8ste FirW Doctoraatssymposium

Papers 2006

**Mechanics**
001 Design of composite material for cost effective large scale production of components for floating offshore structures
Chris Blommaert

002 Characterization of refrigerant two-phase flow for air-conditioning applications
Hugo Canièrè

003 Humidity control by solar heated desiccant wheel in Cuba
Tania Carbonell Morales

004 Optical fibres and electrical resistance measurement for in-situ monitoring of composite fatigue
Ives De Baere, Wim Van Paepegem and Joris Degrieck

005 Damage behaviour of composite systems under biaxial fatigue loading
Ebrahim Lamkanfi and Wim Van Paepegem

006 Forces, Moments and Motions Induced by the Vicinity of Banks on a Sailing Vessel
Evert Lataire

007 Mechanical properties, microstructure and IASCC susceptibility of Stainless Steels with different SFE
Xiaoqiang Li, A. Al Mazouzi and P. Verleysen

008 Experimental characterisation of the impact behaviour of fibre reinforced thermoplastics for aerospace applications
Alexander Montjens, Joris Degrieck and Wim Van Paepegem

009 Vibration reduction using dynamic absorbers
Frits Petit, Mia Loccufier and Dirk Aeyels

010 A comparative economical analysis of different methods to size cogeneration plant
Julio Vaillant Rebollar

011 Coupling CFD with a pyrolysis model as tool for fire engineering
Karim Van Maele

012 Development of high-performance artificial turf for soccer applications
Rudy Verhelst

**Applied Physics**
013 Plasma technology for surface engineering and biomedical applications
Alec De Kyuper

014 Comparison of quantification and image degrading factors for different iodine isotopes (I-123, I-124 and I-131)
Erwann Rault, Stefaan Vandenberghe, Roel Van Holen, Jan De Beenhouwer and Ignace Lemahieu

015 Performance of tungsten materials under ITER relevant thermal loads
Inge Uytdenhouwen, Guido Van Oost, Marc Decréton and Jochen Linke

016 Mn-doped zinc silicate thin films made with sol-gel technology for electroluminescent displays.
Karel Vanbesien, Philippe Smet, Dirk Poelman and Patrick De Visschere

**Photonics**
017 All-optical flip-flop employing a DFB-SOA optical
Wouter D'Oosterlinck
<table>
<thead>
<tr>
<th>018</th>
<th>Optical Biosensor based on Silicon-on-Insulator Microring Resonators for Specific Protein Binding Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Katrien De Vos</td>
</tr>
<tr>
<td>019</td>
<td>A Nanophotonic NEMS-modulator in Silicon-on-Insulator</td>
</tr>
<tr>
<td></td>
<td>Joris Roels, Iwijn De Vlaminck, Dries Van Thourhout, Liesbeth Lagae, Dirk Taillaert and Roel Baets</td>
</tr>
<tr>
<td>020</td>
<td>Focused ion beam for Photonics: A new versatile fabrication method</td>
</tr>
<tr>
<td></td>
<td>Jonathan Schrauwen, Dries Van Thourhout and Roel Baets</td>
</tr>
</tbody>
</table>

**Mathematics**

<table>
<thead>
<tr>
<th>021</th>
<th>Reduced Memory Watershed Segmentation Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Johan De Bock</td>
</tr>
<tr>
<td>022</td>
<td>Modelling the dynamics of cluster formation</td>
</tr>
<tr>
<td></td>
<td>Filip De Smet and Dirk Aeyels</td>
</tr>
</tbody>
</table>

**Industrial Management**

<table>
<thead>
<tr>
<th>023</th>
<th>Cyclic volume planning and fair share mix decisions, delivering a robust service level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frank Van den broecke</td>
</tr>
</tbody>
</table>

**Civil & Structural Engineering**

<table>
<thead>
<tr>
<th>024</th>
<th>Optimal pattern of interacting wave power devices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Charlotte Beels</td>
</tr>
<tr>
<td>025</td>
<td>Numerical modelling of wave energy absorption by a floating point absorber system</td>
</tr>
<tr>
<td></td>
<td>Griet De Backer, Marc Vantorre and Julien De Rouck</td>
</tr>
<tr>
<td>026</td>
<td>A New Hydraulic Model of the Left Ventricle for the Assessment of Wall Deformation</td>
</tr>
<tr>
<td></td>
<td>Benjamin Van Der Smissen</td>
</tr>
<tr>
<td>027</td>
<td>Reactivity of fly ash cement binders</td>
</tr>
<tr>
<td></td>
<td>Gert Baert, Geert De Schutter, Serge Hoste and Nele de Belie</td>
</tr>
</tbody>
</table>

**Architecture**

<table>
<thead>
<tr>
<th>028</th>
<th>Steel: History and Influence of Innovations and Experiments on Belgian Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kris Coene</td>
</tr>
<tr>
<td>029</td>
<td>Indirect Evaporative Cooling: Interaction between Thermal Performance and Room Moisture Balance</td>
</tr>
<tr>
<td></td>
<td>Marijke Steeman, Arnold Janssens and Michel De Paepe</td>
</tr>
<tr>
<td>030</td>
<td>Typology of the school building</td>
</tr>
<tr>
<td></td>
<td>Maarten Van Den Driessche</td>
</tr>
</tbody>
</table>

**Electrical Engineering**

<table>
<thead>
<tr>
<th>031</th>
<th>Vibrations in magnetic cores due to magnetic forces and magnetostriction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tom G. D. Hilgert, Lieven Vandevelde and Jan A. A. Melkebeek</td>
</tr>
<tr>
<td>032</td>
<td>Interaction of Converter-Connected Distributed Generation Units with Grid Voltage Dips</td>
</tr>
<tr>
<td></td>
<td>Bert Renders</td>
</tr>
<tr>
<td>033</td>
<td>Two-level model for the evaluation of hysteresis in</td>
</tr>
<tr>
<td></td>
<td>Van de Wiele Ben</td>
</tr>
<tr>
<td>034</td>
<td>Direct Torque Control of Permanent Magnet Synchronous Machines</td>
</tr>
<tr>
<td></td>
<td>Thomas J. Vyncke</td>
</tr>
</tbody>
</table>
Biomedical Engineering
035 Co-recording of EEG and fMRI data: EEG artifact removal
   Asseffodi Sara
036 Numerical Assessment of the Influence of a Flow Wire on its Measured Maximum Velocity
   Wim Hillewaert, Piet Claus, Guy Mareels, Pascal Verdonck, Paul Devos and Patrick Segers
037 Challenges in realizing vascular fluid-structure-interaction using Fluent and Abaqus software
   Lieve Lanoye, Jan Vierendeels, Patrick Segers and Pascal Verdonck
038 Assessment of strategies to improve oxygen availability in the AMC bioartificial liver using CFD
   Guy Mareels, Paul P. C. Poyck, Sunny Eloit, Robert A. F. M. Chamuleau and Pascal Verdonck

Chemical Engineering
039 Ab initio modeling of the oxidation of hydrocarbons over metal oxide catalysts
   Konstantinos Alexopoulos
040 Single Event Microkinetic Modeling for Hydroprocessing of n-alkanes: Role of catalyst descriptor in optimizing shape selective catalyst design
   I. Roy Choudhury, Joris W. Thybaut and Guy B. Marin
041 Catalytic Reaction Network Elucidation from Noisy Transient Kinetic Data
   Raie Roelant
042 Kinetic Modeling of steam cracking
   Maarten K. Sabbe
043 Single event microkinetics of hydrocarbon cracking on acid catalysts
   Rhona Van Borm
044 Fundamental kinetic model for the suspension polymerization of vinyl chloride
   Joris Wieme

Material Sciences
045 On the formation of Cr-rich precipitates in FeCr
   Giovanni Bonny, Dmitri Terentyev and Lorenzo Malerba
046 Behaviour and modelling of multiphase TRIP steels
   J. Bouquerel and J. Van Slycken
047 Simulation of the weft insertion on airjet and rapier looms
   Simon De Meulemeester
048 Design of textile antennas for smart clothing
   Carla Hertleer, Hendrik Rogier and Lieva Van Langenhove
049 Advanced experimental techniques for the comprehension of hardening and embrittlement mechanisms in RPV-steels
   Marlies Lambrecht, A. Al Mazouzi and Yvan Houbaert
050 Microstructure and mechanical properties of n-irradiated Fe-Cr model alloys and steels
   Milena Matijasevic, A. Al Mazouzi and Patricia Verleysen
051 ADS-candidate materials compatibility with Pb-Bi in n-irradiation environment
   Joris Van den Bosch, A. Al Mazouzi and Joris Degrieck

Electronics
052 Fabrication of Elastic Electronic Circuits
   Dominique Brosteaux
<table>
<thead>
<tr>
<th>Paper Number</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>053</td>
<td>FPGA Architectures for Fast Circuit Compilation</td>
<td>Karel Bruneel</td>
</tr>
<tr>
<td>054</td>
<td>Improvement of copper adhesion by chemical modification of epoxy</td>
<td>Bert De Roo, Alfons Vervaet, Etienne Schacht, An Gielen, Johan De Baets and André Van Calster</td>
</tr>
<tr>
<td>055</td>
<td>Synthesis of reversible circuits</td>
<td>Yvan Van Rentergem and Alexis De Vos</td>
</tr>
<tr>
<td>056</td>
<td>Dynamic thermal simulation and modelling of micro- and nano-electronics</td>
<td>Bjorn Vermeersch</td>
</tr>
<tr>
<td>057</td>
<td>Advanced Techniques for Automated Linux Kernel Memory Footprint</td>
<td>Dominique Chanet</td>
</tr>
<tr>
<td>058</td>
<td>Analysis of Runtime Implementation Switching in OSGi Based Applications</td>
<td>Raf Hens</td>
</tr>
<tr>
<td>059</td>
<td>Performance estimation of applications using microarchitecture-</td>
<td>Kenneth Hoste, Lieven Eeckhout and Koen De Bosschere</td>
</tr>
<tr>
<td></td>
<td>independent characteristics</td>
<td></td>
</tr>
<tr>
<td>060</td>
<td>Information Systems on Mathematical Foundations - Turning Software</td>
<td>David Matthys</td>
</tr>
<tr>
<td></td>
<td>Development into Software Engineering</td>
<td></td>
</tr>
<tr>
<td>061</td>
<td>Dimensioning of IP Networks for Transport of Unicast/Multicast TV</td>
<td>Zlatka Avramova, Sabine Wittevrongel, Herwig Bruneel and Danny De Vleeschauwer</td>
</tr>
<tr>
<td></td>
<td>Channels</td>
<td></td>
</tr>
<tr>
<td>062</td>
<td>Hybrid Optical Switching as an Enabling Technology for Next</td>
<td>Jurgen Baert, Marc De Leenheer, Chris Develder, Bart Dhoedt, Filip De Turck and Piet Demeester</td>
</tr>
<tr>
<td></td>
<td>Generation Service Grids</td>
<td></td>
</tr>
<tr>
<td>063</td>
<td>Cross-layer Architecture and Optimizations in Hybrid Wireless Mesh</td>
<td>Stefan Bouckaert, Ingrid Moerman and Piet Demeester</td>
</tr>
<tr>
<td></td>
<td>Networks</td>
<td></td>
</tr>
<tr>
<td>064</td>
<td>Burst-mode Receivers for Long-reach Amplified Optical Networks at 10</td>
<td>Tine De Ridder, Peter Ossieur, Xing-Zhi Qiu and Jan Vandewege</td>
</tr>
<tr>
<td></td>
<td>Gbit/s</td>
<td></td>
</tr>
<tr>
<td>065</td>
<td>Predicting the Performance of Reconfigurable Interconnects in Shared-</td>
<td>Wim Heirman, Joni Dambre and Jan Van Campenhout</td>
</tr>
<tr>
<td></td>
<td>Memory Systems</td>
<td></td>
</tr>
<tr>
<td>066</td>
<td>Micromobility Support and Resource Reservations in IP-based Access</td>
<td>Liesbeth Peters</td>
</tr>
<tr>
<td></td>
<td>Networks</td>
<td></td>
</tr>
<tr>
<td>067</td>
<td>Resilience in all-optical label switching networks: a node dimensioning</td>
<td>Ruth Van Caenegem, Didier Colle, Mario Pickavet and Piet Demeester</td>
</tr>
<tr>
<td></td>
<td>point of view</td>
<td></td>
</tr>
<tr>
<td>068</td>
<td>Data-aided channel estimation in a multipath fading environment</td>
<td>Dieter Van Welden</td>
</tr>
<tr>
<td>069</td>
<td>Optical Interconnects embedded in flexible substrates</td>
<td>Erwin Bosman, Wim Christiaens, Peter Geerinck, Geert Van Steenberge,</td>
</tr>
</tbody>
</table>
Jan Vanfleteren and Peter Van Daele
070 A Framework for Parallel Event Driven Simulation of Large Spiking Neural Networks
Michiel D'Haene
071 Broadband over Powerline
Els De Backer, Johan Bauwelincx, Xing-Zhi Qiu and Jan Vandeweghe
072 Video Shot Detection on H.264/AVC Compressed Bitstreams Using Temporal Prediction Types
Sarah De Bruyne
073 Requantization techniques for H.264/AVC rate reduction transcoding
Jan De Cock and Stijn Notebaert
074 Increasing the efficiency of beam tracing for noise mapping
Bram de Greve
075 Performance Analysis of Retransmission Protocols in a Wireless Environment
Koen De Turck
076 Towards an end-to-end QoS enabled overlay multicast platform
Bart De Vleeschauwer
077 Applying unequal error protection in H.264 by means of flexible macroblock ordering
Yves Dhondt
078 Parallel Multilevel Fast Multipole Algorithm for GRID computing allowing Full-Wave Electromagnetic Simulations
Jan Fostier and Femke Olyslager
079 Workload reduction for multiprogrammed workloads running on multithreaded processors
Filip Hellebaut
080 Halftoning with Grid Diffusion
Stefaan Lippens and Wilfried Philips
081 Digital Reconstruction Of Degraded Low Resolution Images
Hi Luong and Wilfried Philips
082 Data partitioning in H.264/AVC: a performance evaluation
Stefaan Mys and Rik Van de Walle
083 Quality assessment of MPEG-2 to H.264/AVC intra transcoding architectures
Stijn Notebaert and Jan De Cock
084 Motion Compensation and Reconstruction of H.264/AVC-coded Pictures using the GPU
Bart Pieters, Dieter Van Rijsselsbergen and Wesley De Neve
085 Robust moving object detection in video surveillance applications
Chris Poppe
086 Intersubband Error Concealment for Subband Coded Images
Joost Rombaut and Wilfried Philips
087 Function Level Parallelism Lead by Data Dependencies
Sean Rul and Hans Vandierendonck
088 Anycast Routing Algorithms for Effective Job Scheduling in Optical Grids
Tim Stevens and Marc De Leenheer
089 Phonological Features for Automatic Speech Recognition
Frederik Stouten
090 Characterizing the industrial wireless channel at practical frequencies
Emmeric Tanghe, Wout Joseph and Luc Martens
091 An exact 2.5D BiCGS-FFT forward solver to model electromagnetic scattering in an active millimeter wave imaging system
Sara Van den Bulcke and Ann Franchois

092 Automatic Generation of generic Bitstream Syntax Descriptions using gBFavor
   Davy Van Deursen

093 Automatic Generation of Synthetic Benchmarks
   Luk Van Ertvelde, Lieven Eeckhout and Koen De Bosschere

094 AmplifyingWaveguide Optical Isolator
   Wouter Van Parys, Dries Van Thourhout and Roel Baets

095 Identification of Parallel Program Phase Behavior
   Frederik Vandeputte, Lieven Eeckhout and Koen De Bosschere
Optical interconnections embedded in flexible substrates

Erwin Bosman

Supervisor(s): Prof. Dr. Ir. Peter Van Daele (1), Prof. Dr. Ir. Jan Vanfleteren (2)
(1) Ghent University – Department INTEC, (2) Ghent University – Department ELIS
TFCG-Microsystems, Technologiepark Building 914A, 9052 Zwijnaarde

Abstract — Optical data transmission has become the obvious choice for communication over long distances, but new trends force the designers to use optical interconnections also to bridge short distances. This results in the integration of these interconnections on the printed circuit boards. Flexible substrates have the extra advantage of being lighter, more reliable and assembly-friendly and are therefore becoming increasingly important.

This paper combines both trends by embedding optical waveguides, interconnections and opto-electronic chips in flexible substrates. These optical structures are stacked between two Polyimide layers, which increases the mechanical stability and the reliability. Different optical materials have been studied (Truemode™ Backplane Polymer, Ormocer® and Epoxies) as well as different techniques for applying the Polyimide layers (spin-coating and lamination).

Ongoing research focuses on the embedding of opto-electronic components, the electronic assembly on top of the Polyimide layers and the mechanical- and optical characterization of the flexible structure.

Keywords — flexible, interconnection, Optical, Polyimide, waveguide

I. INTRODUCTION

The ever increasing telecommunication sector results in a continuously growing demand for higher communication speeds and data-rates, forcing the step towards optical data transmission. This step is already established for long distance communication, but the increasing density and integration of electronic components on boards forces the market to integrate optical interconnections on the boards.

Together with this trend, the demand for flexible substrates for electronic applications has doubled in the last 5 years [1]. Because of their flexible behavior, the use of these substrates can significantly lower the over-all substrate thickness and weight. Moreover they can ease the assembly, increase the module compactness and can be applied to a curved surface, and even to a dynamic one.

Both increasing trends and needs will result in applications which combine the advantages of optical interconnections and flexible substrate technologies.

This paper focuses on the fabrication of flexible substrates with embedded active opto-electronic components and passive optical interconnections based on multimode waveguides, 45°-turning mirrors and aligning structures.

Different commercially available optical materials were studied, and both a Polyimide foil and a spin-coated Polyimide film is used as flexible substrate. The definition of the optical waveguides, micro-mirrors and aligning structures is done by photolithography and laser ablation. Later on, the fabrication of a proof-of-principal demonstrator is intended, in means of a functional alone-standing opto-electrical flexible module.

II. MATERIALS

The material for the optical transmission medium needs to show low light propagation losses for the common wavelengths for data communication (850 nm) and telecommunication (1.3 or 1.55 µm) and must have the right properties in means of UV-crosslinking ability, spin-coating, temperature- and chemical resistance and mechanical brittleness. Special care must be taken to ensure the compatibility of the material with standard flexible PCB production processes.

Truemode Backplane™ Polymer [2], Ormocer® [3] and Epocore are materials which meet these requirements and have shown good results when applied on rigid substrates in the past [5].

The material for the flexible substrate itself is Polyimide (PI) which is the dominant material in the flexible circuits industry because of its good electrical, chemical, temperature and mechanical behavior [4]. Precautionary steps had to be taken to assure the adhesion of the PI with the optical materials because of the chemical inmertness of Polyimide (PI).

III. STACKING OF OPTICAL- AND POLYIMIDE-LAYERS

The creation of waveguides consists of the stacking of an undercladding,-, core- and uppercladding layer by spin-coating. The optical materials are however not flexible and strong enough to be bended without cracking or damaging. Therefore these layers are sandwiched between two spin-coated Polyimide layers, one at the top and one at the bottom, which absorb all stress and pressure during bending, protecting the inner optical layers from breaking.

Stacking of materials with such a different chemical and mechanical behavior demands special measures like CTE (Coefficient of Thermal Expansion) matching to avoid curling and bad adhesion, and low cure-temperatures for the PI to protect the layers underneath from reaching their glass transition temperature.

As an alternative way to fabricate the stack, lamination of the optical layers between prefabricated commercially
available PI-foil was proposed and studied. This method has the advantage that the PI-foil and the optical layers can be handled and cured separately since the lamination step is one of the last steps in the process flow. A semi cured adhesive, fixed on a ceramic substrate by double-sided tape is used as a carrier for the spincoating of the optical layers and acts as a release layer later in the process by peeling of this adhesive. When creating the stack special care must be taken to ensure no outgassing of remaining solvents in underlying layers appears during cure steps.

IV. FABRICATION OF PASSIVE OPTICAL INTERCONNECTIONS

A. Fabrication of optical waveguides

Creating a core transmission channel, isolated inside a bulk cladding material with a lower refractive index results in an optical waveguide which captures the light due to total internal reflection.

This isolation can be done by patterning the core-layer with a standard photolithographic process with selective exposure of the waveguides to UV-light and in an alternative way by laser ablation, removing the core-material at both sides of the waveguide.

B. Fabrication of 45 degrees out of plane turning mirror

The data-carrying light can be vertically coupled in- and out of the waveguides with 45 degrees out of plane deflecting micro-mirrors, terminating the waveguides and connecting them with laser diodes, receivers, optical fibers, open air or optical elements. These mirrors are realized by laserablation with a Kr-F Excimer laser (248 nm wavelength) [5].

C. Fabrication of alignment structures for a proof-of-principle demonstrator

This research not only focuses on the optical assembly of flexible circuits but the combination of optical and electronic assembly on the same module. This means that the positioning of the VCSEL’s and receivers on one hand and optical fiber-arrays, optical elements and deflecting micro-mirrors on the other hand is crucial. Alignment structures like alignment holes, mechanical stand-offs and fiducials are therefore needed and fabricated using the laser ablation technique.

A proof-of-principle demonstrator will be fabricated in the future, including all the elements which have been discussed in this paper to create a standalone flexible module with embedded optical interconnections and electrical assembly on top of the Polyimide.

V. EMBEDDING OF ACTIVE OPTO-ELECTRONIC DEVICES

Experiments have been done with success to embed ultra thin dummy chips into the optical layers by implementing a cavity with photolithography. Later in the research functional optoelectronic chips, thinned down to 30 µm thickness [6], will be embedded. Micro-via’s will be ablated using a frequency tripled Nd:YAG laser (355 nm wavelength) and metallized by sputtering and plating to fan out the contacts on the top PI layer where all other electrical assembly can be done with standard flex assembly processes. The optical layers have proven to stand the temperature cycles during these processes.

VI. CONCLUSION

The increasing need for flexible modules and the integration of photonics on boards results in a challenging and competitive research which combines both needs by embedding passive optical interconnections and active optoelectronic devices on flexible Polyimide substrates. A complete autonomous opto-electrical and flexible module will be demonstrated.

REFERENCES