国外电子信息精品著作（影印版）

光学及光电子学设备与技术

Optical and Optoelectronic Instrumentation

(China Edition)

Amar K. Ganguly

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内 容 简 介

光学及光电子学设备与技术一书详述了近年来先进的光学及光电子学领域的技术设备。本书对各种光电子设备做了深入浅出的论述，附有大量的习题，语法直观易于阅读。本书既可作为光电子学相关领域专家的重要参考资料，又可作为当前光电子学教学中所需的实用教材，也可以作为研究人员的参考书，对当前光电子学课程教学能起到很好的补充作用。

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《国外电子信息精品著作》序

20世纪90年代以来，信息科学技术成为世界经济的中坚力量。随着经济全球化的进一步发展，以微电子、计算机、通信和网络技术为代表的信息技术，成为人类社会进步过程中发展最快、渗透性最强、应用面最广的关键技术。信息技术的发展带动了微电子、计算机、通信、网络、超导等产业的发展，促进了生命科学、新材料、能源、航空航天等高新技术产业的成长。信息产业的发展水平不仅是社会物质生产、文化进步的基本要素和必备条件，也是衡量一个国家的综合国力、国际竞争力和发展水平的重要标志。在中国，信息产业在国民经济发展中占有举足轻重的地位，成为国民经济重要支柱产业。然而，中国的信息科学支持技术发展的力度不够，信息技术还处于比较落后的水平，因此，快速发展信息科学技术成为我国迫在眉睫的大事。

要使我国的信息技术更好地发展起来，需要科学工作者和工程技术人员付出艰辛的努力。此外，我们要从客观上为科学工作者和工程技术人员创造更有利于发展的环境，加强对信息技术的支持与投资力度，其中也包括与信息技术相关的图书出版工作。

从出版的角度考虑，除了较好较快地出版具有自主知识产权的成果外，引进国外的优秀出版物是大有裨益的。洋为中用，将国外的优秀著作引进到国内，促进最新的科技成就迅速转化为我们自己的智力成果，无疑是值得高度重视的。科学出版社引进一批国外知名出版社的优秀著作，使我国从事信息技术的广大科学工作者和工程技术人员能以较低的价格购买，对于推动我国信息技术领域的科研与教学是十分有益的事。

此次科学出版社在广泛征求专家意见的基础上，经过反复论证、仔细遴选，共引进了接近30本外版书，大体上可以分为两类，第一类是基础理论著作，第二类是工程应用方面的著作。所有的著作都涉及信息领域的最新成果，大多数是2005年后出版的，力求“层次高、内

容新、参考性强”。在内容和形式上都体现了科学出版社一贯奉行的严谨作风。

当然，这批书只能涵盖信息科学技术的一部分，所以这项工作还应该继续下去。对于一些读者面较广、观点新颖、国内缺乏的好书还应该翻译成中文出版，这有利于知识更好更快地传播。同时，我也希望广大读者提出好的建议，以改进和完善丛书的出版工作。

总之，我对科学出版社引进外版书这一举措表示热烈的支持，并盼望这一工作取得更大的成绩。

王越

中国科学院院士

中国工程院院士

2006年12月

In loving memory of my wife

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Amar K. Ganguly

Preface

The rapid development of optoelectronic devices and applications of these devices in the field of fiber-optic communication, sensors, instruments and industrial process control systems influence our daily life. Sophisticated technology of laser diode, light emitting diode, photo-detector, optical fiber and optical computation causes tremendous thrust in the advancement of human life. For this reason, optoelectronics has been included in the curriculum of Universities in under graduate and post graduate level of different stream of science and technology.

The main objective of this book is to meet the requirement of an up-to-date book in optical and optoelectronic instrumentation. This book has been planned to approach the subject, providing a clear impression of the subject. This book is written to cover the syllabus of the subject "Optical and optoelectronic instrumentation" of universities of science and technology. This book will serve as text book of the subject, library reference book and reference book for R&D personnel, technical training center, instrument industries and students of B. Tech., M. Tech., students of diploma Engineering and staff training institutes.

First chapter of this book describes concept of particles and wave. Classical physics treats particles and waves as separate components in physical reality. Traditionally, the particle mechanics and optics of waves are independent subjects. But, in the microscopic world electrons and nuclei are neither particles nor waves in our sense of these terms. The electrons have mass and charge and in some cases they obey the laws of particle mechanics. For this reason we regard electron as particle. On the other hand, under suitable circumstances moving electrons show the electromagnetic wave nature although it consists of stream of particles. Thus wave particle duality exists in the nature of moving electron.

The propagation of light in geometrical optics employs the concept of rays. In the second chapter, the propagation of light is described using ray theory. The formation of images by geometrical optics is also realized by using Fermat's principle. It is also described in second chapter.

Many optical instruments contain spherical surfaces of transparent media with a wide range of curvature. Such spherical surfaces are capable of forming images. The spherical surfaces may be convex or concave. The transparent medium bounded by two such spherical surfaces is called lens. These lenses are made of transparent medium as free as possible from inhomogeneities. In chapter-3, we described the refraction at spherical surfaces separating two media of different refractive indices.

The propagation of light in geometrical optics is described in chapter-2. Geometrical optics is used to design efficient optical instruments. Many optical instruments contain spherical surfaces of transparent media with a wide range of curvature. The formation of images by single lens or combination of lenses and mirrors has been described in chapter-3. This combination of lenses mirrors or prisms are used to make optical instruments. In chapter-4, few standard optical instruments are described.

Dispersion is related to the speed of light in transparent medium and its variation with wavelength. We know that change in refractive index in any medium causes change in speed of light. The dispersion of colour of light occurs on refraction at a boundary between two transparent medium. Actually, dispersion is caused by change in deviation of light with the wavelength. In chapter-5 measurement of refractive index of a medium is described by measuring the deviation of the light due to dispersion.

The conversion of electricity to light and vice versa have been possible only a few decades back when the technology of optoelectronic devices has been developed. The optoelectronic devices now play an important role in our daily lives. Light emitting diode is an important optoelectronic source of light. The LED lamp typically consists of an encapsulated light emitting diode chip in a plastic package with a suitable lens. In recent years, light emitting diode is replacing the incandescent, fluorescent and neon lamps for a wide variety of applications. In chapter-6, the working principle of optoelectronic device is discussed elaborately.

Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. The operating principle of laser is based on stimulated emission process in which the electrons undergo transition by emission of photons. The construction, working principle and characteristics of different types of laser are described in chapter-7.

The process of conversion of optical power into electrical power is called photo-detection. The device which converts light power incident on it into electrical power is called photo-detector. Optical detectors may be classified as either thermal photo-detection or photon photo-detection process. In thermal photo-detection process the device absorbs light energy and hence temperature of the device increases which in turn changes the conductivity of device. Thus the output is proportional to amount of light energy absorbed per unit time. On the other hand, in photo-detection process, minimum photon energy is required to initiate the photo-detection process. Since energy of photons depends on wavelength of light photon detection process has a long wavelength cut off i.e. the maximum wavelength beyond which the device can not operate. The construction, working principle and characteristics of different types of photo-detector are described in chapter-8.

An optical fiber is made of transparent medium with incredibly small diameter. In other words, the dielectric waveguide which transmits light by total internal reflection is known as optical fiber. It is cylindrical in shape and typically fabricated from glass which is a dielectric medium. It consists of core region of higher refractive index surrounded by cladding of lower refractive index. It confines light energy within the core and guides light in the direction of its axis by total internal reflection. The guided light within the fiber may be used as information. The information may be digital or analog depending on communication system. It can carry thousands of telephone signals and large number of television signals. The light power in an optical fiber can be described as a set of guided electromagnetic waves called the modes of the waveguides. The guided modes may also be called as bound modes. The bound modes repeat the pattern of electric and magnetic field distributions after regular interval of time. So optical fiber can be used as waveguide to transmit the information from one place to other. The fiber material is a dielectric. Therefore, fiber optic systems are immune to electromagnetic interference. The construction, working principle and characteristics of different types of photo-detector are described in chapter-9.

Now-a-days optoelectronic devices are widely used in optical isolator and measuring instruments. These devices are used in sensor systems, optical isolators, and optical data processing, voice and data communication systems. Fiber optics technology is also applied in many industries. The optoelectronic systems technology is applied in aircraft manufacturing and maintenance industry, carpet industry, food and drink industry and pharmaceutical industry. Optical fibers play a vital role in medical field also.

Several medical instruments are developed using optoelectronic devices. The endoscopes or fiberscope are developed using large diameter and short length silica fibers. The broncho-fiberscope, gastrointestinal fiberscope, cardio scope, cyst scope, ophthalmoscope and laparoscopes are the important endoscopes used in diagnosis, treatment and surgery. In the chapter-10, the optocoupler, optoelectronic sensors and a few medical instruments are discussed.

Many years ago, the relation between light and electricity was known. But this knowledge was applied only a few decades back when the technology of optoelectronic devices has been developed. Now many optoelectronic displays, sensors and transducers have been developed. These devices are widely used in measuring systems. In chapter 11, we have described display devices and optoelectronic measuring systems.

In a photograph, a three dimensional scene is represented by two dimensional recording. The recorded scene is the intensity distribution on the plane of the photograph. The photographic film is sensitive on intensity variation only. The phase distribution of the scene is not found on the photograph. For this reason, the three dimensional property of the object can not be presented by two dimensional photography. As a result the image can not be viewed from different angle.

A perfect three dimensional image can be recorded by holography. Holography is a Greek word, which means whole writing. It employs interferometric technique for recording both amplitude and phase of the light wave emitted from an object. We have described holographic technique and its application in chapter-12.

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