Final Program

Workshop on Frontiers in Nanophotonics
納米光子學前沿研討會

Saturday 29th October 2005

T.Y.Wong Lecture Theatre,
Ho Sin Hang Engineering Building,
The Chinese University of Hong Kong

Sponsored by:

Center of Advanced Research in Photonics, The Chinese University of Hong Kong

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IEEE Electron Device Society (Hong Kong Chapter)

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Organizing Committee:
Professor H.K.Tsang, The Chinese University of Hong Kong
Professor J.B.Xu, The Chinese University of Hong Kong
Professor Chinlon Lin, The Chinese University of Hong Kong
Ms Emily Chan, The Chinese University of Hong Kong

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Workshop on Frontiers in Nanophotonics
納米光子學前沿研討會

Introduction

The one day workshop will provide postgraduate students and researchers in Hong Kong an opportunity to explore topical issues in nanophotonics. Invited speakers will present their research in silicon-based photonics, passive and active optical devices with nanometer dimensions, nonlinear optical phenomena and applications in nanometer dimension, nanophotonic imaging, nanoplasmonics, optical spectroscopy of nanostructures or nanophotonics for biomedical applications. Keynote talks by Professor Graham Reed (University of Surrey) and Prof El-Hang Lee (Inha University) will be followed by a number of shorter talks by prominent researchers from mainland China, Taiwan, and Hong Kong. A poster session is planned to allow local postgraduate students ample opportunity to interact directly with the invited speakers..

The workshop objectives include:

1. Exchange of information on the latest developments in nanophotonics
2. Fostering of research collaborations
3. Stimulating research activities of postgraduate students and expose them to latest ideas in nanophotonics.

Program Schedule

Speaker (and title of talk where available)	Time
Opening Remarks and Welcome by Professor Chinlon Lin	08:55-09:00
Keynote Talk 1: Professor Graham Reed (University of Surrey): **Recent trends in Silicon Photonics**	09:00-10:00
Keynote Talk 2: Professor El-Hang Lee (Inha University): **Micro/Nano-Scale Optical Printed Circuit Board and VLSI Photonic Integrated Circuits**	10:00-11:00
Tea-break	11:00-11:15
Prof. H.K.Tsang (Chinese University of Hong Kong) : **Nonlinearities in silicon wire waveguides**	11:15-11:45
Prof. Yu Jin Zhong (Institute of Semiconductors Beijing) : **SOI-based Optical Waveguide and Integrated Optical Switch Matrix**	11:45-12:15
Prof. Sailing He, (Zhejiang University) **Some Recent Studies of nanostructured photonic materials, waveguides and devices**	12:15-12:45
Lunch	12:45-14:15
Prof. R. Zhang (Nanjing University) **Substrate issues of nitride LEDs**	14:15-14:45
Prof. J.Y.Chang (National Central Univ Taiwan): **Development of Nano/Micro Optics in National Central University**	14:45-15:15
Posters(by postgraduates students) & Teabreak	15:15-16:00
Prof. Andrew Poon (Hong Kong Univ of Sci & Tech) **Silicon-based polygonal and circular microresonator devices**	16:00-16.30
Prof. D.P.Tsai (National Taiwan University): **Plasmonic Nanophotonics For Ultrahigh Density Nano-Storage**	16.30-17.00

Recent trends in Silicon Photonics

G T Reed, University of Surrey, UK

Silicon Photonics is a research field that is surprisingly mature in some senses, but in other ways, it is in its infancy. The first waveguides were reported in the mid 1980s, in silicon on doped silicon [1,2], silicon on sapphire [3], and Silicon on Insulator (SOI) [4,5]. The silicon on insulator platform, first reported in 1989, has by far become the most popular of the three waveguide systems, and it is this platform that has formed the core of the work carried out by the Silicon Photonics Group at the University of Surrey, which was also established in 1989. The first results from the group were published in early 1991, demonstrating waveguides formed by the SIMOX process [6]. These early waveguides exhibited losses as high as 30dB/cm, but within a year the Group had reported waveguides with a loss of less than 1dB/cm, demonstrating the viability of the technology [7].

The first silicon based optical modulators were proposed in 1986, with modelling suggesting a π-radian phase shift could be achieved in a device less than a 1 mm long. The corresponding loss was less than 1 dB at λ = 1.3 μm for both TE and TM polarisations [8]. However, the electrical power densities required to drive early modulators was very high, and it was not until 1993 that the Surrey group proposed a 3-terminal device that reduced power consumption by an order of magnitude [9, 10]. This device had a bandwidth of up to 20MHz, and was based upon a waveguide with large cross sectional dimensions of the order of 6μm, and a drive current of only 7mA [11].

Interestingly, most work in the early years (~1986 – 1996) was based upon waveguides with large cross sectional dimensions of the order of several micrometres, typically 6 -10μm. This was for ease of coupling to standard telecommunications optical fibres, with core diameters of 9 or 10μm. However, in recent years there has been a trend to dramatically reduce the waveguide dimensions in an attempt to improve the performance of certain devices such as optical modulators, ring resonators or more fundamental devices such as waveguide bends which can be dramatically reduced with waveguide dimensions [12]. There is a natural associated benefit of such miniaturisation which is the reduction in cost of devices with a small area due to the associated increase in packing density. However, with such miniaturisation comes additional difficulty in retaining both single mode behaviour as well as polarisation independence. For very small silicon strip waveguides, the so called silicon wires, polarisation independence is extremely difficult to acheive. Therefore, one of our approaches is to use small rib waveguides in which the rib etch depth offers an additional variable over and above the geometric variations possible in a strip waveguide. We have analysed these waveguides to determine the conditions under which polarisation independence as well as single mode behaviour can be achieved [13]. Figure 1 shows a plot of waveguide width against waveguide etch depth for a rib waveguide with a height of 1.35μm. The TE and TM single mode conditions are different for this waveguide device as boundary conditions start to dominate the modal solution, hence the effective single mode boundary is the lower of the 2 curves, the TM condition. The blue curve is the locus of polarisation independence, where the effective indices of the TE and TM modes are equal. Hence polarisation independence and single mode behaviour can be achieved for waveguides with geometries that lie on the blue curve <u>and</u> are below the red curve. The single mode condition for small rib waveguides with waveguide heights between 1.0μm and 1.5μm can be approximated by the following equation [14]:

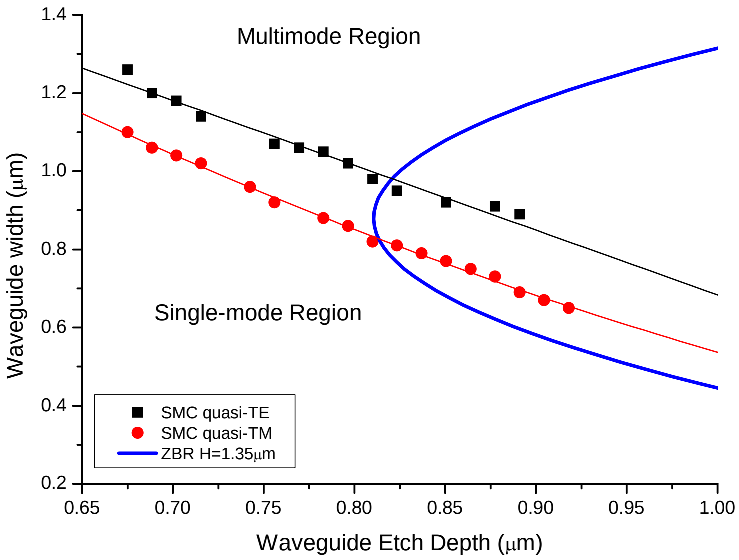

Figure 1. Achieving polarisation independence and single mode propagation simultaneously

$$\frac{W}{H} \leq 0.05 + \frac{(0.94 + 0.25H)r}{\sqrt{1 - r^2}} \quad for\ r \leq 0.5\ and\ 1.0 \leq H \leq 1.5$$

We have applied the principle of polarisation independent single mode waveguides to a series of ring resonator devices. Firstly we have aimed to demonstrate polarisation independence in such a device. A resultant experimentally measured device characteristic is shown in Figure 2 [15]. Whilst polarisation independence has been achieved to within 1pm in this device, the Free Spectral Range (FSR) is very small, due to the large circumference of the ring resonator. Hence we have also looked at increasing the FSR by via smaller bend radii, and by the use of multiple rings. The results will shortly be published elsewhere.

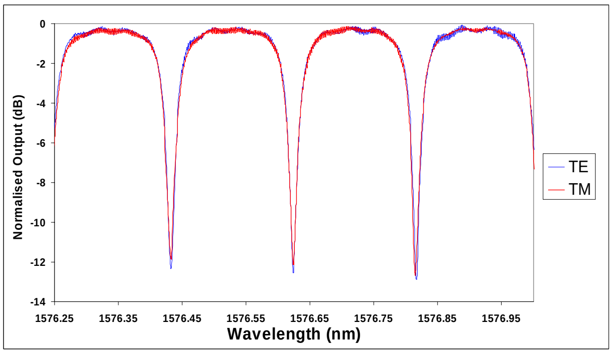

Figure 3. Measured characteristic of a polarisation independent ring -resonator

We have also produced modulators based upon these ring resonator devices. Modulation was via the thermo-optic effect, and resulted in a 3dB bandwidth of 70kHz [16]. Furthermore we have modelled fast p-i-n modulators in rib waveguides. Following our work in the 1990s, these devices were 3-terminal devices, as depicted in figure 4. We considered 3 doping profiles for the n^+ contact doping regions, a Gaussian profile, a constant profile, and an optimised profile. The simulated rise times of all 3 devices are shown in figure 5. Clearly the optimised profile is the fastest, resulting in a bandwidth of approximately 1GHz [17, 18].

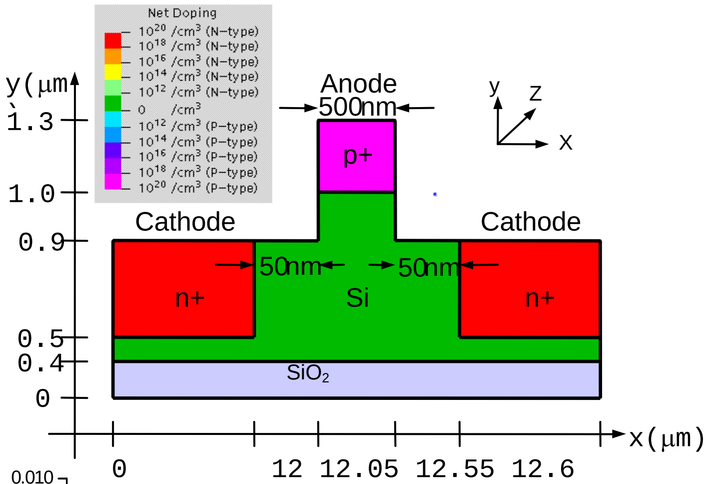

Figure 4 Geometry of the *p-i-n* phase modulator

The move to smaller devices also results in greater difficulty in coupling to small waveguides. Whilst a number of approaches have been adopted we have developed a novel grating based coupler called a Dual Grating-Assisted Directional Coupler (DGADC). Thus far we have achieved a coupling efficiency of 55% as compared to a theoretical efficiency of ~60% [19], whereas the maximum theoretical efficiency can reach more than 90% when coupling from an optical fibre into a 0.25µm waveguide [20]. A schematic of the DGADC is shown in Figure 6. This device shows significant promise for very high efficiency coupling into small waveguides with cross sectional dimensions of the order of 250nm.

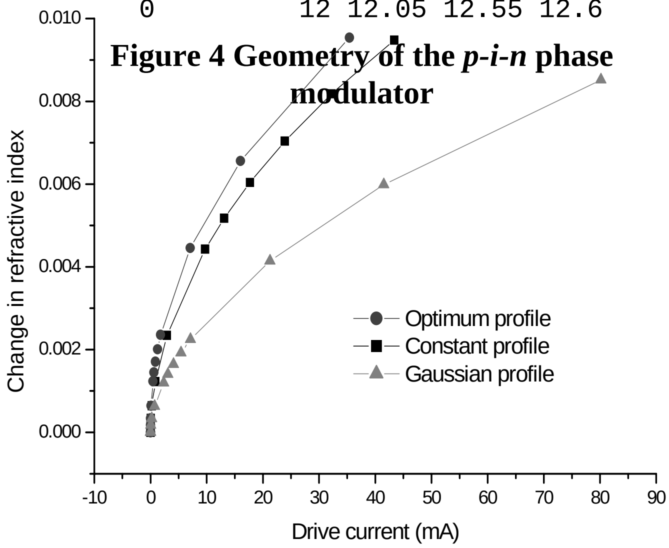

Figure 5 Response of three phase modulators with different n^+ doping profiles

In this paper the trend to smaller waveguide dimensions has been discussed, together with the advantages and disadvantages of such a trend. We have shown that the rib waveguide, whilst not as compact as the strip waveguide offers more control over the modal and polarisation properties of resultant devices, and in particular we have demonstrated the viability of polarisation independent devices

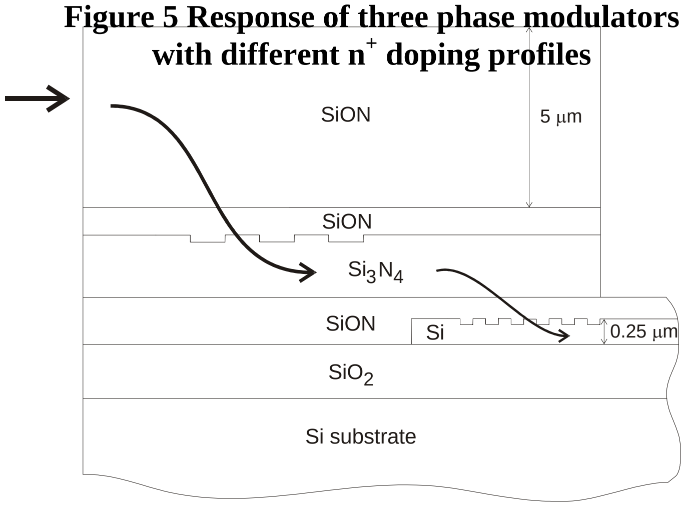

Figure 6 DGADC in cross section

such as ring resonators. Furthermore, fast optical modulators can be fabricated in waveguides of these dimensions. We have also considered the issue of coupling into small waveguides, and have demonstrated a grating based device, the Dual Grating Assisted Directional Coupler (DGADC), that has already been demonstrated with 55% coupling efficiency, and has the potential to reach 90% coupling efficiency.

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Brief Biography: Graham T Reed BSc (Hons), PhD, FIEE, CEng

Graham Reed is Professor of Optoelectronics at the University of Surrey in the UK. He graduated in 1983 with a First Class Honours degree in Electronic and Electrical Engineering. Subsequently he obtained a PhD in Integrated Optics in 1987. After a brief period as leader of the Electro-Optics Systems Group at ERA Technology Ltd, he joined the University of Surrey in 1989, where he established the Silicon Photonics Group. As such this was one of the pioneering groups in silicon photonics, and has made a significant impact on the state of the art. The group is currently the leading group in the UK in this field, and Professor Reed is acknowledged as the individual who initiated research on silicon photonic circuits and devices in the UK. The aim of the silicon work has been to develop a technology that would have a variety of applications. The work has been carried out with collaborators from all around the world, both from academic and industrial institutions. Professor Reed has published extensively in the international scientific literature, has contributed presentations to numerous international conferences both as a submitting and an invited speaker, and has served on a variety of international committees. Recently he has co-authored the first textbook on silicon photonics, entitled Silicon Photonics: An Introduction.

Micro/Nano-Scale Optical Printed Circuit Board and VLSI Photonic Integrated Circuits

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Abstract: We present an overview of our R&D activities and results on the design, fabrication, and integration of micro/nano-scale optical wires and photonic devices for applications in a newly-conceived optical micro-system that we call "optical printed circuit board" (O-PCBs) and "VLSI photonic integrated circuits" (VLSI-PIC). The objective of this study is to realize generic and application-specific O-PCBs and VLSI photonic circuits (ASPIC) that are compact, high-speed, intelligent, light-weight, low-energy and environmentally friendly for low-cost and high-volume universal applications. The O-PCBs consist of 2-dimensional planar arrays of optical wires, circuits and devices of micro/nano-scale sizes to perform the functions of sensing, storing, transporting, processing, switching, routing and distributing optical signals on flat modular boards or substrates. The integrated optical devices include micro/nano-size waveguides, lasers, detectors, switches, sensors, directional couplers, multi-mode interference devices, AWGs, ring-resonators, photonic crystal devices, plasmonic devices, and quantum devices. Materials include polymers and semiconductors. For VLSI nano-scale photonic integration and applications, we designed and fabricated power beam splitters, wavelength splitters and filters using photonic crystals and plasmonic structures. We discuss scientific issues, technological issues, design approaches and fabrication and packaging issues concerning the miniaturization, interconnection and integration of micro/nano-scale photonic devices and circuits leading to ultrasmall dimensions and very large and ultra large scale integration and discuss potential uses of O-PCBs and VLSI micro/nano-photonic integrated circuits for on-board, inter-chip, and intra-chip applications in computer systems, telecommunication systems, transportation systems, space/avionic systems, and bio/sensor-systems. Micro/nano-scale characterization by NSOM, low-coherence, AFM, and femto-second short light pulse methods will be described. Scaling rules for miniaturization and integration of O-PCB and VLSI micro/nano-photonics will also be presented in comparison with those of electrical PCB (E-PCB) and VLSI micro/nano-electronics.

Brief Biography: Prof. El-Hang Lee

B.S.E.E. (summa cum laude), Seoul National University, Korea, 1970, and M.S. and Ph.D., Applied Physics, Yale University, 1973 and 1977, under the guidance of Prof. Richard. K. Chang (Henry Ford II Professor, former student of N. Bloembergen, Nobel Laureate, Physics, 1981) and Prof. John. B. Fenn (Yale, Nobel Laureate, Chemistry, 2002). Conducted teaching, research and management at Yale, Princeton, MEMC, AT&T Bell Labs., ETRI, KAIST and recently at INHA University. Founding Dean, School of Information Science; Founding Director, OPERA and m-PARC. Vice President, OSK; Founding President, IEEE-LEOS Korea; Founding Director, SPIE-Korea. Over 230 international refereed archival journal papers; 640 international presentations; 80 plenary, keynote, and invited talks in international conferences and institutions; and 120 international patents; on semiconductors, optoelectronics, photonics and optical communication. Served more than 50 times as the conference and session chair, committee member, and international advisor. Fellow of the IEE (UK), IEEE (USA), OSA (USA), SPIE (USA), KPS (Korea), IEEK (Korea), KAST (Korean Academy of Science and Technology) and recipient of more than 15 national and international awards.

Nonlinearities in silicon wire waveguides

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Abstract: We shall introduce some of the nonlinear optical properties of silicon, and consider the latest measurements and applications of such nonlinearities. We shall review the measurements of two photon absorption, nonlinear refraction and stimulated Raman scattering in silicon. We will also discuss some of the potential applications in silicon wire waveguides, which allow very high optical intensities to be attained at power levels that could be found in telecommunications networks.

Brief Biography: Hon Tsang received the B.A. (Hons) degree in 1987 in Engineering, and a Ph.D. on 'Optical Nonlinearities in Quantum Well Waveguides" in 1991, both from the Cambridge University. He worked on III-V modulators as a visitor at Bellcore in 1990. Between 1991-93, he was a SERC Postdoctoral Fellow at the University of Bath where he studied two photon absorption in III-V semiconductor waveguides. He joined the Chinese University of Hong Kong in 1993 as a lecturer in the Department of Electronic Engineering. In 2001 he joined Bookham Technology plc as a director of the silicon photonics (ASOC™) technology. He rejoined the Chinese University of Hong Kong in 2003. Hon Tsang has published over 150 papers. His current research interests include nonlinearities in optical waveguides, transient suppression in optical amplifiers and photonic devices for optical label and packet switching. He is currently the Chair of the Hong Kong chapter of the IEEE Lasers and Electro-optics society (LEOS) and an Associate Editor of the IEEE LEOS Newsletter.

SOI-based Optical Waveguide and Integrated Optical Switch Matrix

Jinzhong Yu*, Shaowu Chen, Yuanyuan Chen, Fei Sun,
Jinsong Xia, Jingwei Liu, Yanping Li and Di Yang
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Abstract: Having the potential of OEIC monolithic integration, SOI (Silicon-on-insulator)-based optoelectronic devices have shown many good performances and attracted more and more attention recently. Fabrication processes for SOI-based optoelectronic devices are compatible with conventional IC processes. In this paper, the recent progresses of SOI waveguide devices in our research group are presented. By highly effective numerical simulation, the single mode conditions for SOI rib waveguides with rectangle and trapezium cross section were accurately investigated. Using both chemical anisotropic wet etching and plasma dry etching techniques, SOI single mode rib waveguide, MMI coupler, VOA (variable optical attenuator), 2×2 thermal-optical switch were successfully designed and fabricated. Based on these, 4×4, 8×8 and 16×16 SOI optical waveguide integrated switch matrix are demonstrated for the first time. The insertion loss (IL) and the polarization dependent loss (PDL) at 1.55μm increase with longer device length and more bend and intersecting waveguides. The rise and fall times of the devices are about 4.6 and 1.9μs, respectively.
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Jinzhong YU graduated from Department of Physics of University of Science and Technology of China in 1965, finished his master courses in Institute of Semiconductors, Chinese Academy of Sciences in 1967, and received his doctoral degree in engineering from Osaka University, Japan in 1991. Since he joined Institute of Semiconductors in 1965 he had engaged in design and fabrication of AlGaAs and InGaAsP lasers, growth of AlGaAs/GaAs, InGaAsP/InP and SiGe/Si heterostructures by LPE, MOCVD and UHV/CVD systems, micro-fabrication, including lower energy ion beam etching and etc. He is a research professor in Institute of Semiconductors, Chinese Academy of Sciences since 1994 and a professor in Graduate School of Chinese Academy of Sciences since 1997. His current interests include Si-based photonics, SiGe/Si quantum structures grown by UHV/CVD system, SiGe optoelectronic devices, SOI waveguide devices (modulator, switches, and coupler). He had published a book and more than 150 papers in English and Chinese.

Some recent studies of nano-structured photonic materials, waveguides and devices

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Nano-structured artificial materials (metamaterials) with negative refraction index can give unprecedented physical properties and functionality unattainable with naturally-existing materials. For example, metamaterial-based super lenses, which can give subwavelength focusing and beat the diffraction limit, could lead to some breakthroughs in optical storage applications and lithography techniques for VLSI. Some of our recent results on nano-structured materials of negative refraction index and their applications will be presented.

Electronics circuits keep shrinking in dimensions, according to famed Moore's law, with FET gate lengths in the laboratory being in the tens of nm range. In contrast, photonic circuit elements and waveguides have lateral dimensions on the order of the wavelength, and the circuit elements normally are tens to thousands of wavelengths in length. In terms of integration density and maturity, photonics is several decades behind electronics. A key to make photonics have an electronics-like development is a drastic reduction of size. One way to reduce the size is to use high-index materials, e.g. Si (refractive index is around 3.5 at the wavelength of 1.55um), instead of popular SiO2 (low index material). The wavelength in such materials is scaled down by their high refractive indices. Therefore, the size of photonic devices could also be scaled down accordingly. We will present our recent results on ultra-compact AWG demultiplexers based on Si nano-waveguides. High index materials could help to reduce the size of photonic devices. However, the lateral dimension of those devices is still determined by the diffraction limit, i.e. in the order of the wavelength inside such materials. Surface plasmon (SP) waveguides, which utilize the fact that light can be confined in a single interface between a metal and dielectric, can offer a tight confinement for the light field. The cross-sectional size of a SP waveguide could be pushed down to tens of nanometers, i.e. beyond the diffraction limit. Our recent results on such a novel SP waveguide for high integration will be presented.

Brief Biography: Sailing He received the Licentiate of Technology and Ph.D. degree from the Royal Institute of Technology, Stockholm, Sweden, in 1991 and 1992, respectively. After obtaining his PhD degree, he has worked at the Royal Institute of Technology as an assistant professor, an associate professor and a full professor. He has also been with Zhejiang University (China) since 1999 as a "Chang-jiang project" professor appointed by the Ministry of Education of China. Prof. Sailing He has first-authored one monograph (Oxford University Press) and authored/co-authored over 200 papers in refereed international journals. Prof. He's current research interests are in the area of photonic integration technologies (including planar light wave circuits and nano-photonics), meta-materials and photonic crystals, electromagnetic theory and computational electromagnetics, bio-photonics, and fiber optical communication technologies (including amplifiers, fiber gratings, and networking).

Substrate issues of nitride LEDs

R. Zhang*, X.Q. Xiu, Z.L. Xie, P. Han, S.L. Gu, R.L. Jiang, Y. Shi and Y.D. Zheng
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Nitride LEDs are promising for developing next-generation light source, solid state lighting devices. The core structure of this kind of device is InGaN/GaN quantum wells with nano-scale well width. The crystal quality of the InGaN/GaN quantum wells is crucial to the luminescence efficiency and lifetime of the nitride LEDs. The mismatch of lattice and thermal expansion coefficient between epilayer and substrate is the most important factor to influence the quality of the InGaN/GaN quantum wells in this case. In this talk we will discuss the influence of substrate issues on the properties of the InGaN/GaN quantum wells and the features of GaN-based LEDs, and the trend of substrate techniques for nitride photonic devices.

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Development of Nano/Micro Optics in National Central University

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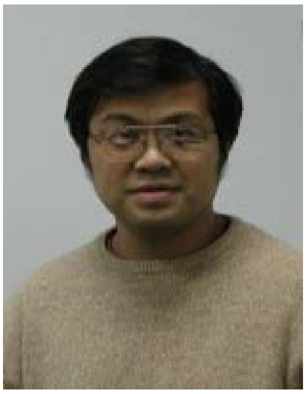
With the matured fabrication technologies, it opens a new era for the developments of conventional optical elements. One can construct miniaturized nano/micro optical elements for versatile applications with these technologies. In National Central University, a modern laboratory for Si-based and III-V semiconductor processing has been established. The research groups in NCU possess advanced technologies for fabrication ability in micro and nano photonic devices.

In the filed of micro optics, we developed the "Si-based Stacked Free Space Optical System" which includes design, fabrication, packaging and measurement. Several microoptical elements such as micromirror, microlens, and etc, were fabricated with Si-based technologies. This Si-based microptical technology can also be used in other applications.

From micro to nano optics, we developed the subwavelength structure to extend the functionality of Si-based optical elements which can be integrated with other Si-based modules and used for optical filtering and sensing. The developing device operates on guided-mode resonance (GMR) effect and possesses flexible spectral response from narrow to broadband. It will be a potential candidate for application to optical communication for its simpler structure compared with the common thin-film filter which suffers from complex structure. Besides, the GMR device can be applied to bio-sensor for detecting the hybridization process of bio reaction for its high sensitivity.

For the research of photonic crystal devices, we have exploited several photonic crystal devices for bi-directional quantum communications, including: InAs quantum dot single photon light sources with novel high-Q photonic crystal cavity, photonic crystal beam splitters, semiconductor hollow waveguides, photonic crystal directional couplers and the loss reduction of photonic crystal waveguides by microspheres.



Jenq-Yang Chang(張正陽) received the B.S degree in chemical engineering and M. S. degree in materials sciences and engineering from National Taiwan University at Taiwan (R.O.C.) in 1980 and 1985, respectively. He received the Ph.D. degree of materials sciences and engineering from Massachusetts Institute of Technology at Cambridge, MA, U.S.A in 1992. He is currently a Professor at Institutes of Optical Sciences, National Central University and is also the Director of the Institute.

His research fields of specialty include nano optics and its fabrication, micro-optical elements and system, crystal growth and characterization of nonlinear photorefractive materials. He co-constructed the MOE lab. in National Central University that supports many academic projects in Taiwan. His professional activities include Program Committee Member in SPIE, Local Committee Chair in IEDMS, and Program Committee Chair in OPT.

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Silicon-based polygonal and circular microresonator devices

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Abstract: We will review our recent works on silicon-based polygonal and circular microresonator devices. We will illustrate key merits and subtleties of waveguide lateral coupling to polygonal microresonators that have flat sidewalls. We will also discuss our experimental results on electro-optical modulators, using circular microdisk resonators with integrated p-i-n structures. Lastly, we will present our preliminary results on a novel near-field scanning optical microscope as applied to image our silicon devices.

Brief Biography: Professor Poon received his BA degree from the University of Chicago, Illinois, in 1995, and his MPhil and PhD degrees from Yale University, Connecticut, in 1998 and 2001, all in Physics. Professor Poon joined HKUST in June 2001. Professor Poon's research focuses on silicon-based micro-sized resonators for optical communication applications.

Plasmonic Nanophotonics For Ultrahigh Density Nano-Storage

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The optical response of the local plasmonic structures of the super-resolution near-field optical structures is the key of the near-field optical recording. The developments of the super-resolution near-field optical structures are closely related to the basic principle of plasmonic nanophotonics, and the connections of the near-field and far-field optical interactions of super-resolution near-field plasmonic structures. We use near-field scanning optical microscopy, Z-scan experiments and optical pump-probe system to explore the optical interactions of various super-resolution near-field plasmonic structures. Many interesting local interactions were found. Measurements of transmission and reflectance indicate complicate transition process of the optical interactions of the super-resolution near-field plasmonic structures. Different local optical responses are observed and analyzed. Possible models of these interactions will be proposed and explained.

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Brief Biography: Din Ping Tsai received his PhD degrees in Physics from University of Cincinnati, USA in 1990. From 1990 to 1991 he was a Member of Research Staff at Micro Lithography Inc., California, USA. He was a Postdoctoral Fellow and Research Associate at Ontario Laser and Lightwave Research Center, Toronto, Canada from 1991 to 1994. From 1994 to 1999 he was an Associate Professor at National Chung Cheng University, Taiwan. In 1999 he joined National Taiwan University as an Associate Professor, and currently he is a Professor for both Center of Nanostorage Research and Department of Physics at National Taiwan University. He is a consultant and invited scientist of Tainan Industrial Park, Taiwan. He is a consultant of Material Research Laboratory, Industrial Technology Research Institute as well. He has supervised 48 graduate students. He is author and coauthor of 62 SCI journal papers, 22 book chapters and conference papers, and 29 technical reports and articles. At least seven of his published journal papers were selected and used in near-field optics related books including milestone series of near-field optics. He had 18 patents in USA, Japan, Germany and Taiwan. Three of his patents have been licensed to the world's largest optical disk manufacture company, Ritek Company in 2004. His current research interests are nano-photonics, near-field optics and plasmonics. His recent nano photonic research has successfully developed a new kind of ultrahigh density near-field optical recording disk. He was invited as an invited speaker for the international conference or symposium more than 36 times in last five years. He has served as chairs and committee members of several international conferences and symposiums as well. He was elected as the chair and vice chair of the International Society for Optical Engineering (SPIE) Taiwan chapter for the 2004 & 2005 and 1996 & 1997, respectively. He is member of the board of Optical Engineering Society and Nano Industry Development Association of Taiwan from 2002 to 2007 and 2004 to 2006, respectively. He is a Fellow of the International Society for Optical Engineering (SPIE), Senior Member of Institute of Electrical and Electronics Engineers (IEEE), and Member of the Optical Society of America (OSA) and American Vacuum Society (AVS).

Poster

Project Title: Photonic Nanojet Scanning Microscope: numerical simulations and preliminary Experiments

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Abstract: We propose and demonstrate a novel optical scanning microscope for sub-micrometer resolution imaging by using a sub-wavelength optical beam known as "photonic nanojet." We obtain the photonic nanojet by side-illuminating an optical glass fiber with a laser beam. Sub-micrometer resolution imaging is obtained by mechanically scanning a sample illuminated by the nanojet. Our microscope has a high resolution potentially exceeding conventional high-power optical microscopes. We use linear-scanning method to capture a two-dimensional millimeter-sized image in duration of few minutes. The technique is non-destructive and relatively low-cost. We believe our photonic nanojet scanning microscope (PNSM) can become a versatile imaging tool in nano-science and technology.