Laser Spectroscopy For Sensing Fundamentals Techniques And Applications Woodhead Publishing Series In Electronic And Optical Materials

Terahertz (THz) and Mid-Infrared (MIR) radiation (TERA-MIR) can be transmitted through nearly any material without causing biological harm. Novel and rapid methods of detection can be created with devices operation in these spectral ranges allowing scanning for weapons, detecting hidden explosives (including plastic landmines), controlling the quality of food and a host of other exciting applications. This book focuses on mathematical and physical aspects of the field, on unifying these two spectral domains (THz and MIR) with regard to common sources, detectors, materials and applications, and on key interdisciplinary topics. The main THz and MIR source is the quantum cascade laser (QCL). Thus significant attention is paid to the challenge of turning this advanced technology into affordable commercial devices so as to exploit its enormous potential. However other alternatives to THz QCLs are also presented, e.g. sub-terahertz imaging from avalanching GaAs bipolar transistors, Josephson junctions as THz sources, semiconductor materials for pulsed THz sources, superconducting THz electronics with Josephson vortices. In summary this book delivers a global picture of the state of the art in TERA-MIR generation, detection and applications.

Jens Bosenberg Max-Planck-Institut fur Meteorologie, Bundesstr. 55, D-20146 Hamburg, Germany TESLAS, which stands for Tropospheric Environmental Studies by Laser Sounding, was formed in November 1987 as a subproject of EUROTRAC to enhance the measurement capabilities for vertical profiling of ozone in the troposphere by means of laser remote sensing. For studies of several atmospheric processes related to the formation and redistribution of photo-oxidants there was a clear need for measuring extended time series with appropriate vertical and temporal resolution. These could not be obtained by conventional in situ techniques, at least not with affordable effort, so remote sensing appeared to be the best way to obtain the required information. At the beginning of the subproject, some Differential Absorption Lidar (DIAL) systems for measuring the vertical distribution of ozone already existed, but their use was restricted to very few laboratories and very few measurement campaigns, since the instruments were highly complex, rather unreliable, and required extensive efforts for maintenance and operation by skilled scientists. In addition, the accuracy of these measurements under a variety of meteorological conditions was not really well established. The main tasks within TESLAS therefore were to develop fully the DIAL-methodology for remote sensing of tropospheric ozone, and to develop instruments which are accurate, reliable, easy to operate, and suitable for field deployment or airborne operation.

In the new edition the editors have preserved the basic concept and structure, with the involvement of some new authors - all recognized experts in laser spectroscopy. Each chapter addresses a different technique, providing a review and analysis of the current status, and reporting some of the latest achievements. With the key formulas and methods detailed in many sections, this text represents a practicable handbook of its subject. It will be a valuable tool both for specialists to keep abreast of developments and for newcomers to the field needing an accessible introduction to specific methods of laser spectroscopy - and also as a resource for primary references.

A wide-ranging review of modern spectroscopic techniques such as X-ray, photoelectron, optical and laser spectroscopy, and related techniques. The book focuses on physical principles and the impact of spectroscopy on our understanding of the building blocks of matter, while examining applications to chemical analysis, photochemistry, surface characterization, environmental and medical diagnostics, remote sensing, and astrophysics. This Third Edition includes the most up-to-date developments.

This monograph offers detailed and easy-to-read descriptions of the main techniques of laser spectroscopy and its applications. It is useful to engineers, technical managers, nonlaser scientists who require an introduction to the field, graduate students, and laser spectroscopists.

ATILA Finite Element Method (FEM) software facilitates the modelling and analysis of applications using piezoelectric, magnetostrictor and shape memory materials. It allows entire designs to be constructed, refined and optimized before production begins. Through a range of instructive case studies, Applications of ATILA FEM software to smart materials provides an indispensable guide to the use of this software in the design of effective products. Part one provides an introduction to ATILA FEM software, beginning with an overview of the software code. New capabilities and loss integration are discussed, before part two goes on to present case studies of finite element modelling using ATILA. The use of ATILA in finite element analysis, piezoelectric polarization, time domain analysis of piezoelectric devices and the design of ultrasonic motors is considered, before piezo-composite and photonic crystal applications are reviewed. The behaviour of piezoelectric single crystals for sonar and thermal analysis in piezoelectric and magnetostrictive materials is also discussed, before a final reflection on the use of ATILA in modelling the damping of piezoelectric structures and the behaviour of single crystal devices. With its distinguished editors and international team of expert contributors, Applications of ATILA FEM software to smart materials is a key reference work for all those involved in the research, design, development and application of smart materials, including electrical and mechanical engineers, academics and scientists working in piezoelectrics, magenetostrictors and shape memory materials. Provides an indispensable guide to the use of ATILA FEM software in the design of effective products Discusses new capabilities and loss integration of the software code, before presenting case studies of finite element modelling using ATILA Discusses the behaviour of piezoelectric single crystals for sonar and thermal analysis in piezoelectric and magnetostrictive materials, before a reflection on the use of ATILA in modelling the damping of piezoelectric structures

Starting from fundamentals and moving through a thorough discussion of equipment, methods, and techniques, the Handbook of Laser-Induced Breakdown Spectroscopy provides a unique reference source that will be of value for many years to come for this important new analysis method. The authors, with a total of over 60 years of experience in the LIBS method, use a combination of tutorial discussions ranging from basic principles up to more advanced descriptions along with extensive figures and photographs to clearly explain topics addressed in the text. In this second edition, chapters on the use of statistical analysis and advances in detection of weapons of mass destruction have been added. Tables of data related to analysis with LIBS have been updated. The Handbook of Laser-Induced Breakdown Spectroscopy, Second Edition: provides a thorough but understandable discussion of the basic principles of the method based on atomic emission spectroscopy, including recently available data leading to better characterization of the LIBS plasma; presents a discussion of the many advantages of the method along with limitations, to provide the reader a balanced overview of capabilities of the method; describes LIBS instrumentation ranging from basic set-ups to more advanced configurations; presents a comprehensive discussion of the different types of components (laser, spectrometers, detectors) that can be used for LIBS apparatuses along with suggestions for their use, as well as an up-to-date treatment of the newest advances and capabilities of LIBS instruments; presents the analytical capabilities of the method in terms of detection limits, accuracy, and precision of measurements for a variety of different sample types; discusses methods of sampling different media such as gases, liquids, and solids; presents an overview of some real-world applications of the method, with new emphasis on sampling of biologically and physically dangerous materials; provides an up-to-date list of references to LIBS literature along with the latest detection limits and a unique list of element detection limits using a uniform analysis method; provides annotated examples of LIBS spectra which can serve as references for the general reader and will be especially useful for those starting out in the field.

This volume contains reports on state-of-the-art studies relevant to signal detection in important scientific areas such as environmental, industrial and biomedical monitoring. Critical issues in the fields of material development for advanced sensing applications, nuclear techniques using neutrons for humanitarian demining, sensors for biomedical, industrial and environmental monitoring as well as solid state detectors for biomedical applications are confronted with the cross-disciplinary approach of physicists, chemists and biologists.

Contents:Solid State Detectors for Biomedical ApplicationsSensors for Biomedical, Industrial and Environmental MonitoringMaterial Development for Advanced Sensing ApplicationsNuclear Techniques Using Neutrons for Humanitarian Demining Readership:Graduate students, academics and industrialists in applied physics, high energy physics and networks. Keywords:Sensors;Conducting Polymers;Nanostructured Materials;Pollution Monitoring;Process Control;Solid State Detectors;Medical Imaging

Leading experts discuss the characteristics, advantages, limitations and future aspects of modern spectroscopic techniques for environmental analysis. Demonstrates how these methods can be applied to trace gas detection and assessment. Concentrates on the latest techniques--both laser and non-laser based--which offer advantages for air pollution and gas monitoring as opposed to more conventional methods. Numerous examples of applications illustrate the potential of the techniques backed up by cutting-edge information and representative data.

Stringent legislation is forcing manufacturing industry to be aware of the impact its operations have on the environment, in order to control and reduce the affect of those operations. Increasingly sophisticated equipment is required for this monitoring, and development of that equipment and strategies for its use is a multi-disciplinary field involving chemists, analytical scientists and engineers. This volume is divided into two parts, the first introducing the reader to the various sensor systems and illustrating the advantages and disadvantages those systems have for monitoring programmes, and the second introducing the problems associated with environmental monitoring, and showing how the sensors discussed in the first section can be applied to produce a thorough monitoring programme.

Concentrating on the natural science aspects of forensics, top international authors from renowned universities, institutes, and laboratories impart the latest information from the field. In doing so they provide the background needed to understand the state of the art in forensic science with a focus on biological, chemical, biochemical, and physical methods. The broad subject coverage includes spectroscopic analysis techniques in various wavelength regimes, gas chromatography, mass spectrometry, electrochemical detection approaches, and imaging techniques, as well as advanced biochemical, DNA-based identification methods. The result is a unique collection of hard-to-get data that is otherwise only found scattered throughout the literature.

Laser Spectroscopy for SensingFundamentals, Techniques and ApplicationsWoodhead Publishing

Keeping abreast of the latest techniques and applications, this new edition of the standard reference and graduate text on laser spectroscopy has been completely revised and expanded. While the general concept is unchanged, the new edition features a broad array of new material, e.g., frequency doubling in external cavities, reliable cw-parametric oscillators, tunable narrow-band UV sources, more sensitive detection techniques, tunable femtosecond and sub-femtosecond lasers (X-ray region and the attosecond range), control of atomic and molecular excitations, frequency combs able to synchronize independent femtosecond lasers, coherent matter waves, and still more applications in chemical analysis, medical diagnostics, and engineering.

Laser spectroscopy is a valuable tool for sensing and chemical analysis. Developments in lasers, detectors and mathematical analytical tools have led to improvements in the sensitivity and selectivity of spectroscopic techniques and extended their fields of application. Laser Spectroscopy for Sensing, Second Edition examines these advances and how laser spectroscopy can be used in a diverse range of industrial, medical, and environmental applications. The book provides an overview of laser spectroscopy at three levels: the fundamental aspects to consider when planning use of laser spectroscopy to solve a problem (from the sample properties to the laser properties to the data analysis), the technical aspects of several spectroscopic techniques, and the fields of applications of such techniques. In the new edition, key advancements from the field are captured as well as two new chapters on Raman Spectroscopy and Laser-induced breakdown spectroscopy. Laser Spectroscopy for Sensing provides readers with a broad overview of the techniques and applications of laser spectroscopy for sensing. Presents the fundamentals of laser technology for controlling the spectral and temporal aspects of laser excitation Explores laser spectroscopy techniques, including Raman spectroscopy and laser-induced breakdown spectroscopy Considers spectroscopic analysis of industrial materials and their applications in nuclear research and industry

The emerging field of green analytical chemistry is concerned with the development of analytical procedures that minimize consumption of hazardous reagents and solvents, and maximize safety for operators and the environment. In recent years there have been significant developments in methodological and technological tools to prevent and reduce the deleterious effects of analytical activities; key strategies include recycling, replacement, reduction and detoxification of reagents and solvents. The Handbook of Green Analytical Chemistry provides a comprehensive overview of the present state and recent developments in green chemical analysis. A series of detailed chapters, written by international specialists in the field, discuss the fundamental principles of green analytical chemistry and present a catalogue of tools for developing environmentally friendly analytical techniques. Topics covered include: Concepts: Fundamental principles, education, laboratory experiments and publication in green analytical chemistry. The Analytical Process: Green sampling techniques and sample preparation, direct analysis of samples, green methods for capillary electrophoresis, chromatography, atomic spectroscopy, solid phase molecular spectroscopy, derivative molecular spectroscopy and electroanalytical methods. Strategies: Energy saving, automation, miniaturization and photocatalytic treatment of laboratory wastes. Fields of Application: Green bioanalytical chemistry, biodiagnostics, environmental analysis and industrial analysis. This advanced handbook is a practical resource for experienced analytical chemists who are interested in implementing green approaches in their work.

This work details tunable laser applications of broad interest, historical significance and potential future value. Atomic and molecular spectroscopy, interferometry, lightening triggering, imaging, laser radar, lidar and gyroscopes are discussed. The work focuses on various sources of coherent radiation such as optical parametric oscillators, external cavity semiconductors lasers, and dye, gas, C02, ultrashort-pulse and free-electron lasers.

Sensor technologies are a rapidly growing area of interest in science and product design, embracing developments in electronics, photonics, mechanics, chemistry, and biology. Their presence is widespread in everyday life, where they are used to sense sound, movement, and optical or magnetic signals. The demand for portable and lightweight sensors is relentless in several industries, from consumer electronics to biomedical engineering to the military. Smart Sensors for Industrial Applications brings together the latest research in smart sensors technology and exposes the reader to myriad applications that this technology has enabled. Organized into five parts, the book explores: Photonics and optoelectronics sensors, including developments in optical fibers, Brillouin detection, and Doppler effect analysis. Chapters also look at key applications such as oxygen detection, directional discrimination, and optical sensing. Infrared and thermal sensors, such as Bragg gratings, thin films, and microbolometers. Contributors also cover temperature measurements in industrial conditions, including sensing inside explosions. Magnetic and inductive sensors, including magnetometers, inductive coupling, and ferro-fluidics. The book also discusses magnetic field and inductive current measurements in various industrial conditions, such as on airplanes. Sound and ultrasound sensors, including underwater acoustic modem, vibrational spectroscopy, and photoacoustics. Piezoresistive, wireless, and electrical sensors, with applications in health monitoring, agrofood, and other industries. Featuring contributions by experts from around the world, this book offers a comprehensive review of the groundbreaking technologies and the latest applications and trends in the field of smart sensors.

Gas-phase photoacoustics are treated comprehensively for the first time in this book. Review articles by leading scientists in the

respective research areas introduce their fields, review present knowledge and conclude with the latest developments and future prospects. Topics covered include the theory of photoacoustics in the frequency and time domains, acoustic resonator models, a great variety of experimental setups and techniques, studies of spectrocopy and fundamental kinetic processes such as energy transfer and chemical reactions, and applications such as air and exhaust monitoring and trace gas detection in biology and agriculture. The book will interest newcomers to photoacoustics, since it gives an overview of the important directions of current research and detailed descriptions of experimental methods. It will also be a valuable source of information for those already involved in photoacoustic research due to its clear presentation of theory and experimental results. All relevant literature references in this rapidly expanding field of laser applications are included.

This authoritative new resource provides an overview of the deployment of various devices in systems in actual field conditions and efficacy established in warfare. The book covers laser and optronic technologies that have evolved over the years to build practical devices and systems for use in Homeland Security and low-intensity conflict scenarios. Readers will be able to assess combat and battle-worthiness of various available devices and systems. This book covers state-of-the-art and emerging trends in various optoelectronics technologies having applications in Homeland Security. It provides information on operational aspects, deployment scenarios, and actual usage of laser and optoelectronics based technologies for low intensity conflicts, offering insight into the utility of each technology/device for a given operational requirement. This book evaluates the merits of various laser and optoelectronic sensor based technologies intended for low intensity conflict operations, including counter-insurgency and anti-terrorist operations. It is a useful reference for those specializing in defense electronics and optronics and professionals in the defence industry involved in operation and maintenance of laser based security equipment. Packed with tables, photographs, and a comprehensive list of references in every chapter, this is the only book that covers all topics related to Laser and Optoelectronics devices intended for low intensity conflict operations in a single volume.

The new, fully colored standard in Biophotonics to serve as THE reference for the scientific basics and the latest applications in life science!

Delving into Infrared Spectroscopy: Principles, Advances and Applications, and with basic knowledge of IR spectroscopy, will provide the reader with a synopsis of fundamentals and groundbreaking advances in the field. Readers will see a variety of MIR applications and difficulties encountered, especially in an industrial environment. Competency in FT-IR spectroscopy in biomedical research and early-stage diagnosis of obesity is shown. Challenges associated with VIS-NIR applications are shown through application of the technique in assessing quality parameters of fruits. Moreover, IR spectroscopic studies of radiation-stimulated processes, and the influence of using IR in developing an ideal catalyst and hence an efficient catalysis process, are discussed. The impact of coupling multivariate data analysis techniques to IR is shown in almost every chapter.

Infrared laser absorption spectroscopy (IRLAS) employing both tuneable diode and quantum cascade lasers (TDLs, QCLs) has been applied with both high sensitivity and high time resolution to plasma diagnostics and trace gas measurements. TDLAS combined with a conventional White type multiple pass cell was used to detect up to 13 constituent molecular species in low pressure Ar/H2/N2/O2 and Ar/CH4/N2/O2 microwave discharges, among them the main products such as H2O, NH3, NO and CO, HCN respectively. The hydroxyl radical has been measured in the mid infrared (MIR) spectral range in-situ in both plasmas yielding number densities of between 1011 ... 1012 cm-3. Strong indications of surface dominated formation of either NH3 or N2O and NO were found in the H2-N2-O2 system. In methane containing plasmas a transition between deposition and etching conditions and generally an incomplete oxidation of the precursor were observed. The application of QCLs for IRLAS under low pressure conditions employing the most common tuning approaches has been investigated in detail. A new method of analysing absorption features quantitatively when the rapid passage effect is present is proposed. If power saturation is negligible, integrating the undisturbed half of the line profile yields accurate number densities without calibrating the system. By means of a time resolved analysis of individual chirped QCL pulses the main reasons for increased effective laser line widths could be identified. Apart from the well-known frequency down chirp non-linear absorption phenomena and bandwidth limitations of the detection system may significantly degrade the performance and accuracy of inter pulse spectrometers. The minimum analogue bandwidth of the entire system should normally not fall below 250 MHz. QCLAS using pulsed lasers has been used for highly time resolved measurements in reactive plasmas for the first time enabling a time resolution down to about 100 ns to be achieved. A temperature increase of typically less than 50 K has been established for pulsed DC discharges containing Ar/N2 and traces of NO. The main NO production and depletion reactions have been identified from a comparison of model calculations and time resolved measurements in plasma pulses of up to 100 ms. Considerable NO struction is observed after 5 ... 10 ms due to the impact of N atoms. Finally, thermoelectrically cooled pulsed and continuous wave (cw) QCLs have been employed for high finesse cavity absorption spectroscopy in the MIR. Cavity ring down spectroscopy (CRDS) has been performed with pulsed QCLs and was found to be limited by the intrinsic frequency chirp of the laser suppressing an efficient intensity build-up inside the cavity. Consequently the accuracy and advantage of an absolute internal absorption calibration is not achievable. A room temperature cw QCL was used in a complementary cavity enhanced absorption spectroscopy (CEAS) configuration which was equipped with different cavities of up to 1.3 m length. This spectrometer yielded path lengths of up to 4 km and a noise equivalent absorption down to 4 x 10-8 cm-1Hz-1/2. The corresponding molecular concentration detection limit (e.g. for CH4, N2O and C2H2 at 1303 cm-1/7.66 Aem) was generally below 1 x 1010 cm-3 for 1 s integration times and one order of magnitude less for 30 s integration times. The main limiting factor for achieving even higher sensitivity is the residual mode noise of the cavity. Employing a 0.5 m long cavity the achieved sensitivity was good enough for the selective measurement of trace atmospheric constituents at 2.2 mbar.

Los investigadores Rafael Escribano e Isabel Tanarro cuentan con una larga experiencia en espectroscopia molecular y física del plasma, y se han centrado durante los últimos quince años en el estudio de sistemas de relevancia atmosférica y astrofísica. En este libro, presentan una serie de contribuciones de otros renombrados colegas a cerca de la atmósfera, la espectroscopia y la astronomía, la metodología y la descripción de técnicas empleadas en estos campos, así como los resultados actualizados de sus propias investigaciones. Esta obra incluye en definitiva algunos temas de gran interés tanto para la comunidad científica como para el público en general, como las recientes misiones espaciales a cometas, sucesos luminosos espectaculares en la alta atmósfera, o la controvertida cuestión del calentamiento global y el cambio climático.

Trace gas sensing technologies are widely used in many applications, such as environmental monitoring, life science, medical diagnostics, and planetary exploration. On the one hand, laser sources have developed greatly due to the rapid development of laser media and laser techniques in recent years. Some novel lasers such as solid-state, diode, and quantum cascade lasers have

experienced significant progress. At present, laser wavelengths can cover the range from ultraviolet to terahertz, which could promote the development of laser gas sensing technologies significantly. On the other hand, some new gas sensing methods have appeared, such as photothermal spectroscopy and photoacoustic spectroscopy. Laser spectroscopy-based gas sensing techniques have the advantages of high sensitivity, non-invasiveness, and allowing in situ, real-time observation. Due to the rapid and recent developments in laser source as well as the great merits of laser spectroscopy-based gas sensing techniques, this book aims to provide an updated overview of the state-of-the-art laser gas sensing technologies.

The book provides the reader with a profound knowledge of basic principles, properties and preferred applications of diverse kinds of CO2 measurement. It shows the advantages, disadvantages and limitations of several methods and gives a comprehensive overview of both possible applications and corresponding boundary conditions. Applications reach from environmental monitoring to safety control to biotechnology and food control and finally to medicine.

A wide-ranging review of modern spectroscopic techniques such as X-ray, photoelectron, optical and laser spectroscopy, and radiofrequency and microwave techniques. On the fundamental side the book focuses on physical principles and the impact of spectroscopy on our understanding of the building blocks of matter, while in the area of applications particular attention is given to those in chemical analysis, photochemistry, surface characterisation, environmental and medical diagnostics, remote sensing and astrophyscis. The Fourth Edition also provides the reader with an update on laser cooling and trapping, Bose-Einstein condensation, ultra-fast spectroscopy, high-power laser/matter interaction, satellite-based astronomy and spectroscopic aspects of laser medicine.

This dissertation describes laser absorption spectroscopy methods developed for temperature and carbon oxide (CO and CO2) sensing in high-pressure, fuel-rich combustion conditions of hydrocarbon-fueled bipropellant rockets. The scope of the work includes fundamental studies of spectroscopic interactions at high gas density, development of unique laser tuning and signal processing methods, and application of prototype sensors to rocket combustion devices under investigation at the Air Force Research Laboratory in Edwards, CA. Infrared vibrational spectra of CO and CO2 were probed using tunable semi-conductor lasers to infer gas properties. Initial sensor design targeted the absorption spectra of CO near 4.98 m, selected to minimize spectral interference with other combustion gas species at the extreme temperatures (> 3000 K) and pressures (> 50 atm) of a kerosene-fueled rocket combustion environment. Successful measurements were conducted up to 70 bar utilizing a scanned wavelength modulation spectroscopy technique, creating a new pressure-limit for quantitative in situ species sensing in a combustion device. At higher pressures (which were tested), collisional-broadening effects blended the targeted absorption transitions, causing differential absorption to diminish and reducing the signal-to-noise ratio of the measurements. To overcome the pressure-constraints, a more advanced laser absorption sensing strategy was developed, targeting the vibrational bandheads of CO near 2.3 m and CO2 near 4.2 m and exploiting the band narrowing effects of collisional line mixing to counter collisional broadening. Spectral line mixing--typically observed at high gas densities in which intermolecular collisions are sufficiently frequent and strong to cause a shift in energy level populations--corresponds to a transfer of absorption intensity from weak to strong absorption regions, inducing a narrowing of spectral features. This non-ideal phenomenon is more prominent in spectrally dense regions, such as bandheads. Targeting infrared bandheads to exploit line mixing, measurements of CO and CO2 concentration were demonstrated over a range of high pressures up to 105 bar in a single-element-injector RP-2/CH4-GOx rocket combustor. To make such measurements quantitative,spectroscopic models accounting line mixing effects have been developed utilizing a high-enthalpy shock tube; these models are then employed for interpretation of measured absorption signals for quantitative temperature and species sensing.

The third edition of this established classic text reference builds upon the strengths of its very popular predecessors. Organized as a broadly useful textbook Principles of Fluorescence Spectroscopy, 3rd edition maintains its emphasis on basics, while updating the examples to include recent results from the scientific literature. The third edition includes new chapters on single molecule detection, fluorescence correlation spectroscopy, novel probes and radiative decay engineering. Includes a link to Springer Extras to download files reproducing all book artwork, for easy use in lecture slides. This is an essential volume for students, researchers, and industry professionals in biophysics, biochemistry, biotechnology, bioengineering, biology and medicine.

This book presents comprehensive reviews on the latest developments of nanotechnologies to detect and remove pollutants in water, air and food. Polymer nanocomposites, nanoparticles from microbes and application of nanotechnologies for desalination and agriculture are also addressed. Pollution of water and air by contaminants and diseases is a major health issue leading globally to millions of deaths yearly, according to the World Health Organization, and such an issue requires advanced methods to clean environmental media.

As we enter the nineties, there is worldwide awareness that the future of all mankind is inexorably linked by the world we share, and its response to man's activities. Lasers and the optical sciences have brought powerful tools to measure and understand our environment. LIDAR (laser radar) and laser fluorescence allow us to measure atmospheric and oceanic pollutants, as well as industrial emissions, from many kilometers distance. And a variety of sensitive laser-based spectroscopic techniques permit the accurate analysis of heavy metals and other trace elements in the environment. In September 1989, an international group of scientists me.t in Erice, Sicily, for the 14th Course of the International School of Quant~ Electronics. This Course was devoted to "Optoelectronics for Envi~onmental Science", and was ably directed by Prof. V. S. Letokhov of the USSR Institute of Spectroscopy and Prof. A. M. Scheggi of the C.N.R. Electro magnetic Waves Institute, Florence, Italy. This book gives the proceedings of that conference, which covered not only basic tutorial papers but also reports on the latest research results. The first half of this volume describes the techniques used for direct "In-Situ Measurements" of the environment. In "Techniques and Programs", four chapters and one extended abstract give tutorial discussions of the most important remote sensing techniques: LIDAR, laser fluorescence, and

optical fiber sensors, plus a description of the Italian program in this area.

Keeping abreast of the latest techniques and applications, this new edition of the standard reference and graduate text on laser spectroscopy has been completely revised and expanded. While the general concept is unchanged, the new edition features a broad array of new material, e.g., ultrafast lasers (atto- and femto-second lasers), coherent matter waves, Doppler-free Fourier spectroscopy, interference spectroscopy, quantum optics and gravitational waves and still more applications in chemical analysis, medical diagnostics, and engineering.

Laser-Induced Breakdown Spectroscopy (LIBS) and Raman spectroscopy are still growing analytical and sensing spectroscopic techniques. They significantly reduce the time and labor cost in analysis with simplified instrumentation, and lead to minimal or no sample damage. In this dissertation, fundamental studies to improve LIBS analytical performance were performed and its fusion with Raman into one single sensor was explored. On the fundamental side, Thomson scattering was reported for the first time to simultaneously measure the electron density and temperature of laser plasmas from a solid aluminum target at atmospheric pressure. Comparison between electron and excitation temperatures brought insights into the verification of local thermodynamic equilibrium condition in laser plasmas. To enhance LIBS emission, Microwave-Assisted LIBS (MA-LIBS) was developed and characterized. In MA-LIBS, a microwave field extends the emission lifetime of the plasma and stronger time integrated signal is obtained. Experimental results showed sensitivity improvement (more than 20-fold) and extension of the analytical range (down to a few tens of ppm) for the detection of copper traces in soil samples. Finally, laser spectroscopy systems that can perform both LIBS and Raman analysis were developed. Such systems provide two types of complimentary information--elemental composition from LIBS and structural information from Raman. Two novel approaches were reported for the first time for LIBS-Raman sensor fusion: (i) an Ultra-Violet system which combines Resonant Raman signal enhancement and high ablation efficiency from UV radiation, and (ii) a Ti:Sapphire laser based NIR system which reduces the fluorescence interference in Raman and takes advantage of femtosecond ablation for LIBS.

Electromagnetism, quantum mechanics, statistical mechanics, molecular spectroscopy, optics and radiation form the foundations of the field. On top of these rest the techniques applying the fundamentals (e.g. Emission Spectroscopy, Laser Induced Fluorescence, Raman Spectroscopy). This book contains the basic topics associated with optical spectroscopic techniques. About 40 major sources are distilled into one book, so researchers can read and fully comprehend specific optical spectroscopy techniques without visiting many sources. Optical diagnostics are widely used in combustion research. Ideas first proposed here are now applied in other fields, including reacting flows for materials production (CVD reactors, oxidation reactors and some plasma work), atmospheric sensing, measuring constituents of exhaled human breath (to indicate stress in airway passages and the lungs and hence,e.g., provide a very early indicator of lung cancer). Researchers not formally trained who apply spectroscopy in their research need the detail in this book to ensure accuracy of their technique or to develop more sophisticated measurements. Time is valuable and future research will benefit. Learning "on the fly" can involve direct information on a specific diagnostic technique rather than gaining the background necessary to go into further depth.

The five volume set LNCS 10960 until 10964 constitutes the refereed proceedings of the 18th International Conference on Computational Science and Its Applications, ICCSA 2018, held in Melbourne, Australia, in July 2018. Apart from the general tracks, ICCSA 2018 also includes 34 international workshops in various areas of computational sciences, ranging from computational science technologies, to specific areas of computational sciences, such as computer graphics and virtual reality. The total of 265 full papers and 10 short papers presented in the 5-volume proceedings set of ICCSA 2018, were carefully reviewed and selected from 892 submissions. The paper Nitrogen Gas on Graphene: Pairwise Interaction Potentials is available open access under a Creative Commons Attribution 4.0 International License via link.springer.com.

An invaluable text for the teaching, design, and development of gas sensor technology. This excellent resource synthesizes the fundamental principles of spectroscopy, laser physics, and photonics technology and engineering to enable the reader to fully understand the key issues and apply them in the design of optical gas absorption sensors. It provides a straightforward introduction to low-cost and highly versatile near-IR systems, as well as an extensive review of mid-IR systems. Fibre laser systems for spectroscopy are also examined in detail, especially the emerging technique of frequency comb spectroscopy. Featuring many examples of real-world application and performance, as well as MATLAB computer programs for modeling and simulation, this exceptional work is ideal for postgraduate students, researchers, and professional engineers seeking to gain an in-depth understanding of the principles and applications of fibre-optic and laser-based gas sensors.

A rigorous account of the physics and engineering of diode and fibre laser gas sensor design, with key applications.

Wireless MEMS Networks and Applications reviews key emerging applications of MEMS in wireless and mobile networks. This book covers the different types of wireless MEMS devices, also exploring MEMS in smartphones, tablets, and the MEMS used for energy harvesting. The book reviews the range of applications of wireless MEMS networks in manufacturing, infrastructure monitoring, environmental monitoring, space applications, agricultural monitoring for food safety, health applications, and systems for smart cities. Focuses on the use of MEMS in the emerging area of wireless applications Contains comprehensive coverage of the range of applications of MEMS for wireless networks Presents an international range of expert contributors who identify key research in the field

This e-book is an essential review of land-based laser sensing methods, such as differential absorption, Raman scattering, laser-induced fluorescence, Doppler effect methods, laser-induced breakdown spectroscopy, and laser ultrasonics, and their respective application to specific industrial needs, such as natural gas leak detection, hydrogen gas leak detection, pollutant detection, wind profiling for windmill sites, minor constituent monitoring and concrete structure health monitoring. Readers will gain an updated overview of laser remote sensing techniques and their applications to the industrial environment.