2 Applied Physics
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Atomic Physics and Quantum Optics

Note:
The Atomic Physics and Quantum Optics Session contains only poster presentations.

Friday, 22.06.2012, HCI J 6

Time	ID	**Applied Physics I** *Chair: Ivo Furno, CRPP-EPFL*
11:00	**201**	**Vector Spherical Harmonics for active magnetic field compensation** *Grzegorz Wyszynski, Institute of Particle Physics, ETH Zürich, Schafmattstrasse 20, 8093 Zürich* The measurement of the neutron electric dipole moment requires a very stable and uniform magnetic field. It is obtained with a combination of passive and active magnetic shielding. The active external magnetic field compensation systems are usually based on three Helmholtz-like coil pairs whose compensation performance is still far from being optimal. We are designing a new external field compensation system by using a different approach for coil design. For the underlying concept, vector spherical harmonics have been chosen as basis functions for a decomposition of the magnetic field. This way of description allows to select sets of spherical coils, which can generate the most appropriate compensating magnetic field. With 8 coils all independent uniform components and 1st order gradients could be attenuated by a factor ~100 within 50% of the volume (80% of radius) enclosed by coils. Simulations of operation of such a system will be presented along with the results from a first prototype measurement. This project is supported by the Swiss National Science Foundation under grant number 200021_138211 and by the Foundation for Polish Science - MPD program, co-financed by the European Union within the European Regional Development Fund.
11:15	**202**	**Handling wide dynamic PMT signals with high precision in ground-based gamma-ray detectors** *Arno Gadola, Physik-Institut, Universität Zürich, Winterthurerstrasse 190, 8057 Zürich* Gamma-ray astrophysics is the discipline of investigating high-energy gamma rays from our Universe. In the energy range above GeV, gammas are produced in non-thermal processes and hence give another, new inside view into cosmic objects. The Cherenkov Telescope Array (CTA), currently under development, will be the new large ground-based observatory with increased sensitivity over current imaging air Cherenkov observatories, including a wider range of accessible energies. The observatory will consist of a northern and a southern hemisphere array. A typical camera of a 12 m Cherenkov telescope consists of about 1800 pixels. Each pixel must handle light pulses with a wide range of photon counts (0 - 5000 photons) with a very high precision in amplitude and time resolution. This talk will present a new approach to handle the large dynamic range with only one signal path per pixel.
11:30	**203**	**A new internal field mapping device for the nEDM experiment** *Dieter Ries, Paul Scherrer Institute, 5232 Villigen, on behalf of the nEDM collaboration* A non vanishing electric dipole moment of the neutron (nEDM) violates both time and parity reversal symmetry. The current best upper limit for the nEDM is $2.9*10^{-26}$ e*cm. A collaboration at the Paul Scherrer Institute aims at improving this limit first by optimising the apparatus originally used by the RAL/Sussex/ILL collaboration, which measured the current limit, and using a new apparatus in a second step. Several systematic effects of the measurement depend heavily on the homogeneity of the magnetic field inside the apparatus. A field mapping device based on a three axis fluxgate magnetometer was built to study the homogeneity and the response of the field to the various coils used for shaping and compensation. Details about the construction and performance of the mapping device as well as first results will be presented. This work is supported by the Swiss National Science Foundation under grant number 200020_137664.

11:45	**204**	**High brilliance electron beam extraction from metallic microstructured photocathode** *Ardana Fernando [1,2], Frederic Le Pimpec [1], Alexander Anghel [1], Christoph Hauri [1,2]* *[1] PSI, 5232 Villigen, [2] EPFL* We present unexpected high quantum efficiency from a novel type of photocathode driven by an ultrashort UV laser. The cathode consists of micro-structured wires containing tens of thousands of very fine metallic filaments of um diameter. The wire consists of Nb_3Sn and is conventionally used for superconducting applications. The main idea behind our investigation was to take advantage of the presence of the fine filaments to improve the coupling of the laser field to the cathode and to use surface plasmon-polariton effects to enhance the photoelectric emission. The investigated cathode provides two orders higher quantum efficiency and charge and withstands unexpected high laser fluence. This novel type of electron source is expected to be of great benefit for many applications, like ultrafast electron diffraction, modern particle accelerators and Free Electron Lasers.
12:00		***Postersession (continued), Lunchbuffet***
		Applied Physics II *Chair: NN*
13:30	**211**	**Cocaine Detection in Saliva with Attenuated Total Reflection (ATR) Spectroscopy** *Kerstin Hans, Michele Gianella, Markus Sigrist* *Institute for Quantum Electronics, ETH Zürich, Schafmattstrasse 16, 8093 Zürich* Saliva is the easiest accessible body fluid for drug testing and therefore of great interest. The established techniques are either sophisticated or lacking quantitative information. Infrared spectroscopy combined with a simple one-step extraction serves as a new, semi-quantitative and easy-to-use technique with potential for miniaturization yielding a current detection limit around 1 µg/ml. Extensive studies on saliva and other possible interfering substances determined the best spectral range to detect cocaine around 5.7 µm. A quantum cascade laser (QCL) and FTIR spectrometer combined with an ATR-unit serve as detection systems. Initial preconcentration and future design changes should lower the detection limit significantly.
13:45	**212**	**Sensitive detection of cocaine in a liquid solvent with a quantum cascade laser** *Michele Gianella, Markus Sigrist, Kerstin Hans* *Institute for Quantum Electronics, ETH Zürich, Schafmattstr. 16, 8093 Zürich* Portable devices for non-invasive on-site tests for a variety of drugs, like the Breathalyzer® for alcohol, are of great interest. But unlike alcohol which can easily be detected in the exhaled breath, many drugs are much less volatile and therefore harder to detect. A test for cocaine in saliva, for example, must be able to detect as little as 10 ng/mL to be considered sufficiently sensitive. Sensors based on infrared laser spectroscopy are sensitive and selective and thus ideal for this task. We will present measurements of low concentrations of cocaine in a suitable liquid solvent by using a quantum cascade laser at 5.7 microns.
14:00	**213**	**Mid-infrared fiber-coupled photoacoustic sensor for the detection of glucose in biological samples** *Jonas Kottmann, Urs Grob, Julien M. Rey, Markus W. Sigrist* *Institute of Quantum Electronics, ETH Zürich, Schafmattstr. 16, 8093 Zürich* In-vivo non-invasive glucose sensing is of great interest for diabetes patients but still does not exist. We report on a new approach towards this goal using mid-infrared laser spectroscopy and photoacoustic (PA) detection. Medical devices for self-monitoring and diagnostics often require a high degree of flexibility and a compact design. To meet these requirements we coupled for the first time a mid-infrared fiber directly with a small volume PA cell (35 mm^3). The PA cell is constantly ventilated with N_2 to avoid varying conditions and is conically shaped to perfectly match the beam escaping the silver halide fiber. An external-cavity quantum-cascade laser (1010-1095 cm^{-1}) covering two strong glucose absorption peaks is employed as a light source to monitor glucose in gelatin samples serving as human skin phantom. Results on sensor characterization and detection sensitivity are presented. Spectra are recorded to increase glucose selectivity.

14:15	**214**	**Tracking of Murine Cardiac Stem Cells by Harmonic Nanoparticles** *Thibaud Magouroux [1], Andrii Rogov [1], Jérôme Extermann [1], Marisa Jaconi [2], Pernilla Hoffman [2], Daniel Ciepielewski [3], Luigi Bonacina [1], Jean-Pierre Wolf [1]* *[1] GAP Biophotonics, University of Geneva, 22, chemin de Pinchat, 1211 Geneva* *[2] Department of pathology and immunology, Geneva Faculty of Medicine, Centre Médical Universitaire 1, rue Michel-Servet, 1211 Geneva* *[3] Nikon France, Division Instruments, 191 Rue du Marché Rollay, FR-94504 Champigny Sur Marne Cedex* Harmonics nanoparticles (HNPs) are a valid alternative to fluorescent probes, featuring excitation wavelength tunability, absence of bleaching, and coherent response. Here, we show how PEG-stabilized HNPs efficiently bind to mouse embryonic stem cells (SC) membranes, without interfering with their development and differentiation. We demonstrate for the first time how strong HNPs signal emitted can be used to monitor the rhythmic contractions of a 3D cardiac beating cluster differentiated from mouse embryonic SC. In addition to information at the cellular level of 3D contraction pattern, this approach can be readily applied to monitor the evolution of SC in a 3D supporting biomatrix or their engraftment and integration in a tissue, both in vitro and in vivo.
14:30	**215**	**Analysis of Human Tone-Burst-Evoked Otoacoustic Emissions** *Reinhart Frosch, PSI and ETHZ (retired), Sommerhaldenstr. 5B, 5200 Brugg* In her contribution to Forum Acusticum 2011, "Investigating the Periodicity of Transient-Evoked Otoacoustic Emission Envelopes", Sarah Verhulst presented experimental waveforms of human otoacoustic emissions evoked by tone bursts. In the present paper, it is shown that these waveforms, which depend strongly on the frequency and on the sound-pressure level of the tone burst, agree with predictions based on the assumption of two different types of emission source, namely (1) outer hair cells feeding mechanical energy into the cochlear travelling waves generated by the central-frequency component and also by the high- and low-frequency satellite components of the Hann-windowed tone bursts used, and (2) different outer hair cells feeding mechanical energy into stationary localized evanescent waves triggered by the tone bursts. This set of emission-source types differs from that commonly considered in the hearing-science literature.
14:45	**216**	**High power SESAM modelocked thin disk lasers access to sub-100 fs pulses and first CEO beat frequency detection** *Cinia Schriber [1], Clara Saraceno [1], Selina Pekarek [1], Oliver Heckl [1], Cyrill Baer [1], Matthias Golling [1], Kolja Beil [2], Christian Kränkel [2], Günter Huber [2], Thomas Südmeyer [3], Ursula Keller [1]* *[1] Institute for Quantum Electronics, ETH Zürich, Wolfgang-Pauli-Strasse 16, 8093 Zürich* *[2] Institute of Laser Physics, University Hamburg, Luruper Chaussee 149, Building 69, DE-22761 Hamburg* *[3] Institut de Physique, Université de Neuchâtel, Av. de Bellevaux 51, 2000 Neuchâtel* Ultrafast thin disk lasers, passively modelocked with semiconductor saturable absorber mirrors (SESAMs), currently achieve the highest average powers and pulse energies compared to any other laser oscillators. To date an average power of >140 W in 738 fs pulses and a pulse energy of >40 µJ in 1.1 ps have been demonstrated. However, until now the pulse duration has been too long for efficiently driving high harmonic generation (HHG). Furthermore, single attosecond pulse generation requires a stabilized carrier envelope offset (CEO) phase. Here, we present our most recent results with ultrafast thin disk laser oscillators generating sub-100 fs pulses and demonstrating the first measurement of the CEO beat frequency. These two key milestones open the door to novel megahertz VUV/XUV sources with intralaser and laser external HHG.

15:00	**217**	**Enhancing the Performance of Solid State Organic Solar Cells by Self-assembled Monolayer Technique** *Ali Kemal Havare [1], Mustafa Can [2], Serafettin Demic [3], Salih Okur [3], Siddik Icli [2]* *[1] University of Toros, Department of Electrical and Electronics, Bahcelievler Kampüsü, 1857 Sokak, No: 12, Yenisehir, TR-33140 Mersin* *[2] Inst. of Solar Energy at Ege University, Günes Enerjisi Enstitusu, 35100 Bornova, TR-35100 Izmir* *[3] Izmir Katip Celebi University, Department of Materials and Engineering, Atatürk Organize Sanayi Bölgesi (A.O.S.B.) Mahallesi Havaalani Sosesi No:33/2 Balatcik 35620 Cigli Izmir, TR-35620 Izmir* The 5-[2,5-di-2-thienyl-1H-pyrrol-1-yl)isophthalic acid and 4'-[(3-methylphenyl)(phenyl)amino)]biphenyl-4-carboxylic acid were synthesized as self-assembled monolayer (SAM) forming material at interface of ITO and donor-acceptor layer. We have investigated the effects of SAM with carboxylic acid (COOH) headgroups on the bonding and performance of ITO solid-state organic solar cell. SAM about 2-3 nm in thickness were grown on ITO surface by successive chemical adsorption and reaction, and photovoltaic devices were fabricated as a solid-state hole conductor.
15:15	**218**	**Wave Propagation in Elastic and Thermoelastic Materials** *Mario Leindl [1], Eduard Oberaigner [1], Marianne Mataln [2]* *[1] Institute of Mechanics, University of Leoben, Franz-Josef-Straße 18, AT-8700 Leoben* *[2] Materials Center Leoben Forschung GmbH, Roseggerstraße 12, AT-8700 Leoben* The analysis of elastic wave propagation is of crucial importance in several areas of engineering, e.g., design of spacecraft and aeroplanes, exploration geophysics, design of civil structures. Since the middle of the last century technical innovations in the latter mentioned areas have increased the importance of understanding of dynamic phenomena. The first decades in studying dynamic aspects were marked by analytical methods [1, 5, 6, 7], e.g., integral transformation techniques like Laplace and Fourier transform or appropriate modifications of them, the Green's function method, etc. In the last decades of the 20th century digital computers became available for most scientists and numerical solution techniques, e.g., finite difference, boundary element, finite volume method [9], or finite element [3] method were used effectively, additionally nonlinear problems were analysed by numerical methods [4]. Today, the study of the behaviour of different materials, especially smart materials, e.g., shape memory alloys, ceramics, is another important aspect [8, 10]. This work deals with analytical and numerical solution methods for elastic and thermoelastic wave propagation phenomena in strings and rods. Further, reflection and transmission effects occurring at interfaces are discussed. For analytical considerations the Green's function [2] method and for numerical computations the finite element method [3] is used. An improved version of this method for wave propagation problems in solids is presented in this work. Finally, thermo-mechanically coupled wave propagation problems [5, 6] are described. The field equations are presented and some coupling phenomena are discussed. [1] J. D. Achenbach. Wave Propagation in Elastic Solids. North Holland, Amsterdam, 1973. [2] G. Barton. Elements of Green's Functions and Propagation: Potentials, Diffusion, and Waves (Oxford Science Publications). Oxford University Press, Oxford, UK, 1989. [3] K. J. Bathe. Finite Element Procedures in Engineering Analysis. Prentice Hall, Englewood Cliffs NJ, 1982. [4] A. Berezovski, J. Engelbrecht and G.A. Maugin. Numerical Simulation Of Waves And Fronts In Inhomogeneous Solids. World Scientific Publishing Co. Pte. Ltd., Singapore, 2008. [5] A. C. Eringen, E.S. Suhubi. Elastodynamics: Finite Motions Vol. I. Academic Press Inc., New York, 1974. [6] A.C. Eringen, E.S. Suhubi. Elastodynamics: Linear Theory Vol. II. Academic Press Inc., New York, 1975. [7] K. F. Graff. Wave Motion in Elastic Solids. Oxford University Press, Oxford, 1975. [8] M. Leindl, M. Fischlschweiger and E. R. Oberaigner. Damping Behaviour of Vibrating Shape Memory Alloy Rods Investigated by a Novel Constitutive Model. in PAMM, 11 403–404, 2011. [9] R. J. LeVeque. Finite Volume Methods for Hyperbolic Problems. Cambridge University Press, Cambridge, 2002. [10] E. R. Oberaigner, K. Tanaka and F. D. Fischer. Damping of a vibrating SMA rod through phase transformation. in Proc. IUATM Symposium on Variations of Domains and Free Boundary Problems in Solid Mechanics, 1 35–44, Kluwer Academic Press, Dordrecht, 1999.
15:30		***Coffee Break***

Time	ID	Applied Physics III *Chair: NN*
16:00	221	**Highly efficient Cu(In,Ga)Se_2 solar cells grown on flexible polymer films** *Adrian Chirilă* *Lab. for Thin Films and Photovoltaics (Abt. 130), EMPA, Überlandstrasse 129, 8600 Dübendorf* Solar cells based on thin film Cu(In,Ga)Se_2 semiconductor with a world record conversion efficiency of 18.7% have been developed on flexible plastic substrate. A value that is now comparable to the best efficiencies that are achieved on rigid glass substrates, which withstand much higher temperatures than plastic substrates, and polycrystalline Si-wafer based cells. This breakthrough was achieved by an innovative co-evaporation process which enables growth of high-quality Cu(In,Ga)Se_2 layers at low growth temperatures that are required for plastic substrates. Key point was the adaption of the compositional gradient along the film depth to enable efficient carrier collection and minimized recombination.
16:30	222	**Dynamic nuclear polarization at moderate magnetic fields and temperature using photo-excited triplet states of aromatic molecules** *Tim Rolf Eichhorn [1], Ben van den Brandt [1], Arnaud Comment [2], Martin Haag [1], Patrick Hautle [1], Tom Wenckebach [1]* *[1] Paul Scherrer Institute, 5252 Villigen* *[2] LIFMET, EPFL, Station 6, 1015 Lausanne* Dynamic nuclear polarization (DNP) has become the method of choice to greatly enhance spectroscopic signals from nuclear spins in magnetic resonance (NMR) or in magnetic resonance imaging (MRI) e.g. for studying metabolism in vivo. The classical schemes of DNP require low temperatures (~ 1K) and strong magnetic fields (2.5 – 5 T). These stringent conditions can be relieved with a more recent and very promising DNP method that uses optically excited electronic triplet states. We will briefly introduce the triplet DNP scheme applied to pentacene-doped naphthalene samples and present the versatile experimental setup comprising of a home-built pulsed ESR / NMR spectrometer and a state of the art high-power laser. Typical enhancement factors for classical DNP methods are around 100 compared to the thermal proton spin polarization at experimental conditions. We can report on enhancement factors of the proton polarization of 4 orders of magnitude built up within minutes at 100 K and 0.3 T.
16:45	223	**Dynamical study of electron pump based on self-assembled quantum dots** *Giancarlo Cerulo, Laurent Nevou, Valeria Liverini, Fabrizio Castellano, Jérôme Faist* *Institute of Quantum Electronics ETH-Hönggerberg, Wolfgang-Pauli-Strasse 16, 8093 Zürich* The unique properties of semiconductor quantum dots (QD) can be exploited to realize a current standard and redefine the Ampere [1]. The atom-like electronic structure of QDs allows us to generate a quantized current by pumping electrons out of the dots using optical pulsed radiation. In this work we have studied the dynamic properties of the injection stage of an electron pump based on self-assembled QDs. The injection stage heterostructure consisted of an InGaAs quantum well reservoir coupled via an AlGaAs barrier to the QD plane. Three devices with different AlGaAs barrier thicknesses have been characterized. The refilling times of the QDs have been estimated using two independent experiments. The first one is based on the Pump&Probe technique, while the second one on the study of the saturation of the photocurrent. The measured refilling times are in good agreement with a model based on the transfer matrix approximation.

17:00	**224**	**DAST/SiO_2 multilayer structure for efficient generation of 6 THz single-cycle pulses via cascaded optical rectification** *Andrey Stepanov, Luigi Bonacina, Jean-Pierre Wolf* *GAP Biophotonics, University of Geneva, chemin de Pinchat 22, 1211 Geneva* During the last 10 years, significant progress has been made in the development of high-power THz sources. Today, in the frequency range of 0.1-3 THz, a few optical rectification techniques provide laser-to-THz photon conversion efficiency above 100% due to cascaded nonlinear processes. Further increasing the THz generation efficiency demands control over the cascaded nonlinear processes. In spite of this progress, there is still an absence of powerful table-top sources in the frequency range of 3–9 THz. High-energy ultrashort THz pulses in this range are desirable for nonlinear probing of lattice dynamics in polar semiconductors and for two-dimensional THz spectroscopy of the nonlinear vibrational response of water. In this contribution, we propose a new technique for efficient generation of 6 THz near-single-cycle pulses which allows to obtain phase-matched optical rectification of 800 nm femtosecond laser pulses in DAST. Moreover, it provides an unique opportunity for controlling cascaded nonlinear processes.
17:15	**225**	**Laser induced magnetization reversal in GdFeCo nanostructures** *Michele Buzzi [1], Loic Le Guyader [1], Souliman El Moussaoui [1], Rajesh Chopdekar [1], Laura Heyderman [1], Arata Tsukamoto [2], Akiyoshi Itoh [2], Andrei Kirilyuk [3], Theo Rasing [3], Alexey Kimel, [3] Frithjof Nolting [1]* *[1] Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI* *[2] College of Science and Technology, Nihon University, 24-1 Narashinodai 7-chome, JP-274-8501 Chiba* *[3] Radboud University Nijmegen, Institute for Molecules and Materials, Heyendaalseweg 135, NL-6525 Nijmegen* In this work we demonstrate laser induced magnetization reversal in GdFeCo nanostructured magnetic domains with size range between 1 micron and 200 nm. Imaging of the magnetic domain configuration was obtained using spatially resolved X-ray magnetic circular dichroism effect at the Fe L3 edge with a photoemission electron microscope. An azimuthal dependent study allowing the determination of the magnetization vector components revealed that the nanostructures display in-plane magnetized rims and out-of-plane domains at the center. Spectromicroscopy in combination with atomic force microscopy show that the in-plane magnetized rims arise from a thinning of the magnetic layer at the edge of the nanostructures. However, no drastic influence of these in-plane magnetized rims on the switching efficiency of the nanostructures was observed. These results constitute an important step towards the application of laser induced magnetization switching in storage devices displaying tremendous recording speed.
17:30	**226**	**Electrochemical deposition of photoconductive silicon based films using organic solvents** *Agata Krywko-Cendrowska [1], Ernst Meyer [1], Laurent Marot [1], Marek Szklarczyk [2], Marcin Strawski [2], Bartosz Maranowski [2]* *[1] Department of Physics, University of Basel, Klingelbergstrasse, 4056 Basel* *[2] Department of Chemistry, University of Warsaw, Pasteura 1, PL-02-093 Warszawa* Silicon based films on gold and platinum are assuming increasing importance in the manufacturing of macroelectronic devices, such as solar cells, and efficient means for their production is an active area of research. This study focuses on the application of a potentiostatic method, involving solutions of trichlorosilane and tert-butylammonium bromide in propylene carbonate, for the electrochemical deposition of silicon based films and the optimisation of the deposition parameters using a variety of diagnostics for surface characterization. These include X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy for chemical surface analysis and atomic force microscopy (AFM) as well as optical microscopy for topological surface characterization. Emphasis is put on the application of XPS measurements for the quantification of the species synthesized on the electrode surfaces and the investigation of the influence of the electrodeposition conditions, such as solution composition, electrochemical potential and the concentration of a particular silicon salt.
17:45		***END***

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Optical position feedback and closed loop control for electrostatically driven MOEMS mirrors

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For MOEMS (micro-opto-electro-mechanical systems) mirrors, which do not have an intrinsic on-chip feedback, position information can be obtained using optical methods. Here we present a new position sensing device based on the measurement of back-reflected light using a quadrant diode with a central hole, through which illumination is performed. This device enables the measurement of arbitrary mirror trajectories in a very compact configuration and still provides high accuracy. Position feedback is the basis for closed loop control, which is necessary for accurate and fast positioning of these micro-mirrors. We present simulation results and finally a microcontroller based implementation of a control loop, which was tested with electrostatically driven quasi-static scanner mirrors. The measured results are compared to the characteristics of the devices when driven in open loop mode. Settlings times and operating bandwidth can be improved by a factor of 10 compared to open loop operation.

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Structural and piezoelectric investigation of $BaTiO_3$ thin films on Si

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Tetragonal $BaTiO_3$ films can achieve large piezoelectric coefficients depending on their crystallographic orientation. Still, the growth of $BaTiO_3$ on Si with stabilized tetragonal structure and good piezoelectric response remains a big challenge. Such films were grown following a hybrid approach. A buffer of 10 unit cells (UC) of $SrTiO_3$ and 20 UC of $BaTiO_3$ is deposited by MBE on Si(001) followed by the RF sputtering of 300 nm of $BaTiO_3$ at various temperatures. X-ray diffractometry, spectroscopic ellipsometry and TEM show that the sputtered films are amorphous, but crystallize in the tetragonal phase along [100] after post-annealing in O_2 at 650°C. The transverse piezoelectric coefficient e31,f (T) measured up to 300°C, using a modified vibrating beam technique, exhibits a distinct feature at the Curie temperature around 120°C. The results are compared with PZT and AlN reference samples.

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Strain effects on the properties of III-V MOSFETs

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Strain engineering is a well-known method to increase the carrier mobility in the channel of high performance n- and p-MOSFETs. We have investigated the effect of tensile and compressive biaxial strain on the transport characteristics of $In_{0.53}Ga_{0.47}As$ MOSFETs using a home-built beam bending setup. Since mobility is given by the ratio of the scattering time teff over the effective mass m*, both related to the band structure, the impact of strain on these quantities has been simulated using the k·p perturbation theory. A simple structure featuring our InGaAs devices is used for our simulation with the program Nextonano3. In pseudo-MOSFET devices we measured an increase of the on-current up to 65% at a tensile strain level of 0.6%. This enhancement is believed to be due to the shift of the conduction band edge, which increases the sheet carrier density, rather than to the reduction of m*.

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Physical properties of ZnSe/SnO_2/glass films: Annealing (Ar atmosphere) temperature effects

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The II-VI semiconductor ZnSe films were grown on SnO_2/glass by CBD for solar energy conversion. The phase analysis was made by x-ray diffraction, and crystallite size, dislocation density and strain were calculated and the changes in such structural parameters depending on the annealing temperature were investigated. The optical band gap energy of all films was calculated. The band gap values decrease upon temperature increase (3.08 eV to 2.43 eV). The transport properties of the films were measured by four-point probe technique. Some of the

films (annealed at 373 K, 473 K, and 573 K) show two distinct temperature regions such as exponential at high temperature and linear region at low temperature. Here, we discuss about the changes in electrical properties upon temperature increase, and also upon annealing temperature increase.
Reference: H. Metin, S. Durmus, S. Erat, M. Ari, Applied Surface Science, 257 (2011) 6474–6480

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Structural and Electrical properties of Inkjet Printed CdS Thin Films

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A Dimatix DMP-2831 inkjet material printer has been used to produce CdS thin films which were deposited onto glass substrates. The printed solution has been prepared from the ball milled CdS powder which was embedded within α-terpineol and clorobenzene. The α-terpineol and clorobenzene were used as stabilizers which were removed by annealing the films at 300 °C in air after the jetting process. Ultrasonically cleaned glass substrate was kept at 70 °C during the deposition process. Then, 75 V and 45 µs pulse widths were applied by the inkjet printer in order to obtain uniform and stable droplets of the CdS solution, which affects the quality of the thin films. The inkjet printed CdS thin films were characterized using Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDX), X-ray diffraction (XRD) and 4-point probe techniques.

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Characterization of Inkjet Printed CdTe Thin Film

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Inkjet printing technique was used to fabricate CdTe thin films which were produced from the solution of CdTe that was embedded within α-terpineol and clorobenzene. The structural and electrical properties of the CdTe thin films were characterized by using Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDX), X-ray diffraction (XRD) and 4-point probe measurement methods. The CdTe thin films which deposited onto glass were annealed in air at 300 °C to remove the solvents in order to obtain the homogeneity of the films. The glass substrate has been kept at 70 °C during the jetting process, which was ultrasonicated for 10 min in acetone to obtain clean surface. 75 V and 45 µs pulse widths were applied by the Dimatix DMP-2831 inkjet material printer to obtain stable and uniform droplets of the CdTe solution.

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Electrical Properties and Crystallographic Properties of Ternary Ho_2O_3 and Eu_2O_3 Doped Bi_2O_3 Polymorphs

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In this study, stable δ-phase of bismuth trioxide which doped with holmium trioxide and europium trioxide ternary system have been measured by 4-point probe technique and the temperature dependence of the electrical properties. The samples obtained in air atmosphere were characterized by x-ray powder diffractions (XRD). The unit cell parameters were defined from the indexes of the powder diffraction patterns. The $(Bi_2O_3)_{1-x-y}(Ho_2O_3)_x(Eu_2O_3)_y$ ternary system were obtained with x=5,15 mol % and y=5,10,15,20 mol % dopant concentrations. Thermal behavior and thermal stability of the phases were investigated by thermal analysis techniques. Surface and grain properties of the related phases were determined by SEM analysis.

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Electrical Properties And Crystallographic Characterisation of $(Bi_2O_3)_{1-x-y}(Ho_2O_3)_x$ and $(Tm_2O_3)_y$ System

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The main aims of this study to determine δ-phase of bismuth trioxide holmium trioxide and europium trioxide ternary system and the temperature dependence of the electrical transport properties. The reaction products obtained in an open air atmosphere were characterized by x-ray powder diffractions (XRD). The unit cell parameters were defined from the indexes of the powder diffraction patterns. The $(Bi_2O_3)_{1-x-y}(Ho_2O_3)_x(Tm_2O_3)_y$ ternary system system were obtained whit x=20,15 mol % and y=5,10,15,20 mol % dopant concentrations. Thermal behavior and thermal stability of the phases were investigated by differential thermal analysis (DTA). Surface and grain properties of the related phases were determined by SEM analysis. The temperature dependence of the electrical properties of δ-phase of solid solution samples were measured by four point probe d.c. conductivity method.

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Surface morphology and Thermoluminescence of CBD grown ZnSe Films

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The semiconductor Zinc Selenide (ZnSe) thin films have been deposited on glass substrates by conventional chemical bath deposition method at 70ºC and the films were annealed at different temperatures in order to improve the quality of the films. The increase in the grains upon annealing temperature increase was observed by Atomic Force Microscopy (AFM) with non-tapping mode and Scanning Electron Microscope (SEM). The thermoluminescence properties of the films were recorded after $^{90}Sr/^{90}Y$ β-source irradiation. The kinetic parameters i.e. the activation energy of the traps involved in the TL emission, the kinetic order b, and the frequency factor s, associated with the glow peaks were calculated.

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Scattered light fluorescence microscopy in three dimensions

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Recently, we have proposed a method to image fluorescent structures behind turbid layers at diffraction limited resolution using wave-front shaping and the memory effect. However, this was limited to a raster scanning of the wave-front shaped focus to a two dimensional plane. In applications, it can however be of great importance to be able to scan a three dimensional volume. Here we show that this can be implemented in the same setup. This is achieved by the addition of a parabolic phase shift to the shaped wave-front. Via the memory effect, this phase shift leads to a shift of the interference based focus in the z-direction, thus opening the possibility of three dimensional imaging using scattered light fluorescence microscopy. Here, we show an example of such a three dimensional image of fluorescent nano-beads taken behind a turbid layer more than 10 mean free paths thick. Finally, we discuss the differences of the scanning in the z-direction with that in the x–y plane and the corresponding possibilities and limitations of the technique.

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Sensitivity of RADFETs with various gate oxide thicknesses

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The sensitivity of RADFETs to the ionizing radiation, representing the dependence of threshold voltage on dose, of five transistor types with the oxide thicknesses of 400 nanometers and 1 micrometer has been investigated. The RADFETs have extremely small sizes and allow the dose measurement in vivo in real time, which is especially important for radiotherapy.
The threshold voltage shift is caused by the radiation-induced oxide charge, representing the holes trapped in SiO_2 and at Si/SiO_2 interface, and the creation of interface states at the Si/SiO_2 boundary. The sensitivity increasing can be achieved by the increasing the gate oxide thickness or stacking more transistors. The investigation of RADFETs with a thick gate oxide has been intensified because of their enhancement radiation sensitivity.

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Spectral properties of mid-infrared quantum cascade lasers

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During the last decade, quantum cascade lasers (QCLs) have become one of the most versatile light sources in the mid-infrared range. They are now available as a commercial product for a vast number of wavelengths and increasingly interesting performances in terms of threshold current and operating temperatures. However, some of their properties, such as their frequency noise or linewidth, remain rather poorly known and understood. We present here our latest results of linewidth characterization of continuous wave mid-IR QCLs at 4.55 µm, assessed from the measurement of their frequency noise. We also discuss the dependence of the linewidth on the current-driver characteristics, which can have a disastrous effect for the most demanding applications in terms of spectral properties.

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Simple approximate relation between laser frequency noise and linewidth: experimental validation

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Laser frequency fluctuations can be characterized extensively by the frequency noise spectrum or in a simple but incomplete way by the laser linewidth. A formal relation exists to calculate the linewidth from the frequency noise spectrum, but in general, its application is not straightforward. Recently we proposed a simple approximation allowing us to easily calculate the linewidth from arbitrary frequency noise spectrum. Here we present an experimental validation of this approximation. We used laser sources of different intrinsic noise characteristics to produce light fields with different frequency noise spectra. For each of them we measured the frequency noise spectrum and calculated the approximate linewidth from it. At the same time we directly measured the lineshapes and we extracted their linewidths. We observe a very good agreement between the approximate and directly measured linewidths over a broad range of values (from kHz to MHz).

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External cavity tuning of broadband QCLs at 3.3 µm and 8 µm

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The detection of characteristic broad absorption features in the mid-infrared of molecules requires widely tunable light sources in this region. Two broadband active region designs were measured in an external cavity setup in Littrow configuration. The laser at 3.3 µm is based on a heavily strained Sb-free homogeneous design by Bismuto et al. Two step barriers (AlInAs-AlAs) are used in the active region design in order to limit the material strain introduced by AlAs. In the 8 µm emission range a multistack, bound-to-continuum active region design was used with three different active regions yielding a gain covering the region from 7 to 10 µm. The back and front facet coatings tuning ranges of over 275 cm^{-1} and 445 cm^{-1} were measured for the 3.3 µm and 8 µm region respectively. With improved front facet coatings even broader tunings are expected.

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Ground state Hanle effect based on atomic alignment: theory and experiment.

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Magnetic sub-level coherences play an important role in atomic physics and quantum optics. In this communication we report on the ground-state Hanle effect (GSHE) of cesium atoms excited by linearly polarized laser light on the D1-line. The GSHE manifests itself as a resonance in the sample's optical transmission when an applied magnetic field B is scanned though B=0 (zero-field level crossing). We show that either bright or dark resonances can be observed, depending on the orientation of the scanned field. The Liouville equation describing the dynamics of atomic multipole moments is solved algebraically. The resulting expressions for the lineshapes in fields of arbitrary magnitude and direction are in excellent agreement with our experimental observations.

285 Study of phase gradients in the Swiss continuous atomic fountain frequency standard

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Atomic fountains clocks provide the best realization of the second with relative uncertainties of a few parts in 10^{16}. All the atomic fountain frequency standards presently contributing to TAI operate in pulsed mode. Our alternative approach consists in making use of a continuous beam of laser-cooled cesium atoms. This approach is very interesting from the metrological point of view since the relative importance of the inaccuracy budget contributors is notably different for a continuous fountain compared to a pulsed one. Recently, microwave phase gradients have been the subject of intensive research efforts in order to reduce their contribution to the inaccuracy budget of pulsed fountains. Despite the different microwave cavity design, phase gradients have also been identified as the main inaccuracy contributor in our continuous fountain. Because of the different microwave cavity design, a dedicated research effort is necessary to understand and reduce the effect of these phase gradients.

286 Femtosecond gigahertz diode-pumped solid-state laser for frequency comb generation

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Stable frequency combs from femtosecond lasers have been a major breakthrough in optical science and metrology. Typical frequency combs are either based on complex green-pumped Ti:sapphire lasers or amplified fiber laser systems. We have demonstrated the first gigahertz frequency comb based on a more compact diode-pumped solid-state laser. The laser is based on Yb:KGW (ytterbium-doped potassium gadolinium tungstate) and we have demonstrated pulse repetition rates up to 4.8 GHz using a semiconductor saturable absorber mirror (SESAM) for stable fundamental passive modelocking. Using a high brightness distributed Bragg reflector (DBR) tapered diode laser as the pump source this compact diode-pumped solid-state laser reaches an average output power of 1.9 W with an optical-to-optical efficiency of 36 % at 4.8 GHz with a pulse duration of 396 fs at a center wavelength of 1043 nm. Combining the high repetition rate with femtosecond pulses and Watt level power makes this laser a promising source for multi-GHz self-referenced frequency combs. We will discuss the requirements for stable frequency comb generation using such sources.

287 Ultrafast optically pumped VECSELs and MIXSELs

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Ultrafast vertical external cavity surface emitting lasers (VECSELs) are attractive laser sources for applications such as multi-photon microscopy and self-referenceable gigahertz frequency combs. Fundamental modelocking of VECSELs is typically obtained using semiconductor saturable absorber mirrors (SESAMs), resulting in output power levels of 2.1 W with 4.7 ps pulses or extremely short pulses of 107 fs at 3 mW. However, the combination of high output power and femtosecond pulses was not demonstrated until 2011, when we presented the first Watt-level femtosecond VECSEL with 1.05 W in 784-fs pulses. In 2007, we moreover demonstrated the vertical integration of the absorber in the VECSEL structure. This concept is referred to as modelocked-integrated external-cavity surface-emitting laser (MIXSEL). Today, this technology enables us to obtain output power levels of up to 6.4 W in 28-ps pulses, which is the highest output power of any modelocked semiconductor laser. We present the path towards Watt-level femtosecond MIXSELs.

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Mid-IR Broadband Quantum Cascade Laser Frequency-Comb

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We show a free-running broadband QCL emitting a frequency-comb of 490 nm in the mid-IR region at 7 µm whose spectral phase signature resembles to the one of a frequency-modulated (FM) laser. The only requirement for a comb operation is the periodicity of the waveform with the round-trip frequency, not the generation of high intensity pulses. Since the intensity of a perfectly FM-laser is constant, the power envelope of such a beam is not perturbed by the fast gain-recovery of the QCL while the spectrum of such a laser is also composed of equally spaced, discrete spectral lines. To gain an insight on the respective phases and coherence properties of the modes, we performed an interferometry technique (beatnote-interferogram) where the autocorrelation of the intermode-beatnote is measured using a Michelson interferometer. The Fourier transform of the beatnote-interferogram yields the beatnote spectrum that indicates the spectral regions contributing to the beatnote.

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Single-cycle high-power THz pulses above 1 MV/cm

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We show latest results on the generation of high-power single-cycle THz pulses exceeding 1 MV/cm field strength by nonlinear frequency down-conversion. Such THz pulses offer a large potential for a wide set of different applications, like initiating catalytic reactions, coherent control on magnetic switching or the study of resonant modes in condensed matter. Different THz conversion schemes have been studied and results will be discussed with regards to the realization of a tunable THz source across the so-called THz gap.