The Centre for Photonics Fabrication Research at Carleton University

CPFR
Centre for Photonics Fabrication Research

PRESENTS
ADVANCES IN PHOTONICS FABRICATION WORKSHOP #3

Thursday, March 05, 2009, M-50 Auditorium, NRC, Ottawa

In partnership with
CPFC, Ottawa Photonics Cluster, and the Ottawa Photonics Research Alliance (OPRA)

Agenda

8:30am: **Coffee and Networking**

9:00am – 9:15am: **Introduction**

9:15am – 10:45am: **Session A**

9:15am-9:45am: Presentation #1 (20-minute presentation + 10 minutes Q/A)

Title: Optically reconfigurable wireless components based on novel functional polymers

Principal Researchers: Dr. Langis Roy, Professor and Chair, Department of Electronics, Carleton University, Dr. Barry Syrett, Professor at the Department of Electronics, Carleton University. Dr. Wayne Wang, Canada Research Chair in Emerging Organic Materials. Department of Chemistry, Carleton University

Speaker: Dr. Langis Roy

9:45am-10:15am: Presentation #2 (20-minute presentation + 10 minutes Q/A)

Title: An All Optical Multiplexer for Radio Over Fiber Systems

Principal Researchers: Dr. Roshdy Hafez, Professor, Department of Systems and Computer Engineering, Carleton University
Dr. Xavier Fernando, Associate Professor, Ryerson Communications Research Lab, Department of Electrical and Computer Engineering, Ryerson University

Speaker: Dr. Xavier Fernando

10:15am-10:45am: Presentation #3 (20-minute presentation + 10 minutes Q/A)

Title: Micro Optofluidic Cell Sorter based on Cross-Type Optical Chromatography

Researchers: Dr. Jianping Yao, Professor, School of Information Technology and Engineering, University of Ottawa. Drs. Ping Zhao, Gaozhi Xiao and Zhiyi Zhang at the Institute for Microstructural Science at the NRC, Montréal Road, Ottawa

Speaker: Honglei Guo, PhD student, School of Information Technology and Engineering, University of Ottawa

10:45am – 11:30am **Coffee Break**

11:30am – 1:00pm: **Session B**

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11:30am-12:15pm: Presentation #4 (two 15-minute presentations + 15 minutes Q/A):

Title:	High-Speed Low-Power Analog-to-Digital Converters
Principal Researchers:	Dr. Len MacEachern, Associate Professor, Dept. of Electronics, Carleton University and Dr. Samy Mahmoud, Professor, Department of Systems and Computer Engineering, Carleton University
Presentation #4 Part 1:	A 10-bit Successive Approximation ADC with tunability and offset correction
Speaker:	Lado Filipovic, M.Sc. Student, Dept. of Electronics, Carleton University
Presentation #4 Part 2:	High-Speed Sigma-Delta ADC with Interleaving for Applications in Imaging Systems
Speaker:	Igor Miletic, Ph.D. Student, Dept. of Electronics, Carleton University

12:15pm-1:00pm: Presentation #5 (two 15-minute presentations + 15 minutes Q/A):

Title:	Linear Fast Laser Drivers and Amplifiers for Optical Transmission in Radio-over-Fiber and UWB Applications
Principal Researchers:	Dr. Samy Mahmoud, Professor, Department of Systems and Computer Engineering, Carleton University and Dr. Len MacEachern, Associate Professor, Dept. of Electronics, Carleton University
Presentation #5 Part 1:	Fully-Integrated CMOS Distributed Amplifier as Active Tunable UWB Duplexer/Circulator for Wireless Transceiver Applications
Speaker:	Ziad El-Khatib, Ph.D. Student, Dept. of Electronics, Carleton University
Presentation #5 Part 2:	Very Large BW Coplanar Waveguide Balun for Connecting Differential Laser Drivers to Single-Ended Lasers
Speaker:	Zhan Xu, Ph.D. Student, Dept. of Electronics, Carleton University
1:00pm:	**Adjourn**

ABSTRACTS

<u>Presentation #1:</u> Optically reconfigurable wireless components based on novel functional polymers

Demand continues to grow for advanced wireless mobile devices operating at microwave frequencies that can dynamically adapt to field conditions, such as varying frequency bands, transmit power levels and antenna characteristics. Although component re-configurability using silicon semiconductor electronics is possible, future mobile radio service offerings will increasingly complicate such designs and potentially reach the limits of silicon technology in terms of cost-effectiveness. This project targets improving the cost-to-performance ratio of advanced mobile devices through the use of optically re-configurable microwave components that employ organic materials as building blocks instead. The research is being carried out at three levels: development of novel polymer materials, extraction of their microwave/optical properties, and realization of optically-tunable microwave devices. Results will be presented showing the synthesis and properties of near-infrared photoconductive polymer films (based on metal dithiolene doped PVK); the development of specialized test structures and measurement techniques (both planar interdigitated- and rectangular waveguide-based) for microwave characterization of the films under optical excitation; and the design of miniature optically-controllable microwave filters and antennas based on these films (in combination with advanced LTCC ceramic-based packaging technologies). Future perspectives on material selection, development and integration for enhanced optical reconfigurability of components will be given.

<u>Presentation #2:</u> An All Optical Multiplexer for Radio Over Fiber Systems

Subcarrier multiplexed transmission of radio signals over fibre can be done to deliver multiple wireless services simultaneously. These RF signals need to be demultiplexed to separate these wireless services. The demultiplexing is preferred to be done in the optical domain to avoid loss and noise due to optical-to electrical conversion. However, it is challenging to optically isolate signals at sub-gigahertz range due to the need for very narrow optical bandpass filters with high selectivity and low insertion loss and distortion. We have been developing such a novel sub-picometer all-optical bandpass filter by creating a resonance cavity using two closely matched fibre Bragg gratings. The resonance cavity acts like comb filter giving multiple transmission windows. The RF signals can be separated by aligning them to the transmission peaks. Preliminary results show that this filter is capable to optically separate two RF signals spaced as close as 100 MHz without significant distortion. The bit-error rate of the underlying baseband data is measured to ensure the quality of the demultiplexed RF signal and the isolation of the filter.

<u>Presentation #3:</u> Micro Optofluidic Cell Sorter based on Cross-Type Optical Chromatography

The capability of handling a small amount of cell particles is vital to biologists and medics physicists in the new drug development. The conventional flow cytometers, which currently dominate the flow cytometer market, are only good at dealing with large amount of cell particles. To address this issue, optofluidic cell sorters based on the principle of optical tweezers have been proposed with some demonstrations shown in the lab. Because a microscope is used in this technique to perform imaging and to provide a gradient optical field, the whole system has the disadvantages of bulky size and high cost, and is difficult to be integrated with the emerging lab-on-a-chip technology. In this work, a novel design of an optofluidic cell sorter based on an optical chromatography structure is implemented. In our proposed optofluidic device, the light beam from a laser source is introduced into the microfluidic channel perpendicular to the fluid flow direction, which is termed as the cross-type optical chromatography. Optically driven transport of polystyrene particles with diameters of 2 μm and 6 μm is experimentally realized using the developed optofluidic device. In the experiment, the retention distances for the two different particles are shown to be different. The proposed architecture could realize the function of cell sorting with lower cost and more flexibility.

Presentation #4 Part 1: A 10-bit Successive Approximation ADC with tunability and offset correction

A 10-bit successive approximation analog-to-digital converter (ADC), with offset correction circuitry and a tunable series attenuation capacitor is presented. The ADC is designed in a standard 0.13μm CMOS process technology and can operate with supply voltages down to 0.6 V. The ADC uses MOSFETs that are designed to operate in the sub-threshold region of operation. The ADC achieved sample rates of up to 500 kS/s with all 1024 codes present and an INL and DNL of 0.1009LSB and 0.1429LSB respectively. A power dissipation of 20.9 pJ/cycle was measured, while operating at 100 kS/s, with a 0.6 V supply voltage and an INL and DNL of 0.2585LSB and 0.2862LSB respectively, with all codes present. With a 1.0 V VDD, a 320 kS/s signal achieved an INL and DNL of 0.1623LSB and 0.2858LSB, respectively, with all codes present. A series attenuation capacitor is used to reduce the size of the circuit. Since processing variations can change the value of this capacitor and degrade the ADC operation, it was designed to vary between 401.7 fF to 487.5 fF using five digital input bits. Without process variations, the optimal variable capacitor code was designed to be the middle code, “10000”.

Presentation #4 Part 2: High-Speed Sigma-Delta ADC with Interleaving for Applications in Imaging Systems

In search of further improvements in elecotronic system, there is large interest in increasing the bandwidth of Analog-to-Digital Converters (ADC). For example, in imaging systems using single ADC to read every pixel will remove column errors and make calibration much easier. In RF system using fast ADC will ultimately allow for direct conversion, which in turn will allow removal of many sensitive components in the system. At the same time such wide-bandwidth ADC must be competitive with current state-of-the-art converters in terms of power and size. The proposed ADC will be based on time interleaved approach. Most of the interleaved approaches suffer from signal to noise degradation due to channel mismatches. Proposed technique will use Sigma-Delta ADC with interleaving done after the conversion. This technique allows simple channel mismatch cancellation, therefore allowing it to use larger number of channels.

Presentation #5 Part 1: Fully-Integrated CMOS Distributed Amplifier as Tunable UWB Active Duplexer/Circulator for Wireless Transceiver Applications

The interest in high level integration and multi-functional sub-systems motivates the development of wideband fully-integrated CMOS bidirectional distributed amplifiers for wireless transceiver applications. Driven by the demand of low-cost and compact mobile devices, fully-integrated design techniques are required to address linearity improvements for radio over fiber transmitters and phase shifting in multi-band multiple-antenna wireless communication systems. The proposed fully-integrated CMOS bidirectional DA based tunable active duplexer/circulator has broadband gain and high isolation response in the reverse gain direction over ultra-wide bandwidth of operation in a relatively small silicon area and in a manner that eliminates the need for off-chip discrete components.

Presentation #5 Part 2: Very Large BW Coplanar Waveguide Balun for Connecting Differential Laser Drivers to Single-Ended Lasers

In optical transmitters, laser drivers are usually designed using differential structures to improve the switching speed and signal quality. In order to fully utilize the driving capability of a laser driver and to improve the linearity, a balun needs to be inserted for converting the differential output of the laser driver to the input of a single-ended laser. This wok is going to present a technique which allows designing a balun with very large bandwidth, which makes it suitable for various radio-over-fiber applications. A planar wideband balun has been designed for operating over 1-7GHz. It uses coplanar waveguide with ground plane (CPWG) as the coupled line structure to provide tight coupling by shielding the center line from the ground. The wide bandwidth is achieved by the combination of a wideband impedance matching L-section and multiple stages of $\lambda/4$ step transformer. Results show that better than −20dB return loss can be observed from 1 to 7.5GHz, and the phase error of the balanced output is less than 4° from dc to 7.2GHz.

About the CPFR

The Centre for Photonics Fabrication Research (CPFR), was established at Carleton University in March 2005 with ORDCF funding from the Ontario Ministry of Research and Innovation (MRI). The Principal Investigator responsible for the CPFR is Dr. Samy Mahmoud, Professor at the Department of Systems and Computer Engineering, Carleton University. The main objective of the CPFR is to establish research and training projects in photonics and optoelectronics involving design, fabrication and testing of novel photonic components and subsystems. These projects are intended to enable collaboration among university researchers and industry partners and result in innovative designs of application-specific photonic components and subsystems for fabrication in facilities based in Ontario Universities and the Canadian Photonics Fabrication Research Centre. To date the CPFR funded 22 photonics research and training projects:

- Seventeen research projects at Carleton, McMaster, Ottawa, York and Ryerson Universities
- Three hands-on photonics fabrication training workshops (at Carleton University Microfab and the CPFC) for Algonquin students enrolled in Algonquin College photonics program
- Two hands-on photonics fabrication training workshops for Graduate students involved in photonics research in Ontario Universities. These are based at Carleton University Microfab, the CPFC and McMaster University CEDT (Centre for Emerging Device Technologies).