2012

IEEE Topical Symposium on RF Nanotechnology

May 22-24, 2012

Resorts World Sentosa, Singapore

Towards Greener ICT

Final Program

Technical Co-Sponsors

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MESSAGE FROM THE SYMPOSIUM CHAIR

On behalf of the Steering Committee of 2012 IEEE Radio Frequency Nanotechnology Topical Symposium, I am privileged and honored to invite you, your colleagues and families to join us for the event of IEEE RF Nanotechnology on a beautiful Sentosa island from Tuesday, May 22 to Wednesday, May 23 in Singapore, the Lion City.

With the success of the workshops organized by IEEE MTT TC-25, RF Nanotechnology 2010 in Anaheim and 2011 in Baltimore, respectively. A general interest was arosed from MTT TC-25 to hold such a workshop in Asia region to enhance the awareness of RF Nanotechnology and to provide an opportunity for researchers in this domain to share their findings. IEEE RF Nanotechnology Topical Symposium is being organized first time in Asia and technically co-sponsored by MTT TC-25.

The importance of the nanotechnology has been ever increased due to rising interest in device miniaturization and high speed data requirement. These challenges provide us opportunities to develop novel methodologies, devices, and fabrications techniques. This symposium covers different topics in nano-domain from RF to optical frequancies, including the emerging areas such as graphene, plasmonics etc.

The venue of the symposium will be Resorts World Sentosa, Singapore, which boasts not only some of the best convention facilities for our technical sessions, workshops and special events, but also world-class accommodation, spectacular attractions, entertainment, and fine dining for the entire family. Singapore is a vibrant, innovative, ultra-modern and safe city state that embraces many different cultures. Among its four official languages, English is spoken by virtually all its inhabitants.

So come and join us in Singapore in May of 2012 for an outstanding scientific/technical event and an unforgettable experience for you and your family.

With best wishes
Er-Ping Li, IEEE Fellow
Chair for 2012 IEEE RF Nanotechnology Topical Symposium

SYMPOSIUM STEERING COMMITTEE

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Dr. Er-Ping LI
A*STAR-IHPC, Singapore
Email: eplee@ihpc.a-star.edu.sg

Dr. D. BAILLARGEAT
NTU, Singapore
Email: dbaillargeat@ntu.edu.sg

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GENERAL INFORMATION

Registration

Early registration is strongly recommended, as on-site registration often can be time consuming. There is significant discount for early registration. This page will contain links to the on-line registration site and downloadable registration forms.

Registration Package	On or Before April 16, 2012	After April 16, 2012
Package C: Registration for Topical Symposium on RF NanoTechnology from May 22 to 23, 2012	SGD 450	SGD 550
Student Registration for Topical Symposium on RF NanoTechnology from May 22 to 23, 2012	SGD 250	SGD 300

Registration Enquiry
Symposium Secretariat
Miss Allison LAW
Tel: +65-6336 2328
Fax: +65-6336 2583
Email: emcsingapore@cma.sg

Additional Purchase
Symposium Banquet voucher - SGD 130 per coupon

Conference Venue

Resorts World™ Sentosa

The RF Nanotechnology Symposium will be taking place at the Resorts World™ Sentosa – Asia's ultimate destination – which is Singapore's first integrated resort that promises the richest experiences to last a lifetime.

Taking pride of place at Singapore's resort island of Sentosa and spanning 49 hectares, this mega-resort, costing S$6.59 billion to build, will be home to Southeast Asia's first and only Universal Studios theme park and the world's largest oceanarium, Marine Life Park.

The resort dazzles with 6 world-class themed hotels, Universal Studios Singapore® - a movie-themed park, Voyage de la Vie™ - a theatrical circus spectacular, and a myriad of gourmet fare with more than 60 restaurants featuring dining options by celebrity chefs.

The meeting and incentive event venues in Resorts World Sentosa™ comprises of The Resorts World Convention Centre™ which houses the largest column-free ballroom in the region, 30 function rooms, and also several indoor and outdoor spaces. The first corporate event was hosted in March 2010. They have since welcomed more than 415,000 MICE delegates and guests, with more than 2,300 corporate events in the past year.

Venue - Location map

CONVENTION & EXHIBITION CENTRE

1 Resorts World™ Sentosa

HOTELS
2 Crockfords Tower
3 Hotel Michael
4 Hard Rock Hotel Singapore
5 Festive Hotel
6 Equarius Hotel (Opening Soon)
7 Spa Villas (Opening Soon)

ENTERTAINMENT & SHOPPING
8 Gaming
9 VOYAGE de la VIE
10 St James Power Station
11 VivoCity

ATTRACTIONS
12 Universal Studios Singapore
13 Marine Life Park
14 Maritime Experiential Museum & Aquarium
15 Festive Walk
16 Crane Dance

Resorts World at Sentosa Pte Ltd
8 Sentosa Gateway, Sentosa Island, Singapore 098269
✆ +65 6577 9977 F +65 6577 7770
Website: www.rwsentosa.com

Nearest MRT Station: HabourFront Station in VivoCity Shoppling Mall

How to Get to Resorts World Sentosa

Please visit Resorts World™ Sentosa official website for more information on directions.

Car
If entering via RWS B1 car park (at the casino), only car park charges apply.
If entering via Sentosa gantry, Sentosa Island admission and car park charges apply.

MRT
Take a **North-East** line MRT rail system, alight at HarbourFront Station. From there, you may take any of the following transportation:

- **The Sentosa Express**
- **RWS 8**

The Sentosa Express
Take the Sentosa Express located on Level 3 VivoCity (Lobby L) then alight at Waterfront Station. A flat fee of S$3.00 applies.

RWS 8
Proceed to the bus stop either outside VivoCity or Merrill Lynch HarbourFront. For a flat fee of S$2.00, guests will be taken into the resort.

Boardwalk / Travellator (Walking)
The Sentosa Boardwalk, featuring canopy-covered travellators, F&B and retail will let you take leisurely strolls to Sentosa. S$1 fee applies.

Taxi
Taxi bays are located at various points of the resort to ensure visitors easy access to taxis.
If entering via RWS B1 car park, only prevailing taxi charges apply. If entering via Sentosa gantry, Sentosa island admission and taxi charges apply. All guests departing from RWS will be required to pay S$3.00 surcharge.

Accommodations

Special rates have been negotiated for the Symposium attendees at the hotels listed in the symposium web. For hotel reservation, please refer to the conference website
www.apemc2012.org/travel_hotel.htm

Hard Rock Hotel

Rock and roll attitude meets five-star service at the Hard Rock Hotel Singapore. Breathtaking design, fashionable dining options, and the legendary entertainment experience only Hard Rock can offer make this the obvious choice for those looking for a stay that is beyond the ordinary.

Room rate per night: S$280++

Festive Hotel

Exuberant yet relaxing, Festive Hotel is ideal for vacationers seeking a welcoming and relaxing island stay. Other than the luxurious king-sized bed or twin beds, there's also a bonus sofa bed that folds out to a double bed in all rooms and loft beds to cater to the children in most rooms, so it's the perfect getaway hotel for families travelling with their kids.

Room rate per night: S$280++

Hotel Michael

Art lovers would appreciate this gem of a hotel, a tribute to one of America's greatest contemporary architects, Michael Graves. The designer lends his elegant, distinctive strokes to every aspect of this boutique hotel, from lamps to crockery, to lounge chair and carpet.

Room rate per night: S$280++

Furama City Centre

Furama City Centre is centrally located in vibrant Chinatown and at the fringe of the Central Business District (CBD). This Singapore business hotel is within easy access to Chinatown and Clarke Quay MRT stations, as well as shopping, food and entertainment.

Room rate per night: S$255++

Bay Hotel

Bay Hotel Singapore is a business choice, city getaway and lush escape all in one at the entertainment district and close to VivoCity, just outside of Sentosa.

Room rate per night: S$215++

Hotel registration enquiry and for other lower rate hotels, please contact
Symposium Secretariat
Miss Allison Law
Tel: (65) 6336 2328
Email: emcsingapore@cma.sg

Useful Information and Telephone Numbers

Restaurant and Food

Level 2, 3 & II

HARD ROCK HOTEL SINGAPORE
1. Rang Mahal Pavilion
2. The Rock Bar
3. Starz Restaurant
4. The Rock Bar

FESTIVE HOTEL
5. Boulangerie
6. Festive Pool & Deck (Level 3)
7. Fiesta (Level 3)
8. Festive Lounge

WORLD SQUARE
9. OSIA

HOTEL MICHAEL
10. Chinois
11. Palio
12. Michael's Lounge

Level 1

THE BULL RING
13. Chili's Grill & Bar
14. Noodle8

HOTEL MICHAEL
15. L'Atelier de Joël Robuchon
16. Joël Robuchon Restaurant

THE FORUM
17. The Coffee Bean & Tea Leaf
18. Putien
19. Hard Rock Café
20. Ding Tai Fung @ Baits
21. Big Easy

WATERFRONT
22. Malaysian Food Street
23. Korean Charcoal BBQ Buffet
24. Singapore Seafood Republic
25. Anar

Basement 1

CROCKFORDS TOWER
26. Feng Shui Inn (Level G2)

THE FORUM
27. Imperial Treasure La Mian Xiao Long Bao
28. Bread Talk & Toast Box
29. Livewire – Pick & Bite
30. Only You Desserts
31. Lunar Café
32. Ramen Play
33. Ruyi

Getting Around

MRT

The nearest Mass Rapid Transit (MRT) station to the Symposium venue is Habour Front MRT Station. You may check for the exact fare at an MRT station or call the Transitlink hotline 1-800-225 5663 for assistance. The operating hours for the hotlines, from Mondays to Sundays (excluding Public Holidays), are 8.00 am to 6.00 pm.

Bus

Public bus (air-conditioned) fares are tied to routes. You may check with the bus driver for the exact bus fare of your intended route or call the TransitLink hotline 1-800-225 5663 for assistance.

Cab Calling

Dial-A-Cab	:	(65) 6342 5222
CityCab	:	(65) 6552 1111
SMRT Taxis	:	(65) 6555 8888

Ambulance	:	995
Police	:	999
Fire Brigade	:	995

About Singapore

Tourist Hotline	:	1800 736 2000
Flight Information	:	1800 542 4422
Weather Forecast	:	(+65) 6542 7788

Credit Cards

American Express	:	(+65) 6396 6000
Diners Club	:	(+65) 6416 0800
JCB	:	(+65) 6734 0096
MasterCard	:	1636 722 7111
Visa	:	800 4481 250

Registration Hours

Admission to all sessions and hosted functions requires identification.

Please wear your name badge at all times.

- 22 – 23 May, Tuesday to Wednesday : 07:30am - 6:00pm (outside Level 1 Gemini 2)

Floor Plan – Level 1: Exhibition Hall and Meeting Rooms

Meeting Rooms: Gemini 1 & 2, Leo 4 and Aquarius 3 & 4

Secretariat Room: Scorpio

Exhibition Hall: Leo 1 – 3

Instructions for Presenters

Oral Presentation

Prepare Your Presentation

Each oral presentation is limited to 20 minutes including questions and answers. Length of presentation material should be in accordance to your time allotted. You are requested to load your Power Point presentation materials before the session starts.

Determine Your Audio Visual Needs

All meeting rooms are equipped with the following audio-visual equipment:
1-LCD Projector
1-Windows-based PC
1-Screen
1-Laser Pointer

The computers in the meeting rooms are being provided to Windows-based PC users. The PC will be configured with Microsoft Windows 7 Professional operating system as well as with Microsoft Office 7.

Create a Backup Copy of Your Presentation

We recommend you bring at least 2 copies of your presentation to the meeting in case there is a problem with one of them. Thumb Drive and hard disk are accepted.

Give Your Presentation

- Be considerate of the other speakers and audience by staying within your allocated time. The allocated time for your presentation includes a discussion and changeover to the next speaker. Session Chairs will hold you to the allotted time. This is essential to ensure adequate time for questions and discussion as well as adherence to the schedule.
- Please discuss the same materials as reported in your paper submission. At the end of the meeting, all presentation files will be destroyed.

Technical Sessions

Tuesday Morning, 22 May 2012

Time	Aquarius 3
8:30am – 10:30am	**NANO-1** **Chairs:** Dr. Erping Li, Singapore Dr. Johannes Russer, Germany
8:30am	TU-AM-NANO 1-1 **Radio-Frequency Nanoelectronics – Bridging the Gap between Nanotechnology and R.F. Engineering Applications** (Invited DML talk) Luca Pierantoni Università Politecnica delle Marche, Ancona, Italy
9:10am	TU-AM-NANO 1-2 **Integrated Antennas for RF Sensing, Wireless Communications and Energy Harvesting** (Invited) Peter Russer, Johannes Russer, Giuseppe Scarpa, Paolo Lugli and Wolfgang Porod Technical Universityof Munich, Germany
9:40am	TU-AM-NANO 1-3 **Technical Issues and Recent Progress on Graphene-based RF MOSFET** (Invited) Byung Jin Cho Korea Advanced Institute of Science and Technology (KAIST), Daejeon ,Korea
10:10am	TU-AM-NANO 1-4 **Coupled Maxwell and Schrodinger Approach for Simulation of Nano-devices** Iftikhar Ahmed, Eng Huat Khoo and Er-ping Li Institute of High Performance Computing, A*STAR, Singapore
	10:30 – 10:40 am Tea Break
10:40am – 12:30pm	**Opening Ceremony @ Gemini 1-2** **Plenary Talk 1: ICT (Information Communication Technology) meets Energy** Dr. Ingo Wolff IEEE Life Fellow, President of the Information Technology Society (ITG/VDE), Germany, President/CEO of IMST GmbH, Kamp-Lintfort, Germany **Plenary Talk 2: Through Silicon Via(TSV) Design and Measurement for Terabit Data-Bandwidth of 3D IC** Prof. Joungho Kim Department Chair of Electrical Engineering and Computer Science, Korea Institute of Advanced Science and Technology, Korea

Tuesday Afternoon, 22 May 2012

Time	Aquarius 3
1:30pm – 3:30pm	**NANO-2** **Chairs:** Dr. Seng-Tiong Ho, USA ; Dr. Maki Suemitsu, Japan
1:30pm	TU-PM-NANO 2-1 **Plasmonic Nano-Lasers with Directional Output for Integration in Plasmonic-Photonic Integrated Circuit** (Invited) Seng-Tiong Ho[1], Xi Chen[1], Qian Wang[2], Yingyan Huang[3] [1]Northwestern University, USA; [2]Data Storage Institute, A*STAR, Singapore [3]OptoNet Inc. Evanston, USA
2:00pm	TU-PM-NANO 2-2 **Inkjet-Printed Nanotechnology-enabled RFID, IoT and "Zero-Power" Wireless Sensor Nodes** (Invited) Manos M. Tentzeris , Georgia Institue of Technology, USA
2:30pm	TU-PM-NANO 2-3 **Cu-Based Horizontal Plasmonic Waveguide Components for Silicon Integrated Nanoplasmonics** Shiyang Zhu, G. Q. Lo, and D. L. Kwong Institute of Microelectronics, A*STAR, Singapore
2:50pm	TU-PM-NANO 2-4 **Miniaturized RF Slotted-Slit-Microstrip Antenna on Meta-surface** Kush Agarwal[1], Nasimuddin[2], A. Alphones[1], [1]Nanyang Technological University, Singapore; [2]Institute of Infocomm Research, A*STAR, Singapore
3:10pm	TU-PM-NANO 2-5 **Microwave and THz Detection Device using Bi-Layer Graphene FET** A. M. Mahjoub[1], N. Aoki[1], K. Miyamoto[1], T. Omatsu[1], J. P. Bird[2], D.F. Ferry[3], K. Ishibashi[4], Y. Ochiai[1] [1]Chiba University, Japan ; [2]University at Buffao, The State University of New York, USA; [3]The Arizona State University, Tempe, AZ, USA; [4]Institute of Physical and Chemical Research, Japan
	3:30-3:50pm Tea Break
3:50pm – 5:50pm	**NANO-3** **Chairs:** Dr. Din Ping Tsai, Taiwan; Dr. Ai Qun Liu, Singapore
3:50pm	TU-PM-NANO 3-1 **Blinking of Plasmonic Hotspots on Laser-treated AgOx Thin Film** (Invited) Ming Lun Tseng[1], Pin Chieh Wu[1], Yao-Wei Huang[1], Min-Kai Hsiao[2], Hsin Wei Huang[1], Hao Ming Chen[1], Yu Lim Chen[1] , Cheng Hung Chu[1], Nien-Nan Chu[5], You Je He[1], Chia Min Chang[1], Wei Chih Lin[1], Ding-Wei Huang[1], Hai-Pang Chiang[2], Ru-Shi Liu[1], Greg Sun[4], Din Ping Tsai[1,3,5] [1] National Taiwan University, Taiwan; [2] National Taiwan Ocean University, Taiwan; [3] National Applied Research Laboratories, Taiwan; [4] University of Massachusetts, Boston , USA; [5] Research Center for Applied Sciences, Academia Sinica, Taiwan
4:20pm	TU-PM-NANO 3-2 **A Tunable Nano/Micromachined Metamaterials** (Invited) Ai Qun Liu Nanyang Technological University, Singapore
4:50pm	TU-PM-NANO 3-3 **Silicon Polarization Independent Circuit for Wavelength-Agile Integrated Receiver** Chao Li[1], Huijuan Zhang[1], Shiyi Chen[1], Jing Zhang[1], Ning Duan[2], Mingbin Yu[1], G. Q. Lo[1] [1]Institute of Microelectronics, A*STAR, Singapore ; [2]National Metrology Center,

	Singapore
5.10pm	TU-PM-NANO 3-4 **Well-confined and Low-loss Plasmon Modes Synthesized with Doped Graphene Sheets** Gan Choon How, Chu Hong Son and Erping Li Institute of High Performance Computing, A*STAR, Singapore
5.30pm	TH-AM-NANO 3-5 **Optical Switch through Optical Gradient Force** Hong Cai, L. Ding, J. F. Song, M. B. Yu and G. Q. Lo Institute of Microelectronics, A*STAR, Singapore

Wednesday Morning, 23 May 2012

Time	Aquarius 3
8:40am – 10:20am	**NANO-4** **Chairs:** Dr. Ze Xiang Shen, Singapore; Dr. Dominique Baillargeat, Singapore
8:40 am	WE-AM-NANO 4-1 **RF Nanopackaging based on Carbon-Nanostructures** (Invited) W.L. Chow[1, 2], C.C. Yap[1, 2], D. Tan[1, 2], M. Shakerzadeh[2], M.K. Samani[2], C. Brun[1, 3], E.H.T. Teo[1, 4], D. Baillargeat[1] and B.K. Tay[1, 2] [1] CINTRA CNRS/NTU/THALES, Singapore [2] Nanyang Technological University, Singapore [3] Université de Limoges/CNRS, Singapore [4] Temasek Laboratories, Singapore
9:10am	WE -AM-NANO 4-2 **Graphene: An Ideal Material for Fundamental Research and Applications** (Invited) Ze Xiang Shen, Da Zhan, Jiaxu Yan and Linfei Lai Nanyang Technological University, Singapore
9:40am	WE -AM-NANO 4-3 **Growth Kinetic Studies of Graphene on Cu Foils** Emmanuelle Pichonat, R. Fleurier, D. Vignaud, H. Happy IEMN CNRS UMR, France
10:00am	WE -AM-NANO 4-4 **Computational Quantum Electrodynamics: Simulation of Electromagnetic Fields and Nanostructures interaction** Xue-Cang Zhang[1], Erping Li[1,2] [1]Zhejiang University, Hangzhou China [2]Institute of High Performance Computing, A*STAR, Singapore
	10:20 – 10:40 am Tea Break
10:40am– 12:30pm	**NANO-5** **Chairs:** Dr Eng Huat Khoo, Singapore; Dr. Zhengtong Liu, Singapore
10:40am	WE -AM-NANO 5-1 **Nanomaterials for Thermal Management in Electronics** (Invited) Yong Ken Tye, Ng Geok Ing, Subramaniam Arulkumaran Nanyang Technological University, Singapore; CINTRA CNRS/NTU/THALES, Singapore
11:10am	WE -AM-NANO 5-2 **Efficient Modelling of Passive Metal-Insulator-Metal Waveguide Components Using Circuit Theory** Dongying Li, Erping Li Institute of High Performance Computing, A*STAR, Singapore

11:30am	WE-AM-NANO 5-3 **A Thermal Silicon-Nitride Slot Waveguide Biosensor** Xiaoguang Tu, Junfeng Song, Tsung-Yang Liow, Mi Kyoung Park, Jessie Quah Yiying, Jack Sheng Kee, Mingbin Yu, and Guo-Qiang Lo Institute of Microelectronics, A*STAR, Singapore
11:50am	WE-AM-NANO 5-4 **Switching Optical Forces using Plasmonics Vortex** E. H. Khoo, I. Ahmed, Erping Li Institute of High Performance Computing, A*STAR, Singapore
12:10pm	WE-AM-NANO 5-5 **Red-shifting the Responsivity of Ge Waveguide Photodetector by Localized Stresso** Liang Ding, T.-Y. Liow, M. B. Yu, and G.-Q. Lo Institute of Microelectronics, A*STAR, Singapore

Wednesday Afternoon, 23 May 2012

Time	Aquarius 3
1:30pm – 3:30pm	**NANO-6** **Chairs:** Dr.Yukio Kawano, Japan; Dr. Iftikhar Ahmed, Singapore
1:30 pm	WE-PM-NANO 6-1 **High Efficiency CW THz Source by Nano-antenna Incorporated Photomixing** (Invited) Teng Jing Hua, Institute of Material Research, A*STAR, Singapore
2:00pm	WE-PM-NANO 6-2 **Nanoscale THz Sensors and Imagers** (Invited) Yukio Kawano, JTokyo Institute of Technology, Japan
2:30pm	WE-PM-NANO 6-3 **Integrated In-band Optical Signal-to-noise Ratio Monitor** Lianxi Jia, Song Junfeng, Liow Tsung-Yang, Yu Mingbin, Patrick Lo Institute of Microelectronics, A*STAR, Singapore
2:50pm	WE-PM-NANO 6-4 **High Performance Graphene Field-effect Transistors with Extremely Small Access Length using Self-aligned Source and Drain Technique** Myung-Ho Jung, Goon-Ho Park, Tomohiro Yoshida, Hirokazu Fukidome, Tetsuya Suemitsu, Taiichi Otsuji , Maki Suemitsu Tohoku University, Japan
3:10pm	WE-PM-NANO 6-5 **Heterogeneous Si/III-V Integration for Optical Interconnect** Qian Wang[1], Doris Keh Ting Ng[1], Yadong Wang[1], Yongqiang Wei[1], Jing Pu[1], Payam Rabiei[1], Seng Tiong Ho[1,2] , [1]Data Storage Institute, A*STAR, Singapore; [2]Northwestern University, USA
	3:30-3:50pm Tea Break
3:50pm – 5:50pm	**NANO-7** **Chairs:** Dr. Teng Jing Hua, Singapore ; Dr. Dongying Li, Singapore
3:50 pm	WE-PM-NANO 7-1 **The Features and Limitations of Nanoscale Imaging with the Veselago/Pendry Superlens** (Invited) Wolfgang J. R. Hoefer Institute of High Performance Computing, A*STAR, Singapore
4:10pm	WE-PM-NANO 7-2 **Resonance Lineshape Manipulation in Silicon Feedback Microring Coupled MZI** Xianshu Luo, Junfeng Song, Mingbin Yu, and Guo-Qiang Lo Institute of Microelectronics, A*STAR, Singapore

4:30pm	WE-AM-NANO 7-3 **High Efficiency Optical Switches Using Silicon-on-insulator Technology** Junfeng Song[1,2], X. S. Luo[1], X. G. Tu[1], L. X. Jia[1], T. Y. Liow[1], M. B. Yu[1], G. Q. Lo[1] [1]Institute of Microelectronics, A*STAR, Singapore, [2]Jilin University, China
4:50pm	WE-PM-NANO 7-4 **Designing Carbon-Nanotube-Based Millimeter to Sub-millimeter Antennas** Pierre Franck, Dominique Baillargeat, Beng Kang Tay Nanyang Technological University Singapore CINTRA CNRS/NTU/THALES, UMI 3288, Singapore
5:10pm	WE-PM-NANO 7-5 **Ge/Si Avalanche Photodetector by Selective Epitaxial Growth** Ning Duan, Tsung-Yang Liow, Andy Eu-Jin Lim, Liang Ding and G. Q. Lo Institute of Microelectronics, A*STAR, Singapore
5:30pm	WE-PM-NANO 7-6 **Effect of Low Permittivity Dielectric Materials on Microstrip Antenna at Terahertz Frequency** Kumud Ranjan Jha[1], G. Singh[2] [1]Shri Mata Vaishno Devi University, India [2]Jaypee University of Information Technology, India

Thursday Morning, 24 May 2012

Gemini 1	
10:40am–13:00pm	**NANO: Nanotechnology for EMC** Chairs: Dr. Junhong Deng, Singapore Dr. Ping Li, Singapore
10:40am	TH-AM-NANO-1 **Circuit Modelling of Multilayer Graphene Nanoribbon (MLGNR) Interconnects** Yuan Fang, Wen-Sheng Zhao, Xu Wang, Feng Jiang, Wen-Yan Yin Zhejiang University, China
11:00am	TH-AM-NANO-2 **EMI Shielding Evaluations of Carbon Nanotube Based Coatings and Applications** Ping Li[1], Yueyan Shan[2], Lie Liu[3], Junhong Deng[4], Ong Guat Choon[1], Xijiang Yin[1] [1]Singapore Polytechnic, Singapore [2]A*STAR National Metrology Centre (NMC), Singapore [3]Temasek laboratories, Singapore [4]TUV SUD PSB Pte. Ltd., Singapore
11:20am	TH-AM-NANO-3 **Graphite Nano-Platelet-Based Composites for Microwave Absorbing Small Enclosures** Alessandro D'Aloia, Alessio Tamburrano, Marcello D'Amore, Maria Sabrina Sarto Sapienza University of Rome, Italy
11:40am	TH-AM-NANO-4 **High Permittivity and Shielding Effectiveness of Microwire Composites with Optical Transparency** Lie Liu[1], Zhi Hong Yang[1], Ling Bing Kong[1], Ping Li[2], Ce Huang Poo[2] [1]Temasek Laboratories, Singapore [2]Singapore Polytechnic, Singapore
12:00pm	TH-AM-NANO-5 **Performance Investigation of a Uni-planar Compact Electromagnetic Bandgap (UC-EBG) Structure for Wide Bandgap Characteristics** M. S. Alam, M. T. Islam, N. Misran Universiti Kebangsaan Malaysia, Malaysia

Abstracts

Tuesday Morning, 22 May 2012

8.30 am - 9.10 am TU-AM-NANO 1-1

Radio-Frequency Nanoelectronics – Bridging the Gap between Nanotechnology and R.F. Engineering Applications

Luca Pierantoni
Università Politecnica delle Marche, Ancona, Italy
Email: l.pierantoni@univpm.it

Abstract:

In view to the new epochal scenarios that nanotechnologics disclose, nanoelectronics has the potential to introduce a paradigm shift in electronic systems design similar to that of the transition from vacuum tubes to semiconductor devices. Since many nano-scale devices and materials exhibit their most interesting properties at radio-frequencies (RF), nanoelectronics provides an enormous and yet widely unexplored opportunity for the microwave engineering community. We present a technical overview of some of the main research fields of nanoelectronics for RF applications, showing the potentialities offered by the emerging nano-scale materials (e.g. carbon-based). While the advancement of research in this area heavily depends on the progress of manufacturing technology, still, the global modeling of multiphysics phenomena at the nanoscale is crucial to its development. Modeling, in turn, provides the appropriate basis for design. The aim of this effort is to close the gap between the nanosciences and a new generation of highly integrated and multifunctional devices, circuits, and systems, for a broad range of applications and operating frequencies, up to the optical region. This aim can be achieved by using the panoplia of microwave engineering at our disposal. Electrical engineering is at a crossroads. For the last fifty years, semiconductors have been driving the development of information technology, which has completely transformed our society. Conventional electronics, however, is reaching scaling and performance limits which jeopardizes future developments. New materials with unique properties are necessary and graphene, a one atom thick layer of sp2 bonded carbon, is at the top of potential candidates. Graphene not only has outstanding transport properties, but it also shows many unique properties not found in any other high performance electronic material. It is flexible, transparent, ultimately scalable, easily transferable to any surface, and its ambipolar conduction offers new possibilities for advanced electronics. In this talk, we describe how the use of these properties allows the development of new devices, which can overcome some of the main limitations of traditional electronics in terms of sensitivity, maximum frequency, and linearity. Several novel devices will be discussed for RF communications and remote sensing, including graphene frequency multipliers, graphene RF mixers and graphene chemical sensors.

9.40 am - 10.10 am TU-AM-NANO 1-3

Technical Issues and Recent Progress on Graphene-based RF MOSFET

Byung Jin Cho
Dept. of Electrical Engineering, KAIST, Daejeon, Korea 305-701
Email: bjcho@ee.kaist.ac.kr

Abstract:

Graphene has attracted much attention for future nanoelectronics due to its superior electrical properties. Owing to its extremely high carrier mobility and controllable carrier density, graphene is a

promising material for practical applications, particularly as a channel layer of high-speed RF FET. Furthermore, the planar form of graphene is compatible with the conventional top-down CMOS fabrication processes and large-scale synthesis by chemical vapor deposition (CVD) process is also feasible. Despite these promising characteristics of graphene, much work must still be done in order to successfully develop graphene RF FET to Tera Hz range operation. One of the key issues to be addressed is the process technique for gate dielectric formation because the channel mobility of graphene FET is drastically changed by the gate dielectric interface quality. Formation of high quality gate dielectric on graphene is still a challenging. Dirac voltage, the charge neutral point of the device, also strongly depends on gate dielectrics. Another performance killer in graphene FET is source/drain contact resistance, as the contact resistant between metal and graphene S/D is usually one order of magnitude higher than that between metal and silicon S/D. Optimization on graphene FET device structure is also a key issue for high frequency operation. Besides the device-related issues, the synthesis of high quality graphene is a prerequisite for all of these issues. In this workshop, the key issues on graphene RF FET, including organicinorganic hybrid gate dielectric formation, controlling of Dirac voltage, reduction of source/drain contact resistance, device structure optimization, and graphene preparation technique are addressed. Recent technical progresses on these issues are presented as well.

10.10 am - 10.30 am TU-AM-NANO 1-4

Coupled Maxwell and Schrödinger approach for simulation of Nano-devices

I. Ahmed[1]*, E. H. Khoo[1], E. P. Li[1]

[1]Institute of High Performance Computing, A-STAR, 1 Fusionopolis Way, Connexis, Singapore 138632

Email: iahmed@ihpc.a-star.edu.sg

Abstract:

The rising interest in the field of nanotechnology is gearing up interesting and useful applications in almost all fields of our daily life. It is also being expected that nanotechnology will revolutionize the world similar to the silicon technology approximately 50 years ago. At nano-scales material properties changes abruptly as compared to the bulk materials, therefore, there is need of modifications in the conventional modeling and simulation approaches, which have worked well for bulk materials. The reason of modifications is the appearance of new phenomena at nano-scales comparatively such as quantum effects etc. For the simulation at this scale we develop and implement a coupled time domain Maxwell and Schrödinger equations approach, and it has potential to simulate nano-device effectively. The proposed approach is applied to different applications.

Tuesday Afternoon, 22 May 2012

1.30 pm - 2.00 pm TU-PM-NANO 2-1

Plasmonic Nano-Lasers with Directional Output for Integration in Plasmonic-Photonic Integrated Circuit

Seng-Tiong Ho[*1], Xi Chen[1], Qian Wang[2], Yingyan Huang[##3]

[1]EECS Department, Northwestern University, 145 Sheridan Road, Evanston, IL 60208, USA

[2]Data Storage Institute, 5 Engineering Drive 1, Singapore 117608

[##3]OptoNet Inc., 828 Davis Street, Evanston, IL 60201, USA

Email: sth@northwestern.edu

Abstract:

This paper describes nano-plasmonic ring lasers with various geometries at tens to hundreds of nanometer dimensions simulated using a multi-level multi-electron (MLME) FDTD method. A proposed scheme to couple light out from these lasers into dielectric planar waveguides enables the laser to be integrated in a plasmonic-photonic integrated circuit.

2.00 pm - 2.30 pm TU-PM-NANO 2-2

Inkjet-Printed Nanotechnology-enabled RFID, IoT and "Zero- Power" Wireless Sensor Nodes

Prof. Manos M. TENTZERIS
Georgia Institute of Technology
Email: etentze@ece.gatech.edu

Abstract:

Nanotechnology and Inkjet-printed flexible electronics and sensors fabricated on paper, plastic and other polymer substrates are introduced as a sustainable ultra-low-cost solution for the first paradigms of Internet of Things, "Smart Skins" and "Zero-Power" applications. The talk will cover examples from UHF up to the millimeter-wave frequency ranges (mmID's), while it willl include the state of the art of fully-integrated wireless sensor modules on paper or flexible polymers and show the first ever 2D sensor integration with an RFID tag module on paper, as well as numerous 3D multilayer paper-based and LCP-based RF/microwave structures, that could potentially set the foundation for the truly convergent wireless sensor ad-hoc networks of the future with enhanced cognitive intelligence and "zero-power" operability through ambient energy harvesting. Examples from wearable (e.g. biomonitoring) antennas and RF modules will be reported, as well as the first integration of inkjet-printed nanotechnology-based sensors on paper and organic substrates. The talk will also present challenges for injet-printed highcomplexity modules as well as future directions in the area of environmentally-friendly ("green") RF electronics and "smart-house" conformal sensors.

2.30 pm - 2.50 pm TU-PM-NANO 2-3

Cu-Based Horizontal Plasmonic Waveguide Components for Silicon Integrated Nanoplasmonics

Shiyang Zhu, G. Q. Lo, and D. L. Kwong
Institute of Microelectronics,
A*STAR (Agency for Science, Technology and Research), Singapore, 117685
Email: zhusy@ime.a-star.edu.sg

Abstract:

We report experimental realization of various Cu/SiO2/Si/SiO2/Cu plasmonic waveguide based building blocks, including low loss (~0.28 dB/μm) waveguides, low loss (~0.52 dB/turn) bends, power splitters, and Mach-Zehnder interferometers with ER of ~18.7 dB. This is a significant step toward plasmonic nanocircuits on the Si platform.

2.50 pm - 3.10 pm TU-PM-NANO 2-4

Miniaturized RF slotted-slit-microstrip antenna on meta-surface

Kush Agarwal[#], Nasimuddin[*], A. Alphones[#]

[#]Nanyang Technological University, Singapore, [*]Institute for Infocomm Research, Singapore

Email: ealphones@ntu.edu.sg

Abstract:

With the emerging wireless applications in our every day life, there is a continuous need for RF researchers to design more efficient, low cost and miniature sized antennas which can be used for GSM, WLAN, RFID, and biotech specific uses. Most of the communication devices used in these applications require flexibility in terms of device orientation and highly compact size for which usage of small circularly polarized microstrip antennas becomes a necessity. But achieving the size reduction of the circularly polarized microstrip antennas with desirable axial ratio and impedance bandwidth has always been a challenging task.

A compact, asymmetric-slotted-slit-microstrip based patch antenna on the reactive impedance meta-surface is proposed and studied for the circularly polarized radiation. By asymmetric slots cut along the orthogonal and slits cut along the diagonal directions of the patch radiator, the circularly polarized radiation and size reduction are achieved. The meta-surface underneath the asymmetric-slotted-slit-microstrip patch radiator is used for further miniaturization. The proposed antenna is designed with the help of the commercial Microwave Studio software. The antenna prototype is designed on a low cost FR4 substrate and measured. The measured 3-dB axial-ratio bandwidth of 1.7 % (42 MHz) and 10-dB return loss bandwidth of 9.5 % (240 MHz) are achieved with gain of 3.8 dBic. The patch radiator area is 0.187λo × 0.179λo at the operating frequency of 2.6 GHz. The prototype of the proposed antenna is shown.

3.10 pm - 3.30 pm TU-PM-NANO 2-5

Microwave and THz detection device using bi-layer graphene FET

A. M. Mahjoub[1], N. Aoki1, K. Miyamoto[1], T. Omatsu[1], J. P. Bird[2], D.F. Ferry[3], K.Ishibashi[4] and Y. Ochiai[1]

[1]Graduate School of Advanced Integration Science, Chiba University, Chiba, Chiba 263-8522, Japan

[2]Department of Electrical Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14216, USA

[3]Department of Electrical Engineering, The Arizona State University, Tempe, AZ 85287-5706, USA

[4]Advanced Device Laboratory, The Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan

Email: ochiai@faculty.chiba-u.jp

Abstract:

In order to apply on electronics device such as field effect transistor (FET) or a wide band simple sensor from microwave to terahertz (THz) ranges, as well as bolometric detectors, quantum interference nature of electron waves has been studied in conductance fluctuations of the low temperature transports in nano-scaled system. In bilayer graphene, a small forbidden gap appears and the quantum transports are originated from massive Dirac fermions, in especially contrast to conventional semiconductors whose relevant band-gap are typically several orders of magnitude larger. In our study, we discuss on high frequency characteristics in bi-layer graphene FET at room temperature, specifically focusing on an analysis of the two-terminal conductance in microwave and THz radiation including the rectification characteristics up to THz frequency regions. As in quasi-

ballistic transport in semiconductor quantum dots, the magneto-resistance (MR) shows a quantum-coherent conductance fluctuation whose basic transport parameters are discussed as well as in semiconductor quantum dots. Graphene FET device has been prepared by mechanical exfoliation and the characteristic in the electrical properties discussed by based on the low-temperature MR measurements. These studies demonstrate the formation of open quantum-dot structures in small graphene flakes, contacted by sub-micron scale metal electrodes. The relationship between the underlying quantum transport and potential device applications is discussed based on the coherent nature of the GR determined by the MR natures.

3.50 pm - 4.20 pm TU-PM-NANO 3-1

Blinking of Plasmonic Hotspots on Laser-treated AgOx Thin Film

Ming Lun Tseng[1,2], Pin Chieh Wu[1,2], Yao-Wei Huang[1,2], Min-Kai Hsiao[3], Hsin Wei Huang[1,2], Hao Ming Chen[1,4], Yu Lim Chen[2], Cheng Hung Chu[1,2], Nien-Nan Chu[5], You Je He[2], Chia Min Chang[2,6], Wei Chih Lin[2], Ding-Wei Huang[6], Hai-Pang Chiang[3], Ru-Shi Liu[4], Greg Sun[7], and Din Ping Tsai[1,2,5,8*]

[1] Graduate Institute of Applied Physics, National Taiwan University, Taipei 106, Taiwan

[2] Department of Physics, National Taiwan University, Taipei 106, Taiwan

[3] Institute of Optoelectronic Sciences, National Taiwan Ocean University, Keelung 202, Taiwan

[4]Department of Chemistry, National Taiwan University, Taipei 106, Taiwan

[5] Instrument Technology Research Center, National Applied Research Laboratories, Hsinchu 300, Taiwan

[6] Institute of Photonics and Optoelectronics, National Taiwan University, Taipei 106, Taiwan

[7] Department of Physics, University of Massachusetts, Boston MA 02125, USA

[8] Research Center for Applied Sciences, Academia Sinica, Taipei 115, Taiwan

Email: dptsai@phys.ntu.edu.tw

Abstract:

The silver oxide thin film is illuminated by femtosecond laser beam for fabricating the Ag nanostructures with a lot of plasmonic hotspots. For probing the hotspots on the nanostructures, a blinking experiment using the drifting dyed beads in water solution is present.

4.20 pm - 4.50 pm TU-PM-NANO 3-2

A Tunable Nano/Micromachined Metamaterials

A. Q. Liu

School of Electrical and Electronic Engineering, Nanyang Technological University

50 Nanyang Avenue, Singapore 639798

Email: eaqliu@ntu.edu.sg

Abstract:

Metamaterials are functional materials with rational designed sub-wavelength structures which may leads to unique EM properties such as negative refractive index, perfect absorption, sub-wavelength focusing and extraordinary transmission etc. Recently, tunable Nano/micromachined metamaterials based on Microelectromechanical Systems (MEMS) fabrication technology is a new approach and the essential in applications where functional materials with designable electromagnetic (EM) properties

and tunablilities are required, such as variable wave plates, tunable filters, optical delay line and controllable luminescence etc. Most of the existing tuning methods of the metamaterials are based on the nonlinearity of their construction materials or surrounding mediums which, somehow, limit the tunable capabilities of the metamaterials.

In this paper, it is to focus on new innovation of reconfigurable nano/micromachined metamaterials through tuning of unit cell microstructures. This novel approach for reconfigurable metamaterials not only enables large tuning range of the metamaterials but also shows the capabilities in tuning the metamaterials properties, which promises unique tunabilities on optical anisotropy, selectively the resonance modes and TE/TM switchable etc.

4.50 pm - 5.10 pm TU-PM-NANO 3-3

Silicon Polarization Independent Circuit for Wavelength-Agile Integrated Receiver

Chao Li,[1,*] Huijuan Zhang[1], Shiyi Chen1, Jing Zhang[2], Ning Duan[1], Mingbin Yu[1], and G. Q. Lo[1]

[1]Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research)

11 Science Park Road, Science Park II, Singapore 117685

[2]National Metrology Centre, A*STAR (Agency for Science, Technology and Research),

1 Science Park Drive, Singapore 118221

Email: lic@ime.a-star.edu.sg

Abstract:

In recent years, silicon photonic integrated circuit (PIC) has attracted considerable academic and industrial interest in various applications including optical communications, optical interconnects, signal processing and sensing. Compared with hybrid integration, silicon PICs can significantly reduce the device footprint and packaging cost of optical communications modules. However, there are still several key issues to be addressed, such as the polarization dependence and the efficient photodetection. The polarization diversity scheme in silicon PICs can be implemented the combination of the polarization splitter and rotator. Recently, germaninum (Ge), which is compatible with current CMOS fabrication technology, has been demonstrated as an attractive material for high performance near-infrared photodetector (PD) due to its favorable absorption coefficient. The research on silicon PICs has become more active for wider applications. In this paper, a wavelength-agile silicon photonics circuit with polarization diversity is presented by monolithic integrating a Ge p-i-n PD with a polarization independent optical tunable filter. The PIC is fabricated using standard CMOS technology on SOI platform. The measured fiber-to-PD responsivity of the photonic integrated circuit is ~0.10 A/W upon a reverse bias of 5 V. The wavelength tuning range of the integrated circuit can cover the free spectral range of ~11.2 nm. The polarization dependent loss of the output electrical signal from PD is ~0.5 dB. The wavelength-agile capability for receiver will be very useful to help reduce traffic congestion and optimize network bandwidth utilization by switching wavelength channels.

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5. 10 pm - 5.30 pm TU-PM-NANO 3-4

Well-confined and low-loss plasmon modes synthesized with doped graphene sheets

Choon How Gan, Hong Son Chu, and Er Ping Li

Electronics and Photonics Department, A*STAR Institute of High Performance Computing, 138632, Singapore

Email: ganch@ihpc.a-star.edu.sg

Abstract:

We investigate through analytic calculations the surface plasmon dispersion relation for a separated parallel pair of graphene monolayers. For parallel graphene pairs separated by small gaps, the dispersion relation of the surface plasmon splits into two branches, one with a symmetric and the other with an antisymmetric magnetic field across the gap. For the symmetric (magnetic field) branch, it is found that the confinement may be improved at reduced absorption loss over a wide spectrum, unlike conventional SP modes supported on metallic surfaces that are subjected to the trade-off between loss and confinement. This symmetric mode becomes strongly suppressed for very small separations however. On the other hand, its antisymmetric counterpart exhibits reduced absorption loss for very small separations or long wavelengths, serving as a complement to the symmetric branch. An additional degree of freedom to tune the SP dispersion may be gained by varying the chemical potential μ1 of one of the graphene sheets while keeping the other one (μ2) constant. Since the symmetry is broken, the fields no longer possess symmetry in this case. However, we take the case μ1 = μ2 as reference, and consider branches AS' and AA' that stem from the AS and AA modes respectively. Under the right conditions, our analysis shows that an asymmetric chemical potential can significantly reduce the absorption loss for the AA' branch. Our results suggest that grapheme plasmon structures could be promising for waveguiding and sensing applications in the mid-infrared and terahertz frequencies.

5.30 pm - 5.50 pm TU-PM-NANO 3-5

Optical Switch through Optical Gradient Force

H. Cai[1], L. Ding, J. F. Song, M. B. Yu and G. Q. Lo
Institute of Microelectronics,
A*STAR (Agency for Science, Technology and Research), 117685 Singapore
Email: caih@ime.a-star.edu.sg

Abstract:

A novel optical switch driven by gradient optical force is demonstrated, allowing weak light to switch a strong one. The proposed optically controlled switch achieves an extinction ratio of 26 dB with ~ns switching speed.

Wednesday Morning, 23 May 2012

9.10 am - 9.40 am WE-AM-NANO 4-2

Graphene: an ideal material for fundamental research and applications

Ze Xiang Shen, Da Zhan, Jiaxu Yan and Linfei Lai
School of Physical and Mathematical Sciences and School of Materials
Science and Engineering, Nanyang Technological University, Singapore
E-mail: zexiang@ntu.edu.sg

Abstract:

Graphene exhibits many exciting properties, such as anomalously quantized Hall effects, massless Dirac-Fermions like charge carrier, existence of a minimum conductivity, which make it promising material for the future nano-electronic devices. All these properties are originated from its unique band structure whose conical valence and conduction bands meet at the Dirac point in Brillouin zone. In this talk, I will present our results of graphene study: new understanding on graphene

intercalation (The crystal structures are shown in Fig. 1), and properties of folded and mis-oriented graphenes. With the availability of few layer graphene, we shed new light on the mechanism of intercalation of graphite which is not possible before. Folded graphene sheets exhibit two-dimensional Dirac-like (single layer graphene-like) character of electronic states and with reduction of Fermi velocity. For applications in nano-electronic devices and energy harvesting, opening of the band gap is needed. On the other hand, many of the unique properties of graphene are accorded to that of single layer graphene

(SLG). But it is very difficult to fabricate large single crystalline SLG samples for practical applications. It would be most desirable to modify few-layer graphene (FLG) samples so that they have similar properties as that of SLG. I will also present our results in modifying graphene for various applications, including modifying edge chirality, hydrogenation, and studies of graphene with mis-oriented layers and applications in energy storage.

9.40 am - 10.00 am WE-AM-NANO 4-3

Growth kinetic studies of graphene on Cu foils

E. Pichonat[1], R. Fleurier, D. Vignaud, H. Happy
IEMN CNRS UMR 8520, Cité scientifique-avenue Poincaré BP 60069
59652 VILLENEUVE D'ASCQ CEDEX – FRANCE
Email: emmanuelle.pichonat@iemn.univ-lille1.fr

Abstract:

The growth of graphene on copper foils has attracted attention in the last 3 years due to its feasibility for a controllable growth process. One of the key issues for RF applications of graphene is wafer-scale growth. Synthesis produces today technological grade graphene films up to 30 inch square surface on Cu. However, the detailed chemical process of graphene synthesis is not clearly known, and the role played by hydrogen on graphene growth is known for having an important influence. Up to know, hydrogen is thought to promote the growth of single layer graphene instead of graphite due to etching of the graphene layer. However, in relation with the partial pressure of methane or hydrogen, the mechanisms leading to graphene growth on copper are not clearly understood. Thus, the growth conditions to form high-quality graphene are not yet established. Here we study the growth process of graphene with respect to the different synthesis parameters that are pressure, temperature, partial pressure of methane, hydrogen and the carrier gas, argon and synthesis time, showing the different growth kinetics of graphene on copper foil.

10.00 am - 10.20 am WE-AM-NANO 4-4

Computational quantum electrodynamics: Simulation of electromagnetic fields and nanostructures interaction

Xue-Cang Zhang and Er-Ping Li
Department of Information Science & Electronic Engineering
Zhejiang University, Hangzhou 310027, China
Email: zhangxuecang@zju.edu.cn

Abstract:

Modeling and computational design are fundamental for better control of molecular self-assembly, quantum behavior, creation of new molecules, and interaction of nanostructures with external electromagnetic (EM) fields in order to build materials, devices, and system in nanotechnology.

Traditionally, EM-field is taken as a known external potential in quantum mechanics, and microscopic material response under EM-field is incorporated into Maxwell equation by macroscopically averaged dielectric function (such as Lorentz-Drude model) in electromagnetics. In this paper, based on the rigorous quantum electrodynamics, the Maxwell-Schr¨odinger system and Maxwell-Dirac system are summarized for the modeling of nonrelativistic and relativistic EM-nanostructure interaction respectively. They can serve as a starting point for further model simplification and numerical simulation. Furthermore, a time-splitting framework, which has been successfully used in the simulation of many other coupling system, is provided for simplifying their computational procedure. The challenges in simplification and simulation are also discussed. The development of molecular-nano scale science and technology is calling a new branch of computational science and engineering: computational quantum electrodynamics.

11.10 am - 11.30 am WE-AM-NANO 5-2

Efficient Modelling of Passive Metal-Insulator-Metal Waveguide Components Using Circuit Theory

Dongying Li[1], Er-Ping Li[2]
Institute of High Performance Computing, A*STAR, Singapore, 138632
Email: [1]lid@ihpc.a-star.edu.sg

Abstract:

The development of modern communication system towards broadband, compact sizes and low power consumption led towards the utilization of frequency bands up to the near-infrared region. The plasmonic devices, which confines the optical propagation over dimensions smaller than the diffraction limit, has been proposed as a suitable means for the signal propagation in such frequency bands.
Currently, the characterization of plasmonic devices mainly relies on full-wave simulation tools. Nevertheless, due to the strong presence of evanescent waves, the mesh fineness has to be increased significantly at the metal-dielectric interface in numerical modelling. This leads to tremendous computational cost in both time and memories. To this end, the equivalent circuit model, which has been well exploited in the microwave regime, was extended as an efficient means to represent waveguide-based plasmonic devices.

In this work, two issues related to the circuit modelling of plasmonic structures are discussed. First, a more accurate transmission-line model of the Metal-Insulator-Metal (MIM) plasmonic waveguide is proposed. It is shown that under large gap widths, the proposed model is much more accurate than the simplified model proposed in. Second, circuit models for passive MIM components, including bends and splitters, are extracted from the scattering parameters of the full wave simulation. The circuit models of the MIM waveguide components, consisting of parasitic inductors and capacitors embedded within transmission line representations of the structure. The accuracy of the circuit model combined with the improved transmission line representation is validated by an example of MIM splitter.

11.30 am - 11.50 am WE-AM-NANO 5-3

Athermal Silicon-Nitride slot waveguide biosensor

Xiaoguang Tu[1], Junfeng Song[1], Tsung-Yang Liow[1], Mi Kyoung Park[1], Jessie Quah Yiying[1], Jack Sheng Kee[1], Mingbin Yu[1], and Guo-Qiang Lo[1]

[1]Institute of Microelectronics, A*STAR (Agency of Science, Technology and Research), 11 Science Park Road, Singapore Science Park II , 117685, Singapore.
Email: tux@ime.a-star.edu.sg

Abstract:

We present a Mach-Zehnder Interferometer (MZI) biosensor based on silicon nitride slot waveguides. The biosensor is designed for minimal temperature dependence without compromising the performance in terms of sensitivity and detection limit. With air cladding, the measured temperature dependence is 5.0 pm/o C. With water cladding, the measured bulk sensitivity and detection limit reach 1730(2π)/RIU and 1.29×10-5 RIU respectively.

11.50 am - 12.10 pm WE-AM-NANO 5-4

Switching Optical Forces using Plasmonics Vortex

E. H. Khoo[1†], I. Ahmed[1], E. P. Li[1]
[1]Institute of High Performance Computing, A-STAR
1 Fusionopolis Way, Connexis, Singapore 138632
([†]Tel (65) 6419-1550, Fax (65) 6463-5176,
Email: khooeh@ihpc.a-star.edu.sg

Abstract:

Surface plasmons (SPs) interference generates many interesting phenomena. One example is the formation of optical vortex from curved nanoslits with circularly polarized light. Optical vortices formed this way have different radii due to different phase interference from the circular polarized light. This interesting property allows the design of nanostructures with controllable optical properties using the different optical vortices radii. In this paper, we study the excitation of localized surface plasmonics (LSP) on a small perturbation with different polarizations. Circular polarization with left and right handedness is incident onto four 1/4 curved nanoslits, each with increasing radius from r to r+ λsp in the angle 0 to π/2 radian. The four curved nanoslits give optical vortex with ring radius of 1.7 and 1.2 μm for left (LCP) and right circular (RCP) polarized light. This is due to the different phase interference from both circular polarizations. A small perturbation, with size of 8 × 8 × 5 nm is deposited on the inner ring of optical vortex form for LCP light. When LCP light is incident on the nanoslits, LSP is excited on the surface of the perturbation. However, RCP polarized light do not excite LSP on the surface of the perturbation. This "switching" of LSP on the perturbation using circular polarized light is believed to have many potential applications such as optical switching, molecular imaging and optical trapping.

12.10 pm - 12.30 pm WE-AM-NANO 5-5

Red-shifting the Responsivity of Ge Waveguide Photodetector by Localized Stressor

L. Ding, T.-Y. Liow, M. B. Yu, and G.-Q. Lo
Institute of Microelectronics, A*STAR (Agency for Science, technology and Research)
11 Science Park Road, Science Park II, Singapore 117685
Email: dingl@ime.a-star.edu.sg

Abstract:

We report a Ge waveguide photodetector which covers the entire C- and L-band. Localized stressor structures were designed and fabricated to red-shift the responsivity spectrum. With stressor structures, the roll-off in responsivity is found to be red-shifted from 1520 nm to beyond 1620 nm.

Wednesday Afternoon, 23 May 2012

1.30 pm - 2.00 pm WE-PM-NANO 6-1

High efficiency CW THz source by nano-antenna incorporated photomixing

Teng Jing Hua
Institute of Materials Research and Engineering, A*STAR, Singapore 117602
Email: teng-jh@imre.a-star.edu.sg

Abstract:

The lack of efficient room-temperature operating terahertz source remains as a significant technical hurdle in the development of compact terahertz system. Terahertz source utilizing photomixing technology is promising for its continuous wave (CW) emission, which has the advantages of high spectral resolution, fast response, tunability and low cost. The key challenge is to improve the THz emission efficiency and power. In this talk, I will give a brief review of the possible CW THz generation methods followed by the introduction of the nano-antenna enhanced THz emission in a LTGaAs based photomixer. The enhancement is more than two-order of magnitude when compared to a photomixer using typical interdigitated structure. This new nano-antenna incorporated photomixer could be an enabling technology towards highly efficient compact CW terahertz source for future high resolution imaging and spectroscopy systems. Besides, THz polarizer on semiconductor substrate using a new method with the potential of integration with the CW THz source will also be introduced.

2.00 pm - 2.30 pm WE-PM-NANO 6-2

Nanoscale THz Sensors and Imagers

Yukio Kawano
Department of Physical Electronics, Tokyo Institute of Technology
2-12-1 Ookayama, Meguro-ku, Tokyo 152-8552, Japan
Email: kawano@pe.titech.ac.jp

Abstract:

We present a new type of THz sensors and imagers with nano-electronic devices based on semiconductors and carbon nanotubes. A frequency-tunable photon sensor and highresolution imager beyond the diffraction limit are described.

2.30 pm - 2.50 pm WE-PM-NANO 6-3

Integrated in-band optical signal-to-noise ratio monitor

Jia Lianxi, Song Junfeng, Liow Tsung-Yang, Yu Mingbin, Patrick Lo

Institute of Microelectronics, A*STAR (Agency of Science and Technology Research), 11 Science Park Road, Science Park II, Singapore, 117685
Email: jialx@ime.a-star.edu.sg

Abstract:

Based on the different coherence properties of signal and noise, we measured the in-band optical signal-to-noise ratio using integrated thermally tunable Mach-Zehnder optical delay interferometer (MZ-ODI) on SOI platform.

2.50 pm - 3.10 pm WE-PM-NANO 6-4

High performance graphene field-effect transistors with extremely small access length using self-aligned source and drain technique

Myung-Ho Jung, Goon-Ho Park, Tomohiro Yoshida, Hirokazu Fukidome, Tetsuya Suemitsu, Taiichi Otsuji and Maki Suemitsu
Research Institute of Electrical Communication, Tohoku University, Sendai 980-8577, Japan
Email: jungmh@riec.tohoku.ac.jp

Abstract:

A self-aligned source/drain (S/D) graphene field-effect transistor (GFET) with extremely small access lengths has been successfully fabricated using a simple process without sidewall spacer formation. The self-aligned S/D GFET exhibits superior electrical characteristics, which includes a cut-off frequency of 13 GHz obtained for this rather large gate length of 3 μm.

3.10 pm - 3.30 pm WE-PM-NANO 6-5

Heterogeneous Si/III-V Integration for Optical Interconnect

Qian Wang[1], Doris Keh Ting Ng[1], Yadong Wang[1], Yongqiang Wei[1], Jing Pu[1], Payam Rabiei[1], and Seng Tiong Ho[1,2]
[1]Data Storage Institute, Agency for Science, Technology and Research, 5 Engineering Drive 1,
[2]Dept. Electrical Engineering and Computer Science, Northwestern University, Evanston, IL, 60208
Email: Wang_qian@dsi.a-star.edu.sg

Abstract:

This paper presents a new heterogeneous Si/III-V integration and the optical vertical interconnect to the silicon-on-insulator (SOI) nanophotonic layer. The III-V thin-film is directly bonded to the SOI layer and etched to form the heterogeneous Si/III-V waveguide. The optical vertical interconnect access is realized through tapering both the III-V and SOI layer in the same direction. Optimal design leads to a confinement factor of ~24% in a 100 nm-thick active region for a 1.5 μm wide Si/III-V waveguide and the vertical optical interconnect access gives ~100% coupling efficiency with a 20 μm long tapering region.

3.50 pm - 4.10 pm WE-PM-NANO 7-1

The Features and Limitations of Nanoscale Imaging with the Veselago/Pendry Superlens

Wolfgang J. R. Hoefer
1Institute of High Performance Computing, A-STAR
Email: hoeferwjr@ihpc.a-star.edu.sg

Abstract:

This paper summarizes the essential features of the Veselago/Pendry superlens and discusses the theoretical limitations that determine the maximum resolution achievable with such a device in the visible range. Even though the realization of a suitable metamaterial with both negative permittivity and permeability at optical frequencies remains elusive,the study of the physical limitations of the superlens is essential in defining the challenges that must be overcome in order to realize it. These limitations include not only the losses and the granularity of the lens material, but also the time required to achieve a given resolution and the dynamic range of the superresolution system. Since superresolution imaging involves the interaction of electromagnetic waves with objects of a size close to the wavelength, microwave concepts can effectively be used as a basis for both theoretical and numerical investigations of the superlens even at optical wavelengths.

4.10 pm - 4.30 pm WE-PM-NANO 7-2

Resonance lineshape manipulation in silicon feedback microring coupled MZI

Xianshu Luo*, Junfeng Song, Mingbin Yu, and Guo-Qiang Lo
Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research), 11 Science Park Road, Singapore Science Park II, Singapore 117685
Email: luox@ime.a-star.edu.sg

Abstract:

We propose and demonstrate the optical resonance manipulation by using feedback microring coupled MZI in silicon-on-insulator (SOI) substrate. The resonance lineshape manipulation is realized by electro-optical effect via supplying DC bias to the integrated p-i-n diodes.

4.30 pm - 4.50 pm WE-PM-NANO 7-3

High Efficiency Optical Switches Using Silicon-on-insulator Technology

J. F. Song[1,2*], X. S. Luo[1], X. G. Tu[1], L. X. Jia[1], T. Y. Liow[1], M. B. Yu[1] and G. Q. Lo[1]
[1]Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research), 11 Science Park Road, Singapore Science Park II, Singapore 117685
[2]State Key Laboratory on Integrated opto-electronics, College of Electronic Science and Engineering, Jilin University, Changchun, People's Republic of China, 130023
Email: songjf@ime.a-star.edu.sg

Abstract:

The SOI waveguide based optical devices are attracting more and more attentions in recent years, thanks for its high refractive index contrast between oxide and silicon, thereby allowing the

realization of ultra small optical devices. The fabrication process is compatible with CMOS IC technology. SOI based optical components are wildly applying in optical communication, on-chip optical interconnects and fiber to the home (FTTH). Optical switch is as a key building block in these applications. Mach-Zehnder interferometer (MZI) based thermal optical (TO) switches have been widely studied. In our previous works, we investigated MZI and Michelson interferometer (MI) optical switches. MI type optical switch reduces the switching power by half, with ~10 mW switching power and ~35 μs switching time. We also investigate the two types of heater-on-slab TO switch. In the first type, the silicon slab regions are doped highly to form the heaters. For this type of switch, the switching power is ~85 mW and the switching time is ~27 μs. In the second type, a strip of metal in direct contact with the silicon slab forms the heater. For this type of switches, the switching power is ~25 mW and the switching time is ~17 μs. An extinction ratio of ~28.4 dB was also achieved. In this paper, we are using NiSi as heater materials to replace TiN. The switch power reduced down to ~9 mW and switching time is shorten to 12 μs.

4.50 pm - 5.10 pm WE-PM-NANO 7-4

Designing carbon-nanotube-based millimeter to sub-millimeter antennas

Pierre Franck[1,2], Dominique Baillargeat[1], Beng Kang Tay[1,3]
[1]CINTRA CNRS/NTU/THALES, UMI 3288 Research Techno Plaza, 50 Nanyang Drive, Border X Block, Level 6, Singapore 637553
[2]XLIM UMR 7252, Université de Limoges/CNRS, 123 Avenue Albert Thomas 87060 Limoges
[3]School of Electrical and Electronics Engineering, Nanyang Technological University, Block S1, 50 Nanyang Avenue, Singapore 639798
Email: pierre.franck@etu.unilim.fr

Abstract:

In a continued effort towards carbon-nanotube-based antennas, we study resonances of bundled carbon nanotubes in the millimeter range and beyond where previous work hints for better achievable performance. Simulation is performed using a circuit model for dipoles of bundles. The different parameters and their effects are covered and the applications addressed.

5.10 pm - 5.30 pm WE-PM-NANO 7-5

Ge/Si Avalanche Photodetector by Selective Epitaxial Growth

Ning Duan, Tsung-Yang Liow, Andy Eu-Jin Lim, Liang Ding and G. Q. Lo
Institute of Microelectronics, A*STAR (Agency for Science, Technology and Research), 11 Science Park Road, Singapore Science Park II, Singapore 117685.
Email: duann@ime.a-star.edu.sg

Abstract:

Avalanche photodiodes (APDs) are important components in optical communications due to the sensitivity margin provided by their internal gain. Much of the research on these APDs has focused on achieving lower noise and higher gain-bandwidth products to accommodate the ever-increasing bit rates of fiber-optic systems. Recent progress made in silicon photonics has shown Ge/Si SACM APDs are promising for the realization of high performance APDs due to the intrinsic low k (ratio of the ionization coefficients of electrons and holes) value (~ 0.01 -0.1) in silicon material. Using CMOS-compatible process technology, It is reported that the fabrication of Ge/Si APDs with gain-bandwidth

product of 340GHz at 1310nm wavelength. The Ge- and Si-layers were grown non-selectively and circular mesas were formed by dry and wet etch.

On the other hand, in order to fabricate optical receiver with Ge/Si APD and TIA (trans-impedance amplifier) integrated on the same silicon substrate, selective epitaxial growth (SEG) of both silicon multiplication layer and Ge absorption layer is preferred. In this work, we report a normal incident Ge/Si avalanche photodiode by selective epitaxial growth. By eliminating germanium impact-ionization at high gain, high responsivity of 12A/W and large gain-bandwidth product of 310GHz have been achieved at 1550nm.

The current-voltage (I-V) characteristics of 30-μm-diameter Ge/Si APD device measured under dark and 1550nm illumination conditions. The breakdown voltage Vb is ~-29.4V, defined at a dark current of 100 μA. Dark current at 90% Vb is only 1.5uA. The bandwidth of Ge/Si APD with a diameter of 30 μm versus gain. The 3-dB bandwidth at bias less than -27V is less than 5GHz as the Ge absorption layer is partially depleted with long transit time dominated by carrier diffusion. When Ge is fully depleted with E-field more than 3kV/cm, the maximum measured bandwidth is 8GHz at gain of ~30, which is dominated by avalanche build-up time. Bandwidth remains 8GHz when gain reaches to 39 before breakdown. This gives rise to a resulting gain-bandwidth product of 310GHz. This high bandwidth at high gain indicates no impact ionization occurs in Ge absorption layer when device is operating close to breakdown

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5.30 pm - 5.50 pm WE-PM-NANO 7-6

Effect of Low Permittivity Dielectric Materials on Microstrip Antenna at Terahertz Frequency

Kumud Ranjan Jha[1] and G. Singh[2],

[1]School of Electronics and Communication Engineering

Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir, India

[2]Department of Electronics and Communication Engineering

Jaypee University of Information Technology, Solan-173 234, India

Email: drghanshyam.singh@yahoo.com

Abstract:

In this paper, a low-relative dielectric permittivity substrate material PTFE (ε=2.08 tanδ =0.0004) with the periodic implantation of air cylinders has been analysed at 600 GHz. Further, it has been shown that the effective dielectric permittivity of the material in this case is reduced below unity and due to this the size of patch is increased, which reduce the fabrication constraint of the antenna at terahertz frequencies while maintaining the high directivity.

Thursday Morning, 24 May 2012

11.20 am - 11.40 am TH-AM-NANO-2

EMI Shielding Evaluations of Carbon Nanotube Based Coatings and Applications

Ping Li [#1], Yueyan Shan[*2], Lie Liu[%3], Junhong Deng[+4], Xijiang Yin[#5]

[#]Advanced Materials Technology Centre, Singapore Polytechnic 500 Dover Road, Singapore 139651

[*]National Metrology Centre (NMC), A*STAR, 1 Science Park Drive, Singapore 118221

[%]Temasek laboratories, National University of Singapore, Singapore, 117508

[+]Electrical & Electronics, TUV SUD PSB Pte Ltd 1 Science Park Drive, Singapore 118221

Email: liping@sp.edu.sg

Abstract:

Electromagnetic interference (EMI) shielding coatings based on carbon nanotube has been prepared and evaluated. The electromagnetic shielding effectiveness (SE) is measured using planar material fixture method from 10MHz to 3 GHz and with free space method in the range of 3 GHz to 18 GHz. The results show that carbon nanotube based coating is effective in providing EMI shielding in broad frequency range from 10 MHz to 18 GHz. Carbon nanotube based coating showed good shielding effectiveness (25-30dB) and absorption performances (60%-90%) in wide frequency range.

11.40 am - 12.00 am TH-AM-NANO-3

Graphite Nano-Platelet-Based Composites for Microwave Absorbing Small Enclosures

Alessandro D'Aloia, Alessio Tamburrano, Marcello D'Amore, Maria Sabrina Sarto
Research Center on Nanotechnology applied to Engineering - Sapienza University of Rome
DIAEE, via Eudossiana 18, 00184 Rome, Italy
Email: alessandrogiuseppe.daloia@uniroma1.it

Abstract:

The use of novel nanocomposites, consisting in polymeric-based system filled with graphite-nanoplatelets (GNP), is proposed to increase the shielding performance and to reduce the Q of small enclosures excited by impinging plane waves in the gigahertz frequency range. Structure and electrical characteristics of the realized GNP-based composites are described. Absorbing performances of a planar infinite screen made with two layers panel backed on a metallic surface, illuminated by a TM and a TE polarized plane waves, are computed in reverberating conditions. The same absorbing nanostructure is considered to realize the walls of a small-dimensions cubic box with a slot aperture. The full-wave numerical simulations demonstrate that the use of the new material produces resonance damping of microwave electric field and a factor 104 reduction of the Q of a full-metallic enclosure.

12.00 am - 12.20 am TH-AM-NANO-4

High Permittivity and Shielding Effectiveness of Microwire Composites with Optical Transparency

L. Liu[%1], Z. H. Yang[%2], L. B. Kong[%3], P. Li[#4] and C. H. Poo[#5]
[%]Temasek laboratories, National University of Singapore, Singapore, 117508
[#]Advanced Materials Technology Centre, Singapore Polytechnic 500 Dover Road, Singapore 139651
Email: poo_ce_huang@sp.edu.sg

Abstract:

Flexible composites with optical transparency were fabricated with glass-coated nanocrystalline ferromagnetic microwires and transparent silicone matrix. Free space method was employed to measure the effective permittivity and shielding effectiveness of samples fabricated from 4 to 20 GHz. Due to resonance phenomena of the embedded microwires with certain lengths, both dielectric permittivity and loss of the composite are quite high at designed microwave frequency. Broadband shielding effectiveness (SE) of the transparent shielding layer with 0.5wt% of microwires and

thickness less than 0.75mm can be 10 to 14 dB. The maximum SE of combining two layer of sheets (~1.5mm) with microwires of different length could be better than 20dB.

12.00 am - 12.20 am TH-AM-NANO-5

Performance Investigation of a Uni-planar Compact Electromagnetic Bandgap (UC-EBG) Structure for Wide Bandgap Characteristics

M. S. Alam*#1, M. T. Islam#2, N. Misran*#3
*Department of Electrical, Electronic & Systems Engineering
#Institute of Space Science (ANGKASA)
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor D. E., Malaysia
Email: 1titu_jfc@yahoo.com

Abstract:

A simple uni-planar EBG structure with reduced cell size is proposed for lower frequency band operation. The simulations of the design are performed using finite element method. Directive transmission method is applied to compute the bandgap of the EBG. The compact EBG structure exhibits wide stopband with different type of substrate materials. From the reflection and transmission characteristics the maximum bandgap obtained is 2.57 GHz (56.8%) and the best mutual coupling reduction level is -90 dB. The planar design can be easily fabricate on regular PC board and suitable for wide range of compact applications.
