SSOM

Swiss Society for Optics and Microscopy

Société Suisse pour l'Optique et la Microscopie

Schweizerische Gesellschaft für Optik und Mikroskopie

Mitteilungsblatt/Bulletin d'information 3/2007

Change of President

Good bye
and
thank you !

Kurt
Pulfer

Wellcome
and
good luck !

Markus
Dürrenberger

SWISS SOCIETY FOR OPTICS AND MICROSCOPY

www.ssom.ch (services : username "ssom", password "engelberg")

BOARD MEMBERS 2007 - 2009

President

Dr. Markus Dürrenberger
Zentrum für Mikroskopie ZMB,Bio-Pharmazentrum
Universität Basel, Klingelbergstrasse 50/70
CH-4056 Basel
Tel. +41 61 267 14 04, Fax +41 61 267 20 78
markus.duerrenberger@unibas.ch

Treasurer

Gianni Morson
Zentrum für Mikroskopie ZMB, Bio-Pharmazentrum
Universität Basel, Klingelbergstrasse 50/70
CH-4056 Basel
Tel. +41 61 267 14 06, Fax +41 61 267 14 10
gianni.morson@unibas.ch

Redactor

Dr. Reto Holzner
Apfelbaumstrasse 2
CH-8050 Zürich
Tel. +41 44 312 15 63
reto.holzner@hispeed.ch

Webmaster

Daniel Mathys
Zentrum für Mikroskopie ZMB, Bio-Pharmazentrum
Universität Basel, Klingelbergstrasse 50/70
CH-4056 Basel,
Tel. +41 61 267 14 01, Fax +41 61 267 14 10
daniel.mathys@unibas.ch

Optics Section Vice President

Prof. Dr. Hans Peter Herzig
Institut de Microtechnique
Rue A.-L. Breguet 2
CH-2000 Neuchâtel
Tel. +41 32 718 32 70, Fax +41 32 718 32 01
hanspeter.herzig@unine.ch

Microscopy Section Vice President

Dr. Sousan Abolhassani
Laboratory for Materials Behaviour
Paul Scherrer Institut
CH-5232 Villigen PSI
Tel. +41 56 310 21 91, Fax +41 56 310 22 05
sousan.abolhassani@psi.ch

Nanotechnology Section Vice President

PD Dr. Harry Heinzelmann
CSEM, Nanoscale Technology &
Biochemical Sensing, Jaquet-Droz 1
CH-2007 Neuchâtel
Tel. +41 32 720 55 33, Fax +41 32 720 57 50
harry.heinzelmann@csem.ch

Optics Section Board

Dr. Markus Rossi
Heptagon Oy, Moosstrasse 2
CH-8803 Rüschlikon
Tel. +41 44 497 30 03, Mob.+41 79 470 24 91
Fax +41 44 497 30 01
markus.rossi@heptagon.fi

Prof. Dr. Markus W. Sigrist
Institut für Quantenelektronik
ETH-Hönggerberg HPF D 19
CH-8093 Zürich
Tel. +41 44 633 22 89, Fax +41 44 633 10 77
sigrist@iqe.phys.ethz.ch

Dr. Berthold Schmidt
Bookham Switzerland AG, Binzstrasse 17
CH-8045 Zurich
Tel. +41 44 455 85 94, Fax +41 44 455 85 86,
berthold.schmidt@bookham.com

Dr. Guy Delacrétaz
Laboratoire d'Optique Appliquée
EPFL STI IOA LOA
CH-1015 Lausanne
Tel. +41 21 693 51 84, Fax +41 21 693 37 01
guy.delacretaz@epfl.ch

Beat Neuenschwander
Institut für angewandte Lasertechnik IALT
Berner Fachhochschule, Pestalozzistrasse 20
CH-3400 Burgdorf
Tel. +41 34 426 42 20,Fax +41 34 423 15 13
beat.neuenschwander@bfh.ch

Martin Forrer
Fisba Optik AG
Rorschacher Str. 268
CH-9016 St.Gallen
Tel. +41 71 282 31 81, Fax +41 71 282 33 02
martin.forrer@fisba.ch

Microscopy Section Boad

Dr. Patrick Schwarb
Maulbeerstrasse 66
WRO-1066.2.16
CH-4058 Basel
Tel. +41 61 6975172, Fax +41 79 353 49 65
patrick.schwarb@fmi.ch

Dr. Heinz Gross
Elektronenmikroskopie-Zentrum der ETH
Zürich, c/o Institut für angewandte Physik
CH-8093 Zürich
Tel. +41 44 633 33 04, Fax +41 44 633 11 05
heinz.gross@iap.phys.ethz.ch

Prof. Dr. Lukas Landmann
Universität Basel, Anatomisches Institut
Pestalozzistr. 20, CH-4056 Basel
Tel: +41 61 267 39 33, Fax +41 61 267 39 59,
lukas.landmann@unibas.ch

Dr. Robin Schäublin
EPFL SB CRPP Groupe Matériaux
P.a. Paul Scherrer Institut, ODGA
CH-5232 Villingen-PSI
Tel. +41 56 310 40 82, Fax +41 56 310 45 29
robin.schaeublin@psi.ch

Matthias Ochs
Universität Bern, Institut für Anatomie,
Baltzerstrasse 2
CH-3000 Bern 9
Tel. +41 31 631 46 24, Fax +41 31 631 38 07
ochs@ana.unibe.ch

Marco Cantoni
EPFL SB CIME-GE
MXC 135 (Bâtiment MXC) , Station 12
CH-1015 Lausanne
Tel: +41 21 693 48 16
marco.cantoni@epfl.ch

Nanotechnology Section Board

Prof.Dr. Christian Schönenberger
Institut für Physik, Universität Basel
Klingelbergstrasse 82
CH- 4056 Basel
Tel: +41 61 267 36 90 , Fax +41 61 267 37 84
christian.schoenenberger@unibas.ch

Dr. Jens Gobrecht
Paul Scherrer Institute
Laboratory for Micro- and Nanotechnology
CH - 5232 Villigen-PSI
Tel: +41 56 310 2529
jens.gobrecht@psi.ch

Biomedical Photonics working group

PD Dr. Martin Wolf
Clinic of Neonatology, University Hospital
Zurich, Frauenklinikstr. 10
CH-8091 Zürich
Tel: +41 44 255 53 46, Fax +41 44 255 44 42
martin.wolf@alumni.ethz.ch

Table of content

From the president

Dear member,

The general assembly of the SSOM took place at 12th of September in Basel. We could award three prices to four young scientists (the SSOM-price was devided). At this place, congratulations to the winners and thanks to the founders (LEICA Geosystems and GMP). The winners and an abstract of their work will be presented in this issue.

We also had some business to do: the new constitution was accepted and the elections according to the new constitution took place. I would like to thank all the board members that resigned for their great work they did for our society. The new board members elected I would like to welcome. They will be presented in the next issue.
Also your president has changed. Many thanks to Kurt Pulfer for his performances for the SSOM. Thanks to you for the credit electing me as your new president. In the next issue I will also present a short CV.

After having a new constitution, my task will be to restructure the SSOM according to the ideas formulated in the constitution. This has to be done until mid of January 2008.

One of the big problems of the SSOM is also the shrinkage of the number of members. We will have to analyze the reasons why and then try to take measures to counteract.

At the end of my editorial I would like to encourage you to take actively part in the events of our society. An updated version of events you will always find on our homepage: www.ssom.ch

With kind regards

Markus Dürrenberger
President SSOM

Motivation and brief history

In the recent years, a number of new competence networks and platforms , *e.g.* OptecNet Deutschland e.V. [1] ("the net of the networks"), the European laboratory platform Laserlab Europe or the European technology platform Photonics21 [3] have been founded in the field of optics. To keep up with these developments, particularly in the field of laser materials processing and of power photonics, a few research teams from different Universities and Universities of Applied Sciences (Fachhochschulen / Haute Écoles Spécialisée) initiated a first meeting in the summer of 2005. Apart from getting to know each other, the meeting demonstrated a clear need for a stronger collaboration between these institutions. All of the participating institutions were too small to play a major role in the continuously changing European environment. The bundling of the different partner energies should improve their position toward a stronger collaboration with industries and national or international organisations and networks.

At the same time, the KTI/CTI started its "excellence in cooperation" initiative and started its support for R&D consortia. The idea of a SwissLaserNet SLN as a society, now with participation of the industry, was soon formed in follow up meetings. Finally, the KTI/CTI consortium was accredited on November 16th 2006 and the society SwissLaser Net [4] was officially founded on November 21th, 2006.

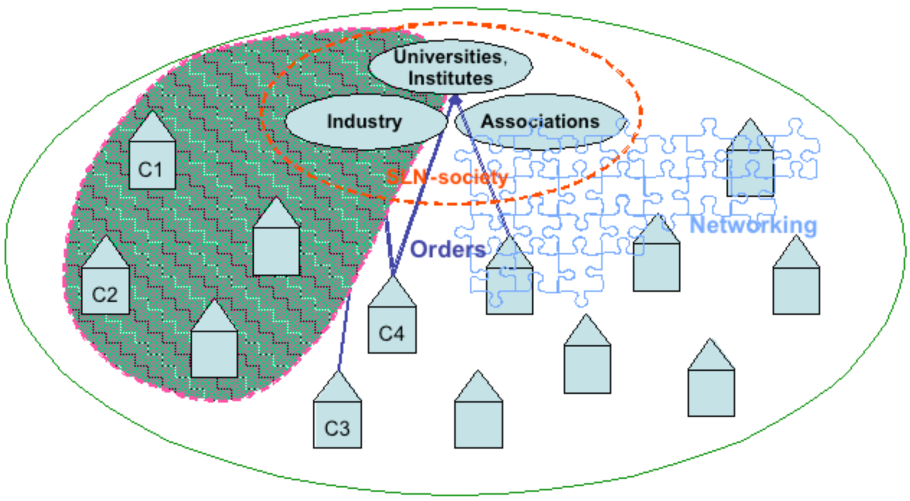
The idea of the SLN

Due to the complementarity of its members (University institutes, Technical Universities, Universities of Applied Sciences, other research institutions and in the meantime also industry) the SLN competence sphere spreads across a large field, from physical laser simulations, over the development of laser sources and new laser processes, up to concrete implementations, business cases and process comparisons and analysis, respectively. The SLN members have a detailed knowledge in manufacturing processes and process chains for complete the laser based processes, as for example chipping technologies, forming, conventional welding, electrical discharge machining and plasma etching. The SLN is therefore neither a pure research network nor a pure user network, but it will cover the whole process from basic research to industrial preproduction model. The core business of the SLN is therefore the problem solution in the field of laser based processes from the analysis to the industrial preproduction model and its main product is the knowledge about laser based processes and the underlying physics and technology.

How SLN works

The backbone of the SLN, the SLN-society, is formed by members whose main activities lie in the field of laser materials processing and power photonics, both from industry and academia. The SLN-society or its individual members may work anytime and project-related with appropriate further external partners and will act in Switzerland as a counterpart for laser based problems. Hence, the SLN addresses itself to current or potential users of the laser technologies, with focus on small and middle sized companies. It offers

- Solutions for laser based problems
- Access to the laboratories of the different members for application tests
- Partner for research projects (CTI, EU etc.)
- Representation of interests on other platforms (*e.g.* Photonics 21, SSOM)
- Education and continuous education in the laser field
- Realization of congresses and seminaries
- Direct projects and orders ("fire service exercises")



Since its start, in November 2006, a lot of work has already been done in the frame of SLN. The SLN is an active member of the European platform Photonics21, has initiated the contact to networks and societies (e.g. SSOM, OptecNet), has already initiated two CTI-projects and it's preparing further applications, has established the continuous education course "Laserfertigung" [5], has completed its board and is extending its numbers of members with industrial companies. But there are still challenging tasks ahead of the young SLN and interested persons are kindly invited to visit the SLN web site [4] and to join the society.

Beat Neuenschwander
Founding president of the SLN

[1] www.optecnet.de
[2] www.laserlab-europe.net
[3] www.photonics21.org
[4] www.swisslaser.net
[5] www.laserweiterbildung.ch

SSOM Forschungspreis für junge Forscher und Forscherinnen

Vor 10 Jahren hat die SSOM erstmals einen Forschungspreis für junge Forscher und Forscherinnen ausgeschrieben. Seither wurden jeweils im Rahmen der alle zwei Jahre stattfindenden Generalversammlung insgesamt 11 Preise zu je CHF 5'000 verliehen, sechs gesponsert von der Leica Geosystems, je zwei von der GMP SA und der SSOM selbst, sowie einer von Nortel.

Dieses Jahr konnten drei Preise offeriert werden. Ein

- **Leica Geosystems Preis** für hervorragende Arbeiten auf dem Gebiet der modernen Optik, Photonik, Bildverarbeitung und Mikrotechnologie, ein
- **GMP Preis** für hervorragende Arbeiten, welche in direkter Beziehung zum Gebiet der Photonik oder speziell des Lasers stehen, und schliesslich der
- **SSOM Preis** für hervorragende Arbeiten, welche thematisch zu den Fachgebieten der SSOM, bevorzugt der Nanotechnologie stehen.

Dem reichen „Angebot" entsprechend war auch die Anzahl von Bewerbungen sehr gross: 28 Arbeiten mussten von der elfköpfigen Jury unter Leitung von Karl Knop beurteilt werden.

Das Niveau der Arbeiten war im Allgemein sehr hoch und der Entscheid bei den Finalisten schwierig. Neben der wissenschaftlichen Qualität der Arbeit wurde besonderen Wert auf Neuheit und Originalität gelegt. Beim SSOM Preis entschied die Jury, den Preis auf zwei Gewinner zu verteilen.

Die Preise wurden überreicht vom Präsidenten der SSOM, Kurt Pulfer und den beiden Vertreter der Sponsoren, Eugen Voit, CTO von Leica Geossytems und Jean-Jaques Goy, CEO von GMP SA am 12. September 2007 an der SSOM GV in Basel.

Die Gewinner

Resultat der Jury-Sitzung vom 5. Juli 2007 in Zürich (SATW)

SSOM 1/2	EXPANDING THE HORIZON OF MOLECULAR ELECTRONICS VIA NANOPARTICLE ASSEMBLIES	 **BERNARD Laetitia**	Institut für Physik, Universität Basel, Klingelbergstrasse 82, CH-4056 Basel +1 203 606 5942 +1 203 432 6420 laetitia.bernard@yale.edu http ://laetitia.isuisse.com
SSOM 1/2	NANOPARTICLE PRINTING WITH SINGLE-PARTICLE RESOLUTION	 **KRAUS Tobias**	Tobias Kraus IBM Research GmbH Zurich Research Laboratory Säumerstrasse 4 CH-8803 Rüschlikon ++41 1 724 86 50 tobias@kraus.net
LEICA	COMPENSATION NUMERIQUE DES ABERRATIONS ET IMAGERIE DE POLARISATION EN MICROSCOPIE HOLOGRAPHIQUE DIGITALE	 **COLOMB Tristan**	Route de Mauvoisin 204 CH-1947 Versegères tristan.colomb@a3.epfl.ch
GMP	FEMTOSECOND LASERS IN FLUID INCLUSION ANALYSIS	 **STOLLER Patrick**	University of Bern Biomedical Photonics Division Institute for Applied Physics Sidlerstrasse 5 CH-3012 Bern Home Phone : +41 31 351 02 07 Mobile Phone: +41 79 601 59 46 patrick.stoller@iap.unibe.ch

Die ausgezeichneten Arbeiten wurden anschliessend in vier Kurzreferaten vorgestellt. Leider konnten zwei Gewinner wegen Auslandsabwesenheit nicht selber dabei sein.

Die SSOM dankt den Sponsoren und allen Wettbewerbsteilnehmern und Teilnehmerinnen fürs Mitmachen und hofft, dass auch 2009 wieder attraktive Preise an junge Forscher und Forscherinnen vergeben werden können.

Karl Knop
Präsident der Jury

EXPANDING THE HORIZON OF MOLECULAR ELECTRONICS VIA NANOPARTICLE ASSEMBLIES

by

Laetitia Bernard

In the scope of novel nanotechnology developments, molecular electronics is attracting an increasing research attention. This is primarily supported by the possibilities offered by synthetic chemistry for the tailoring of single molecules to achieve specific electronic functions. Whereas various experimental approaches have been devised to form and electrically study molecular junctions, the integration of individual junctions into functional electronic circuits remains a demanding task, requiring innovative approaches in the nanofabrication philosophy and circuit structure.

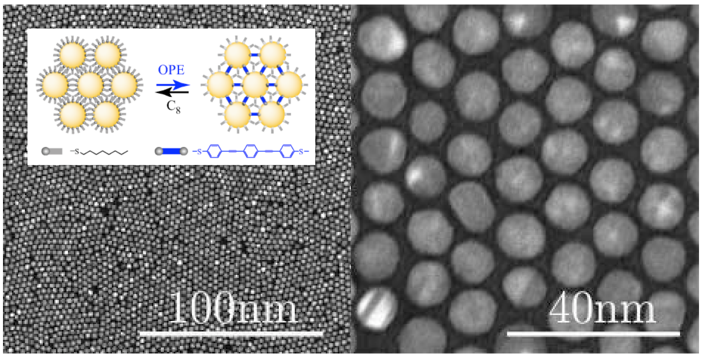


Fig.1:
Self-assembled monolayer of functionalised gold nanoparticles (magnifications); inset: schematics of the reversible place-exchange.

My PhD Thesis presents a multidisciplinary study, interlinking *chemistry* (synthesis of nano-objects constituting building blocks), *engineering* (design of circuits based on the assembly of such building blocks) and *physics* (understanding of the ensemble properties). It is shown that an approach combining the self-assembly and micro-contact printing of ligand-protected metallic nanoparticles, followed by an *in-situ* ligand place-exchange reaction, allows the preparation of stable two-dimensional networks of molecular junctions (Fig.1) [1]. Moreover, I also demonstrate that the formation of the molecular junctions is reversible, thus enabling to “switch” the network from unlinked to linked state and vice versa. This remarkable property makes nanoparticle networks a valuable platform for the development of molecular electronic circuits [2,3].

Electrical transport measurements combined with optical characterisation enabled the investigation of the mechanism underlying the place-exchange. Moreover, it provided information on the network's physical properties, such as electrical resistance, tunnelling decay coefficient and optical permittivity. The exchange of alkanethiol ligands with conjugated organic wires - thiolated oligo(phenylene ethynylene) (OPE) and oligo(phenylene vinylene) (OPV) - is found to significantly influence the electronic and optical properties of the device. A spectacular decrease in resistance (by one to three orders of magnitude) after the exchange of alkanethiol ligands with OPE confirms a proper interlinking of neighbouring nanoparticles (Fig.2A). The comparison of different ligands and exchanged molecules demonstrates the flexibility of this nanoparticle-based device as “molecular breadboard” and reveals important insights on the electrical transport mechanisms involved.

Ultraviolet-visible (UV-vis) and fast fourier infrared (FTIR) spectroscopies revealed to have a great potential in developing a reliable molecular system, as they provide independent further understanding [4]. The study of surface plasmon resonance of the particle arrays firstly gives confirmation of the proper exchange process, and of its reversibility (Fig.2B). A significant red shift of the absorption peak occurs due to the introduction of OPE in the array, increasing the surrounding medium global permittivity.

Infrared vibrational states inspection gives compelling evidences for the presence of the OPE after insertion, combined with the partial loss of the ligands, and also the full removability of OPE after subsequent exchange (Fig.2C). Furthermore, both visible and FTIR techniques demonstrate the partial stay of the alkanethiols, which is a necessary condition for the arrays' robustness. In addition, quantitative studies give an estimation of the percentage of molecules exchanged.

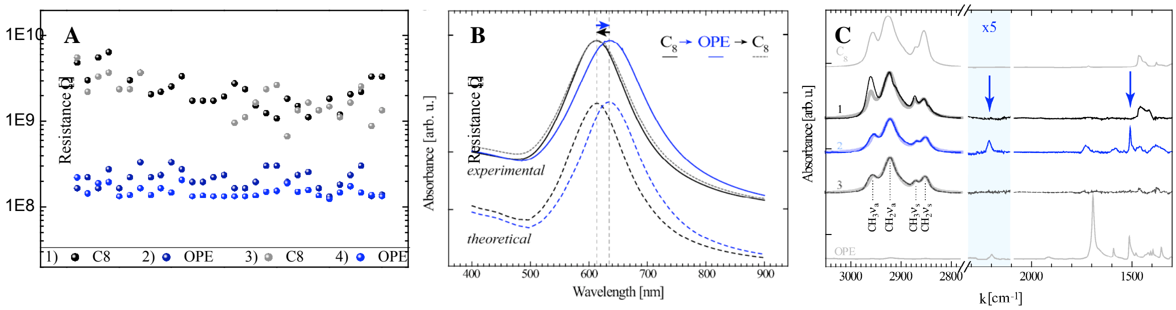


Fig.2: **A**. Electrical resistance of 30 devices, switching successively from unlinked (high R) to OPE-linked (low R); **B**. Visible absorption spectra of a device unlinked (black), OPE-linked (blue) and unlinked again (grey dashed). **C**. FTIR spectra for the same sequence, with the references (light grey) for free alkanethiols and free OPE molecules.

Whereas the exchange rate is determined via time dependent electrical measurements, the exchange percentage is evaluated by FTIR and visible spectroscopies. Hence, and as demonstrated electrically and optically, the reversibility of such a molecular exchange makes nanoparticle networks appear as valuable platforms for the investigation and comparison of various organic molecules. Moreover, the flexibility of this approach lets envision the fabrication of more complex networks, for instance by intermixing functional molecules within the nanoparticle network. Finally, their simple and highly parallel fabrication also makes them good candidate for future nanoelectronic circuit implementation.

[1] J. Liao, L. Bernard, M. Langer, C. Schönenberger and M. Calame, *Adv. Mater.***18**, 2444-2447 (2006)
[2] News & Views, *Nature* **442**, 994 (2006)
[3] Press releases: *Uni News* (13.09.06), *Basler Zeitung* (15.09.06), *Neue Zürcher Zeitung* (20.09.06), *Chemische Rundschau* (21.11.06)
[4] L. Bernard, Y. Kamdzhilov, Sense Jan van der Molen, M. Calame, J. Liao and C. Schönenberger, submitted (2007)

ASSEMBLY AND PRINTING OF MICRO AND NANO OBJECTS

by

Tobias Kraus

The oldest route to form objects in the micrometer or nanometer range is to make particles, as has been done for centuries in metal colloids, pigments, milled powders, and other polydispersed materials. Recently, advances in chemistry and microfabrication have enabled the synthesis of monodispersed particles with well-defined structures. Such particles exhibit useful individual properties, and some of them interact with electromagnetic radiation when arranged in regular patterns. Thus, particles are promising candidates for a cost-efficient creation of metamaterials or devices with nanoscale features.

Even though the synthesis of particles is now possible from various precursors in bulk quantities, their arrangement and integration into functional devices remains a challenge, in particular for nanoparticles with diameters well below 1 µm. This article outlines our strategy to arrange and integrate particles of different length scales on surfaces by employing a parallel method that retains the efficiency of the particle synthesis while enabling accurate placement with single-particle resolution. The method is called “SATI”, because it combines directed self-assembly, transfer, and integration to handle many particles in parallel.

Particles can be efficiently arranged through directed self-assembly. Such self-assembly methods exploit forces that act on the particles because of the presence of a template and cause predictable particle deposition. We mainly use capillarity-based self-assembly: in a typical assembly, the meniscus of a colloidal suspension containing the particles is moved over a patterned, hydrophobic substrate (Fig. 1a). The confinement introduced by the gas-liquid boundary and the capillary forces direct particles into predictable positions on the template, where they remain in the dry state after the liquid has passed over them (Fig. 1b). Confinement and capillary action depend on the contact angle and the pinning behavior, which have to be tuned appropriately through the choice of the template materials and the introduction of surfactants. If small numbers of particles are to be assembled at specific positions, the particle transport reaches a shot-noise limit. To still produce high yields, large local concentrations will be needed.

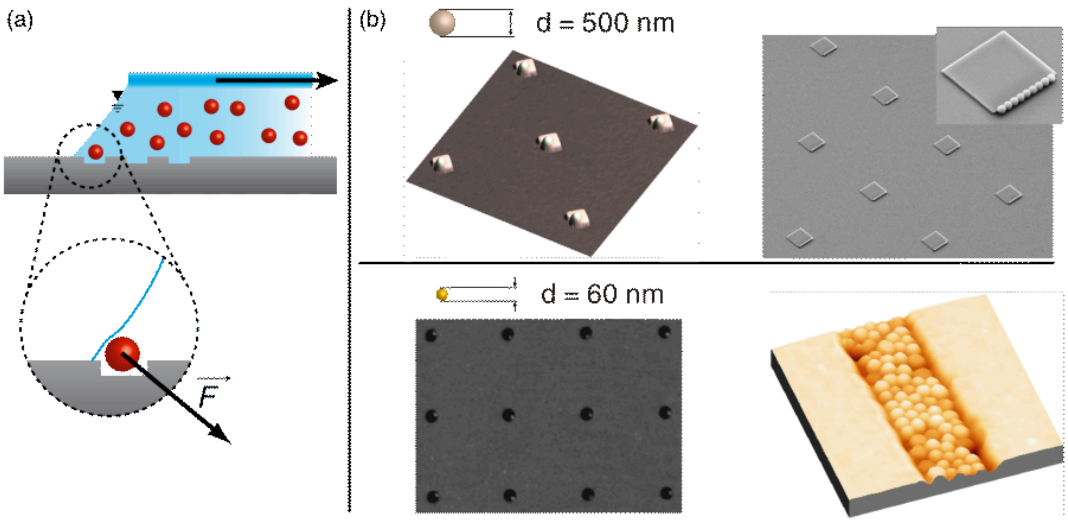


Figure 1. Capillary assembly of small particles. (a) The meniscus of a colloidal suspension is moved over a patterned substrate. A contact angle of about 60° prevents unspecific deposition, while appropriately-shaped binding sites capture particles at predefined locations. (b) Particles assembled in different geometries.

Directed self-assembly often requires surface properties or surface geometries that are not available on the target substrate. In SATI, the assembly process is therefore decoupled from the final particle integration. After they have been assembled on a patterned template, the particles are transferred in parallel to the target substrate through controlled adhesion. The magnitude of particle-surface adhesion is tuned to create an adhesion cascade. In this cascade, the arranged particles adhere to a carrier so that they can be transported, but leave them when they come into contact with the target substrate that provides stronger adhesion. Depending on the size of the particles, the required adhesion differences can be created by exploiting the difference between hard and soft contacts or between low-energy and high-energy surfaces, by using adhesion layers in between particle and substrate, or by manipulating the particle geometries. Figure 2 shows various strategies for adhesion tuning in different size ranges that we applied in the SATI process.

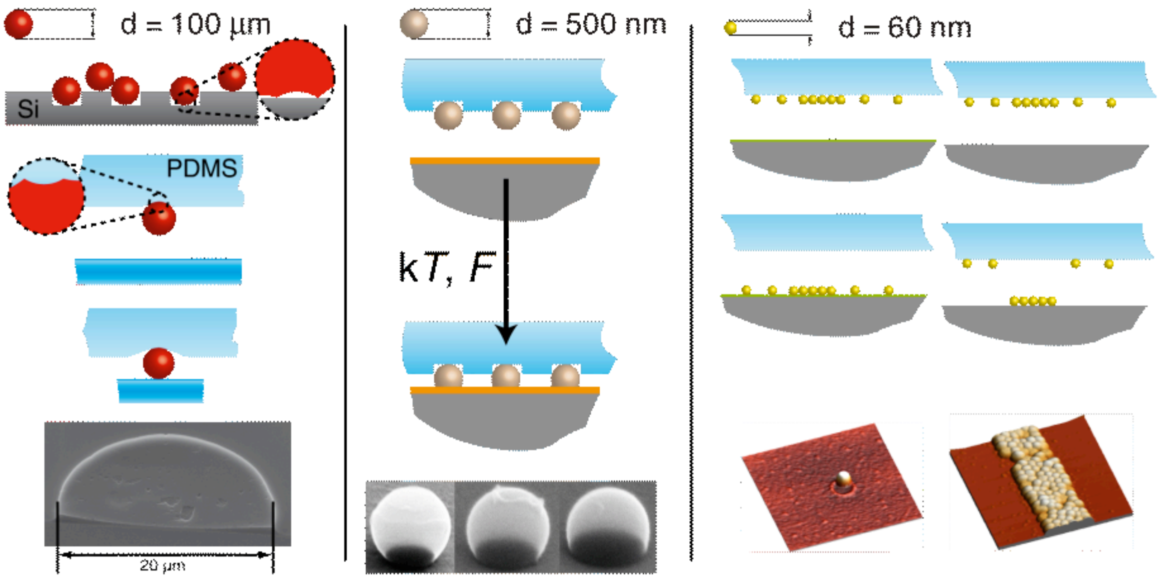


Figure 2. Adhesion-based handling of particles. Depending on the particle diameter and material, adhesion cascades to transfer particles from one surface to another can be created by exploiting hard versus soft contacts and adhesion layers (100 µm glass beads), softening of the particles and thus increase of interfacial area (500 nm polystyrene latex) or particle interactions and adhesion layers (60 nm gold nanocrystals).

Using the SATI process, regular arrays of particles with diameters ranging from 100 µm down to 60 nm have been created on substrates of interest (Figure 3). Among these were 100-µm ball grid arrays as used in packaging, 500-nm resist particle arrays suitable to etch silicon pillars and metal patches, and arrays of 60-nm catalytically-active gold particles to grow silicon nanowires. Finally, 3D stacks and complex arrangements were created using multi-step SATI.

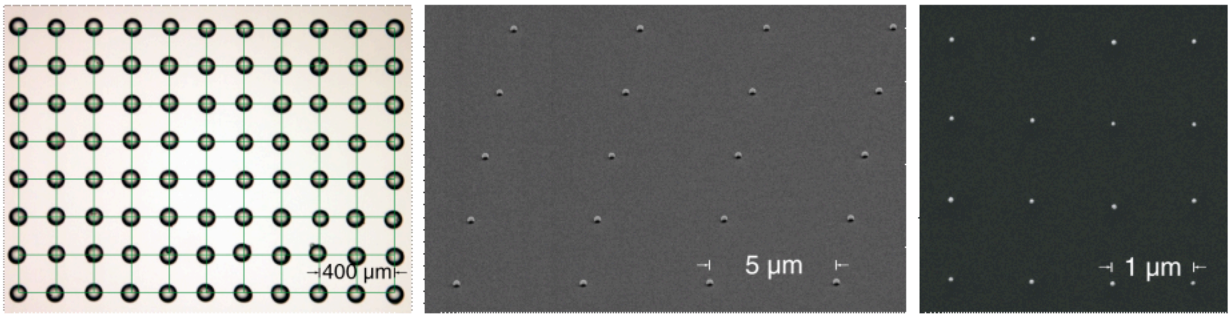


Figure 3. Spaced, regular particle arrays. From left to right, 100-µm glass beads on glass, 500-nm polystyrene spheres on silicon oxide and 60-nm gold crystals on silicon [1].

[1] T. Kraus, L. Malaquin, E. Delamarche et al., *Advanced Materials* **17** (20), 2438 (2005); T. Kraus, L. Malaquin, N. D. Spencer, H. Wolf, *Nature Nanotechnology*, accepted.

ULTRA-SHORT PULSE LASERS IN FLUID INCLUSION ANALYSIS

by

Patrick Stoller, Yves Krüger, Jaro Ricka and Martin Frenz

The development of reliable, low-maintenance, all-solid-state ultra-short pulse lasers has led to the growing application of ultra-short laser pulses in fields such as laser micromachining, ultra-fast laser spectroscopy and multiphoton microscopy and nanosurgery of biological samples. Two recent studies conducted in our laboratory have opened a new field of applications of such lasers, namely in the analysis of geological fluid inclusions (previously reported on briefly in the third issue of the 2006 SSOM Bulletin). Geologists can take advantage of two new techniques: one to determine the volume ratio of the liquid and the gas (vapor) phase in fluid inclusions—information that is needed to calculate the bulk composition and bulk density of the fluids—and the other to investigate metastable fluid inclusions that were previously out of reach of microthermometric analysis due to failure of phase nucleation.

Fluid inclusions

Fluids inside the Earth's crust play an important role in geological processes such as, to give only one example, the formation of ore and mineral deposits. The fluids are involved in dissolution, transport and precipitation of minerals and mineral compounds, in mineral reactions and in mineral re-crystallization. Geological fluids are (with the exception of oil) aqueous solutions containing salts and gases of various compositions and concentrations. During crystal growth or during healing of cracks in the crystals, small quantities of these fluids can become trapped in microscopic cavities and are termed fluid inclusions. In most cases, these fluid inclusions preserve the composition and the volumetric properties of the fluid over geological time scales. Geologists use a wide range of analytical techniques, including microthermometry, Raman spectroscopy, laser ablation inductively coupled plasma mass spectroscopy and crush-leach methods to determine these properties in order to estimate temperature and pressure conditions of fluid entrapment and mineral formation. This in turn allows them to identify the fluid sources and to understand the geological processes involved in mountain-building, in the genesis of ore and mineral deposits, or in the evolution of oil reservoirs.

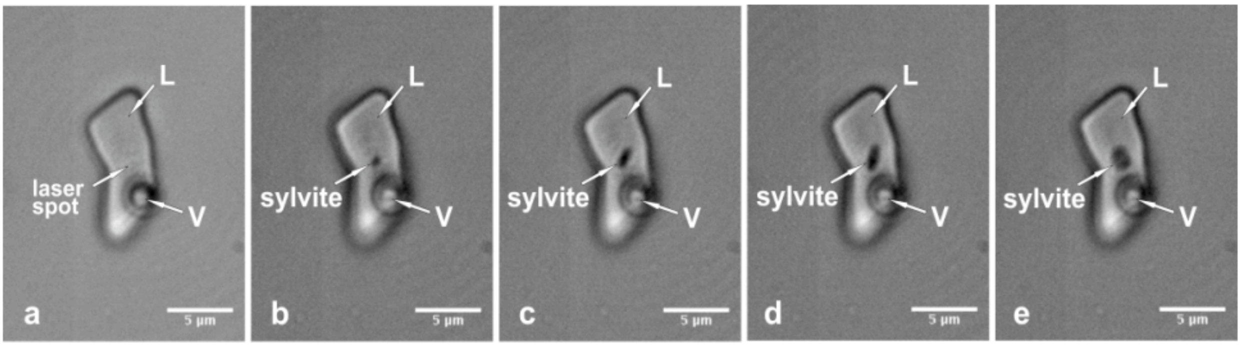


Figure 1: Nucleation of a sylvite crystal in a KCl supersaturated fluid inclusion in quartz and subsequent growth of the crystal. A single ultra-short laser pulse was used to nucleate the crystal. From : Krüger et al., in press.

Overcoming metastable phase states using amplified ultra-short laser pulses

Microthermometry is likely the most important and widely used technique in fluid inclusion analysis. It provides information about the density and the salt composition and concentration of fluid inclusions by measuring the temperature of different phase transitions of the fluid, e.g. ice melting, dissociation of salt and gas hydrates, salt dissolution and liquid-vapor homogenization. Metastable fluid states, particularly the absence of a thermodynamically stable phase under specific P-V-T-X conditions, are characteristic features of microthermometric measurements of fluid inclusions and appear as a temperature gap between disappearance and nucleation of phases. This temperature delay on nucleation can often be used to precisely determine phase transition temperatures. However, in specific cases nucleation of phases such as the vapor bubble, salt crystals or salt hydrates fails to occur and thus prevents microthermometric measurements.

We have solved this problem by developing a reliable method to overcome metastable phase states using single, tightly focused, ultra-short laser pulses [1]. We couple the output of an amplified ultra-short pulse laser into an upright microscope equipped with a heating-cooling stage and a sensitive CCD camera. The laser pulses are focused into the metastable fluid inclusion using a high numerical aperture microscope objective. A single ultra-short laser pulse suffices to overcome a metastable phase state (e.g. by nucleation of a salt crystal or a vapor bubble). Figure 1 illustrates laser-induced nucleation of a sylvite crystal in an inclusion in quartz. Although the mechanism involved is still the subject of ongoing investigation, nucleation likely occurs when a cavitation bubble forms during plasma-mediated ablation of a small part of the inclusion wall (a volume too small to see under a microscope).

Laser-induced phase nucleation usually does not result in a detectable change in the inclusion volume as long as the pulse energy does not significantly exceed the nucleation threshold; it can therefore be performed repeatedly. The use of ultra-short pulse lasers provides the high intensities necessary to achieve nucleation without depositing sufficient energy in the inclusion to heat or modify it. We are currently using this method to induce vapor bubble nucleation in fluid inclusions in stalagmites in order to subsequently determine liquid-vapor homogenization temperatures. As stalagmites represent an important record of past climate variation dating back thousands to hundreds of thousands of years, we intend to use these homogenization temperatures as a new paleothermometer. Quantitative reconstruction of natural climate variations in the past is crucial to understanding recent climate changes in the context of the current debate on global warming and how best to mitigate its impact.

Volumetric imaging of fluid inclusions in quartz using second harmonic generation microscopy

Ultra-short pulse lasers also lend themselves to addressing a second problem in fluid inclusion analysis: determination of the volume ratio of the gas and the liquid phase. To determine this ratio, two-dimensional images of fluid inclusions acquired using a spindle stage and brightfield microscopy can be used. This technique, however, is limited to inclusions of certain regular shapes. We turn instead to nonlinear optical microscopy, a technique that has found widespread and growing use in biology recently. An ultra-short pulse laser beam is focused onto the sample using a high numerical aperture microscope objective and the beam or the sample is raster scanned to obtain an image. The focused femtosecond laser pulses provide sufficient intensity for nonlinear effects to occur—multiphoton fluorescence or harmonic generation—without depositing so much energy as to damage the sample. Second harmonic generation—a process in which two photons at a given frequency are coherently converted into a single photon with double the frequency—was first observed in 1961 using a pulsed ruby laser and a quartz sample [2] , within a year of the first report of a working laser [3]. Second harmonic generation is widely used today to double the frequency of many different lasers and thus expand the range of wavelengths at which laser radiation can be produced. Key to achieving efficient frequency doubling within the crystalline second-order nonlinear materials used is good matching of the phase of the laser light and the generated second harmonic light. Due to material dispersion and birefringence (the polarization of the second harmonic light can differ from that of the laser), the nonlinear polarization induced by the laser and the second harmonic light propagating in a crystal can become out of phase, leading to a reduction in, rather than further enhancement of, the second harmonic signal. Phase-matching can sometimes be achieved by aligning the crystal so that the phase shifts due to material dispersion and birefringence cancel each other. Quartz is not very useful for frequency doubling laser light (it cannot be phase-matched), but we have recently demonstrated that second harmonic generation experiments provide information about quartz samples that is very useful to geologists [4]. Focusing a laser beam into a material also affects the phase matching: a focused Gaussian beam undergoes a phase shift of π, termed the Gouy phase shift, and this phase shift differs for the laser light and the nonlinear polarization induced in the material [5]. In fact, in the limit of very tight focusing, no second harmonic signal is generated inside the material. Only at the edge of the material does this effect not lead to cancellation of the signal. Since the walls of a fluid inclusion represent the boundary between quartz and a medium with different optical properties, second harmonic generation microscopy represents an ideal method to image fluid inclusions. We are thus able to generate three-dimensional images of fluid inclusions of arbitrary shape in quartz and to determine their volume (Figure 2). By measuring the volume of the spherical gas bubble in the inclusion using conventional brightfield microscopy, we can then determine the liquid-gas ratio, which geologists need to fully characterize the composition and density of gas-bearing fluid inclusions.

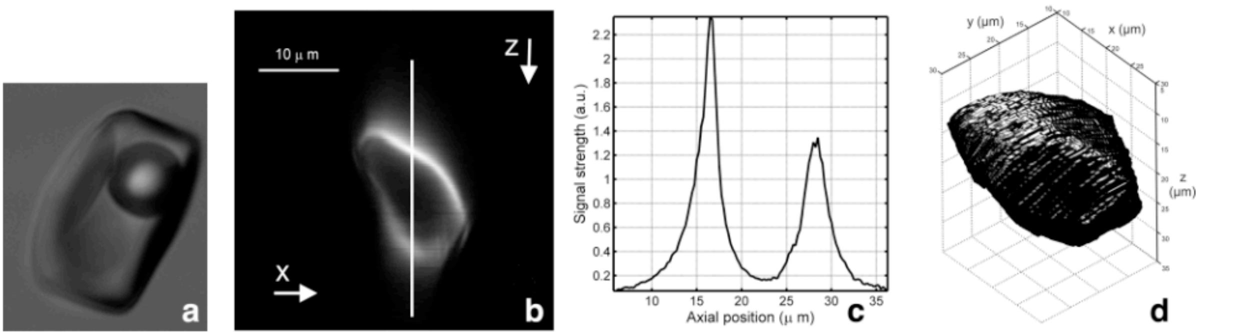


Figure 2: a) Conventional two-dimensional brightfield microscopy image of a fluid inclusion. b) Cross-section through a three-dimensional second harmonic generation image stack of the same inclusion. The z-direction represents the laser propagation direction. The same scale is using in both a) and b). c) Cross-section through the image slice in b) showing the strong signal at the inclusion surfaces. d) Reconstruction of the three-dimensional shape of the fluid inclusion from image slices.

[1] Y. Krüger, P. Stoller, J. Rička and M. Frenz. “Femtosecond lasers in fluid inclusion analysis: Overcoming metastable phase states.” European Journal of Mineralogy. In press.
[2] P.A. Franken, A.E. Hill, C. W. Peters and G. Weinreich. “Generation of optical harmonics” Physical Review Letters. Vol. 7. No. 4. pp. 118 - 119. 1961.
[3] T.H. Maiman. “Stimulated optical radiation in ruby” Nature. Vol. 187. No. 4736. pp. 493-494. 1960.
[4] P. Stoller, Y. Krüger, J. Rička and M. Frenz. “Femtosecond lasers in fluid inclusion analysis: Three-dimensional imaging and determination of inclusion volume in quartz using second harmonic generation microscopy.” Earth and Planetary Science Letters. Vol. 253. pp. 359-368. 2007.
[5] R. Boyd. “2.10 Nonlinear Optical Interactions with Focused Gaussian Beams.” Nonlinear Optics. San Diego, CA: Academic Press, 2003.

NUMERICAL ABERRATIONS COMPENSATION AND POLARIZATION IMAGING IN DIGITAL HOLOGRAPHIC MICROSCOPY

by
Tristan Colomb

Introduction

Digital holographic microscopy (DHM) permits the reconstruction of full-field amplitude and phase contrast images of an object wavefront out of a single digitally acquired hologram. The principle consists to digitizing - with a digital camera (CCD, CMOS) - the interference between a reference and an object wave in an off-axis geometry (small angle between the object and reference waves). Then, by analogy with classical holography, the digital hologram is numerically re-illuminated by a digital reference wave and the resulting wavefront is propagated from the hologram to the image plane within the Fresnel approximation by a numerical process. Several parameters must be adjusted or calibrated to achieve a correct reconstruction. Generally, the object wave contains aberrations including the tilt due to the off-axis geometry, the defocus aberration introduced by the microscope objective (MO) used to increase the spatial resolution, and all the optical aberrations of the setup (astigmatism, coma, spherical aberration...).

Digital Optics

By analogy with classical microscopy, where high quality optical lenses are placed strategically in the setup to minimize image distortion and aberrations of the physical wavefronts, a digital optics, involving numerical lenses, was developed in order to numerically compensate for aberrations of the reconstructed numerical wavefronts. Furthermore, because digital holography allows a direct access to quantitative phase information, the ideal shape of these numerical lenses can be automatically computed with two different methods.

A first method consists to fit, in the least-square sense, the parameters of phase aberration models (standard or Zernike polynomials) in the areas of the field of view where the phase should be constant (red areas of Fig. 1a): assumed flat areas in reflection mode (mirror surface, flat support) or areas without specimen in transmission mode (air, immersion liquid, support holder). Then, the numerical lens, computed as the inverse phase image defined by the fitted parameters, is added to the measured phase image (Fig. 1a) and gives the corrected phase reconstruction (Fig. 1b).

A non fitting procedure is also possible by using a reference hologram (without specimen). The compensation for aberrations is done in the hologram plane by the addition of the phase specimen wavefront with the numerical lens, defined as the inverse phase obtained from the reference hologram.

The numerical lenses can be applied in any plane because the numerical wavefronts are numerically propagated. But in order to achieve fast reconstruction rate, they are applied in the hologram plane (before numerical propagation) or/and in the image plane. The use of a numerical lens in the hologram plane has another advantage than only compensate for phase aberrations; it allows compensating also for image distortion as demonstrated in Fig. 2. Finally, the numerical lenses are applied to achieve numerical magnification that allows compensation for chromatic aberrations for multi-wavelengths digital holography.

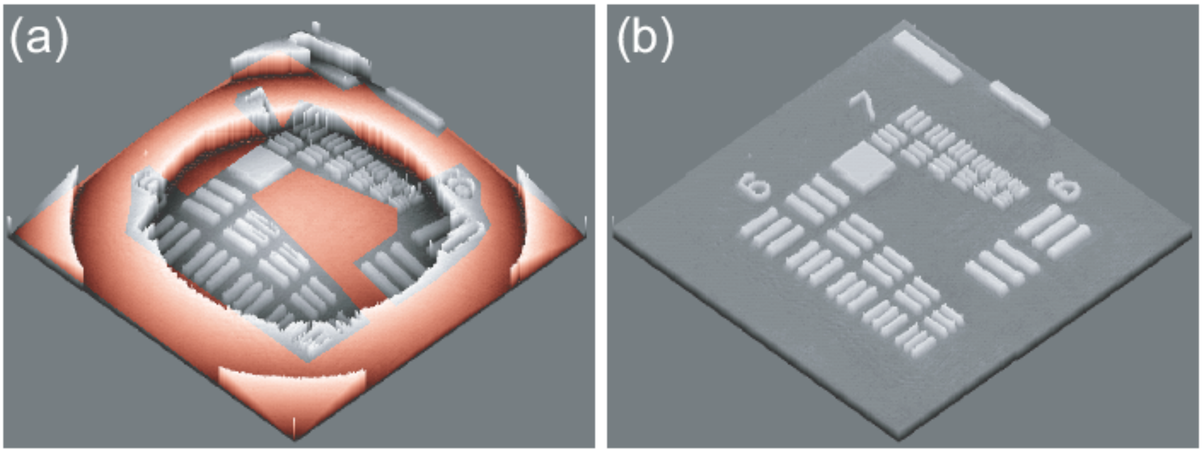


Figure 1: Compensation for phase aberrations by computation of the polynomial coefficients of the numerical lens. 3D representations of the phase images of a USAF test target (a) before and (b) after aberrations compensation (assumed flat areas in red).

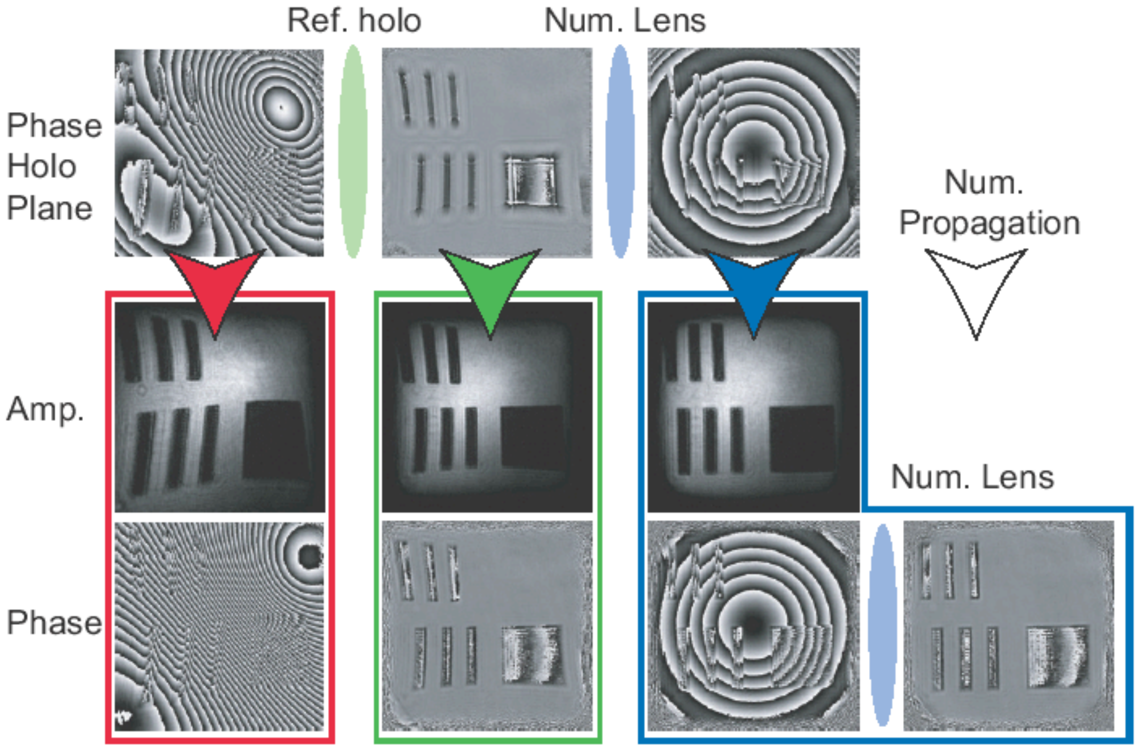


Figure 2: Complete numerical compensation for image distortion and phase aberration induced by a lens ball used as MO. In red, the reconstruction without compensation; in green after the reference hologram method correction; and in blue the manual compensation for residual image distortion.

Polarization Imaging

DHM allows reconstructing the amplitude and the phase of a wavefront, but another characteristic can be measured: the polarization state. The principle consists to achieve multiplexing holograms by making the off-axis geometry interference of an object wave - with unknown polarization state induced by the specimen - with two orthogonally polarized reference waves. The digital hologram is therefore composed of two different fringes patterns (blue and green lines in Fig. 3b) that record separately the Jones vector components of the object wave. The parallel digital reconstructions of these two wavefronts permit real-time quantitative full-field imaging of the quotient of the amplitude and the phase difference that correspond to the dichroism and the birefringence of the specimen. Figure 3 presents the schematic of the setup, and birefringence measurement induced by the internal stress in an optical fiber.

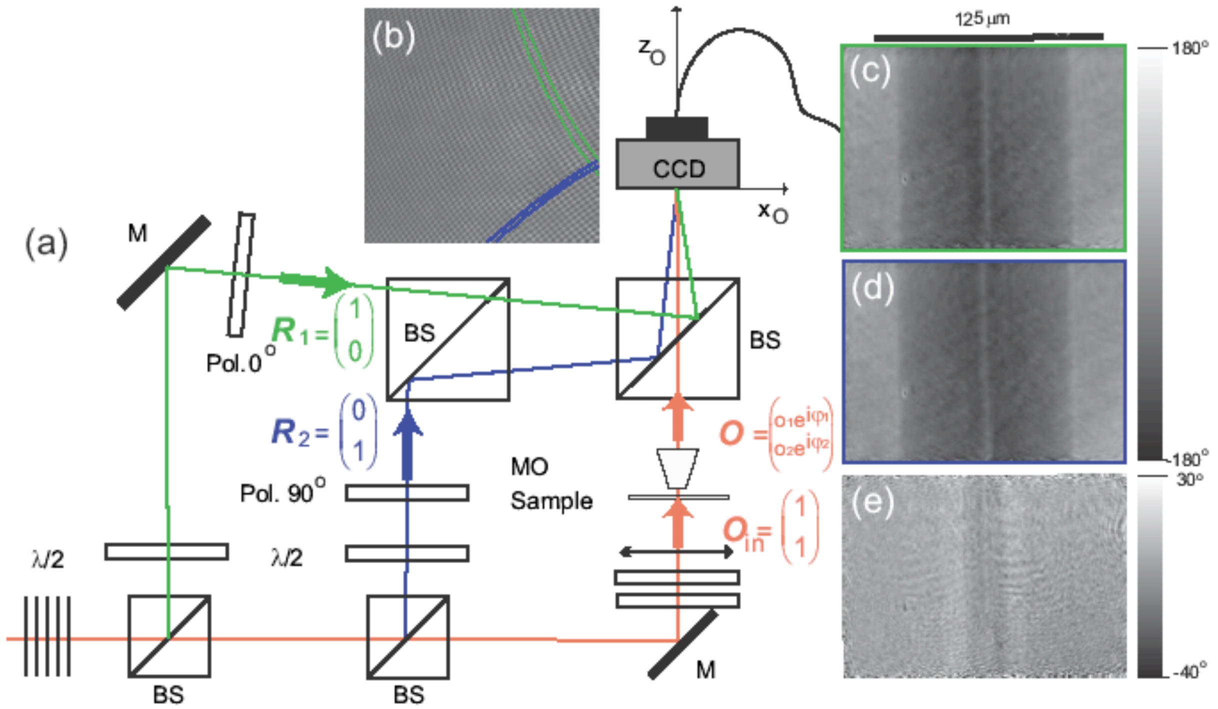


Figure 3: Polarization imaging by DHM. (a) Setup, (b) hologram, (c-d) reconstructed phase images from interference of object wave O with the orthogonal polarized reference waves R1 and R2; and (c) phase difference image revealing internal stress in an optical fiber.

This work (http://library.epfl.ch/theses/?nr=3455) was performed in the Microvision and Microdiagnostics Group (http://apl.epfl.ch/page12232.html), directed by Prof. Christian Depeursinge. The author also would like to thank the people at Lyncée Tec SA (www.lynceetec.com), PSE-A, CH-1015 Lausanne, for their dynamism and the fructuous discussions.

Leonhard Eulers Einfluss auf die Entwicklung von Optik und Mikroskopie

Zusammenfassung des Vortrags
bei der Mitgliederversammlung der SSOM am 12.9.2007

Auch heute noch wird der Einfluss Eulers sowohl auf die Erforschung der Eigenschaften des Lichtes, als auch auf die Korrektur der Linsenfehler, der sphärischen und der chromatischen Aberration, in der Literatur ignoriert, kaum wahrgenommen oder unterschätzt.

Euler stellte mit seiner Arbeit die Verbindung von Huygens unvollkommener Wellentheorie zu den moderneren Theorien von Augustin-Jean Fresnel und Thomas Young im 19. Jahrhundert her.
Die Beweisführung gegen die Korpuskulartheorie Newtons, dass die farbigen Anteile des Lichtes aus unterschiedlich grossen Teilchen bestehen war gewagt, da das Renommee Newtons besonders in England sehr gross war. Als Euler im Folgenden auch Zweifel an dessen Behauptung anmeldete, eine Lösung des Problems der Achromasie sei unmöglich, führte dies zu heftigen Reaktionen der Anhänger Newtons.

Als diese den experimentellen Gegenbeweis antraten und überraschenderweise Euler bestätigten mussten, wurde es erstmals möglich, korrigierte Fernrohre und später auch Mikroskope zu bauen. John Dollond, anfänglich Hauptopponent Eulers führte die Experimente durch, lenkte ein und konnte sein achromatisches Linsensystem, bestehend aus einer Kombination aus Kron- und Flintglas patentieren lassen und vermarkten. Euler, dem das perfekte, von Gott geschaffene Auge, als Idealsystem vorschwebte, konnt anfänglich nicht glauben, dass das Problem durch zwei verschiedene Glassorten zu beheben sei, da er wie im Auge eine flüssige Phase für notwendig erachtete. Erst durch Clairaut konnte er von der Richtigkeit der Ergebnisse überzeugt werden.

Wie aus seinem Brief vom 12. März 1762 an Sophie Charlotte von Brandenburg-Schwedt hervorgeht, war er äusserst stolz darauf, das theoretische Fundament zu Dollonds Arbeit geliefert zu haben. Diese Reaktion ist ein Beweis dafür wie kompliziert das Problem zu lösen war, denn Stolz auf eine Leistung kommt bei Euler eher selten vor.

Die Bedeutung Eulers auf vielen Wissensgebieten ist unbestritten, lediglich in der Optik spielt sie, zu Unrecht, eine untergeordnete Rolle. Seine Führungsrolle, gerade auf diesem Gebiet ist aber der von Descartes, Newton, Hugens oder Hooke mindestens gleichzusetzen.

Kurt Paulus

Successful Annual Meeting 2007 of the Biomedical Photonics Network in Zurich

The annual meeting 2007 of the Biomedical Photonics Network (bmpn), a work group of the SSOM, took place on 5th of June 2007. Since Biomedical Photonics is an interdisciplinary field, which includes many clinical applications, bmpn was hosted at the University Hospital and turned out to be an exciting interdisciplinary event. It generated a lot of interest and attracted more than 60 participants, who came almost equally distributed from all over Switzerland and southern Germany. We are happy to have received several new members to the SSOM on this occasion. A novelty at this year's meeting was the first presentation of an award for presenters younger than 36 years inaugurated by FISBA Optik AG St. Gallen.

After a nice start in the morning with croissants, fruit, and beverages, kindly sponsored by MM Biomedical, Martin Wolf, USZ, welcomed everybody and introduced the goal of the bmpn, which mainly is the promotion of interdisciplinary collaboration between different fields (biology, computer science, medicine, economics, engineering, physics) and institutions (companies, funding agencies, hospitals, institutes of technology, universities, universities of applied sciences). This is achieved by creating personal contacts among people in different fields. Since its formation many collaborations have already been inaugurated.

The first speaker Edoardo Charbon from the EPFL presented his newest developments in highly integrated single photon avalanche diodes, which enable single photon counting and the measurement of time of flight with the resolution of a CCD. Andreas Stemmer from the EHTZ illustrated new ways of improving the resolution of light microscopy. These expeditions to cutting edge technology were followed by a clinician and pioneer in biomedical research: Emanuela Keller, USZ, demonstrated the application of near infrared spectroscopy to measure blood flow in the brain in neurointensive care patients. The morning was concluded by three speakers from the EPFL, who were all competing for the FISBA award: Adrian Bachmann reported on resonant Doppler Fourier domain optical coherence tomography for optical segmentation of retinal blood flow, Fabrice Merenda provided a talk on on-chip optical tweezers based on high-numerical aperture micro-mirrors and Johann Rohner concluded on parallel bioanalytics monitored on multiple laser-trapped beads in a microfluidic system.

A lively discussion continued throughout lunch, which was an excellent Swiss cheese buffet kindly sponsored by the OptETH, CIMST and SSOM. In the lunch area posters, which also competed for the FISBA award, were presented and many ideas were exchanged and fruitful interactions took place.

In the afternoon Philipp Kukura, ETHZ, reported on label-free detection and tracking of single viruses, Benjamin Rappaz, EPFL, on living cell analysis with digital holographic microscopy, Rolf Kaufmann, CSEM Zurich, on phase-contrast X-ray imaging. Thomas Gisler, University of Konstanz, Germany, described how to measure blood flow non-invasively using diffusing-wave spectroscopy and reported on studies on the human visual cortex.

The session after the coffee break (sponsored by MMBiomedical) focused on photodynamic diagnosis and therapy (PDT). Georges Wagnières, EPFL, started by giving a methodological introduction and continued on the detection of early bladder cancer by fluorescence imaging using Hexaminolevulinate. Patrice Jichlinski, CHUV Lausanne, complemented with the clinical application of Hexaminolevulinate. Günther Hofbauer, USZ, gave an overview of the clinical fluorescence dynamic diagnosis and

photodynamic therapy of the skin, one of the main fields of application of PDT. Angelika Rück, University of Ulm, Germany, followed up with fluorescence life time imaging as a new sophisticated method in molecular imaging.
Luigi Gallo, University of Zurich, concluded the talks with optoelectronic concepts for high-precision minimally invasive joint tracking.
Following the talks it was now time to reveal the winner of the first FISBA award - including a certificate and 500CHF- and the excitement rose. Every participant of the meeting had received a ballot to vote for the best presentation. The winner's name is Fabrice Merenda whom the audience congratulated for his didactically excellent presentation.
Concluding the annual meeting Heinrich Walt and Martin Wolf thanked all the participants, organizers and sponsors. Writing this report we would like to thank again, we feel that we had another fruitful and enjoyable day.

Martin Wolf und Heinrich Walt
University Hospital Zurich

Emanuela Keller presents clinical applications of near infrared spectroscopy in the neurointensive care unit.

Fabrice Merenda receives the Fisba award.

A delicious Swiss cheese buffet with fresh fruit refreshes everybody for lunch. Participants are engaged in lively discussion also at the posters.

Veranstaltung	Ort	Datum	Bemerkungen
		2008	
SSOM Vorstandssitzung	Bern	18. Januar	
SAOG-GSSI meeting	Fribourg	25. Januar	www.saog-gssi.org
Biomedical Photonics Network	Lausanne.	4. June 2008	Annual Meeting

October

11 – 12	**EOS Short Course on Optical Fabrication Technology (OFT)** Fisba Optik AG, St Gallen, Switzerland http://myeos.org/stgallen
21 – 23	**EOS Topical Meeting on Diffractive Optics** Barcelona, Spain http://myeos.org/barcelona

November

14 – 16	**Nanotech 2007** Montreux, Switzerland
21 – 23	**Nanosolutions 2007** Frankfurt, Germany
26. – 30.	**MRS Fall 2007: Symposium C:** Quantitative Electron Microscopy for Material Science

2008

March 2008

31 – 2 Apr	**EOS Topical Meeting on** **Photonics Devices and their application in health and medicine** Utrecht, The Netherlands http://myeos.org/utrecht2008

April 2008

7 – 11	**Photonics Europe 2008** Strasbourg, France http://spie.org/photonics-europe.xml

May 2008

27 – 30	**ELMI 2008** Davos, Switzerland, www.elmi08.unibas.ch

June 2008

open	**EOS – Topical Meeting Information Optics** Engelberg, Switzerland ??
3 – 6	**EPMT** (Environnement Professionnel MicroTechnologies) ▪ 3.6.08 : “Optical Metrology”, Annual Meeting SSOM - Optics ▪ 4.6.08 : “Biomedical Photonics”, Annual Meeting BMPN ▪ 5.6.08 : “Laser Processing”, Annual Meeting SwissLaserNet ▪ 6.6.08 : “Porte ouvertes” Section de Microtechnique, EPFL Lausanne, Switzerland http://www.epmt.ch

September 2008

1 – 5 Oct	**14th European Microscopy Congress EMC 2008** Aachen, Germany www.emc2008.de
29 – 2 Oct	**EOS Annual Meeting 2008** Paris, France http://www.europeanopticalsociety.org/events

See also according pages on ***www.ssom.ch***
www.nanoscience.ch/events.asp
www.ssom.ch/bmpn/activities.html
for further events ......

SSOM

Swiss Society for Optics and Microscopy
Société Suisse pour l'Optique et la Microscopie
Schweizerische Gesellschaft für Optik und Mikroskopie

☐ Anmeldung zur Mitgliedschaft / Demande d'Adhésion
☐ Adressänderung / Changement d'Adresse

Name/Nom : ....
Vorname/Prénom : ....
Institut/Firma/Institution : ....
....
Adresse : ....
....
PLZ/Code Postal : .... Ort/Lieu : ....
Telephon : .... Fax : ....
E-mail : ....

Mitgliedschaft in Sektion oder Arbeitsgruppe / Demande d'adhésion en section ou groupe de travail
☐ Optik ☐ Mikroskopie ☐ Nanotechnologie ☐ Biomedical Photonics

---

Jahresbeiträge als / Cotisations annuelles (Zutreffendes bitte ankreuzen)
☐ Einzelmitglied / Membre individuel : **CHF 30.-** (Optik **CHF 42.50**)
☐ Kollektivmitglied / Membre collectif : **CHF 150.-**
Haupt-Delegierter / Délégué principal : ....
Kollektivmitglieder, Namen und Adressen der Delegierten / Noms et adresses des délégués (max. 10)
....
....
....
....

Datum / Date : ....
Unterschrift / Signature : ....

Bitte Anmeldung an Kassier / A renvoyer au caissier svp :
Gianni Morson, Universität Basel, Zentrum für Mikroskopie,
Pharmazentrum, Klingelbergstrasse 50, CH-4056 Basel
Tel. (061) 267 14 06, FAX (061) 267 14 10,
Email: Gianni.Morson@unibas.ch

Redaktion: Dr. Reto Holzner
Apfelbaumstrasse 2
8050 Zürich

Tel. 044 312 15 63
reto.holzner@hispeed.ch

Adressänderungen : Bitte direkt an Gianni Morson
mit umseitigem Formular.

Redaktionsschluss : 15. Februar, 15. Mai, 15. August, 15. November

Die SSOM ist Mitglied bei der

Schweizerischen Akademie der Naturwissenschaften
Schweizerischen Akademie der Technischen Wissenschaften

Druck: Druckerei Dietrich AG, Pfarrgasse 11, 4019 Basel

Der Druck wurde unterstützt von der
Schweizerischen
Akademie der Naturwissenschaften

sc | nat

Member of
the Swiss Academy of Sciences