed successfully, and the ultra-precision machining of the key parts of the laser nuclear fusion key parts has been used. National University of Defense Technology has firstly broken through an ion beam and magnetorheological optical polishing technology in China, and established the basic theory of magnetic fluid and ion beam and other controllable flexible body medium polishing. A complete set of process routes and equipment for optical mirror full waveband error control have been formed, and the grade processing precision of the surface, spherical and aspherical mirror surfaces can be realized steadily in a nanoscale.

1.3.11 Design

Zhejiang University has deeply studied a product concept design and virtual prototyping technology based on Intelligent Computing, and put forward a key design technology of mass customization, which is product configuration, product variant, product evolution and product recursion, and realized the virtual simulation test of the creative generation and design performance of product design concept. The technology and system of computer aided product innovation design have been developed and docked with data interface of famous foreign systems. Hebei University of Technology has developed creatively a theory, a qualitative and quantitative analysis methods of multi-conflict and the domain transformation technology are put forward, and the creation pattern of innovative ideas in the fuzzy front end of product innovation is summarized.

1.3.12 Forming Manufacturing


Forming manufacturing

Rapid prototyping manufacturing is the most representative manufacturing technology of traditional manufacturing to multi-disciplinary and digital modern manufacturing. Xi'an Jiaotong University, Tsinghua University, and Huazhong University of Science and Technology have made a deep study of stereo lithography apparatus, laminated object manufacturing, fused deposition modeling and selected laser sintering, and promoted the formation and development of rapid prototyping. The technology has applied to the fields of automobile, medical rehabilitation engineering, agricultural water-saving devices and so on, and promoted the industrialization of new technology.

1.3.13 Microelectronic Fabrication


Microelectronic fabrication

Northwestern Polytechnical University has proposed an integrated design tool supporting arbitrary processes. Peking University has developed three sets of standard process flow and established a high-level silicon processing platform. The first forming technology of multilayer silicon micromechanical structure, the fabrication of silicon based optical waveguide and the new method of wafer level packaging have been invented by Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences. And the fabrication process of the double side micromechanical piezoresistive sensor based on single silicon wafer structure is formed. Dalian University of Technology has developed an automatic manufacturing equipment for plastic microfluidic chip. It has mastered the key technology of batch production of microstructure hot pressing metal mould and microfluidic chip. A nanoscale imprinting process of "pressure preserving-release-soliding" under the normal temperature soft imprinting was put forward by Xi'an Jiaotong University. The influence of the properties of the corrosion inhibitor and the liquid-solid interface and solid-solid interface on the filling quality and the release effect of the mold cavity was found, and the nanoscale imprint was realized with a good compound fidelity. Institute of Physics, Chinese Academy of Sciences has successfully developed a probe for dual probe scanning tunneling microscope with symmetrical mechanical structure. North University of China has developed a wafer level microstructural stress testing platform based on Raman spectroscopy, and has completed static stress and dynamic stress testing.

Words and Expressions

nanotribology [ˌnænəʊtraɪˈbɒlədʒi] nano+tribology, the branch of tribology that studies friction, wear, adhesion and lubrication phenomena at the nanoscale, where atomic interactions and quantum effects are not negligible	*n.* 纳米摩擦学
chemical mechanical polishing [ˈkemɪkl məˈkænɪkl ˈpɒlɪʃɪŋ]	化学机械抛光
wheel-rail interaction [wiːl reɪl ˌɪntərˈækʃən]	轮轨关系
corrugation [ˌkɒrʊˈgeɪʃən] the process of corrugating; contraction into wrinkles or alternate ridges and grooves	*n.* 钢轨的波浪形磨耗，简称波磨
helix theory [ˈhiːlɪks ˈθɪəri]	螺旋理论
Lie group [liː gruːp]	李群