Call for participation on NEMO Summer School

"Technologies and Applications of Microoptics"

Location
FEMTO-ST, Département d'Optique
UFR des Sciences et Techniques
16 route de Gray, 25030 Besançon, France

Date
25 August – 5 September 2008

Local Organizing Committee
Christophe Gorecki, Chair of the School
Daniel Charraut,
Jorge Albero
Jean-Claude Jeannot

Scientific Committee
Hervé Maillotte, FEMTO
Vincent Laude, FEMTO
Malgorzata Kujawinska, WUT
Pentii Karjoja, VTT

Contact
Christophe Gorecki,
e-mail: nemo.summer-school@femto-st.fr

The course
The Summer School on "Technologies and applications of Microoptics" is a training program of NEMO network offering a unique opportunity to experience 10 intensive days of high-level teaching on topics at the heart of microoptics. This includes both highly specialized lectures and hands-on experience in the clean-room and laboratory. Various visits including high-tech companies, as well as a visit to the Institute FEMTO-ST and several social events are included in the course.

Target audience
The program is ideal for recent graduates and doctoral students in physics or engineering who wish to boost their standing in microoptical technologies. This targets the course particularly to young scientists coming from NEMO partner groups. A maximum of 16 students will be accepted for the course including lectures and laboratories.

LABORATORY	LECTURES
- technology MEMS/MOEMS for microoptics with fabrication of thermally actuated micromirror - 3D micromachining with initialisation to introduction to wire EDM, laser machining, micro-molding and rheology of moulded polymers at different temperatures - laboratory on microstructured fibers - design and /modelling for mictoptics	- micro-optics and diffractive optics - microstructured optics fibers - supercontinuum lasers -MEMS technology - micro-molding and hot-embossing - technologies of packaging for photonics - integrated optics and waveguided MOEMS - photonic crystals and photonic waveguides - microoptical sensors - modelling in micro and nanooptics

Summer School place

Besançon, the capital of Franche-Comté, is well known for its micromechanic activities. With its abundance of wide open spaces, mountains, forests and rushing waters, its architectural heritage, its fine cuisine and excellent wines, Franche-Comté offers an escape to a quality of life.
Links: http://www.citadelle.com/accueil-en.php and www.besancon.com (in French only)

Venue

Besançon is directly connected by train (TGV) to Paris.
Arrival to Lyon/Mulhouse/Genève airports is also suitable.

Registration fees

Participation to lectures+laboratories (2 weeks):

- NEMO partners: 460 €
- Not NEMO partners: 595 €

Participation only to lectures (1 week):

- NEMO partners: 250 €
- Not NEMO partners: 300 €

Contact: nemo.summer-school@femto-st.fr
This amount contains the accommodation, lunch cost and Franche-Comté trip.

Registration form

(Send to nemo.summer-school@femto-st.fr)

Last Name ....First Name ....

Research group ....

Address ....

Country ....

Tel number....................................Fax number ....

E-mail ....

Date of arrival ....Departure date ....

Payment details

• *By check in Euros* (payable in France to "Université de Franche-Comté, SAIC"), sent to:
SAIC, Direction de la Valorisation, Temis Innovation - Maison des Microtechniques
18, rue Alain Savary, 25000 Besançon, France

• *By Bank or Post transfer in Euros to the order of:*
Agent Comptable de l'Université de Franche-Comté, NEMO Summer school

Bank references:
Trésor Public, Trésorerie Générale – Quai Veil Picard, 25000 Besançon, France
Account Number: 00001002577
Key: 08
Swift (BIC): BDFEFRPPXXX
IBAN Code: FR76 1007 1250 0000 0010 0257 708

• *By Credit Card* directly at the beginning of the Summer School

• *By order form to*
Université de Franche-Comté
SAIC, Direction de la Valorisation, Temis Innovation - Maison des Microtechniques
18, rue Alain Savary, 25000 Besançon, France

All bank charges are at the sender's expense in addition to the actual registration fee.

SUMMER SCHOOL NEMO, 25 August-5 September 2008, Besançon
PROGRAM OF LECTURES

Introduction:

Introduction of research activity at FEMTO-ST, Michel de Labachelerie, Head of FEMTO-ST, France

Technical Lectures:

Introduction to Microoptics, Hans Peter Herzig, IMT-University of Neuchâtel, Switzerland

Micro-optical elements are ideal components for building compact optoelectronic systems. Typical elements are refractive and diffractive microlenses, Dammann gratings, optimized phase elements, and polarizers. Modern microfabrication technology enables the manufacturing of almost any structure shape including asymmetric aspherics, which provides all degrees of freedom for design. The lecture will introduce the base concepts to realize elements and systems. In addition, the potential and limitations of micro-optics will be discussed for selected applications.

Diffractive optics, Jani Tervo, University of Joensu, Finland

Diffractive optics has made a long route from exotic sub-field of optics to a mature technology with a large number of applications. One of the characteristics of diffractive optics has always been the need for more and more advanced manufacturing methods which enable exploitation of new optical phenomena. In addition to a general overview to the subject, the special focus of this lecture will be in the possible future applications, such as polarization and/or amplitude control by deep optical micro and nanostructures, which require further development and fine-tuning of fabrication methods. Also interaction between weakly coherent light and diffractive structures is briefly discussed.

MEMS technologies for MOEMS and Microoptics, Jan Dziuban, Wroclaw University of Technology, Poland

The technological background of the MEMS technique delivers from microelectronic procedures, adapted to meet new challenges: machining of three-dimensional micro-mechanical structures, possessing both, good electronic and mechanical properties. After relatively short period of utilization of the newly discovered micro-electro-mechanical devices as sensors, MEMS technique expanded toward fabrication of several types or micro-devices forming fascinating “small things” slowly replacing XIX Century-based technical macro-world. There are plenty of examples of products utilizing MEMS technology, among them, micro-optical-electro-mechanical (MEOMS) and micro-optical “small things” play one of the most important role. The mainstream methodology of fabrication of MEOMS and microoptical devices is taken from the MEMS technique, and, as natural consequence this methodology utilizes well know planar technological procedures for example: photolithography, thin-film layers formation, high-temperature or ion-implanted doping, wire bonding and some packaging techniques. Formation of three dimensional, microengineered parts of MEMS, MEOMS and another “small things” uses a scope of etching techniques, micromechanical bonding of sandwiched stacks of the processed wafers, and specialty packaging. Forming of microoptical components or whole systems needs another specialized method and techniques, which will be more detail discussed in the lecture. Several “smart” methods, based in part on the own experimental works will be described. Examples of MEOMSs and micro-optical devices will be shown.

Technologies of packaging for photonics, Pentti Karjoja, VTT, Oulu, Finland

In photonic module integration, optoelectronic chips, micro-optical elements and integrated circuits are integrated into functional components, sub-assemblies, modules and systems. The building blocks of the photonic system must be fabricated by the use of cost-efficient, reproducible, well-established, high-volume manufacturing technologies. The reliability of the system as well as the tolerances of device alignment are key issues in photonics integration. Two technologies are depicted with several packaging examples including a high-speed optical interconnects transceiver, fiber optic transceiver and plastic integrated macro lens module.

For high performance systems, Low Temperature Co-fired Ceramics (LTCC) technology provides powerful tools for photonic integration and for high-volume applications, plastic integration is more cost efficient technology. In LTCC, the primary aim is to process co-fired 3D structures, such as, grooves, cavities, holes, bumps and alignment fiducials for the passive alignment of photonic devices. LTCC provides means for full 3D integration. The tolerances of the alignment structures are typically ±5µm and in some specific cases ±2µm. LTCC structures provide means for the passive alignment of multimode fiber, for example. With Monte-Carlo tolerancing tools, we can simulate and optimize the performance of the system and estimate manufacturing yield in volume production. Thermal management by the use of thermal vias is a well-established technique; liquid cooling channels in the LTCC substrate provide efficient means for high-power laser cooling. LTCC provides inherently hermetic substrate allowing the possibility for hermetic encapsulation. High-speed ICs as well as millimeter-wave circuits can easily be integrated into the LTCC substrate. Novel materials allow the fabrication of advanced systems, especially, for millimeter-wave operation.

Integrated Optics and MEMS: a good marriage, Christophe Gorecki, FEMTO-ST, France

Silicon micromachining have the advantage of small scale and easy integration with electronic circuits and sensors, resulting in the production of miniaturized and smart microsystems with moving parts. The size of MEMS/MOEMS devices is immediately compatible with the size of integrated optics (IO), and is appropriate to control or manipulate optical radiations. This technology is therefore suitable to fabricate precision-defined optical components and offers a relative easy alignment procedures of optical parts. This paper examines the contribution of micromachined structures in the specific context of optical fiber sensing technology as well as optical telecommunication devices. A number of demonstrator sensors will be discussed, with special emphasis to sensors with micromachined IO structures, optical MEMS gyrometers and accelerometers, nano-scale SNOM sensors, and fiber IO circuits coupling systems.

Photonic crystals and photonic waveguides Maria Pilar Bernal, FEMTO-ST, France

Many of the true breakthroughs in our technology have resulted from a deeper understanding of the properties of the materials. One of this 20th century achievements has been the control of the electrical properties in the materials. Thus, advances in the semiconductor physics have allowed us to tailor the conducting properties of some materials initiating the transistor revolution in the field of electronics. In the last decade, scientists have focused their efforts in a parallel goal: the complete control of the materials optical properties. These optical materials are commonly known as photonic crystals and are capable of prohibit light propagation or to allow it in certain directions at certain frequencies as well as to localize light in extremely small specific areas. In order to understand what short of material can afford us complete control over light propagation one must rely on the analogy with the electronic materials. In the optical case, the “periodic” potential appears due to the creation of a lattice of macroscopic dielectric media instead of atoms. Fibre optics, lasers, high speed computers and spectroscopy are just a few of the domains in which enormous progress are and will be done from the advances of photonic crystals.

The course will provide with a brief and comprehensive description of light propagation in photonic crystals and the original properties like optical confinement, guiding, ultra refraction, frequency conversion etc. The core of the course on photonic crystals will be devoted to the different nanofabrication techniques, the different characterisation techniques and to the most relevant state-of-the art applications.

Microstructured optics fibers: fundamental&applications, John Dudley, FEMTO-ST, France

This lecture will describe the basic features and propagation characteristics of microstructured (photonic crystal) optical fibres. Emphasis will be placed on the engineering design freedom of their nonlinear and dispersive properties, and both solid core and hollow core fibres will be discussed. A basic survey of their nonlinear properties will be provided and the basic nonlinear optical processes in fibres will be reviewed. This will serve as a prerequisite for the subsequent detailed lecture on practical supercontinuum sources.

Supercontinuum lasers: from implementing to nonlinear aspects, Thibaut Sylvestre, FEMTO-ST, France

Broadband optical supercontinuum (SC) sources continue to attract intense research interest because of their numerous important applications in domains ranging from optical frequency metrology to biophotonic imaging. This lecture is devoted to SC generation based on conventional or photonic crystal fibers and with a special attention to the nanosecond and continuous-wave pumping scheme that can lead to very high spectral power density.

Modelling in micro and nanooptics, Fadi Baida/Brahim Guizal, FEMTO-ST, France

An introduction to some numerical methods used in modelling micro/nano-optical devices will be proposed. We will focus on two main methods that are complementary in nature: the first is the Finite Difference Time Domain that works by solving Maxwell's equations in direct space and in time. The second is the Fourier Modal Method tailored to treat diffraction problems from gratings (but can be generalized to non periodic structures) and works by solving harmonic Maxwell equations in the Fourier space. After the principles of the two methods are given, some applications will be proposed in order to show the potentialities of each one. Finally, a computer session will be organized to put in practice the above theory.

Selected microoptical sensors, Timo Mappes, IMT-University of Karlsruhe, Germany

The lecture presents different approaches to build micro optical sensors. Therefore selected examples of micro optical sensors for a broad field of applications are presented, ranging from distance sensors to biophotonic and optofluidic devices.

Advantages and limits of the micro optical elements used in these sensors are discussed.

Integration of micro optical elements and electro optical detectors or light sources are shown. The combination of micro optical benches and electro optical boards are presented as well as highly integrated optics in monolithic micro optical sensor devices.

Laser direct-writing of micro-optics, Mick Withford, Macquarie Univ/CUDOS, Australia

High intensity lasers are being increasingly used to produce a diverse range of micro-optical devices. This talk will review direct-writing methods, where tightly focussed laser beams are used to either remove, redistribute or modify optical materials. Particular emphasis will be placed on the new field: ultrafast laser fabrication of embedded lightwave devices.

Lithographic Fabrication Techniques for Micro- and Nano-Optics, Uwe Zeitner, Fraunhofer Institute of Applied Optics and Precision Engineering, Germany

Since the beginning of micro-optics fabrication most of the technologies used for origination of structures have been adapted from or are related to semiconductor fabrication techniques. These are widely known and the special microelectronics fabrication tools, especially lithography machines, are available at numerous places. In the presentation the special demands of optical microstructures on the fabrication technologies will be discussed and common realization approaches such as binary-, multi-level, and continuous profile fabrication are introduced. The features of state-of-the-art micro- and nano-optics fabrication tools will be presented.

Micromolding and hot-embossing, Mathias Heckele, IMT/FZK University of Karlsruhe, Germany

Plastic replication is an important fabrication technology for micro parts and microstructured components. The large variety of polymers with outstanding properties makes these technologies interesting for different applications from micro fluidics, micro optics up to high temperature or harsh environment applications.

The presentation will give an overview about the main replication technologies for plastic micro structuring as injection moulding, thermoforming and hot embossing. How do they work, where are the differences to the macro world and what are typical applications.

A closer look will be made on the hot embossing, as a technology which is mainly used for micro structuring. In hot embossing, a microstructured tool (mold insert) in an evacuated chamber is pressed with high force into a thermoplastic foil that has been heated above its softening temperature. The mold insert is filled by the plastic material that replicates the microstructures in detail. Then, the setup is cooled down and the mold insert is withdrawn from the plastic. This technology is not only suitable for the fabrication of fast first prototypes from a multitude of micro structured mold inserts. The low forming speed allows the replication of high micro structures with large aspect ratio. It is also possible to structure multi layers from polymers with different properties, e.g. for optical wave guides. Furthermore the integration of metallic layers into polymer microstructures by hot embossing is feasible.