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Plasmonic Optical Antennas for Enhanced Light Detection and Emission Fabrication and Characterization Capabilities of the Microdevices Laboratory Advanced Packaging Nanofabrication Biosensors and Molecular Technologies for Cancer Diagnostics Advanced Packaging Advanced Packaging Transport Spectroscopy of Confined Fractional Quantum Hall Systems Electron-beam, X-ray, and Ion-beam Technology Synthesis, Modelling and Characterization of 2D Materials and their Heterostructures Coaxial-tip Piezoresistive Cantilever Probes for High-resolution Scanning Gate Microscopy Fundamentals of Microfabrication High Resolution 3D Nanoimprint Technology Physics of Semiconductor Devices Semiconductor International From MEMS to Bio-MEMS and Bio-NEMS MEMS and NEMS Conference on Binary Optics Miniaturized Systems with Micro-optics and Micromechanics Proceedings of the Fourth International Symposium on Magnetic Materials, Processes, and Devices

Proceedings of the Symposium on High Speed III-V Electronics for Wireless Applications and the Twenty-Fifth State-of-the-Art Program on Compound Semiconductors (SOTAPOCS XXV) Manufacturing Techniques for Microfabrication and Nanotechnology Nanostructure Based Sensors for Gas Sensing: from Devices to Systems Magnetic Materials, Processes, and Devices VII and Electrodeposition of Alloys Scanning Probe Lithography Fundamentals of Microfabrication and Nanotechnology, Three-Volume Set Solid State Technology Optical Engineering Micro and Nano Fabrication Request for Mask Aligner and Upgrade for a Reactive Ion Etcher Microfabricated Components for an Integrated Microfluidic Electroanalysis System Compound Semiconductors 1998 Annual Report to the President Electrothermally Actuated Polymer Microvalves Electrical and Optical Polymer Systems Silicon Carbide MEMS Devices for Harsh Environments A Spectrometric Study of High Energy Electrons Using Planar Doped Barrier Launchers Fabrication and Characterization of the Planar Doped Barrier Spectrometer High-performance Integrated DNA Analysis Microsystems Liquid Gallium Contact RF MEMS Switch and VLSI MEMS Switch

The development of micro- and nano-mechanical systems (MEMS and NEMS) foreshadows momentous changes not only in the technological world, but in virtually every aspect of human life. The future of the field is bright with opportunities, but also riddled with challenges, ranging from further theoretical development through advances in fabrication technologies, to developing high-performance nano- and microscale systems, devices, and structures, including transducers, switches, logic gates, actuators and sensors. MEMS and NEMS: Systems, Devices, and Structures is designed to help you meet those challenges and solve fundamental, experimental, and applied problems. Written from a multi-disciplinary perspective, this book forms the basis for the synthesis, modeling, analysis, simulation, control, prototyping, and fabrication of MEMS and NEMS. The author brings together the various paradigms, methods, and technologies associated with MEMS and NEMS to show how to synthesize, analyze, design, and fabricate them. Focusing on the basics, he illustrates the development of NEMS and MEMS architectures, physical representations, structural synthesis, and optimization. The

applications of MEMS and NEMS in areas such as biotechnology, medicine, avionics, transportation, and defense are virtually limitless. This book helps prepare you to take advantage of their inherent opportunities and effectively solve problems related to their configurations, systems integration, and control. Advanced Packaging serves the semiconductor packaging, assembly and test industry. Strategically focused on emerging and leading-edge methods for manufacturing and use of advanced packages. Publishes papers reporting on research and development in optical science and engineering and the practical applications of known optical science, engineering, and technology. Now in its third edition, Fundamentals of Microfabrication and Nanotechnology continues to provide the most complete MEMS coverage available. Thoroughly revised and updated the new edition of this perennial bestseller has been expanded to three volumes, reflecting the substantial growth of this field. It includes a wealth of theoretical and practical information on nanotechnology and NEMS and offers background and comprehensive information on materials, processes, and manufacturing options. The first volume offers a rigorous

theoretical treatment of micro- and nanosciences, and includes sections on solid-state physics, quantum mechanics, crystallography, and fluidics. The second volume presents a very large set of manufacturing techniques for micro- and nanofabrication and covers different forms of lithography, material removal processes, and additive technologies. The third volume focuses on manufacturing techniques and applications of Bio-MEMS and Bio-NEMS. Illustrated in color throughout, this seminal work is a cogent instructional text, providing classroom and self-learners with worked-out examples and end-of-chapter problems. The author characterizes and defines major research areas and illustrates them with examples pulled from the most recent literature and from his own work. Bridging the gap between research and clinical application, Biosensors and Molecular Technologies for Cancer Diagnostics explores the use of biosensors as effective alternatives to the current standard methods in cancer diagnosis and detection. It describes the major aspects involved in detecting and diagnosing cancer as well as the basic elements of biosensors and their applications in detection and

diagnostics. The book addresses cancer molecular diagnostics, including genomic and proteomic approaches, from the perspective of biosensors and biodetection. It explains how to measure and understand molecular markers using biosensors and discusses the medical advantages of rapid and accurate cancer diagnostics. It also describes optical, electrochemical, and optomechanical biosensor technologies, with a focus on cancer analysis and the clinical utility of these technologies for cancer detection, diagnostics, prognostics, and treatment. Making biosensor technology more accessible to molecular biologists, oncologists, pathologists, and engineers, this volume advances the integration of this technology into mainstream clinical practice. Through its in-depth coverage of a range of biosensors, the book shows how they can play instrumental roles in the early molecular diagnosis of cancer. MEMS technology and applications have grown at a tremendous pace, while structural dimensions have grown smaller and smaller, reaching down even to the molecular level. With this movement have come new types of applications and rapid advances in the technologies and techniques needed to fabricate the increasingly

miniature devices that are literally changing our world. A bestseller in its first edition, Fundamentals of Microfabrication, Second Edition reflects the many developments in methods, materials, and applications that have emerged recently. Renowned author Marc Madou has added exercise sets to each chapter, thus answering the need for a textbook in this field. Fundamentals of Microfabrication, Second Edition offers unique, in-depth coverage of the science of miniaturization, its methods, and materials. From the fundamentals of lithography through bonding and packaging to quantum structures and molecular engineering, it provides the background, tools, and directions you need to confidently choose fabrication methods and materials for a particular miniaturization problem. New in the Second Edition Revised chapters that reflect the many recent advances in the field Updated and enhanced discussions of topics including DNA arrays, microfluidics, micromolding techniques, and nanotechnology In-depth coverage of bio-MEMs, RF-MEMs, high-temperature, and optical MEMs. Many more links to the Web Problem sets in each chapter For Microelectromechanical Systems

(MEMS) and Nanoelectromechanical Systems (NEMS) production, each product requires a unique process technology. This book provides a comprehensive insight into the tools necessary for fabricating MEMS/NEMS and the process technologies applied. Besides, it describes enabling technologies which are necessary for a successful production, i.e., wafer planarization and bonding, as well as contamination control. From MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications details manufacturing techniques applicable to bionanotechnology. After reviewing MEMS techniques, materials, and modeling, the author covers nanofabrication, genetically engineered proteins, artificial cells, nanochemistry, and self-assembly. He also discusses scaling la Scanning probe techniques provide a wealth of information about the nanoscale properties of materials and devices. In scanning gate microscopy (SGM), the current through a sample is recorded as a sharp, conductive tip that modifies the local electrostatic potential is scanned above the surface. SGM has been used to map current flow, carrier density and potential barriers. Existing, unshielded SGM probes have significant stray

capacitance, resulting in poor lateral resolution when they are used to image nanostructures. Thus, there is a need for a probe that minimizes stray capacitance to produce highly-localized electric fields. This probe must also self-sense topography for tip-sample alignment, as the conventional laser-based detection methods can disturb photosensitive samples. In this thesis, we present a new scanning probe that integrates a coaxial tip on a piezoresistive cantilever. The coaxial tip is comprised of a heavily-doped silicon inner conductor and an aluminum outer shield, separated by a silicon dioxide insulator. By shielding the inner conductor up to the tip apex, this tip configuration minimizes stray capacitance to produce narrow electrostatic potential profiles. A piezoresistor is embedded at the root of the cantilever and enables electrical measurement of deflection at the free end. Scanning gate microscopy is commonly performed at room temperature (room-T) and low temperature (low-T). We discuss the design of piezoresistive cantilevers for atomic force microscopy (AFM) under both temperature regimes. We introduce a numerical optimizer that we used to identify 12 cantilever designs for use at room-T and

low-T for hard, semiconductor samples and soft, biological samples. We show the results of finite-element analysis used to predict the electrostatic potential profiles produced by unshielded and coaxial tips. We investigate how the full-width at half-maximum (FWHM) of the coaxial tip perturbation varies with lift height and tip geometry. We discuss the development of a 7-mask process to fabricate scanning probes with both a coaxial tip and a piezoresistor. We compare two methods to create sub-micron tip apertures with focused ion beam milling, and provide a recipe that can repeatably produce openings with a radius of 30 nm. We describe the characterization of the piezoresistive cantilevers at room-T on a commercial AFM and at low-T on a home-built cryogenic scanning system. Finally, we provide images of the potential profile from the coaxial tip, obtained using a quantum point contact at low-T. In a measurement bandwidth from 1 Hz to 10 kHz, our scanning probes achieve a vertical displacement resolution of 2.8 A at 293 K and 82 A at 2 K, where the low temperature performance is limited by amplifier noise. When the coaxial tip is 100 nm above a sample, the FWHM of the electrostatic potential profile it

produces at the surface is less than 240 nm, representing a 2.3x improvement in the lateral resolution of SGM over unshielded tips. Antennas are used across a wide range of frequencies in the electromagnetic spectrum to concentrate wave energy into electronic circuits. The principles that govern the operation of conventional radio-frequency antennas can be extended to much higher frequencies and be applied to produce nano-metallic (i.e. plasmonic) antennas that act as "receivers" and "transmitters" for visible light. These traits make them excellent candidates for light trapping in solar cells, light concentration in sub-wavelength photodetectors, or even localized heating for cancer therapies. The unique optical properties of metals at visible frequencies make it difficult to apply traditional antenna design rules. Using full-field electromagnetic simulations and analytical antenna models, we developed new design rules for producing optical antennas with a desired set of optical properties. We then applied these design rules to create antennas that resonantly enhance absorption on thin silicon detectors as well as enhance emission of cathodoluminescence (CL). Through spatial and spectral mapping of both

photocurrent and CL we clearly show the fundamental and higher-order resonant modes of these antennas. With CL we are also able to map the spatial distribution of these resonant modes with nanometer resolution. In addition to these specific demonstrated applications, the results of this work enable optical engineers to more easily design a myriad of plasmonic devices that employ optical antenna structures, including nanoscale photodetectors, light sources, sensors, and modulators. "Offers background information, methods of characterization, and applications for electrical and optical polymers, including biopolymers, and tutorial sections that explain how to use the techniques." The papers herein were presented at the Conference on Binary Optics held in Huntsville, AL, February 23-25, 1993. The papers were presented according to subject as follows: Modeling and Design, Fabrication, and Applications. Invited papers and tutorial viewgraphs presented on these subjects are included. A mask aligner model Suss MJB3 UV/IR Mask Aligner to support our on going research was proposed for acquisition and the proposal was approved. An upgrade package for an RIB system was also proposed. However, due to

limited funds only the funds for the mask aligner was made available. Consequently, the RIB upgrade portion of the proposed activity was not implemented. The mask aligner got ordered, received, and brought on line in June 2002 rapidly. It has been in use ever since and operating smoothly. The newest addition to the lithography equipment is a Karl Suss MJB3 mask aligner. Some of the features this model garnishes are UV 300 and liv 400 exposure source and front and back side illumination. The aligner is capable of producing about 0.5 j.tm line widths. Available front exposure and viewing, and back viewing allow alignment of the front patterns with respect to those on the back. The unit is either used by or support of research of some 25 researchers at VCU microelectronics center. A photograph of the exposure system is shown in Fig. 1. Scanning Probe Lithography (SPL) describes recent advances in the field of scanning probe lithography, a high resolution patterning technique that uses a sharp tip in close proximity to a sample to pattern nanometer-scale features on the sample. SPL is capable of patterning sub-30nm features with nanometer-scale alignment registration. It is a relatively simple, inexpensive,

reliable method for patterning nanometer-scale features on various substrates. It has potential applications for nanometer-scale research, for maskless semiconductor lithography, and for photomask patterning. The authors of this book have been key players in this exciting new field. Calvin Quate has been involved since the beginning in the early 1980s and leads the research time that is regarded as the foremost group in this field. Hyongsok Tom Soh and Kathryn Wilder Guarini have been the members of this group who, in the last few years, have brought about remarkable series of advances in SPM lithography. Some of these advances have been in the control of the tip which has allowed the scanning speed to be increased from mum/second to mm/second. Both non-contact and in-contact writing have been demonstrated as has controlled writing of sub-100 nm lines over large steps on the substrate surface. The engineering of a custom-designed MOSFET built into each microcantilever for individual current control is another notable achievement. Micromachined arrays of probes each with individual control have been demonstrated. One of the most intriguing new aspects is the use of directly-grown carbon nanotubes

as robust, high-resolution emitters. In this book the authors concisely and authoritatively describe the historical context, the relevant inventions, and the prospects for eventual manufacturing use of this exciting new technology. Advanced Packaging serves the semiconductor packaging, assembly and test industry. Strategically focused on emerging and leading-edge methods for manufacturing and use of advanced packages. The theory, design methodology, simulation technique, fabrication technique and evaluation results are presented for a first-generation, single crystal 6H-silicon carbide piezoresistive MEMS pressure sensor and accelerometer designed for extreme shock and vibration, high pressure and high temperature environments. The design methodology took into account the safe operating stress, high stiffness and high natural frequency of silicon carbide diaphragms to develop the sensor. Finite element analysis was carried out to verify the design principles and to further understand the mechanics of the sensing structures. Fabrication methods were developed to bulk micromachine the sensors from a single crystal silicon carbide substrate using deep reactive ion etching

techniques. After packaging, the sensors were tested in pressure or shock testing modes. For the pressure sensors, a sensitivity of 31 nV/Pa was measured at room temperature. For the inertial sensors, sensitivities between 50 and 343 nV/g were measured for different accelerometer configurations at shock levels up to 42,000 g. However, non-linear behavior was observed over the shock range relative to the commercial benchmark accelerometer. These initial results verify the potential application of silicon carbide sensors in environments that exceed the capability of silicon-based devices and include extreme impact sensing and high-pressure environments where the temperature may reach 600°C and strong electromagnetic fields may exist. The development of solid state gas sensors based on microtransducers and nanostructured sensing materials is the key point in the design of portable measurement systems able to reach sensing and identification performance comparable with analytical ones. In such a context several efforts must be spent of course in the development of the sensing material, but also in the choice of the transducer mechanism and its structure, in the

electrical characterization of the performance and in the design of suitable measurement setups. This call for papers invites researchers worldwide to report about their novel results on the most recent advances and overview in design and measurements for applications in gas sensors, along with their relevant features and technological aspects. Original research papers are welcome (but not limited) on all aspects that focus on the most recent advances in: (i) basic principles and modeling of gas and VOCs sensors; (ii) new gas sensor principles and technologies; (iii) Characterization and measurements methodologies; (iv) transduction and sampling systems; (vi) package optimization; (vi) gas sensor based systems and applications. Compound Semiconductors 1998 explores research and development in key semiconductor materials and III-V compounds such as gallium arsenide, indium phosphide, gallium nitride, silicon germanium, and silicon carbide. It critically assesses progress in key technologies such as reliability assessment and reports on advances in the use of semiconductors in modern electronic and optoelectronic devices. Coverage in this volume reflects

the increased interest and research funding in nitride-based materials; wide band-gap devices; mobile communications, including III-V-based transistors and photonic devices; crystal growth and characterization; and nanoscale phenomena, such as quantum wires, dots, and other low dimensional structures. Synthesis, Modelling and Characterization of 2D Materials and Their Heterostructures provides a detailed discussion on the multiscale computational approach surrounding atomic, molecular and atomic-informed continuum models. In addition to a detailed theoretical description, this book provides example problems, sample code/script, and a discussion on how theoretical analysis provides insight into optimal experimental design. Furthermore, the book addresses the growth mechanism of these 2D materials, the formation of defects, and different lattice mismatch and interlayer interactions. Sections cover direct band gap, Raman scattering, extraordinary strong light matter interaction, layer dependent photoluminescence, and other physical properties. Explains multiscale computational techniques, from atomic to continuum scale, covering different time and

length scales Provides fundamental theoretical insights, example problems, sample code and exercise problems Outlines major characterization and synthesis methods for different types of 2D materials This book provides an overview of recent developments in experiments probing the fractional quantum Hall (FQH) states of the second Landau level, especially the \nu=5/2 state. It summarizes the state-of-the-art understanding of these FQH states. It furthermore describes how the properties of the FQH states can be probed experimentally, by investigating tunneling and confinement properties. The progress towards the realization of an experiment, allowing to probe the potentially non-Abelian statistics of the quasiparticle excitations at \nu=5/2 is discussed. The book is intended as a reference for graduate students, PostDocs and researchers starting in the field. The experimental part of this book gives practical advice for solving the experimental challenges which researchers studying highly fragile FQH states are faced with. Advanced Packaging serves the semiconductor packaging, assembly and test industry. Strategically focused on emerging and leading-edge methods for manufacturing

and use of advanced packages. This book is designed to introduce typical cleanroom processes, techniques, and their fundamental principles. It is written for the practicing scientist or engineer, with a focus on being able to transition the information from the book to the laboratory. Basic theory such as electromagnetics and electrochemistry is described in as much depth as necessary to understand and explain the current practice and their limitations. Examples from various areas of interest will be covered, such as the fabrication of photonic devices including photo detectors, waveguides, and optical coatings, which are not commonly found in other fabrication texts. Designed for science and engineering students, this text focuses on emerging trends in processes for fabricating MEMS and NEMS devices. The book reviews different forms of lithography, subtractive material removal processes, and additive technologies. Both top-down and bottom-up fabrication processes are exhaustively covered and the merits of the different approaches are compared. Students can use this color volume as a guide to help establish the appropriate fabrication technique for any type of micro- or nano-machine.

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