# 2 Applied Physics

## *Tuesday, 22.06.2010, Room 119*

| Time | ID | Applied Physics I<br>*Chair: I. Furno, EPFL* |
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| 14:15 | 201 | **Analysis of Human Oto-Acoustic Emissions**<br><br>*Reinhart Frosch, retired from PSI and ETHZ, Sommerhaldenstr. 5B, 5200 Brugg*<br><br>Click-evoked oto-acoustic emissions from human ears are useful especially in the case of patients with whom communication is impossible. If the outer hair cells (OHCs) in the basal half of the cochlea are damaged, these emissions are weaker than in the case of healthy ears. In the present analysis of measured emissions documented in the literature, it is shown that the time-dependence of the instantaneous frequency of the emissions is consistent with a cochlear model [1] involving two resonators, namely the IOCR (internal organ-of-Corti resonator; spring = OHCs and surrounding structures) and the BMR (basilar-membrane resonator; spring = fibres of the BM). At a given distance-from-base in the basal half of the BM, the resonance frequency of the IOCR is lower than that of the BMR by about one octave. The IOCR is thought to enable, during a sine-tone, the OHCs to feed mechanical energy into the cochlear travelling wave and thus to give rise to the "active" response peak. That OHC-generated mechanical energy is conjectured to cause the oto-acoustic emissions.<br><br>[1] R. Frosch, Old and New Cochlear Maps, Canadian Acoustics Vol. 37 No. 3 (2009) 174–175. |
| 14:30 | 202 | **Electrical impedance measurements for the local detection of modifications of coronary arteries**<br><br>*Patrick Schwaller [1], Michael Held [1], Christian Nussbaum [1], Rolf Vogel [2], Michael Schwager [3]*<br>*[1] Bern University of Applied Science, Pestalozzistrasse 20, 3401 Burgdorf*<br>*[2] ARTORG Center for Biomedical Engineering Research, Stauffacherstrasse 78, 3014 Bern*<br>*[3] SIS Medical AG, Hofackerstrasse 15, 8409 Winterthur*<br><br>Coronary artery disease is the leading cause for mortality in industrialized countries. A timely detection of already minor disease-related lesions would therefore be of crucial interest. Examples include the detection of the absence of neointimal coverage of implanted stents (which may lead to a thrombosis) as well as the characterization of atherosclerotic plaques. We developed a prototype of an inflatable balloon catheter (made of polyamide or PET) for electrical impedance measurements. In our presentation we will discuss design and fabrication issues of the sensor and will present results of in-vitro measurements of different porcine and human coronary arteries. Our results show that with the impedance-frequency behavior a local distinction between different medical states is possible. In addition possible interpretations of the complex electrical impedance behavior of the tested samples regarding a possible modeling will be discussed. |

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| **14:45** | **203** | **Surface structuring of transparent materials by laser induced back side wet etching**<br><br>*Sarah Zehnder, Guido Bucher, Patrick Schwaller, Beat Neuenschwander*<br>*Bern University of Applied Science, Pestalozzistrasse 20, 3401 Burgdorf*<br><br>Laser induced back side wet etching (LIBWE, Wang et al,, Appl. Phys. A68 (1999) 111-113) allows a rapid prototyping of glass. In LIBWE the energy of a laser pulse is absorbed by an adsorbent in solution placed at the back side of the transparent material and causes etching at its rear surface. The mechanism of the process is however not solved yet. The adsorbent for example may be involved in different sub-processes: adsorbing the laser energy to vaporize the solvent and ablating glass through a shock wave or deposition of adsorbent fragments on the glass surface for subsequent absorption of energy directly on the glass.<br>We did LIBWE experiments using nanosecond pulses (wavelength 1064 nm). The etched surfaces have been analyzed by laser scanning and atomic force microscopy. The influence of the adsorbent and laser parameters will be discussed regarding a better understanding of the ablation mechanism. |
| **15:00** | **204** | **Experiments on entanglement of ultracold atoms on an atom chip**<br><br>*Jad C. Halimeh [1], Max F. Riedel [1], Pascal Böhi [1], Theodor W. Hänsch [1], Philipp Treutlein [2]*<br>*[1] Fakultät für Physik, LMU München und Max Planck Institut für Quantenoptik, Schellingstraße 4, DE-80799 München*<br>*[2] Departement Physik, Universität Basel, Klingelbergstraße 82, CH-4056 Basel*<br><br>Atom chips provide a robust, compact, and scalable experimental setup that is ideal for the development, implementation, and testing of quantum-enhanced technologies such as quantum information processing, quantum simulation, and quantum metrology. On our atom chip, state-selective microwave near-field potentials allow for the coherent manipulation of both internal and motional states of ultracold atoms. Elastic collisional interactions are used to create multi-particle entanglement within a single Bose-Einstein condensate (BEC). Proposals to further use these microwave near-field potentials to realize a quantum phase gate with single atoms on an atom chip have been presented. We are currently investigating methods to experimentally entangle two small BECs. This will allow us to study quantum collisional phase shifts and investigate the possibility of using small BECs for quantum information processing. |
| **15:15** | **205** | **Optimization of multidisperse packing problems**<br><br>*Johannes Josef Schneider, Andre Müller, Elmar Schömer*<br>*Fachbereich Physik, Mathematik und Informatik, Universität Mainz, Staudinger Weg 7/9, DE-55099 Mainz*<br><br>Everybody knows the problem: goods just bought at the supermarket must be packed in the rear trunk of the car, often while considering constraints. Also in logistics, packing problems occur: the traveling salesperson must pack the truck in a way corresponding to the sequence of the customers. Further packing problems occur in textile industry as well as in wood- and metal-working industry. Here a multidisperse packing problem shall be considered, in which hard disks with different sizes are packed in a circular environment in a way that the radius of the circumcircle around the disks is minimum. We present our packing algorithm, with which we were able to beat and to match all world records established in |

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| | | an international contest in competition between 155 groups from 32 countries. Our packing algorithm was rated by the Time Magazine to be one of the 50 best inventions of the year 2009. |
| **15:30** | | ***Coffee Break*** |
| | | **Applied Physics II**<br>*Chair: B. Braunecker* |
| **16:00** | **206** | **Multi-foci imaging by depth of field multiplexing with a spatial light modulator (SLM)**<br><br>*Saranjam Khan, Christian Maurer, Stephanie Fassl, Stefan Bernet, Monika Ritsch-Marte, Division for Biomedical Physics, Innsbruck Medical University, Müllerstraße 44, AT-6020 Innsbruck*<br><br>We present a new imaging technique in microscopy where we can observe different focal planes in the sample volume simultaneously. In our setup the spatially multiplexed image path is generated by a spatial light modulator (SLM) located in the Fourier plane of the sample. A phase mask displayed on the SLM modulates the light field. We displayed a series of superposed Fresnel lenses to image different focal planes of the sample into corresponding adjacent section of the CCD chip. This novel technique allows the imaging of dynamic process within a 3D sample without any scanning device. As an example we have shown cytoplasmic streaming in different planes in the filament cell of a tradescantia flower. |
| **16:15** | **207** | **Exchange bias enhancement by Cr addition to CoO in a CoO-Co/Pt multilayer system**<br><br>*Sevil Oezer [1], Niraj Joshi [1], Hans J. Hug [1], Sara Romer [2], Miguel A. Marioni [2]*<br>*[1] Universität Basel, Dep. Physik, Klingelbergstrasse 82, 4056 Basel*<br>*[2] EMPA, 8600 Dübendorf*<br><br>The main use of exchange bias (EB) in magnetic thin-film systems is for causing a unidirectional anisotropy in a F layer, thus selecting its magnetization direction. This ability is key to enabling a number of sensor and storage technologies. In this work we present data supporting the notion that EB can be increased by reducing the frustration of antiparallel coupling between the antiferromagnetic (AF) uncompensated spins (UCS) and the ferromagnetic (F) spins. We studied EB in magnetron sputtered $Si/Pt_{(5)}/\{[Co_{(0.3)}Pt_{(0.7)}]_9Co_{(0.3)}\}/Cu_{(2.2)}/[Co_{1-x}Cr_xO]_{(1.5)}/[Co_{(0.3)}Pt_{(0.7)}]_4Co_{(0.3)}Pt_{(2)}$ structures (numbers in parenthesis are thickness in nm). At x=0 the coupling between the antiferromagnetic (AF) CoO layer and the adjacent F-layer results in EB below the blocking temperature of about 200 K. Sputtering at a slightly elevated temperature of 425 K, the addition of Cr in the AF layer (x=20%) increases the EB field by about 74% at 8.2 K. |
| **16:30** | **208** | **Single crystal growth and twinning in non-stoichiometric $SrCoO_{3-x}$**<br><br>*Sura Ravi Chandra Reddy [1,2], Monica Ceretti [1], Olivier Hernandez [1], Werner Paulus [1], Jürg Schefer [2], Lukas Keller [2]*<br>*[1] Université de Rennes 1, FR-35042 Rennes*<br>*[2] PSI, Laboratory for Neutron Scattering, 5232 Villigen PSI*<br><br>Oxides with high oxygen ionic conductivity have attracted considerable attention in the last decade, mainly related to their potential application as electrodes for solid oxide fuel cells. Two structure types are known today to undergo oxygen |

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| | | intercalation at ambient temperature belong either to the $K_2NiF_4$ structure, e.g. $La_2MO_{4+\delta}$ (M = Co, Ni, Cu) or to the deficient perovskites and more specifically to the brownmillerite type structure such as $SrMO_{2.5}$ (M = Fe, Co).<br>To better understand the underlying mechanisms for oxygen mobility in the Brownmillerite frameworks, we investigated the structure and associated lattice dynamics as a function of the oxygen stoichiometry and temperature for (Sr,Ca)(Fe,Co)$O_{3-x}$. Here we will report on the growth of appropriate single crystals of SrCoOx by the floating zone method, together with the characterization of the obtained single crystals and their twinning behaviour. |
| **16:45** | **209** | **Oxygen diffusion at moderate temperatures in highly ordered frameworks: the case of $La_2CoO_{4+\delta}$.**<br><br>*Loïc Le Dréau [1,2], Olivier Hernandez [1], Werner Paulus [1], Jürg Schefer [2], Carmelo Prestipino [1], Gavin Vaughan [3], Shoichi Hosoya [4]*<br>*[1] University of Rennes 1, Sciences Chimiques de Rennes - UMR 6226 Matériaux Inorganiques: Chimie Douce et Réactivité Campus de Beaulieu, Bât 10B, 35000 Rennes, France*<br>*[2] LNS PSI, Paul Scherrer Institut, 5232 Villigen PSI*<br>*[3] ESRF, B. P. 220, FR-38043 Grenoble cedex*<br>*[4] Institute of inorganic synthesis, University of Yamanashi, faculty of engineering Miyamae-cho 7, 400 Kofu, Japan*<br><br>The understanding of oxygen diffusion at moderate temperatures in solid oxides is a key issue for the tailoring of new technological devices (SOFCs, oxygen sensors, ...). The particular compound $La_2CoO_{4+\delta}$ is a promising candidate since its oxygen content can be triggered by electrochemistry already at ambient temperature. Indeed, some extra oxygen ions can be inserted in interstitial vacancy sites up to one extra-oxygen per unit cell of the lattice. Only few studies have been led on this oxide, due to some complexities encountered during synthesis, however we were able to obtain reproducibly some single crystal samples by TSFZ method. Some structural investigations have been performed by both neutron and X-ray synchrotron diffraction experiments, showing some transitions from commensurately or incommensurately modulated structures to dynamically disordered state depending on oxygen content (δ) and temperature. This gives some new hints about the oxygen diffusion process at RT in this oxide. |
| **17:00** | **210** | **Electron beam properties of molybdenum field emitter arrays with stacked gates**<br><br>*Patrick Helfenstein [1], Konstantins Jefimovs [2], Eugenie Kirk [1], Thomas Vogel [1], Conrad Escher [3], Hans-Werner Fink [3], Soichiro Tsujino [1]*<br>*[1] Labor für Mikro- und Nanotechnologie, Paul Scherrer Institut, 5232 Villigen*<br>*[2] EMPA, Überlandstrasse 129, 8600 Dübendorf*<br>*[3] Physik Institut, Universität Zürich, Winterthurerstr. 190, 8057 Zürich*<br><br>We studied field electron emission properties of microfabricated double-gate molybdenum field emitter arrays (FEA) with stacked gates, where the collimation gate was opened using an FIB assisted process instead of the conventional self-aligned etch-back technique. This has the advantage of the aperture diameter as well as its geometry being precisely definable. In the subsequent experiments, we set the potential between emitter tips and the extraction gate to a fixed value, while the collimation gate voltage was scanned in a predefined range to investigate the influence on the emission angle and extracted current. It was found that the emission angle can be reduced by a factor of 9 - 10 without measurable |

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| | | loss of current. The achievable increase in brilliance compared to the uncollimated beam makes FEA's a valid candidate for future applications demanding high brilliance cathodes such as 4th generation light sources or field emission displays. |
| **17:15** | | ***END*** |

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| **221** | **Table-top Actinic Mask Metrology Tool for Enabling EUV Lithography**<br><br>*Davide Bleiner, Christoph Imesch, Felix Staub, Jürg Balmer,*<br>*Institute for Applied Physics, University of Bern, Sidlerstrasse 5, 3012 Bern*<br><br>The semiconductor industry is preparing to start production at the <32 nm node size by means of extreme UV (EUV) lithography using 13.5 nm (93eV) sources. Unfortunately, a showstopper is the quality of the masks at this nano-scale. The defects carried on the mask are in fact reproduced on the wafers, which hampers production throughput.<br>Detection of nano-sized defect requires actinic metrology tools, i.e. based on 93eV sources as well as the manufacturing tools. The Bern table-top laser offers scalability, XUV tunability (8.8-18.9nm), monochromaticity (rel. wavelength is $10^{-4}$), and high brilliance ($10^6$-fold higher than Synchrotron). All these characteristics are interfaced to a proprietary zone-plate objective for the system-integration of an actinic mask inspection tool. Main features of the system are: low-flare, aberration-free imaging, avoids the complication and cost of EUV-reflective optics. Remaining challenges are also discussed. |
| **222** | **Towards an all-optical ultra-stable microwave oscillator based on an optical frequency comb**<br><br>*Vladimir Dolgovskiy, Stéphane Schilt, Gianni Di Domenico, Daniel Hofstetter,*<br>*Pierre Thomann,*<br>*Institut de Physique, Université de Neuchâtel, Av. de Bellevaux 51, 2009 Neuchâtel*<br><br>An all-optical ultra-stable microwave oscillator is being developed by transferring the relative stability of an ultra-stable laser to the microwave domain using a comb to divide the frequency by an integer N~100'000. Ultra-stable laser performance is obtained by frequency-stabilization to an ultra-high-finesse Fabry-Perot cavity using the Pound-Drever-Hall technique with target stability in the low $10^{-15}$ at 1 sec. The cavity must be made as little sensitive to perturbations (temperature, pressure, vibrations) as possible to have its relative length variations at the same level. An ultra-low expansion glass cavity stabilized at its zero coefficient of thermal expansion (CTE) is used to reduce the influence of temperature fluctuations. The design of a thermal enclosure placed in a vacuum chamber is presented, aiming to achieve both high temperature stability and homogeneity of the cavity by efficiently attenuating external temperature fluctuations to prevent any local deviation from the zero CTE. |

**223**

## High Temperature Crystallographic and Electronic Structure of LaSrFeNi-oxides: a combination of Neutron diffraction and Near Edge X-ray Absorption Spectroscopy

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The transport properties of LaSrFeNi-oxides which are potentially cathode materials for SOFCs are explained in terms of hopping mechanism along with double/super exchange interaction. We concluded that charge transfer from O (2p) to Ni (3d) and increasing the crystallographic symmetry from R-3c to Pm-3m resulting in an increase in superexchange angle between Fe/Ni-O-Fe/Ni give additional contribution to the electrical conductivity at room temperature. For high temperature transport mechanism because of the application, we performed Near Edge X-ray Absorption Spectroscopy up to 600°C with both Transmission and Fluorescence yield mode at Fe L edge and O K edge. We support our Fe L edge spectra with theoretical calculation depending on Ligand Field Atomic Multiplet Theory and get a good agreement between experimental and simulated spectra. We also show high resolution neutron diffraction at high temperature and monitor the phase transformation not only depending on temperature but also on Sr doping concentration.

**224**

## Near Edge X-ray absorption studies on CdSe thin films grown by Chemical Bath Deposition

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*[3] University of Nevada, Chemistry Department, Las Vegas, United States*

CdSe films were synthesized by CBD at 60°C, followed by subsequent annealing in nitrogen atmosphere up to 500°C. Films were subjected to NEXAS at Cd L2,3 edges (3400 eV – 3600 eV) at beamline 9.3.1 at Advanced Light Source in Berkeley, California. Since the films present a concentrated system with a high potential for self-absorption, we recorded the spectra in the TEY mode. Close inspection of the Cd L3 region of the spectra suggests a small chemical shift towards lower energies with increasing temperature, suggesting a chemical reduction of cadmium. Precise quantitative analysis of the pre-edge region shows actually a chemical shift of totally ~ 0.5 eV confirming that the cadmium is slightly reduced with increasing annealing temperature. Interestingly, the spectra of the films annealed at 100°C and 200°C having optical band gap at around 1.8 eV are completely different from those of the others.

## 225 Pinned Uncompensated Spins at the Ferromagnet/Antiferromagnet Interface mapped by high-resolution Magnetic Force Microscopy

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Exchange bias (EB), a unidirectional magnetic anisotropy, occurs if a ferromagnet (F) is coupled to an antiferromagnet (AF). It is generally accepted that EB implies the presence of pinned uncompensated spins in the AF or at its interface with the F. In the past decade intense experimental efforts have revealed that different groups of pinned and rotating UCS exist at the F/AF interface and in the bulk of the AF. The spatial distribution of the UCS was studied by XMCD-PEEM and MFM. The first features element-specifity and thus allows the distinction between magnetic moments of the F from those of the AF. However, PEEM lacks a lateral resolution relevant for polycrystalline materials used in typical applications and even smaller magnetic fields are not permitted during PEEM imaging. The latter hinders a direct distinction between pinned and rotating UCS.
MFM maps a signal related to the magnetic stray field emanating from the sample independent from source of the field. MFM is thus not element-specific and cannot directly distinguish between different sources of the stray field. Moreover, MFM being a scanning or atomic force microscopy technique measures all other tip-sample forces co-existing with the magnetic tip-sample interaction force. This allows the measurement of the topography of the sample but may cause a convolution of the measured magnetic signal with the sample's topography. In this paper, MFM contrast formation above an EB sample is discussed. The various contributions to the measured MFM signal are analyzed to separate the contributions of the signal arising from the domains in the F-layer from the pinned UCS in the AF, and from the topography of the sample. Moreover, the deconvolution of the local density of the pinned magnetic moments from the measured MFM frequency shift signal is discussed.

## 226 A novel biophysical model describing repair modifications and growth inhibition of irradiated cells

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*Gerd Lutters, Institut für Radio-Onkologie, Kantonsspital Aarau, Tellstrasse, 5001 Aarau*

A biophysical model for exploring the dynamic response of irradiated cells (cell death, repair, growth inhibition, repopulation) is developed. In contrast to existing models focussing on DNA lesion kinetics, the proposed model also includes the interaction with the extracellular environment. This may be important to understand the in-vivo response of tumours onto ionizing radiation.
The cellular repair mechanisms are summarized by a transient dose. The transient dose is representing a biological active proportion of the applied dose (absorbed energy per mass) and is determined by a compartmental sub-model.
The results of computer simulation using the proposed model are in good agreement for different fractionation schemes and varying dose rates with the models of Carlone [Med. Phys. 30, p.1948] and Curtis [Radiat. Res. 106, p.252]. The computer simulations are indicating a high potential of the proposed approach for exploring the tumour response onto combined anti-cancer treatments such as hyperthermia-radiotherapy.

**227**

## Magnetoelastic coupling in the triangular lattice antiferromagnet $CuCrS_2$ investigated by neutron and X-ray diffraction, neutron polarimetry and inelastic neutron scattering

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$CuCrS_2$ is a triangular lattice Heisenberg antiferromagnet with a rhombohedral crystal structure. We report on neutron and synchrotron powder diffraction results which reveal a monoclinic lattice distortion at the magnetic transition and verify a magnetoelastic coupling [1]. $CuCrS_2$ is therefore an interesting material to study the influence of magnetism on the relief of geometrical frustration. Polarimetry has been used to determine the magnetic structure to be a spin density wave and to exclude a helical arrangement. Because of the magnetoelastic coupling, the system is assumed to be able to select a magnetic ground state and to overcome frustration. Additionally a magnetic resonance mode has been found at $h\omega$=12 meV which evidences a dimerization of Cr ions in the triangular planes [2].

[1] Julia C. E. Rasch et al, Phys. Rev. 80 (2009) 104431, 1-6
[2] Julia C. E. Rasch et al, submitted to PRL

**228**

## Domain wall structure and propagation in CoFeB and NiFe

*Philipp Eib, Florian Schwarz, Carl Zinoni, Antoine Vanhaverbeke, Andreas Bischof, Rolf Allenspach*
*IBM Research - Zürich, Säumerstr. 4, 8803 Rüschlikon*

We report on the effects of magnetic fields and electrical current pulses on domain walls in $Co_{60}Fe_{20}B_{20}$ and $Ni_{80}Fe_{20}$, structured by electron-beam lithography into wires of 8 to 20 nm thickness and 150 to 1000 nm width including parabolic constrictions in the wire or magnetic bars of 100 nm size close to the wire edge. Wall structure and dynamics in CoFeB wires can be compared to similar NiFe patterns. The magnetic structure is observed by spin-SEM [1]. We determine saturation magnetization, switching fields of films and wires and the domain wall type phase diagram [2] in CoFeB. Current pulses are injected into the wires and wall propagation by spin-transfer torque [3] is investigated. We find that the wall type is determined by the parabolic constriction in the wire. Both the constrictions and, in another experiment, the stray field of nearby magnetic bars influence the wall propagation. We complement our experiments with micromagnetic simulations.

[1] R. Allenspach, IBM J. Res. Develop. 44, 553 (2000).
[2] Y. Nakatani et al., J. Magn. Magn. Mater. 290-291, 750 (2005).
[3] A. Vanhaverbeke et al., Phys. Rev. Lett. 101, 107202 (2008).

**229**

## Quantum state preparation and laser cooling of a continuous atomic fountain with a single optical lattice

*Laurent Devenoges, Gianni Di Domenico, Laboratoire Temps-Fréquence, Université de Neuchâtel, Av. de Bellevaux 51, 2009 Neuchâtel*

We use two lasers optical pumping on a caesium atomic fountain in order to prepare all atoms in the same quantum ground state. A first laser excites the F=4 ground state to pump the atoms toward F=3 while a second $\pi$-polarized beam excites the F=3→F'=3 transition to produce Zeeman pumping toward m=0. To avoid dark states, we implemented the first laser

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| | in a 2D optical lattice geometry thereby creating polarization gradients. This configuration has the advantage to produce Sisyphus cooling if the laser is tuned on the F=4→F'=4-5 crossover, which is important to balance the heating produced by optical pumping.<br>We have measured a total atomic flux (in the detection zone) of $7 \cdot 10^6$ atoms/s, shot-noise limited. Theoretical calculations predict that 98% of these atoms can be pumped in the m=0 clock state and preliminary experiments show an 80% efficiency. The current results will be presented during the conference. |
| **230** | **Deposition and Characterization of First Mirror Candidates for ITER**<br><br>*Baran Eren, Laurent Marot, Roland Steiner, Ernst Meyer*<br>*Departement Physik, Universität Basel, Klingelbergstrasse 82, 4056 Basel*<br><br>Metallic mirrors will be essential components of all optical spectroscopy and imaging systems for ITER plasma diagnostics. Any change in the mirror performance, in particular, its reflectivity, due to erosion of the surface by charge exchange neutrals or deposition of impurities will influence the quality and reliability of the detected signals.<br>Rhodium, molybdenum and stainless steel, due to their high reflectivity in visible and IR range and due to low sputtering yields, are some important candidates for the first mirrors, which will be facing the plasma.<br>The mirror candidates, for experiments in Basel, are either purchased as bulk single crystalline materials or they are produced in Basel via magnetron sputtering or evaporation techniques as polycrystalline thin films. The mirrors are characterized before and after exposures in terms of change in roughness, material content, and reflectivity. The exposures are done either in tokamaks or in controlled conditions in Basel. |
| **231** | **Electronic Structure and Conductivity of n-type CdS films for Solar Energy Conversion**<br><br>*Hulya Metin [1], Selma Erat [2], Artur Braun [2], Iraida N. Demchenko [3], Wayne C. Stolte [3], Mehmet Ari [4], Thomas Graule [2]*<br>*[1] Mersin University, Physics Department, Ciftlikkoy Campus, 33343 Mersin, Turkey*<br>*[2] Laboratory for High Performance Ceramics, EMPA, Überlandstrasse 129, 8600 Dübendorf*<br>*[3] University of Nevada, Chemistry Department, Las Vegas, United States*<br>*[4] University of Erciyes, Physics Department, Kayseri, 38039 Kayseri, Turkey*<br><br>CdS thin films which are popular window materials of solar cells were deposited on glass substrates at 60°C, and annealed in air at different temperatures. Temperature dependent electrical conductivity of films was measured by using four point probe technique. The NEXAS of films were collected at Cd L3 edge (3538 eV). The measurements were performed at beamline 9.3.1 at ALS, Berkeley, California. A chemical shift to lower energy with increasing temperature was observed in the Cd L2,3 spectra. The pre-peak growing at around 3554 eV become dominant in the spectra of the films annealed at 373 K and 573 K. Interestingly these films have the lower temperature coefficient of resistivity ($\alpha$TCR =$-1.75 \cdot 10^{-3}$ $K^{-1}$, between 305 K and 800 K) than the others. There is also some changes in the Sulphur K edge spectra which shows a transition from S (1s) to conduction band S 2p-like orbitals. |