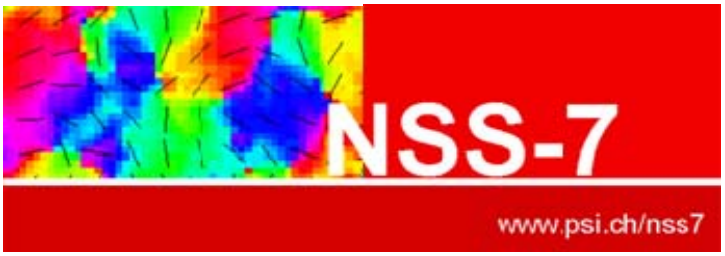

7th International Workshop on Nano-scale Spectroscopy and Nanotechnology

July 2nd – 6th, 2012

Zürich, Switzerland

The NSS7 workshop

is organized by the Paul Scherrer Institute **hosted by ETHZ**

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Table of Contents

Workshop Program

	Tuesday July, 3rd, 2012	Wednesday July, 4th, 2012	Thursday July, 5th, 2012	Friday July, 6th, 2012
09:00	Opening	J. Verbeeck: Electron microscopy on magnetic nanostructures	P. Pianetta: X-Ray spectroscopy on nano- materials	M. Despont: M(N)EM Switch technologies for RF and Logic applications
09:30	J. Wiebe: Tailoring ground states and dynamics of bottom-up engineered nanomagnets	K. Hayashi: Atomic resolution holography with electron beam	G. Martinez-Criado: Hyperspectral nanoimaging using X-rays	A. Bojko: Fabrication of ultrathin nano-porous silicon membranes
10:00	A. Kirilyuk: Magnetism of Tb clusters	N. Yamamoto: High resolution cathodoluminescence	Stefan Eisebitt: X-ray holography for the study of nanostructure dynamics	Break
10:30	Break	Break	Break	U. Duerig: Direct write thermal probe patterning of polymeric films
11:00	L. Nasi: Transmission electron microscopy study of nanostructured semiconductors	C. McNeill: Characterising nanostructured polymer devices with soft x-rays	O. Hellwig: Nano-technology and nano-spectroscopy for characterizing magnetic recording media	H. Shigekawa: Imaging of transient carrier dynamics by nanoscale pump-probe microscopy
11:30	F. Bianco: 1D Silicon nanolines in monohydride Si(001) surface	M. Kazemian Abyaneh: X-ray microscopes for model fuel cells	A. Kleibert: Magnetic properties of individual iron nanoparticles	Closing & Introduction to NSS8
12:00	P. Carrozzo: Electronic properties of Ti and TiOx nanoislands on Au	A. Kafi: Conductive hybrid network to biosensing	T. Kinoshita: Pump-probe time-resolved PEEM at SPring-8	Visit of PSI
12:30	Lunch	Lunch	Lunch	
13:30				
14:00	T. Jung: Electronic and spin states in metal-organic supramolecular materials at surfaces	F. Donati: Giant anisotropies of single Co atoms on graphene/Pt(111)	A. Schirmeisen: Understanding friction on nanoscale	
14:30	J. Dreiser: Towards spintronics with Er molecular magnets	K. Winkler: PEEM on heterogeneous graphene/SiC	S. Heun: Scanning Gate Microscopy imaging	
15:00	S. Martens: Molecular interactions of perylenes on surfaces	C. Kuo: Epitaxial graphene by STM and resonant spectroscopy	M. Kisiel: Non-contact friction over metal-superconductor	
15:30	Break	F. Matsui: Atomic structure visualizations of graphene	Break	
16:00	Poster	Break	K. Horiba: 3D nano ESCA at Spring 8	
16:30		V. Sandoghdar: Optical sensing and spectroscopy down to single molecule level	L. Gregoratti: SPEM for micro- and nano-material characterization	
17:00		O. Scholder: Fabrication of tunable plasmonic antennas	T. Ohkochi: PEEM on insulating samples	
17:30	until 18:00	Workshop Dinner 19:00 - 22:30	N. Pilet: Combining scanning probe and X-ray microscopy	

Sessions:

Low Dim (& graphene)	Semiconductors	Molecules	Polymer and devices
Magnetism	Scanning probe technique	Optical techniques	X-ray techniques
Electron techniques	Fabrication	Poster	Formal - Excursion

Daily Program

The workshop is taking place in the main building of the ETHZ: The talk sessions are in the conference room E5. The poster session and the coffee breaks are in the main hall.
The secretary is open from Tuesday to Friday between 8:30 and 17:00 in room HG E33.1.

Monday, July 2nd, 2012

17:00 – 19:00		**Reception and registration** GEP Pavillon

Tuesday, July 3rd, 2012

9:00 - 9:20	Tue_A1	**Opening & organization** Quitmann & Nolting *Paul Scherrer Institut, Switzerland*
Session: Low Dim 1		
9:20 - 10:00	Tue_A2 *invited*	**Tailoring ground states and dynamics of bottom-up engineered nanomagnets** WIEBE, Jens *Institute of Applied Physics, Hamburg University, Germany*
10:00 - 10:25	Tue_A3	**Magnetism on a length scale shorter than that of the exchange: Tb clusters** KIRILYUK, Andrei *Radboud University Nijmegen, The Netherlands*
10:25 - 11:00		**Break**
Session: Semiconductors		
11:00 - 11:40	Tue_B1 *invited*	**Transmission electron microscopy study of nanostructured semiconductors** NASI, Lucia *CNR-IMEM, Italy*
11:40 - 12:05	Tue_B2	**One-dimensional Silicon nanolines in monohydride Si(001) surface** BIANCO, François *University of Geneva, Switzerland*
12:05 - 12:30	Tue_B3	**Growth and electronic properties of Ti and TiOx nanoislands deposed on Au(111)** CARROZZO, Paolo *Dipartimento di Energia and NEMAS - Center for NanoEngineered Materials and Surfaces, Politecnico di Milano, Italy*
12:30 - 14:00		**Lunch**
Session: Molecules		
14:00 - 14:40	Tue_C1 *invited*	**Electronic and spin states in metal-organic supramolecular materials at surfaces: spectro microscopy correlation experiments** JUNG, Thomas A. *Paul Scherrer Institut, Switzerland*
14:40 - 15:05	Tue_C2	**Towards spintronics with Erbium single-ion molecular magnets** DREISER, Jan Gui-hyon *Paul Scherrer Institut, Switzerland*
15:05 - 15:30	Tue_C3	**Molecular interactions and reactivity of perylenes on surfaces: going from VdW assembly to metal coordination and covalent bonding.** MARTENS, Susanne *Institute of Physics, University of Basel, Switzerland*
15:30 - 16:00		**Break**
16:00 - 18:00	Poster	**Poster Session**

Wednesday, July 4th, 2012

Session: Electron techniques

9:00 - 9:40	Wed_A1 *invited*	**Electron microscopy on magnetic nanostructures** VERBEECK, Johan *EMAT, University of Antwerp, Belgium*
9:40 - 10:05	Wed_A2	**A new type of atomic resolution holography with electron beam** HAYASHI, Kouichi *Institute for Materials Research, Tohoku University, Japan*
10:05 - 10:30	Wed_A3	**High resolution cathodoluminescence: application to plasmonics** YAMAMOTO, Naoki *Tokyo Institute of Technology, Japan*
10:30 - 11:00		**Break**

Session: Polymer and devices

11:00 - 11:40	Wed_B1 *invited*	**Characterising nanostructured polymer devices with soft x-rays** MCNEILL, Christopher *Monash University, Australia*
11:40 - 12:05	Wed_B2	**Synchrotron-based microscopes provide novel tools for exploring nano and micro-structures: with focus on chemical state and morphology of key components in operating model fuel cells** KAZEMIAN ABYANEH, Majid *Elettra Laboratory, Italy*
12:05 - 12:30	Wed_B3	**Conductive enzyme/nanomaterials hybrid network to biosensing** KAFI, A.k.m. *Dept. of Chemistry, The University of Sydney, Australia*
12:30 - 14:00		**Lunch**

Session: Low dim and graphene

14:00 - 14:40	Wed_C1 *invited*	**Giant anisotropies of single Co atoms on graphene/Pt(111)** DONATI, Fabio *Institute of Condensed Matter Physics, EPFL, Switzerland*
14:40 - 15:05	Wed_C2	**High resolution real and reciprocal space photoelectron emission microscopy on heterogeneous graphene/SiC(000-1)** WINKLER, Konrad *Omicron NanoTechnology, Germany*
15:05 - 15:30	Wed_C3	**Localized identification of the quantized unoccupied states for the epitaxial graphene by scanning tunneling microscopy and resonant spectroscopy** KUO, Chien-cheng *Department of Physics, National Sun Yat-sen University, Taiwan*
15:30 - 15:55	Wed_C4	**Atomic structure visualizations of graphite and monolayer graphene by photoelectron holography** MATSUI, Fumihiko *Nara Institute of Science and Technology, Japan*
15:55 - 16:25		**Break**

Session: Optical techniques

16:25 - 17:05	Wed_D1 *invited*	**Optical sensing and spectroscopy down to the single-molecule level** SANDOGHDAR Vahid *Max Planck Insitute for the Science of Light, Germany*
17:05 - 17:30	Wed_D2	**Fabrication and characterization of tunable plasmonic antennas** SCHOLDER, Olivier *EMPA, Switzerland*
17:30 - 19:00		**Break**
19:00 - 22:30		**Workshop Dinner** Departure of the boat from Zurich Bürkiplatz (see map on p. 88)

Thursday, July 5th, 2012

Session: X-ray techniques 1

9:00 - 9:40	Thu_A1 *invited*	**X-Ray spectroscopy on nano- materials** PIANETTA, Piero *SLAC/SSRL, USA*
9:40 - 10:05	Thu_A2	**Hyperspectral nanoimaging using X-ray excited optical luminescence and X-ray fluorescence** MARTINEZ-CRIADO, Gema *European Synchrotron Radiation Facility, France*
10:05 - 10:30	Thu_A3	**X-ray holography for the study of nanostructure dynamics** EISEBITT, Stefan *TU-Berlin, Germany*
10:30 - 11:00		**Break**

Session: Magnetism

11:00 - 11:40	Thu_B1 *invited*	**Nano-technology and nano-spectroscopy for characterizing magnetic recording media** HELLWIG, Olav *San Jose Resreach Center, HGST, USA*
11:40 - 12:05	Thu_B2	**Size-dependent magnetic properties of individual iron nanoparticles studied at room temperature** KLEIBERT, Armin *Swiss Light Source, Paul Scherrer Institut, Switzerland*
12:05 - 12:30	Thu_B3	**Status of pump-probe time-resolved photoemission electron microscopy PEEM at SPring-8** KINOSHITA, Toyohiko *Japan Synchrotron Radiation Research Institute/SPring-8, Japan*
12:30 - 14:00		**Lunch**

Session: Scanning probe techniques 1

14:00 – 14:40	Thu_C1 *invited*	**Understanding friction on the nanoscale** SCHIRMEISEN, Andre *University of Giessen, Germany*
14:40 - 15:05	Thu_C2	**Scanning Gate Microscopy imaging of fractional incompressible stripes in integer quantum Hall channels** HEUN, Stefan *Instituto Nanoscienze-CNR and Scuola Normale Superiore, Italy*
15:05 - 15:30	Thu_C3	**Non-contact friction over metal-superconductor and charge densiy wave (CDW) phase transitions** KISIEL, Marcin *Univeristy of Basel, Institute of Physics, Switzerland*
15:30 - 16:00		**Break**

Session: X-ray techniques 2

16:00 - 16:25	Thu_D1	**Progress of three-dimensional scanning photoelectron microscope at Spring-8 BL07LSU** HORIBA, Koji *Graduate School of Engineering, The University of Tokyo, Japan*
16:25 – 16:50	Thu_D2	**Scanning photoemission imaging and spectromicroscopy with synchrotron radiation, a powerful tool for micro- and nano-material characterization** GREGORATTI, Luca - *Sincrotrone Trieste SCpA, Italy*
16:50 - 17:15	Thu_D3	**Photoemission Electron Microscopy (PEEM) on insulating samples** OHKOCHI, Takuo *Japan Synchrotron Radiation Research Institute / SPring-8*
17:15 - 17:40	Thu_D4	**NanoXAS - combining scanning probe and X-ray microscopy for nanoanalytics** PILET, Nicolas - *Paul Scherrer Institut, Switzerland*

Friday, July 6th, 2012

Session: Fabrication

9:00 - 9:40	Fri_A1 *invited*	**M(N)EM switch technologies for RF and logic applications** DESPONT, Michel *IBM Research – Zurich, Switzerland*
9:40 - 10:05	Fri_A2	**Fabrication of ultrathin nanoporous silicon membranes using self-assembling polymers** BOJKO, Alexandre *CSEM SA / EPFL, Switzerland*
10:05 - 10:35		**Break**

Session: Scanning probe techniques 2

10:35 - 11:00	Fri_B1	**Direct write thermal probe patterning of polymeric thin films** DUERIG, Urs *IBM Research – Zurich, Switzerland*
11:00 - 11:40	Fri_B2 *invited*	**Imaging of transient carrier dynamics by nanoscale pump-probe microscopy** SHIGEKAWA, Hidemi *Institute of Applied Physics, University of Tsukuba, apan*

Session: Closing

11:40 - 12:00		**Closing & introduction to NSS8**

Visit to PSI

12:00 - 13:00		**Bus transfer Zurich - PSI (Lunch box)**
13:00 - 15:00		**PSI Site visit**
15:00 - 16:15		**Bus transfer PSI - Zurich**

Oral Contributions

Tue_A2

Tailoring ground states and dynamics of bottom-up engineered nanomagnets

WIEBE, Jens[1]

[1]*Institute of Applied Physics, Hamburg University*

Abstract:
One realization of a nanomagnet is an array of magnetic atoms adsorbed on the surface of a nonmagnetic metallic substrate which are coupled by direct or Ruderman-Kittel-Kasuya-Yosida exchange [1]. Such nanomagnets are well suited for the investigation of fundamental questions since (i), they can be assembled in almost any geometry one atom at a time using the tip of a scanning tunnelling microscope as a tool and (ii), the strength and sign of the exchange interaction can be tailored by controlling the inter-atomic distances. We use spin-resolved scanning tunnelling spectroscopy (SPSTS) and inelastic STS [2] in order to measure the magnetic-field dependent ground states and dynamics of such nanomagnets in real space and real time. The results are compared to models which use parameters from ab-initio calculations. Distinct ground states of linear chains, depending on even or odd numbers of constituent atoms, and magnetic frustration within complex two-dimensional arrays have been observed directly [1]. Moreover, we have investigated the magnetization dynamics of clusters of direct-exchange coupled atoms and found a strong spin-transfer torque effect. Finally, the obtained knowledge was used in order to realize model systems of all-spin based logic gates [3].

References

[1] A. A. Khajetoorians, et al., Nature Physics DOI: 10.1038/NPHYS2299 (2012).
[2] A. A. Khajetoorians, et al. Phys. Rev. Lett. 106, 037205 (2011)
[3] A. A. Khajetoorians, et al. Science 332, 1062 (2011)

Tue_A3

Magnetism on a length scale shorter than that of the exchange: Tb clusters

KIRILYUK, Andrei[1]; JALINK, Jeroen[1]; PETERS, Lars[1]; KATSNELSON, Mikhail[1]; GHOSH, Saurabh[2]; SANYAL, Biplab[3];ERIKSSON, Olle[3]; VAN DIJK, Chris[4]; BOWLAN, John[5]; FIELICKE, André[5]; MEIJER, Gerard[5]; DE HEER, Walt[6]

[1]Radboud University Nijmegen
[2]Cornell University
[3]University of Uppsala
[4]University of Amsterdam
[5]Fritz-Haber-Institute, Berlin
[6]Georgia Institute of Technology

Abstract:
Magnetism is a macroscopic phenomenon that occurs because of short-range quantum exchange interactions. However, what happens if the size of a system is smaller than the length scale of the exchange? This situation is rather inconceivable if the Heisenberg exchange is considered. However, in rare-earth metals, the RKKY-type exchange extends up to 6-8 Angstrom, thus triggering a question about the magnetism of these metals at nanoscale and beyond. Here we follow, both experimentally and theoretically, the development of structure and magnetism in Tb clusters, starting from the diatomic limit and following it when adding one atom at a time. Experimentally, we used Stern-Gerlach high-resolution spectroscopic deflection technique for magnetic properties, and far-IR vibrational spectroscopy using free-electron laser FELIX for structure determination. For calculations, DFT with a 4f-in-core pseudopotential for structure, and LDA+U for magnetic properties were used. The exchange is shown to oscillate as a function of the interatomic distance, qualitatively similar to the bulk-like RKKY interaction, even though the Fermi surface does not exist and the total system size is about 6 Angstrom As a consequence, magnetic moment oscillates with the cluster size, such oscillations being universal for several rare-earth metals, also Ho and Gd, as shown by experiments. The absence of bulk periodicity also leads to a huge, 5 - 10 meV/atom, magnetocrystalline anisotropy which is also confirmed experimentally.

Tue_B1

Transmission electron microscopy study of nanostructured semiconductors

NASI, Lucia[1]

[1]*CNR-IMEM*

Abstract:
Semiconductor nanostructures provide unique tailored properties for electronic, optoelectonic, photovoltaic and sensing applications. The control of size, shape, crystalline structure and composition at the nanoscale is crucial to finely engineer their properties for advanced functional materials. In addition, inter-mixing and defects formation at the interfaces still represent a critical issue which ultimately limits the exploitation of a variety of materials in semiconductor heterostructures.Transmission Electron Microscopy (TEM) is a powerful and versatile tool which provides information on material morphology, structure and chemical composition at the nanoscale and at the atomic scale. The advantage of using conventional diffraction contrast, high resolution TEM and Scanning TEM-Z-contrast imaging modes as well as analytical TEM techniques will be demonstrated for selected emblematic examples. In particular, the study of InGaAs/GaAs quantum wells, self-assembled In(Ga)As/GaAs quantum dots, core-shell and axial heterostructured nanowires (InAs/InP/In(As)Sb, AlAs/GaAs), and wurtzite ZnS and ZnO porous nanostructures will be presented and discussed. For these systems, the use of the TEM techniques has proven to be successful in gaining a better understanding of the growth mechanisms involved and thus in the control of the functional properties of the nanostructures.

Tue_B2

One-dimensional Silicon nanolines in monohydride Si(001) surface

BIANCO, François[1]; KOESTER, Sigrun A.[1]; BOWLER, David[2]; RENNER, Christoph[1]

[1]*University of Geneva*
[2]*UCL and LCN*

Abstract:
We present a detailed study of the structural and electronic properties of a self-assembled silicon nanoline embedded in the monohydride silicon (001) surface, known as the Haiku stripe. The nanoline is a perfectly straight and defect free endotaxial structure of huge aspect ratio; it can grow micrometer long at a constant width of exactly four Si dimers (1.54nm). Another remarkable property is its capacity to be exposed to air without suffering any degradation. The nanoline grows independently of any step edges at tunable densities, from isolated nanolines to a dense array of nanolines. In addition to these unique structural characteristics, scanning tunnelling microscopy and density functional theory reveal a one-dimensional state confined along the Haiku core. This nanoline is a promising candidate for the long sought after electronic solid-state one-dimensional model system to explore the fascinating quantum properties emerging in such reduced dimensionality.

Reference
F. Bianco, et al., Phys. Rev. B, 84, 035328 (2011)

Tue_B3

Growth and electronic properties of Ti and TiOx nanoislands deposed on Au(111)

CARROZZO, Paolo[1]; CASARI, Carlo Spartaco[1]; PASSONI,Matteo[1];
BPTTANI, Carlo Enrico[1];LI BASSI, Andrea[1]

[1]Dipartimento di Energia and NEMAS - Center for NanoEngineered Materials and Surfaces, Politecnico di Milano, (Italy)

Abstract:
We present a Scanning Tunneling Microscopy and Spectroscopy (STM-STS) investigation of the growth mechanisms and local electronic properties of titanium and titanium oxide nanoislands on the Au(111) surface.

We deposited Ti on Au(111) in UHV by e-beam evaporation at different coverages in the 0.1 ML to 1.5 ML range. STM images show that above 0.3 ML titanium islands start to nucleate outside the Au(111) elbows of the herringbone reconstruction. Differently from what observed for other metals on Au(111), such as Fe [1], negligible island coalescence is observed between 0.5 ML and 1 ML and a second layer starts to grow on top of some islands. Analysis of STM images permits to follow the trend of island average size as a function of coverage. Through STS measurements we characterized the Local Electron Density of States around Fermi level. Low temperature (100 K) dI/dV local measurements at low coverage indicate the presence of three peaks at about -0.4 eV, +0.25 eV and +0.7 eV.

For different initial coverages we exposed the system to ~500 L of O2 and then annealed in vacuum at 850 K to achieve oxidation of Ti islands. Comparing to the system before the oxidation, we observed a reduction of coverage. Moreover, the oxidized islands are now characterized by a more regular shape (hexagonal or triangular). Low temperature STS measurements indicate the presence of a gap around Fermi level, confirming the oxidation of nanoislands.

Reference

[1] F. Donati, et al, Surf. Sci. 606, 702 - 710 (2012)

Tue_C1

Electronic and Spin States in Metal-Organic Supramolecular Materials at Surfaces: Spectro Microscopy Correlation Experiments

Jung, Thomas A.[1]; STOEHR, Meike[2]; LOBO CHECA, Jorge[3];
IACOVITA, Cristian[4]; GADE, Lutz[5]; DECURTINS, Silvio[6]; DIEDERICH, Francois[7]

[1]*Paul Scherrer Institut*
[2]*University of Groningen*
[3]*Centro D'Investigacio en Nanosciencia i Nanotecnologia, Barcelona*
[4]*Dept. of Molecular and Biomolecular Physics, INCDTIM Cluj-Napoca Romania*
[5]*Universitaet Heidelberg*
[6]*University of Bern*
[7]*ETH Zurich*

Abstract:
Well defined electronic and spintronic interfaces can be architectured by combining self-assembly and surface science. The atomically clean metal surface in the ultrahigh vacuum provides a very specific environment affecting the behaviour of the admolecules as well as the adsorbent-adsorbate interaction. Depending on the bonding at the interface, complex electronic and magnetic interaction can occur which can be explored using spectro-microscopy correlation, in this case photoemission and photoabsorption spectroscopy (PES, PAS) and Scanning Tunnelling Microscopy (STM).

One example is provided by the emergence of quantum dot states from the interactionof a porous network with the 2D (Shockley) surface state of Cu(111) which exhibitsufficient residual coupling to show the emergence of a band-like structure in angleresolved photoemission experiments [1]. In another example, specifically chosensurface supported molecules have been shown to exhibit ferromagnetic [2] or antiferromagnetic[3] exchange interaction and their spin system has been shown to changeinduced by physical parameters and / or chemical stimuli [4].

References
[1] J. Lobo-Checa et al. Science 325, 300 (2009)
[2] A. Scheybal et al. Chem. Phys. Lett. 411, 214 (2005)
[3] D. Chylarecka et al. J. Phys. Chem. Lett. 1, 1408–1413 (2010)
[3] C. Waeckerlin et al. Nature Communications 2010 1:61 DOI: 10.1038/ncomms1057

Tue_C2

Towards spintronics with Erbium single-ion molecular magnets

DREISER, Jan Gui-hyon[1]; WAECKERLIN, Christian[1]; PIAMONTEZE, Cinthia[1];
HEIDLER, Jakoba[1]; JUNG, Thomas A.[1]; NOLTING, Frithjof[1];
RUSPONI, Stefano[2]; BRUNE, Harald[2];
PEDERSEN, Kasper S.[3]; BENDIX, Jesper[3]

[1]*Paul Scherrer Institut*
[2]*Ecole Polytechnique Fédérale de Lausanne*
[3]*Department of Chemistry, University of Copenhagen*

Abstract:
Single-ion molecular magnets (SIMs) exhibiting slow relaxation of magnetization are potential building blocks of molecular spintronic devices which aim at interweaving charge and spin degrees of freedom. Until very recently it has remained a challenge to prepare such molecules in an addressable manner for example in 2D arrays at surfaces and to perform experiments with individual molecules like spin excitation and relaxation studies. Here we report our studies on the SIM Er(trensal)
[H3trensal = 2,2‘,2‘‘-tris (salicylideneimino) triethylamine], in which the Er(III) ion is 7-fold coordinated. In contrast to many other molecular magnets Er(trensal) combines magnetization relaxation times of up to several seconds with ultranarrow-linewidth 4f-4f optical transitions which could allow for optical access to the Er magnetization. In this contribution we will show recent results of x-ray photoelectron spectroscopy and scanning tunneling microscopy which reveal that Er(trensal) can be deposited on a Au(111) surface while retaining its molecular structure.

Tue_C3

Molecular Interactions and Reactivity of Perylenes on Surfaces: Going from VdW Assembly to Metal Coordination and Covalent Bonding.

MARTENS, Susanne[1]; MATENA, Manfred[1]; STöHR, Meike[2]; GADE, Lutz H.[3]; JUNG, Thomas A.[4]; BJöRK, Jonas[5]

[1]*Institute of Physics, University of Basel*
[2]*Zernike Institute for Advanced Materials, University of Groningen*
[3]*Anorganisch-Chemisches Institut, Universität Heidelberg*
[4]*Laboratory for Micro- and Nanostructures, Paul-Scherrer-Institute*
[5]*Surface Science Research Centre, Department of Chemistry, University of Liverpool*

Abstract:
By utilizing the concepts of supramolecular chemistry, impressive results for molecular self-assembly on surfaces have been presented. Mostly, non-covalent interactions like metal coordination, hydrogen bonding or dipolar coupling by functional groups are exploited to create supramolecular patterns. In our studies we chose to work with molecular building blocks that contain designed reactivities. Towards this goal we recently devised efficient syntheses for 4,9-diaminoperylene-quinone-3,10-diimine (DPDI) as well as tetraazaperopyrenes (TAPP). Due to their redox convertability, these aza-dyes lend themselves to chemical modification subsequent to a controlled deposition on metal surfaces and thus to significant changes in their intermolecular interactions.

Through the combination of experimental methods such as scanning tunneling spectroscopy, X-ray photoemission spectroscopy, X-ray standing wave measurements and theoretical methods, the electronic and structural properties of the observed surface processes have been elucidated.

References

[1] M. Wahl, M. Stöhr, H. Spillmann, T. A. Jung, and L. H. Gade, Chem. Commun., 1349 (2007)
[2] J. Lobo-Checa, M. Matena, K. Müller, J. H. Dil, F. Meier, L. H. Gade, T. A. Jung, M. Stöhr, Science, 325, 300, (2009)
[3] M. Matena, M. Stöhr, T. Riehm, J. Björk, S. Martens, M. S. Dyer, M. Persson, J. Lobo-Checa, K. Müller, M. Enache, H. Wadepohl, J. Zegenhagen, T. A. Jung, L. H. Gade, Chem. Eur. J. 16, 2079,(2010)

Wed_A1

Electron microscopy on magnetic nanostructures

VERBEECK, Johan[1]

[1]*EMAT, University of Antwerp*

Abstract:
Transmission electron microscopy has achieved many successes in the determination of the atomic structure of materials on a local scale. Spectroscopic techniques add chemical and electronic structure information at the same atomic resolution level making it an ideal tool to study nanomaterials. Also magnetic information can be obtained in several different setups. In this talk an overview will be given on these different setups with attention to the physical limits. Special attention will be paid to the counterpart of X-ray magnetic chiral dichroism (XMCD) with inelastically scattered electrons: energy loss magnetic chiral dichroism (EMCD). The conventional EMCD setup will be discussed and extended with the newly discovered electron vortex beams. Indeed these electron vortex beams open great prospects which tighten the similarity with XMCD even more. Electron vortex beams carry orbital angular momentum similar to the spin angular momentum that is used in XMCD to bring out the magnetic signal. This opens the potential to map the magnetic state of single atom collumns in a material putting the magnetic characterisation possibilities of modern transmission electron microscopes in line with the atomic resolution that was already available for structural and electronic structure information.

Wed_A2

A new type of atomic resolution holography with electron beam

HAYASHI, Kouichi[1]; UESAKA, Akio[2]; MATSUSHITA, Tomohiro[3]

[1]*Institute for Materials Research, Tohoku University*
[2]*Horiba Co. Ltd.*
[3]*SPring-8*

Abstract:
We proposed a new atomic resolution holography method, which was named « internal-detector electron holography [1,2]. The internal-detector electron holography is a time-reversed version of photoelectron holography, and it measures two-dimensional angular dependences of incident electron beam on characteristic X-ray intensities from solid samples. The measured holograms provide structural information similar to that obtained by ordinary photoelectron holography. We have made an equipment of the internal-detector electron holography based on a scanning electron microscope, and have measured holograms of SrTiO3 bulk and Pt thin film. Using an advanced real space reconstruction algorithm (SPEA-MEM)[3], the perovskite structure of SrTiO3 and the fcc structure of Pt were clearly visualized without ghost images. Moreover, we estimated optimized energies of electron beams and adequate thickness of samples by Monte-Calro simulation[4]. The present method is very useful for surface characterization.

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Wed_A3

High Resolution Cathodoluminescence: Application to Plasmonics

YAMAMOTO, Naoki[1]

[1]*Tokyo Institute of Technology*

Abstract:
High resolution cathodoluminescence (CL) technique combined with a scanning transmission electron microscope (STEM) is useful for investigating light emission property due to interaction between high energy electrons and materials. Light emission induced by surface plasmons in metal surfaces has been studied by the STEM-CL technique with a high spatial resolution of nanometer scale. Resolution of STEM-CL is mainly determined by a probe size of the electron beam in this case, and is typically in the order of 1 nm.

Surface plasmon polariton (SPP) on metal surfaces can be excited by high energy electrons, and is converted to photons when propagating on surface structures. SPPs are Bragg reflected by a periodic structure on a metal surface (plasmonic crystal) to form a standing wave, and then a gap opens up in the SPP dispersion pattern. STEM-CL technique can provide information on dispersion relation and spatial distribution of SPP waves. In the present study we show how to observe the dispersion pattern of SPP from 1- and 2-dimensional plasmonic crystals by using the angle-resolved measurement. The optical system utilizes an ellipsoidal mirror for light collection from a sample in a STEM. SPP standing waves at the Γand X points were individually visualized in photon maps using the CL imaging technique. We show dependence of the band gap on surface shape parameters such as diameter of surface holes and width of terraces in the plasmonic crystals.

Wed_B1

Characterising nanostructured polymer devices with soft x-rays

MCNEILL, Christopher[1]

[1]*Monash University*

Abstract:
Semiconducting polymers are an exciting class of material that combine the optoelectronic properties of semiconductors with the materials properties and processability of plastics. The operation of devices based on semiconducting polymers such as polymer solar cells and organic field-effect transistors (OFETs) is very sensitive to film microstructure and morphology. The active layer of polymer solar cells, for example, consists of a ~ 100 nm thick blend of donor and acceptor materials nanostructured on the ~ 10 nm length-scale in order to facilitate exciton dissociation that is the first step in photocurrent generation. The blend must also have interconnected pathways to facilitate charge separation and charge collection. On the other hand, high mobility polymers used in OFETs are typically semicrystalline with nano-sized domains. The role of domain structure in facilitating charge transport and the respective contributions of amorphous and crystalline domains is currently not well understood. In this presentation I will discuss the use of soft x-rays to study the nanostructure of polymer devices with high resolution and chemical specificity. Contrast is based on near-edge x-ray absorption fine-structure (NEXAFS) spectroscopy providing both chemical contrast and sensitivity to molecular orientation, with techniques such as x-ray spectromicroscopy and resonant soft x-ray scattering providing unique insight into the nanostructure and operation polymer devices.

Wed_B2

Synchrotron-based microscopes provide novel tools for exploring nano and micro-structures: with focus on chemical state and morphology of key components in operating model fuel cells

KAZEMIAN ABYANEH, Majid[1]; BOZZINI, Benedetto[2]; GIANONCELLI, Alessandra[1]; MELE, Claudio[2]; GREGORATTI, Luca[1]; KAULICH, Burkhard[3];KISKINOVA, Maya[1]

[1]*Elettra Laboratory, Area Science Park, 34149 Basovizza, Italy*
[2]*Department of Engineering and Innovation, University of Salento, 73100 Lecce, Italy*
[3]*Diamond Light Source, Didcot, Oxfordshire, OX11 0DE, UK*

Abstract:
The complementary capabilities of synchrotron-based X-ray microscopes in terms of imaging, spectroscopy, spatial and time resolution and variable probing depths have opened unique opportunities to explore nano and micro-structure systems and provide chemical composition of these technologically relevant complex materials and correlate simulated systems to the actual operating conditions. TwinMic and ESCA-microscopy beamlines at Elettra, are hosting two powerful X-ray microscopes which use a direct approach to characterize samples at the submicron scale by focusing X-ray beam on the samples using Fresnel zone plates. Some recent achievements in the chemical, physical and compositional characterization of nano and micro-structured materials will be presented providing an overview of the capabilities of these powerful techniques.

Fuel cells are one of the most appealing environmentally friendly devices for effective energy production, but still there are key barriers to their broad commercialization. Along with efficiency a major challenge of fuel cell technology is durability of the key components (interconnects, electrodes and electrolytes) that can be subject of corrosion or undesired morphology and chemical changes occurring under operating conditions. The most recent achievements in this respect will be illustrated by selselected results obtained with simplified versions of proton exchange membrane fuel cells (PEMFC)and solid oxide fuel cell (SOFC).

Wed_B3

Conductive enzyme/nanomaterials hybrid network to biosensing

KAFI, A.k.m.[1]; CROSSLEY, Maxwell J[1]

[1]*Dept. of Chemistry, The University of Sydney, NSW 2006 Australia*

Abstract:
Interfacing the non-biotic and biotic worlds is clearly one of the most important subjects of research. Particularly, the development of a bioelectronics interface for facilitating electron transfer between electrode and biomolecules; and to minimize non-specific interactions that lead to uncontrolled responses to biosensing, is necessary. In this work, the aim was to construct the three-dimensional (3-D) conductive Hemoglobin (Hb) network with carbon nanotube (CNT) onto the thiol-modified gold (Au) electrode. Firstly, CNT was functionalized with thiol group and Hb was functionalized with thioaniline. Finally, those modified CNTs and modified Hb were immobilized a thioaniline monolayer-modified Au electrode by co-electropolymerization. Cyclic voltammogram (CV) and amperometry were employed to study electrochemical properties of the modified electrodes. Our results showed that the direct electrical communication between the redox center of Hb and an Au electrode was established through 3-D network of CNT/Hb. And Hb present in the 3-D CNT/Hb network exhibited a pair of quasi-reversible redox peaks with a midpoint potential of -0.225 V and -0.075, respectively. The modified electrode was used as a biosensor and exhibited a high sensitivity, long linear range and lower detection limit to H2O2, under optimal conditions.

Wed_C1

Giant Anisotropies of single Co atoms on graphene/Pt(111)

DONATI, Fabio[1]; DUBOUT, Quentin[1]; CALLEJA-MITJA, Fabian[1];
PATTHEY, François[1]; BRUNE, Harald[1]

[1]*Institute of Condensed Matter Physics, Ecole Polytechnique Fédérale de Lausanne*

Abstract:
We present spin excitation spectra (SES) [1] recorded with low-temperature scanning tunneling microscopy (STM) elucidating the magnetic properties of single Co atoms adsorbed on graphene on Pt(111). Using a spin Hamiltonian description [2], we deduce an effective spin S=1 with a magnetic ground state mZ=0 and a giant magnetic out-of-plane anisotropy D = (8.2 ± 0.4) meV. Applying an external out-of-plane magnetic field, the two excited states mZ=Â±1 are Zeeman-split with a Landé g factor g = 2.2 ± 0.4.

H adsorption on the Co atoms can drastically modify their magnetic properties. Exposing Co atoms to H2 gas, we found three different types of complexes, clearly distinguished by their apparent height and spectroscopic features. Two of them are interpreted as CoH and CoH2 and show prominent non-magnetic inelastic features attributed to vibrational modes. The third one, probably CoH3, displays spin-excitations in a similar fashion as clean Co, but with a considerably reduced magnetic anisotropy of D=1.7 ± 0.2 meV.

References:
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Wed_C2

High resolution real and reciprocal space photoelectron emission microscopy on heterogeneous Graphene/SiC(000-1)

WINKLER, Konrad[1]; KRöMKER, Burkhard[1]; BARRETT, Nicholas[2]; CONRAD, Edward[3]; ELENI, Anagirou[1]

[1]Omicron NanoTechnology, Germany
[2]IRAMIS, Saclay, France
[3]GeorgiaTech, Atlanta, GE, United States

Abstract:
We present energy filtered electron emission spectromicroscopy with high spatial and wave-vector resolution on few-layer epitaxial graphene on SiC(000-1) grown by furnace annealing.

Conventional electron spectroscopy methods are limited in providing simultaneous real and reciprocal or k-space information from small areas under laboratory conditions. Therefore, the characterization of materials with only micron scale sample homogeneity such as epitaxially grown graphene requires new instrumentation. Recent improvements in aberration compensated energy-filtered photoelectron emission microscopy (PEEM) can overcome the known limitations in both synchrotron and laboratory environments.

Here we report 2D maps of the k-parallel л-л'∗ band dispersion in micron-scale regions and correlate them with spatially resolved chemical information on the same regions. Only the combination of high lateral, high energy, high k-resolution and controlled switching between real space and k-space allows detailed understanding of micron size sample sites with 1-3 layers graphene.

The experiments underline the importance of simultaneous lateral, wave vector and spectroscopic resolution on the scale of future electronic devices in order to precisely characterize the transport properties and band alignments.

Wed_C3

Localized identification of the quantized unoccupied states for the epitaxial graphene by scanning tunneling microscopy and resonant spectroscopy

KUO, Chien-cheng[1]; CHAN, Yao-jui[1]; WU, Shih-yu[1]; HO, Yen-hung[1]; WU, Tsung-hsuan[1]

[1]*Department of Physics, National Sun Yat-sen University*

Abstract:
Graphene, a few-layers graphite material, has recently attracted considerable attention due to its unique electronic properties. Most of these properties are dramatically sensitive to the number of graphene layers. However, different from the layer measurement for the exfoliated graphene on SiO2, in most cases there remains a challenge to identify the number of layer and the real boundaries of the epitaxial graphene, especially for the localized mapping within nanometer resolution. Herein, we show that the quantization of unoccupied states play a significant role, as the fingerprint, to represent the layer numbers of the epitaxial graphene on SiC(0001). These quantized unoccupied states were probed locally by scanning tunneling microscopy and spectroscopy operated in field emission regime. The emitted electrons are scattered by the tip and the graphene surface and cause an oscillated current with bias, showing a series characteristic resonance spectra. Apparently, the amplitudes of these spectra are suppressed at specific biases where the field-emitted electrons coincide, in energy, with the quantized unoccupied states, revealing significant layer dependence. By using the STM tip as an electron source, we are able to identify the layer numbers of epitaxial graphene unambiguously, like the contrast observed by the optical microscope for exfoliated graphene, with nanometer resolution for identifying the local layer distribution of epitaxial graphene.

Wed_C4

Atomic structure visualizations of graphite and monolayer graphene by photoelectron holography

MATSUI, Fumihiko[1]; MATSUSHITA, Tomohiro[2]; DAIMON, Hiroshi[1]; ROTH, Silvan[3]; GREBER, Thomas[3]; OSTERWALDER, Jürg[3]

[1]Nara Institute of Science and Technology
[2]JASRI/SPring-8
[3]University of Zurich

Abstract:
Two-dimensional photoelectron angular distributions from a graphite single crystal and a graphene monolayer grown on the Rh(111) surface were measured by using circularly polarized soft x-ray and Mg K_alpha radiations. A holographic reconstruction algorithm (SPEA-MEM) based on the fitting of elemental diffraction patterns for various C-C bond distances was applied to the full set of measured data. Nano-scale real space images of three graphite layers above the photoelectron emitter atom as well as the layer including emitter atom were clearly reproduced. On the other hand, a single layer atomic image was reconstructed for the graphene monolayer. These are the first examples of the holographic reconstruction by photoelectron diffraction for layered and monolayer materials.

Wed_D1

Optical sensing and spectroscopy down to the single-molecule level

Sandoghdar Vahid[1]

[1]*Max Planck Insitute for the Science of Light*

Abstract:
Over the past few years, we have developed extinction detection and spectroscopy as an alternative to fluorescence for investigating single nano-objects such as metallic nanoparticles, viruses, quantum dots, and organic molecules [1-7]. In this talk, I will introduce the operation principle of this method, using examples from cryogenic spectroscopy of single dye molecules. Next, we will discuss room-temperature applications in imaging and sensing. In particular, I will present measurements of single virus motion and its interaction with receptor lipids [4] as well as studies of nanoparticle motion on artificial membranes and in electrostatic nanotraps [8]. If time permits, I will discuss prospects on ultrafast photophysics using plasmonic nanoantennas [9].

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Wed_D2

Fabrication and characterization of tunable plasmonic antennas

SCHOLDER, Olivier[1]; JEFIMOVS, Konstantins[1]; SHORUBALKO, Ivan[1];
HAFNER, Christian[2]; SENNHAUSER, Urs[1]; BONA, Gian-luca[1]

[1]EMPA
[2]ETHZ

Abstract:
The use of surface plasmon resonance (SPR) biosensors allows the measurements of biomolecular interactions in real-time. An advantage with regards to other detection techniques is the high sensitivity, which allows the detection of binding events on a single molecule level.

We demonstrate the fabrication of antennas with different shapes, sizes and gaps. Gaps of ~5nm were achieved by helium focus ion beam (FIB) milling which is hardly achievable by conventional fabrication techniques such as electron beam lithography or Gallium-FIB milling.

Nano antenna have a very localized field enhancement and are thus suitable to increase the detection sensitivity by orders of magnitude. Due to their small size fabrication is still a challenge today and a perfect geometry is never achieved. Even small defects in the geometry can dramatically change the resonance frequency. We developed a technique to produce nano-antennas on flexible polydimethylsiloxane (PDMS) substrates, which allows to adjust the resonance frequency of the antenna by simple mechanical stretching of the substrate.

Thu_A1

X-Ray spectroscopy on nano- materials

PIANETTA, Piero[1]; MEIRER, Florian[2]; LIU, Yijin[1]; NELSON, Johanna[1]; BOESENBERG, Ulrike[3]; CABANA, Jordy[3]; ANDREWS, Joy[1]

[1]SLAC/SSRL
[2]Fondatiozione Bruno Kessler
[3]LBNL

Abstract:
With the importance of nanoscale systems in applications ranging from Li-ion batteries to catalysis, it is becoming increasingly important to understand the chemical changes within the constituent nanoparticles in three dimensions under operating conditions. We have demonstrated that these problems can be addressed using transmission x-ray microscopy (TXM) in combination with XANES to yield chemically specific images in 2D at sub-30 nm resolution and in 3D at approximately 40 nm resolution. In addition to being able to combine high resolution imaging with spectroscopy, TXM using hard x-rays has the further very desirable property that close to “real world” samples can be studied due to the relatively large depth of focus in the tens of microns and fields of view up to a few hundred microns. Furthermore, sub-second image acquisition times allow chemical reactions in practical systems to be followed. In one example of this approach, we have used the TXM at BL6-2 at the Stanford Synchrotron Radiation Lightsource, to study the 2D time-resolved structural and chemical changes in Li-ion battery electrodes in fully assembled coin cells as well as 3D chemical speciation in the electrodes themselves, ex situ. The changes in these electrodes at the nanoscale ultimately determine the performance characteristics of the battery.

Thu_A2

Hyperspectral nanoimaging using X-ray excited optical luminescence and X-ray fluorescence

MARTINEZ-CRIADO, Gema[1]

[1]*European Synchrotron Radiation Facility*

Abstract:
The assembly of group-III nitride nanowires into optoelectronics offers a promising approach to improve the performance of photonic devices. Sophisticated core/multishell nanowires have already been configured as light-emitting diodes and lasers. Two dimensional quantum confinement effects, created by coaxial band structure engineering, lead large spectral tunability and high luminescence quantum yields. Theory suggests that under nanoscale conditions that vary in elemental composition and cross-sectional geometry, carrier distributions can organize in unusual complexities that exhibit novel localization effects. However, the direct experimental observation of such quantum confinement has never been explored. By combining synchrotron excited optical luminescence with simultaneous energy-disperse X-ray spectroscopy using a hard X-ray nanobeam here we show experimental evidence for local charge accumulation effects in hexagonal n-GaN/InGaN multiquantum-well/p-GaN radial nanowires. We found a stronger InGAN related recombination at the hexagon corners as predicted by theoretical calculations. Our findings confirm the detailed control over geometry, dimensions and doping. More generally, we demonstrate how hard X-ray excited optical luminescence imaging can probe quantum heterostructures with nanoscale spatial resolution. This hyperspectral nanoscale imaging method opens new possibilities in function-property analyses of single nanostructures.

Thu_A3

Soft X-ray Absorption Spectroscopy on sub 10 nm Scale

TYLISZCZAK, Tolek[1]; SHAPIRO, David[1]; MAIA, Filipe[1]; MARCHISINI, Stefano[1]; KILCOYNE, David[1]; KAZNACHEEV, Konstantine[2]

[1]Lawrence Berkeley National Laboratory
[2]NSLS II

Abstract:
Soft X-ray spectroscopy is a powerful method to characterize chemical and physical properties of many systems. When it is combined with a microscope it has many unique applications. The scanning transmission x-ray microscope (STXM) is being used routinely for the spectroscopy measurements with spatial resolution down to about 20 nm In many cases higher resolution is needed, especially when investigating properties of nanoparticles in environment. Progress in zone plate manufacturing may bring the probing x-ray beam size to about 10 nm. To further increase resolution, a new approach is needed. The most promising method is a ptychography, a combination of scanning sample and coherent beam diffraction pattern recording. At hard x-rays, this method is used successfully mainly for imaging. At soft x-ray regime it is in the early development stage. At the ALS we have demonstrated stable reconstruction with 5 nm resolution with potentially 2 nm resolution. To obtain spectroscopic information on this scale, additional considerations are required which will be discussed during the presentation.

Thu_B1

Nano-Technology and Nano-Spectroscopy for Characterizing Magnetic Recording Media

HELLWIG, Olav[1]

[1]*San Jose Resreach Center, HGST, a Western Digital company*

Abstract:
Today's hard disk drives are based on layered CoCrPtX granular magnetic recording media with perpendicular magnetic anisotropy. The down-track magnetic bit length has nowadays reached dimensions of less than 20 nm for grain structures with periods of 9-10 nm. Studying magnetic structures, correlations and their distributions on that small length scale is very challenging.
In my talk I will give a brief overview of how magnetic recording media have evolved in the last 2 decades. Then I will show that Resonant Small Angle X-ray Scattering (SAXS) is an excellent tool to study grain segregation, magnetic clusters and magnetic cluster size distributions in modern perpendicular magnetic recording media. Furthermore I will present examples of other magnetic recording media model systems, such as for example Co/Pd and Co/Pt multilayer films that have been used to study the effect of microstructure changes on the magnetic characteristics of the system. At the end of my talk I will provide an outlook and discuss how newly developed coherent imaging techniques combined with pump-probe experiments may open up new perspectives for characterization of next generation magnetic media, such as used in heat assisted magnetic recording or bit patterned recording.

Thu_B2

Size-dependent magnetic properties of individual iron nanoparticles studied at room temperature

KLEIBERT, Armin[1]; BALAN, Ana[1]; FRAILE RODRíGUEZ, Arantxa[2]; BANSMANN, Joachim[3]; DERLET, Peter[4]; YANES -DIAZ, Rocio[5];NOWAK, Ulrich[5]; NOLTING, Frithjof[1]

[1]Swiss Light Source, Paul Scherrer Institut, Switzerland
[2]Institut de Nanociència i Nanotecnologia (IN2UB), Universitat de Barcelona, Spain
[3]Institute of Surface Chemistry and Catalysis, University of Ulm, Germany
[4]Condensed Matter Theory, Paul Scherrer Institut, Switzerland
[5]Department of Physics, University of Konstanz, Germany

Abstract:
The search for ever smaller nanomagnets being switchable between two states (bistability) at room temperature and sizes which are technologically relevant is a growing area of research due to their potential for applications in fields such as information storage media, biology and medicine. However, below a given size thermal excitations lead to fluctuations of the magnetization and will affect their response to magnetic fields. To study this transition in more detail we have used photoemission electron microscopy (PEEM) together with x-ray magnetic circular dichroism (XMCD) and investigated the magnetization of individual Fe nanoparticles in contact with a Si substrate at room temperature. The transition from stable ferromagnetism to superparamagnetism occurs at a particle size of about 13 nm as revealed by magnetization loops of individual nanoparticles and the onset of thermal fluctuations of the magnetization. The latter give valuable insight in the magnetic anisotr opy energy landscape of the particles.

Thu_B3

Status of pump-probe time-resolved photoemission electron microscopy PEEM at SPring-8

KINOSHITA, Toyohiko[1]; OHKOUCHI, Takuo[1]; OSAWA, Hitoshi[1]; ARAI, Kuniaki[2]; FUKUMOTO, Keiki[1]; OKUDA, Taichi[3];KOTSUGI, Masato[1]; MURO, Takayuki[1]; NAKAMURA, Tetsuya[1]; MATSUSHITA, Tomohiro[1]; YAMAGUCHI, Akinobu[4]; NOZAKI, Yukio[5]

[1]Japan Synchrotron Radiation Research Institute/SPring-8
[2]Institute for Solid State Physics, University of Tokyo
[3]Hiroshima Synchrotron Radiation Center
[4]National Institute of Advanced Industrial Science and Technology
[5]Department of Physics, Keio University

Abstract:
The present status and the recent progress of pump-probe time-resolved photoemission electron microscopy at SPring-8 are introduced [1, 2]. The storage ring of SPring-8 is operated with many different bunch modes in order to satisfy the demands of time-resolved measurements on a variety of time-scales. We combine these bunch modes with laser pulses and/or high-frequency pulse generators to achieve a variety of pump-probe PEEM measurements and investigate phenomena such as magnetic domain motions and photo-induced phase- transitions. These ultra-short excitation sources provide pulsed magnetic fields, electric fields and photon-pulses. The element-specific time evolution of materials in response to the excitation can be observed with spatial and temporal resolutions of (50 - 300) nm and (40 - 100) ps, respectively, with repetition frequencies of up to 42 MHz. By using the magnetic circular dichroism effect, the domain motion of sub-micron sized magnetic areas can be observed. The time evolution of electronic structures in local areas can also be studied. In this talk, the experimental setups and representative activities will be presented. For example, we show the results of dynamical observation of the vortex core motion in mesoscopic size magnetic dots in response to a magnetic field pulse as well as an rf-field. We compare the displacements of the cores by the single magnetic field pulse and that by the rf-field in the resonance condition.

Thu_C1

Understanding friction on the nanoscale

SCHIRMEISEN, Andre[1]

[1]*University of Giessen, German*

Abstract:
Frictional motion plays a central role in diverse systems and phenomena that span vast ranges of scales, from nanometer contacts in nano- and micromachines to the geophysical scales characteristic for earthquakes. Only the advent of new tools such as the friction force microscope enabled the investigation of frictional forces down to atomic scales.

For example, the Prandtl-Tomlinson model envisages molecular friction as the thermally activated hopping of atoms over surface energy barriers. This predicts a time-temperature equivalence, only recently validated by experiments. However, one of the main difficulties in understanding frictional response is the complexity of highly non-equilibrium processes going on in realistic tribological contacts, which include detachment and re-attachment of multiple microscopic bonds at the sliding interface. Again, temperature is of great importance for the kinetics of these processes, leading to non-monotonic temperature dependencies of friction. Apart from these surface dominated friction processes, nanoscale friction on Polymers is an example of volume dominated frictional sliding. Here, the dynamics of polymer chain elements dictate the sliding resistance. Lastly, at the example of sliding gold metal contacts the phenomenon of contact rejuvenation is presented. These examples provide unique snapshots of the different atomic friction mechanisms, a further step in our attempts to identify unifying concepts for friction on the nanoscale.

Thu_C2

Scanning Gate Microscopy imaging of fractional incompressible stripes in integer quantum Hall channels

PARADISO, Nicola[1]; HEUN, Stefan[1]; RODDARO, Stefano[1]; BIASIOL, Giorgio[2]; SORBA, Lucia[1]; PFEIFFER, Loren N.[3];WEST, Ken W.[3]; BELTRAM, Fabio[1]

[1]NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Pisa, Italy
[2]Istituto Officina dei Materiali CNR, Laboratorio TASC, Basovizza (TS), Italy
[3]Dept. of Electrical Engineering, Princeton University, Princeton, New Jersey 08544, USA

Abstract:
Transport experiments provide conflicting evidence on the possible existence of fractional order within integer quantum Hall channels. A number of experiments showed clear indications of fractional phases in constrictions. On the other hand, integer edge states sometimes appear as monolithic objects with no inner structure. Here we use scanning gate microscopy (SGM) and demonstrate that fractional features were unambiguously observed in every integer quantum Hall constriction we studied. Experiments were performed at bulk filling factor nu=1. We brought two counter-propagating integer-edge channels into proximity by means of a quantum point contact (QPC) and used the biased SGM tip to tune backscattering. Plateaus are observed in source-drain differential conductance maps whenever the tip induces an incompressible phase at the QPC center. We present SGM maps which directly reveal the width of the most relevant fractional incompressible stripes, corresponding to filling factors 1/3 and 2/5, together with their particle-hole conjugates 2/3 and 3/5. Our results compare well with predictions of the edge-reconstruction theory and may open up exciting developments. For instance, the ability to partition an integer edge and partially transmit one of its fractional components may be the key for the implementation of fractional quasi-particle Mach-Zehnder interferometers.

Thu_C3

Non-contact friction over metal-superconductor and charge density wave (CDW) phase transitions

KISIEL, Marcin[1]; LANGER, Markus[1]; GNECCO, Enrico[2]; GYSIN, Urs[1]; MEYER, Ernst[1]

[1]*University of Basel, Institute of Physics, Switzerland*
[2]*IMDEA Nanociencia, Campus Universitario de Cantoblanco, Madrid, Spain*

Abstract:
The origins of non-contact friction are investigated by highly sensitive force microscopy in the pendulum geometry. In this mode probe is suspended perpendicularly to the sample and the tip's vibrational motion is parallel to the surface.

The friction forces acting on a sharp probe tip oscillating below 3nm distances from 140nm thick Nb surface have been measured. Measurements reveal a reduction of dissipation in the superconducting state compared to the normal state by a factor 3. Therefore, electronic friction is found to be the dominant dissipation mechanism with power losses of 80ueV/cycle at separations of 0-3nm. Measurement of friction coefficient across the critical temperature of Nb film shows good agreement with the BCS theory.

Ultrasensitive cantilevers were also utilized to probe friction forces between oscillating tip and the 2H-NbSe2 surface - charge density wave (CDW) compound. Measurements reveal an existence of huge maxima of non-contact friction at distances of few nanometers from the surface. The non-contact friction maxima are possibly due to excitation of huge dielectric relaxation modes on 2H-NbSe2 surface. Measurement across the CDW temperature of 2H-NbSe2 showed increase of non-contact friction at temperature of T=33 K for which acoustic phonons softening to zero frequency is expected.

Thu_D1

Progress of Three-Dimensional Scanning Photoelectron Microscope at Spring-8 BL07LSU

HORIBA, Koji[1]; NAGAMURA, Naoka[1]; SHINOHARA, Toshihiro[1]; TOYODA, Satoshi[1]; KUMIGASHIRA, Hiroshi[2]; OSHIMA, Masaharu[1]

[1]*Graduate School of Engineering, The University of Tokyo*
[2]*Institute of Materials Structure Science, High Energy Accelerator Research Organization*

Abstract:
In order to achieve nondestructive observation of the three-dimensional spatially resolved electronic structure of nanostructure species such as stacking structures in semiconductor devices and the surface/interface reactions of catalytic materials, we have developed a scanning photoelectron microscope system with the capability of depth profiling in electron spectroscopy for chemical analysis (ESCA). We call this system “3D nano-ESCA”. For focusing the X-ray, a Fresnel zone plate with an outermost zone width of 35 nm is used. In order to obtain the angular dependence of the photoelectron spectra for the depth-profile analysis without rotating the sample, we adopted a modified VG- Scienta R3000 analyzer with an acceptance angle of 60 degrees as a high-resolution angle-resolved electron spectrometer. The system has been installed at the University-of-Tokyo Materials Science Outstation beamline, BL07LSU, at SPring-8. From the results of the line-scan profiles of the poly-Si/high-k gate patterns, we achieved a total spatial resolution better than 70 nm. From the angular dependence of the photoelectron spectra, we have succeeded in obtaining precise depth profiles for HfO2/SiO2/Si stacking structures using a maximum entropy method analysis. Recent research activities using the 3D nano-ESCA system will be presented.

Thu_D2

Scanning photoemission imaging and spectromicroscopy with synchrotron radiation, a powerful tool for micro- and nano-material characterization

GREGORATTI, Luca[1]; AMATI, Matteo[1]; KAZEMIAN ABYANEH, Majid[1]

[1]*Sincrotrone Trieste SCpA*

Abstract:
The Scanning PhotoEmission Microscope (SPEM) uses a direct approach to characterize chemically surfaces and interfaces at the submicron scale i.e. the use of a small focused x-rayphoton probe to illuminate the sample. The focusing of the x-ray beam is performed by using a Zone Plate (ZP), which is a Fresnel type lens. The SPEM at the Elettra synchrotron light source, hosted at the ESCAmicroscopy beamline, can operate in two modes: imaging and spectroscopy. In the first mode the sample surface is mapped by synchronized-scanning the sample with respect to the focused photon beam and collecting photoelectrons with a selected kinetic energy. The second mode is an XPS from a microspot. The x-ray beam can be downsized to a diameter of 120 nm which allows imaging resolution of less than 50 nm. Samples can be heated and biased during the measurements.
Some recent achievements in the chemical, physical and electronic characterization of nano- and micro-structured materials, such nanotubes and nanowires, will be presented providing an overview of the capabilities of this powerful technique. Other examples will illustrate recents experiments where the contactless monitoring of the diameter-dependent conductivity of GaAs nanowires has been performed as well as the structural dependent redox properties of PtRh nanoparticles produced by Pulsed Laser Deposition.

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Thu_D3

Photoemission Electron Microscopy (PEEM) on Insulating Samples

OHKOCHI, Takuo[1]; KOTSUGI, Masato[1]; KAWANO, Kenji[2]; YAMADA, Keisuke[3]; ONO, Teruo[3]; OURA, Masaki[4];MURO, Takayuki[1]; KINOSHITA, Toyohiko[1]; WATANABE, Yoshio[1]

[1]Japan Synchrotron Radiation Research Institute / SPring-8
[2]TAIYO YUDEN CO,LTD
[3]Institute for Chemical Research, Kyoto Univ.
[4]RIKEN SPring-8 Center, Harima Institute

Abstract:
Photoemission electron microscopy with soft x-ray synchrotron radiation (SX-PEEM) is a powerful tool for nano-scale science because of the integrated capability of chemical mapping, element-specific magnetic domain observation, XAS/XPS spectroscopy in nano-scale areas, and so on. However, poor electroconductivitiy of samples, which causes surface charging and distortion of electron trajectories, is formidable for PEEM despite the expanding demand of nanospectroscopic studies on insulating materials such as oxides, semiconductors, resins, extra-terrestrial matters.

We have developed a technique of PEEM measurements on insulators at the synchrotron radiation facility SPring-8 (BL17SU beamline). In this method, Au is deposited on samples with a-few-tens-micron window areas. Continuous illumination of high-flux x-rays on the insulating area enhances surface conductivity due to photon-induced surface modification, and then electric charges are supplied from surrounding Au pads. The Au deposition equipment for this method is quite simple and effective compared with electron flooding guns which have been conventionally used for photoelectron spectroscopy.

In this talk, we introduce some case studies of PEEM experiments using this technique, such as area-selective x-ray absorption spectroscopy of Al2O3 and magnetic domain observation of NiZn ferrite.

Thu_D4

NanoXAS - Combining Scanning Probe and X-Ray Microscopy for Nanoanalytics

PILET, Nicolas[1]; RAABE, Joerg[1]; QUITMANN, Christoph[1]; FINK, Rainer[2]; HUG, Hans J.[3]

[1]Paul Scherrer Institut
[2]Erlangen-Nürnberg University
[3]EMPA

Abstract:
NanoXAS is a novel x-ray microscope combining x-ray spectroscopy with scanning probe microscopy. While the first one gives access to chemical information, the second reveal the sample topology or other physical properties. We report the first results combining x-ray transmission and atomic force microscopy imaging at the same time.

The instrument uses Fresnel zone plates to focus x-rays (270 - 1800 eV) onto a semi-transparent sample which is raster scanned through the beam. A scanning probe microscope (SPM) is looking on the down stream side of the sample. In complement to the material contrast arising from the x-ray transmission chemical sensitivity, topology, magnetic forces, elasticity, friction, conductivity may be successively assessed using the SPM. Furthermore scanning transmission x-ray microscopy (STXM) images have been recorded using the AFM tip to measure the transmitted x-rays allowing the record of the topological image in the mean time. A few examples will be shown to demonstrate the principle (polymer blend, lithographic metal structures, nanodots, magnetic films).

Fri_A1

M(N)EM Switch Technologies for RF and Logic Applications

DESPONT, Michel[1]; GROOG, Daniel[1]; DRECHSLER, Ute[1]

[1]*IBM Research*

Abstract:
In this presentation, we will report on our developments of Micro(Nano)ElectroMechanical System M(N)EMS technologies for fabricating electrical switch elements. We realized a Radio-Frequency (RF) MEM switch based on a piezoelectric actuator for application in telecommunications as well as a NEM switch based on electrostatic actuation for ultra-low-power logic applications.

In RF technology (e.g. wireless communication), MEMS can offer superior performance at lower cost than traditional solid-state devices. Our RF MEM switch technology exploits wafer-level transfer to integrate PZT-based switches on CMOS in order to mitigate the incompatibility of the PZT material and process with back-end-of-theline CMOS technology.

To overcome the power issue of current CMOS technology, the microelectronics industry needs new devices with drastically improved energy efficiency. One promising technology is NEM switches, which could achieve a significant improvement in energy efficiency. The design of NEM switches for logic applications needs to address many challenges, such as device size, operation voltage, operation speed, robustness, and contact resistance. We propose an in-plane design for electrostatically actuated switches that is compact and robust because of good control of the actuation gap in the closed position. The contact and actuation gap are not defined lithographically but rather through the thickness of the same sacrificial layer, enabling scalability to nanometer sizes.

Fri_A2

Fabrication of ultrathin nanoporous silicon membranes using self-assembling polymers

BOJKO, Alexandre[1]; MONTAGNE, Franck[2]

[1]CSEM SA / EPFL
[2]CSEM SA

Abstract:
Nanoporous membranes fabricated from silicon materials have recently emerged as a new class of inorganic nanosieves offering a relevant technological alternative to commercially available ultra- and microfiltration polymer membranes for the separation of biological compounds at various scales. Here, we present a new fabrication process based on polymer self-assembly for producing arrays of ultrathin nanoporous silicon membranes (NSiMs) at wafer scale. The process utilizes either self-assembled monolayers of block copolymer micelles or to create a nanopatterned metallic mask, which is then used to produce nanopores in silicon nitride layer by deep reactive ion etching. The membrane release is achieved via a combination of dry and wet etching, thus leading to a free-standing nanoporous film. A key aspect of this process is the ability to tune independently the size and density of nanopores, as well as the membrane thickness and dimension. Typically, NSiMs as thin as 100 nm can be produced into various lateral dimensions (up to few mm2) and homogeneous pore sizes in the range of 30 to 500 nanometers. The pore density is about 10e10 pores/cm2, which is superior by two orders of magnitude to commercial track etched membranes. We will show that ultrathin NSiMs enable high flux and low sample retention during molecular transport experiments, making them ideal sieving materials for fast and selective separation, as well as for controlled delivery of biomolecules.

Fri_B1

Direct Write Thermal Probe Patterning of Polymeric Thin Films

DUERIG, Urs[1]

[1]*IBM Research - Zurich*

Abstract:
A novel thermal scanning probe lithography (tSPL) method based on the local removal of organic resist materials has been developed at the IBM Research Laboratory in Zurich [1-3]. A polymeric polyphthalaldehyde (PPA) resist [2-4] responds to the presence of a hot tip by local material decomposition and desorption. Thereby arbitrarily shaped patterns can be written in the organic films in the form of a topographic relief, constrained only by the shape of the tip. The combination of the fast "direct development" patterning of a polymer resist and the in-situ metrology capability of the AFM setup allows to reduce the typical turnaround time for nano-lithography to minutes.
A virtue of (tSPL) is the fact that the evaporation of the organic resist can be precisely controlled via the force which is applied to the tip while writing. This enables the fabrication of three dimensional relief patterns with very good conformity no other lithographic technique can do. Patterning rates of up-to 500 kHz have been achieved using a fast scanning scheme which can operate at up-to 20 mm/s scan speed with an overall position accuracy of +/- 10 nm over a field of 30 micro-meter [4]. The structuring capability in the third dimension expands the lithography landscape and finds applications e. g. in multi-level data storage [4], nano/micro-optic components and directed positioning of nanoparticles in shape-matching guiding structures [5].

Reference:
[1] D. Pires, J. L. Hedrick, A. De Silva, J. Frommer, B. Go

Fri_B2

Imaging of transient carrier dynamics by nanoscale pump-probe microscopy

SHIGEKAWA, Hidemi[1]

[1]*Institute of Applied Physics, University of Tsukuba*

Abstract:
With the size reduction of structures in current electronic devices, differences in the electronic properties caused, for example, by the structural nonuniformity of each element have an ever increasing effect on macroscopic functions. Therefore, study of nonequilibrium quantum dynamics in materials with small structures is of great importance not only from fundamental viewpoints but also as a basis for further development of functional devices. Real-space imaging of transient carrier dynamics in nanostructures is desired for deeper understanding of such as current semiconductor physics, chemical reactions in catalytic activities and efficiency in organic solar devices. Recently, we have developed a new microscopy technique, which enables to probe ultrafast phenomena with atomic resolution, by combining scanning tunneling microscopy (STM) with ultrashort-pulse laser technologies [1,2]. In the time-resolved STM, its tunnel gap is illuminated by a sequence of paired laser pulses and the change in tunneling current is measured as a function of delay time between the paired pulses. This microscopy is applicable to the systems in which the response of the tunneling current has a nonlinear dependence on optical excitation intensity. In this talk, I would like to introduce our new microscopy technique with some new results.

References:
[1] Y. Terada et al., Nature Photonics, 4, 12, 869 (2010); Advances in Opt. Technol., 2011, 510186 (2011)
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Poster Session

Poster 2

Electrodeposition of Polyaniline nanowires

MOHAJERI, S.[1]; DOLATI, A.[1]; JABBARI, E.[1]

[1]*Sharif university of technology*

Abstract:
Electrochemical supercapacitors are the charge-storage devices having high power density. The nano scale materials with high surface area and high porosity, give the best performances as electrode materials for supercapacitors due to their distinctive characteristics of conducting pathways and nano scale dimensions. Therefore, the synthesis and capacitive characterization of the high surface area nanomaterials such as nanowires have been carried out extensively.

In this research, polyaniline nanowires were electrochemically deposited on stainless steel electrode with the technique of choronoamperometry and pulse voltammetry and were characterized by cyclic voltammetry and charge-discharge cycling for supercapacitive properties. The mechanism of electrodeposition was analyzed by cyclic voltammetry and chronoamperometry techniques. The morphology of coatings was investigated by scanning electron microscopy (SEM).

It was determined that electrodeposition is controlled by diffusion with a limited and steady state current and the mechanism of nucleation is absolutely uniform. SEM images of the polyaniline nanowires show that the diameter of the nanowires is in the range of 40-70 nm. The PANI nanowire arrayed electrodes have excellent specific capacitanceand high efficiency of charge/discharge cycling which is very important for the electrode materials of a capacitor to provide high power density.

Keywords: polyaniline, nanowire, supercapacitors, electrodeposition

Poster 3

Uniaxial magnetic anisotropy in1-dimensional Fe nanostructures on Al2O3(0001) induced by oblique deposition

LIN, Wen-chin[1]; CHI, Chiao-sung[1]; WANG, Bo-yao[2]

[1]*Department of Physics/National Taiwan Normal University*
[2]*Department of Physics, Tamkang University*

Abstract:
Self-organized 1-dimensional magnetic structures of Fe on Al2O3(0001) were prepared by oblique deposition. The surface morphology, crystalline structure, and magnetic behavior were studied. The X-ray diffraction (XRD) characterization shows the preferred (110) texture of the Fe lms. Both the XRD and extended X-ray adsorption fine structure (EXAFS) measurements indicate the larger oblique deposition angle (65 deg.) leads to more disorder in the Fe crystalline structure. After capping of the Pd overlayer, the Pd/Fe/Al2O3(0001) still reveals the uniaxial magnetic anisotropy induced by the buried 1-dimensional Fe nanostructures. This uniaxial magnetic anisotropy changes with the variation in Fe thickness and oblique deposition angle. The higher oblique deposition angle results in a larger coercivity, a larger uniaxial MAE, as well as more obvious disordering in the crystalline structure. These results clearly indicate the practicability of manipulating a uniaxial magnetic anisotropy, as well as crystalline order by oblique deposition of magnetic materials. Besides, the hydrogen adsorption in Pd capping layer changes the Kerr signal of the Pd/Fe bilayers. This hydrogen adsorption effect on magneto optical property is shown to be reversible and can be applied in nanotechnology.

Poster 4

Ground state ordering of artificial spin ice

FARHAN, Alan[1]; BALAN, Ana[1]; KLEIBERT, Armin[1]; DERLET, Peter[1]; CHOPDEKAR, Rajesh Vilas; NOLTING, Frithjof[1]; HEYDERMAN, Laura Jane[1]

[1]Paul Scherrer Institut

Abstract:
Artificial spin ice systems, consisting of two-dimensional arrangements of dipolar coupled nanomagnets, allow the detailed investigation of the behaviour of frustrated systems. In particular, using photoemission electron microscopy it is possible to directly observe the moment configurations of such nanomagnet systems. Previous studies have sought to achieve low energy magnetic configurations via demagnetization protocols using a magnetic field [1]. Inspired by the recent work of Morgan et al. [2], we present a ground state magnetic ordering in artificial kagome spin ice nanomagnet arrays, consisting of a finite number of hexagonal rings of nanomagnets. This state nucleates during the early stages of film deposition. In infinite arrays of the artificial kagome spin ice, while a unique ground state is not observed, the ice rule is obeyed at every vertex. Additionally, a strong dependence of the ordering on the film thickness and coupling strength is observed.

References:
[1] E. Mengotti, L.J. Heyderman, A. Fraile Rodriguez, A. Bisig, L. Le Guyader, F. Nolting, and H.B. Braun, Phys. Rev. B 78, 144402 (2008)
[2] J. Morgan, A. Stein, S. Langridge, C.H. Marrows Nature Physics 7, 75-79 (2011)

Poster 5

XRD characterization of nanostructured Al6061 and Al2124 Powders

SAHEB, Nouari[1]

[1]*King fahd University of Petroleum and Minerals*

Abstract:
Al6061 and Al2124 pre-alloyed powders, with particle size ranging between 10-90 microns, were wet ball milled to obtain nanostructured powders. The chemical composition of the powders was determined by x-ray fluorescence (XRF) using a spectrometer machine with Rh tube, operated at a voltage of 30 kV and a current of 1.020 mA. A planetary ball mill (Fritsch Pulverisette P5, Germany) was used. The powders were charged into cylindrical stainless steel vials (250 mL in volume) together with stainless steel balls (10 mm in diameter) and wet milled for deferent times. The wet milling experiments were carried out at room temperature at a speed of 200 rpm in argon atmosphere to prevent the oxidation of the powders. A ball to powder weight ratio of 10:1 was used. Field Emission Scanning Electron Microscope (FESEM) (Tescan Lyra-3, Czech Republic) was used to characterize the milled powders. X-ray diffraction (XRD) measurements were carried out on samples using a Bruker x-ray diffractometer model D8 ADVANCE, with CuK radiation of a wavelength 1.5418 A0. The first four peaks of the XRD pattern were used to determine the crystallite size and lattice strain based on the Williamson-Hall method. It was found that the crystallite size decreased and lattice strain increased with the increase of milling time. The crystallite size was reduced to less than 50 nm in 6 hours of milling. The mechanism of crystallite size reduction was discussed.

Poster 6

Nanoparticles Formation in Si by Zn+ Ion Implantation

PRIVEZENTSEV, Vladimir[1]; KULIKAUSKAS, Vaclav[2]; PETROV, Dmitriy[2];
SHCHERBACHEV, Kirill[3]; LEBEDINSKIY, Yuriy[4]

[1]*Institute of Physics & Technology RAS, Moscow 117218, Russia*
[2]*Skobel'tsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia*
[3]*National University of Science and Technology "MISIS", Moscow 119049, Russia*
[4]*National Research Nuclear University "MIPHI", Moscow 115409, Russia*

Abstract:
Resently the properties of nanoparticles (NPs) in various matrixes are widely investigated because of its possible application in modern electronics devices. Here we present the investigation of NPs formation in Si by Zn implantation and thermal treatment.

The Si substrates were implanted by Zn+ ions with energy 100keV and dose 2E16cm-2. After implantation the samples were subjected to subsequently isochronaly furnace annealing during 1h in inert-oxygen atmosphere from 400 up to 1000°C.

To characterize the NPs formation and phase content the X-ray diffraction (XRD) in grazing mode were made by use D8 DISCOVER (Bruker) diffractometer. The Zn electron state with profile control was detected by X-ray Auger electron spectroscopy (XAES) at XSAM-800 (Kratos) device. The Zn implant profiles were investigated by Rutherford back scattering spectroscopy (RBS) using the ion channeling technique. Surface topography of created samples was studied by scan probe microscopy Solver P47 (NT-MDT) in a atomic force mode (AFM).

On XRD curves have revealed reflexes, connected with metal Zn NPs. In annealed samples the NPs of ZnO, ZnSiO3 and Zn2SiO4 were formed.

The depth XAES profile in annealed samples show existance the Zn electron binding energy variation from oxide Zn state at sample surface to metal Zn state in its body.

From AFM studies have resulted, that after annealing at 700°C on sample surface there were creating of the NPs with size of 10nm order.

Poster 7

Investigating Nanostructures with Scanning Transmission Soft X-ray Spectro-Microscopy

WATTS, Benjamin[1]; RAABE, Joerg[1]

[1]*Paul Scherrer Institut*

Abstract:
Scanning transmission soft x-ray spectro-microscopy (STXM) has been demonstrated to be an excellent tool for the study of a wide range of nanostructured materials due to its high spatial resolution (less than 30 nm) and strong contrast mechanisms based on soft X-ray spectroscopy. In addition to quantitative elemental mapping, STXM can also map molecular composition and oxidation states, based on image contrast achieved through near-edge X-ray absorption fine structure spectroscopy (NEXAFS). More subtle materials properties such as molecular orientation and magnetic domains can also be imaged with the aid of the polarization of the probing X-ray beam.[1]

We will present the basic concepts and operation of the PolLux STXM instrument at the Paul Scherrer Institut, Switzerland, and few examples of its application. Examples will include composition mapping of a thin blend film of conjugated polymers (with application to polymer solar cells and LEDs),[2] molecular orientation mapping in an annealed conjugated polymer film (with application to polymer-based field effect transistors),[2] and magnetic multilayers (with application to data storage technology).[3]

References:
[1] H. Ade and H. Stoll, Nature Materials 2009, 8, 281.
[2] B. Watts, C. R. McNeill and J. Raabe, Synthetic Metals 161 (2012) 2516.
[3] S. Wintz et al., Applied Physics Letters 98 (2011) 232511.

Poster 9

Superconductivity of ultra-thin FeSe1-xTex single crystals obtained by the scotch-tape method

EGUCHI (HORIBA), Ritsuko[1]; SENDA, Megumi[1]; GOTO, Hidenori[1]; KAMBE, Takashi[2]; FUJIWARA, Akihiko[3]; NOJI, Takashi[4]; KOIKE, Yoji[4]; KUBOZONO, Yoshihiro[1]

[1]Research Laboratory for Surface Science, Okayama University
[2]Department of Physics, Okayama University
[3]Japan Synchrotron Radiation Research Institute (JASRI), SPring-8
[4]Department of Applied physics, Tohoku University

Abstract:
Iron-based superconductors have been an attractive subject since the discovery of high-Tc superconductivity in LaFeAsO1-xFx with Tc = 26 K. Tc increases by using small rare-earth atoms and attains a maximum value of Tc = 55 K. They commonly contain anti-PbO-type FeAs layers as superconducting layers in the crystal structure. After that, superconductivity at 8 K has been reported in the anti-PbO-type structure FeSe. With substituting Se for Te, Tc goes up and reaches to 14 K in FeSe0.5Te0.5, and FeTe shows no superconductivity.

We have succeeded in obtaining ultra-thin FeSe1-xTex (x = 1, 0.9) crystals on a SiO2/Si substrate using the scotch-tape method. The thickness of thin crystals is about 50 - 280 nm. The temperature dependence of resistivity and magnetic susceptibility for bulk single crystals show an anomaly around 60 K in FeTe and 40 K in FeSe0.1Te0.9 corresponding to the antiferromagnetic ordering with the tetragonal-monoclinic structural transition and no superconductivity. On the other hand, though the resistivity for ultra-thin FeTe crystals shows same behavior as that for bulk, the resistivity for ultra-thin FeSe0.1Te0.9 crystals shows no anomaly with the structural transition and a sharp superconducting transition at 13 K. The structural transition might be suppressed in ultra-thin single crystals and the superconducting transition occurs. We will discuss the crystal and electronic structures of ultra-thin FeSe1-xTex single crystals.

Poster 10

Methanol decomposition on Pt nanoclusters on a thin film of Al2O3/NiAl(100)

LUO, Meng-fan[1]

[1]*National Central University*

Abstract:
Methanol decomposition on Pt nanoclusters supported on an ordered Al2O3/NiAl(100) thin film was studied with a variety of surface probe techniques. The Pt clusters, grown from vapor deposition, had a mean diameter near 2.2 nm and height near 0.4 nm before cluster coalescence, and were structural ordered — they had a fcc phase and grew with their facets either (111) or (001) parallel to the θ-Al2O3(100) surface, depending on the growth temperature. Adsorbed methanol on the Pt clusters decomposed via two channels: dehydrogenation to CO and C-O bond scission. In the channel of dehydrogenation, adsorbed methanol were dehydrogenated to CO first at low-coordinated Pt sites, at 150 K on Pt(001) clusters and 200 K on Pt(111) clusters, whereas both terrace and low-coordinated Pt sites were reactive toward the dehydrogenation, despite of the cluster size. The produced CO per surface Pt on the clusters are 2 - 6 times more than those on the single crystal counterparts. In addition, the co-adsorbed atomic hydrogen from dehydrogenated methanol can prevent CO from dissociating further to elemental carbon. In the alternative reaction path, the C-O bond scission began about 250 K; the intermediate methyl form methane by combining the atomic hydrogen above 250 K, rather than dehydrogenating to other hydrocarbons. The C-O bond scission exhibited an evident cluster size effect — the probability of C-O bond breaking declined when the cluster size was increased by coalescence.

Poster 11

Development of nano-probe low-temperature cathodoluminescence system and its application to strained piezoelectric nano-rods

WATANABE, Kentaro[1]; VOLK, János[2]; ERDéRYI, Róbert[2]; SEKIGUCHI, Takashi[1]

[1]National Institute for Materials Science
[2]Research Institute for Technical Physics and Material Science

Abstract:
Combination of nano-probing system with low-temperature scanning electron microscope-cathodoluminescence (SEM-CL) system provides various techniques in characterizing nano-materials because nano-prober provides electrical probing, external stress application, and specimen manipulation. When the nano-probe mechanically deformed individual piezoelectric nano-rod, its strain induces not only piezoelectric polarization but also bandgap shift [1,2], which are able to characterize by electrical probing and CL measurements.

Recently, c-axis oriented ZnO nano-rod arrays with various size and area density grown on hetero substrates by low temperature (85 °C) aqueous solution growth were demonstrated [3], which is promising for future piezoelectric device array. However, there exists few reports on piezoelectric properties of individual ZnO nano-rod.[4,5]

We installed nano-probing system into low-temperature (from 8K to room temperature) cathodoluminescence (CL) system. Development of our system and its demonstration will be introduced in this presentation.

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Poster 12

X-ray magnetic circular dichroism on LaNiO3/LaMnO3 superlattices

PIAMONTEZE, Cinthia[1]; HEIDLER, Jakoba[2]; HUANG, Shih-wen[1]; DREISER, Jan[1]; STAUB, Urs[1]; NOLTING, Frithjof[1]; RUSPONI, Stefano[1]; BRUNE, Harald[1]; GIBERT, Marta[2]; ZUBKO, Pablo[2]; SCHERWITZL, Raoul[2]; TRISCONE, Jean-Marc[2]

[1]*Paul Scherrer Institut*
[2]*Département de Physique de la Matière Condensée, University of Geneva*

Abstract:
Transition metal oxides present a range of interesting properties as metal-insulator transitions, superconductivity and colossal magneto-resistance. The fabrication of superlattices composed of such systems has proved to be an interesting route to tailor their properties. Here we present x-ray magnetic circular dichroism measurements in LaNiO3/LaMnO3 superlattices. LaNiO3, is the only member in the nickelate series exhibiting neither magnetic ordering nor metal-insulator transition in bulk. In ultrathin films however it shows a metal-insulator transition and hints of spin fluctuations. When grown in a superlattice sequence with the LaMnO3, interface magnetism develops as evidenced by the unexpected exchange bias effect observed in the LaNiO3/LaMnO3 superlattices (Gibert et al. Nat. Mat. 11, 195 (2012)). Our x-ray absorption spectra point to a mixed valence system Ni2+/3+ and Mn3+/4+, indicating a considerable charge transfer at the interface. Element selective magnetization curves give access to the interfacial magnetism in this system.

Poster 13

Cobalt Clusters in FELICE light: Geometric and Electronic Structure

JALINK, Jeroen[1]; BAKKER, Joost[2]; DIELEMAN, Dennis[1]; RASING, Theo[1]; KIRILYUK, Andrei[1]

[1]Radboud University Nijmegen, Institute for Molecules and Materials
[2]FOM Institute Rijnhuizen

Abstract:
The magnetic properties of transition metal clusters can exhibit strong deviations from the bulk. Cobalt clusters show, for example, an increase in magnetic moment compared to the bulk. Furthermore, a metastable electronic state with reduced magnetic moment is observed. Such trends and individual properties can be explained by Density Functional Theory (DFT) studies. However, a prerequisite to use DFT as an effective tool is experimental data that is directly sensitive to the geometric and electronic structure of the cluster. Up till now, such data remains elusive for neutral cobalt clusters.

We apply an IR-UV spectroscopic technique to probe the ground state structure of isolated neutral cobalt clusters (N=4-15) using the free-electron laser FELICE. When both the IR light is resonant with a vibrational mode and the UV energy approaches the ionization threshold, an enhanced ionization yield is observed. Variation of the IR wavelength produces a vibrational spectrum, whereas the electronic structure near the Fermi level is recorded by varying the UV energy. The experimental IR spectra are compared to calculated DFT spectra using the Generalized Gradient Approximation (GGA) with relativistic corrections. From this we have extracted the ground state structures as well as the corresponding magnetic moments, illustrating a crossover from atomic-like to bulk magnetism. The calculation indicate the presents of a metastable magnetic state in larger clusters.

Poster 14

Flame-made TiO2:Cr and TiO2:Cr/Ag nanoparticles: Correlation of structure, optical properties and photocatalytic activity.

MICHALOW-MAUKE, Katarzyna[1]; OTAL, Eugenio[2]; FORTUNATO, Giuseppino[3]; PARLINSKA-WOJTAN, Magdalena[4]; EMERICH, Herman[5]; GRAULE, Thomas[1]

[1]*Laboratory for High Performance Ceramics, Empa Swiss Federal Laboratories for Material Science and Technology, Switzerland*
[2]*Laboratiry for Solid State Chemistry and Catalysis, Empa Swiss Federal Laboratories for Materials Science and Technology, Switzerland*
[3]*Laboratory for Advanced Fibers, Empa Swiss Federal Laboratories for Materials Science and Technology, St. Gallen, Switzerland*
[4]*1) Electron Microscopy Center, Empa Swiss Federal Laboratories for Materials Science and Technology, 2) Institute of Nanotechnology, University of Rzeszow, Poland*
[5]*SNBL/ESRF, Grenoble, France*

Abstract:
TiO2 is a semiconductor, commonly applied in the photocatalysis field like photocatalytic water and air purification or hydrogen generation. However, due to wide band gap (3.2 eV) TiO2 is not efficient under solar or indoor irradiation. Therefore, it has to be modified. One of the ways is a bulk doping by 3d metal ions and/or surface deposition of noble metals.

The present work reports on the combination of bulk and surface modification of TiO2 nanopowders obtained in a one-step liquid-fed flame spray synthesis (FSS). Cr3+ was chosen as a bulk and Ag as a surface modification aiming at obtaining efficient visible light active photocatalyst. TiO2:Cr particles were 25 nm spheres decorated with 2 nm Ag particles on the surface as observed by STEM. In all cases, anatase was dominating phase and with rising Cr concentration the rutile content increased (XRD). Cr3+ substituted Ti4+ because it had similar environment in TiO2:Cr and TiO2:Cr/Ag to Cr2O3 but the second coordination shell was different (XANES). Both Ag and Cr affected the optical properties of the host material, by reducing the diffuse reflectivity in the visible range. Cr caused a red-shift of the fundamental absorption edge of TiO2. The photocatalytic activity of the nanopowders was evaluated by the degradation of gaseous formaldehyde under visible irradiation. TiO2:Cr/Ag nanopowders showed both enhanced photocatalytic and catalytic properties, where TiO2:2at.%Cr/2at.%Ag was an optimal composition.

Poster 15

X-ray fluorescence holography of In1-xGaxSb mixed crystal

HOSOKAWA, Shinya[1]; OZAKI, Toru[1]; HAPPO, Naohisa[2];
IKEMOTO, Hiroyuki[3]; SHISHIDO, Tohetsu[4]; HAYASHI, Kouichi[4]

[1]*Hiroshima Institute of Technology*
[2]*Hiroshima City University*
[3]*University of Toyama*
[4]*Tohoku University*

Abstract:
In1-xGaxSb mixed crystals are widely used for infrared (IR) telecommunication as raw materials of detecting and emitting IR devices, because the narrow band gap of this system can be controlled simply by the change of the concentration of cations. Due to a large difference of lattice constants of InSb and GaSb crystals, however, it is hard to make a single crystal except in very low In or Ga concentration ranges.

An inconsistency on its structural studies was reported between x-ray diffraction (XD) and extended x-ray absorption fine-structure (XAFS) experiments. The former indicates Vegard's law, i.e., the lattice constant linearly changes with varying the concentration x, while the latter reveals Pauling's bond lengths, i.e., almost constant Ga-Sb or In-Sb interatomic distances are preserved all over the concentration range.

We have measured Ga Ka XFH on In0.995Ga0.005Sb and GaSb for observing 3D atomic images around the Ga atoms. Although the atomic images locate almost on the atomic positions of the InSb crystal, some deviations (the distortion of the lattice) can be observed, in particular for the nearest-neighboring atoms. By comparing the reference GaSb, the image intensities of the first neighboring Sb atoms are extremely weak, while those of further distant Sb atoms recover. In this presentation, we report results of the further detailed analysis, and discuss how the small GaSb4 tetrahedra can be stably located in the InSb lattice with the larger lattice constant.

Poster 16

Improvement of the 3D atomic image reconstruction algorithm for photoelectron holography

MATSUSHITA, Tomohiro[1]; MATSUI, Fumihiko[2]; HAYASHI, Kouichi[3]; DAIMON, Hiroshi[2]

[1]Japan Synchrotron Radiation Research Institute
[2]Nara Institute of Science and Technology
[3]Tohoku University

Abstract:
Atomic resolution holography using photoelectron and Auger electron, and internal-detector electron holography [1] are new powerful methods for the visualization of 3D local atomic structure of crystal surfaces, impurities, thin films, and adsorbates. A key point for realizing such methods is the development of the analysis tools for the hologram reconstruction as well as the measurement control system. We have developed a multiple scattering photoelectron diffraction simulation code: TMSP [2], and a 3D atomic image reconstruction tool based on the our original algorithm: SPEA-MEM [3]. Recently, we improved the algorithm further to reproduce reconstructed atomic images clearer. SPEA-MEM utilized two linear transforms; from the hologram function to the real space function, and from the real space function to the hologram function using the scattering pattern function [2]. However, at the former transform the use of the scattering pattern function generates a broad atomic image, due to the Gaussian-like line shape included in the scattering pattern function, which works as a window function of Fourier transform. We report a new finding of a numerical method to remove the Gaussian-like line shape, which improves the quality of 3D atomic images.

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[2] T. Matsushita, et al., J. Electron. Spectrosc. Relat. Phenom., 178-179, 195 (2010)
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Poster 17

DEVELOPMENT OF MATS COMPOSED BY TiO2 AND CARBON DUAL NANOFIBERS BY ELECTROSPINNING

SANCHEZ-CERVANTES, Eduardo[1]; GARCíA-GóMEZ, Nora[1];
SEPúLVEDA-GUZMáN, Selene[1]; GARCíA-GUTIéRREZ, Domingo[1]

[1]*Universidad Autónoma de Nuevo León*

Abstract:
TiO2/Carbon bicomponent nanofiber mats were prepared simultaneously by electrospinning technique with a side by side spinneret. Crystalline phase of titania/carbon nanofibers were obtained by high temperature calcinations of the polyvinylpirrolidone and polyaniline containing titanium isopropoxide precursor and polyacrilonitrile fibers (TiO2-PVP-PANI/PAN). The morphology and elemental analysis of nanofibers were observed by Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and Energy Dispersion Spectroscopy (EDS). Phase analyses were carried out by Selected Area Electron Diffraction (SAED). The bicomponent nanofiber mats prepared were found to have an average diameter of 110 nm. Both, diameter and roughness of this material were affected by the calcination temperature. TiO2/Carbon nanofibers had a conductivity of 0.4402 S/m +/-0.1518 S/m at room temperature. This very feature makes it attractive to be a material that can be used as an electrode in devices for energy conversion and storage

Poster 19

Synthesis of BiVO4 Hierarchical Photoelectrode by Laser Ablation for Photoelectrochemical Water Splitting

HAN, Hyun Soo[1]; KIM, Ju Sung[1]; PARK, Jong Hoon[1]; SHIN, Sun[1];
CHO, In Sun[2]; NOH, Jun Hong[3]; HONG, Kug Sun[1]

[1]*Department of Materials Science & Engineering, Seoul National University, Seoul, Korea*
[2]*Department of Mechanical Engineering, Stanford University, California 94305, United States*
[3]*Korea Research Institute of Chemical Technology, Daejeon 305-600, South Korea*

Abstract:
Researching photoelectrodes of solar energy conversion devices, large surface area and efficient charge collection ability are key issues for improving the performance of device. Herein, we introduce a novel architecture for water splitting photoanode with large surface area and well linked composed of hierarchical structure of BiVO4 nanoparticles. The BiVO4 hierarchical photoanodes have been directly grown on fluorine-doped tin oxide (FTO) substrates by laser ablation as a function of temperature at oxygen pressure of 300 mTorr. The forestlike architecture composed of individual treelike nanostructures with large surface area has been prepared at room temperature by ablation of BiVO4 target. As the working temperature increases, the porosity of photoelectrode decreases and results in depositing thin film at 500 °C. Photoelectrochemical cell (PEC) performance using BiVO4 photoanode was investigated and discussed based on the changes of morphology of photoelectrode.

Poster 20

On-surface Chemistry explored by Scanning Tunneling Microscopy and Photoelectron Spectroscopy

WäCKERLIN, Christian[1]; FESSER, Petra[2]; IACOVITA, Cristian[3]; SIEWERT, Dorota[1]; VIJAYARAGHAVAN, Saranyan[3]; HOWES, Kara[2]; GISSELBRECHT, Jean-Paul[4]; CROBU, Maura[5]; BOUDON, Corinne[4]; BALLAV, Nirmalya[6]; STöHR, Meike[7]; DIEDERICH, François[2]; JUNG, Thomas A.[1]

[1]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, 5232 Villigen, Switzerland
[2]Laboratorium für Organische Chemie, ETH Zürich, 8093 Zürich, Switzerland
[3]Department of Physics, University of Basel, 4056 Basel, Switzerland
[4]Laboratoire d'Electrochimie et de Chimie Physique du Corps Solide, Université de Strasbourg, France
[5]Department of Materials, ETH Zürich, 8093 Zürich, Switzerland
[6]Department of Chemistry, Indian Institute of Science Education and Research (IISER), India
[7]Zernike Institute for Advanced Materials, University of Groningen, The Netherlands

Abstract:
On surface chemical reactions are of profound importance for the modification of surfaces by adding specific covalent/ionic molecular assemblies. Fast, highly directive reactions with small functional units serving as reactants, so called “click” reactions, are well established in nature’s biochemistry and are particularly useful also to design specific ad-surface molecular layers in subsequent reactions.

Current understanding, however, of chemistry in the solvent-free on-surface environment is just at its start: experience gathered and reaction mechanisms derived for “in-solution” chemistry are not necessarily transferrable to solution-free processes occurring at surfaces. Herein, we discuss the on-surface chemistry of the strong electron acceptor 7,7,8,8-tetracyano-p-quinodimethane (TCNQ) and explore the reaction in two main branches of strong chemical interactions: covalent bonding and charge-transfer. We discuss the cycloaddition of TCNQ to form a covalent bond with an acetylene-appended porphyrin [1] and we demonstrate charge-transfer of TCNQ with NaCl to form a complex ionic compound [2]. Both systems are providing model cases which unravel the complexity in on-surface chemistry and have been explored by the combination of local and spatially averaging techniques, namely scanning tunneling microscopy and X-ray/UV photoelectron spectroscopy.

References:
[1] P. Fesser, et al., Chem. Eur. J. 17, 5246 (2011)
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Poster 21

Highly dispersed nano TiO2 and Clay UP resins with enhanced mechanical properties

ZAMIRIAN, Salma[1]; SOLEIMANI HAMIDY NEZHAD, Peyman[1]

[1]*Islamic Azad University, Iran*

Abstract:
The concept of nanoscale reinforcement provides opportunity for synthesis of polymer materials with unique properties. Behavior of Unsaturated Polyester (UP) and Unsaturated Polyester nanocomposites containing different nanofillers, such as TiO2, nanoclay (Cloisite 30B) were investigated. Samples were prepared with the nano content 0.5, 1, 2, 4 wt % and their mechanical properties such as Tensile Strength, Tensile Modulus and Fracture Toughness have been considered. The fracture toughness of the nanocomposites significantly increased with increasing nanofillers, suggesting a toughening effect from the nanoparticles.

Tensile strength and deflection at break also increased with increasing TiO2 and Clay loading. Nanofillers were dispersed into a UP matrix via blending using a mechanical stirrer.

Transition Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) data and Wide Angle X-Ray Diffraction(WAXD) were in support of the formation of partially delaminated nanocomposite material.

Poster 22

Effect of Processing on Mechanical Properties and Structure Development of Epoxy/SiO2-TiO2 Nanocomposite

ZAMIRIAN, Salma[1]; SOLEIMANI HAMIDY NEZHAD, Peyman[1]

[1]*Islamic Azad University, Iran*

Abstract:
Behavior of epoxy resin (EP) and EP nanocomposites containing different shape nanofillers, such as (SiO2, TiO¬2 and TiO2-SiO2 composites, with ratio 1 to 1 were investigated. This makes it possible to develop novel type of epoxy-based materials with improved wear resistance for various applications. The nanocomposites were processed by shear mixing at different clay concentrations (0.5, 1, 2, 3, 4 and 5 wt %). Differences in the aspect ratio of differences of nanofillers distribution in the epoxy matrix were caused by shear force. X-ray diffraction, transmission electron microscopy (TEM) and scanning electron microscopy (SEM) were utilized to investigate the degree of exfoliation and morphology. The mechanical properties of composites such as impact strength, flexural strength, tensile strength, flexural modulus and deflection at break are also investigated. Tensile strength and Young's modulus also increased with increasing TiO2 and SiO2 loading.

Poster 23

Evaluation of Imidazolium-based Ionic Liquids as Alternative Media for Atmospheric Mercury Capture

IUGA, Cristina[1]; SOLIS, Corina[2]; MARTíNEZ, Miguel Angel[2]; MONDRAGóN, Antonieta[2]

[1]*Universidad Autonoma Metropolitana - Azcapotzalco*
[2]*Universidad Nacional Autónoma de México*

Abstract:
In the present work, the capacity of three different imidazolium-based ionic liquids (IL) for atmospheric mercury capture have been evaluated. The chloride, thiocyanate and hexafluorophosphate salts of the 1-Butyl-3-Methyl-Imidazolium [BMIM] cation have been investigated, using theoretical and experimental methodologies. Theoretical calculations show that [BMIM][SCN] and [BMIM][Cl] efficiently capture gaseous mercury, while [BMIM][PF6] shows the least ability. Since the mercury capture appears to be the result of the formation of a complex involving Hg0 and ions in the IL complex, the high affinity for mercury sequestration of the [BMIM][Cl] salt appears to be related to the large charge-volume ratio of the Cl- anion.

The theoretical results are supported by experimental infrared data. In the case of [BMIM][SCN], after four weeks of Hg0 exposure the hydration of the ionic liquid was made evident by the increase in intensity of the water associated bands. The [BMIM][PF6] infrared spectrum remains unaltered after the four week exposure to mercury.

Poster 25

On the Indigo Carmin Photocatalytic Degradation Mechanism in Water; A Combined Theoretical and Experimental Study

IUGA, Cristina[1]; SOLIS CORREA, Hugo[2]; ORTIZ, Elba[2]

[1]*Universidad Autonoma Metropolitana - Azcapotzalco*
[2]*Autonoma Metropolitana - Azcapotzalco*

Abstract:
Dyes are found as common contaminants of the aquatic environment. In particular, the colored industrial wastewaters are a dramatic source of esthetic pollution and perturbation of the aquatic life. To avoid the accumulation of dyes in the aquatic environment, research efforts are underway to develop powerful oxidation techniques for their removal in industrial wastewaters.

Most dyes are toxic and recalcitrant to biodegradation. Various chemical and physical processes are currently used, based on direct precipitation and separation of pollutants , or elimination by adsorption on activated carbon or similar materials. However, in this case the problem is only displaced, and further treatments are needed in order to separate the purified effluents or to regenerate the adsorbents; and therefore, new and different pollution risks are faced. Alternatively, a photochemical approach has been adopted, based on ultraviolet irradiation combined or not with oxidative agents such as ozone or hydrogen peroxide, which leads to a complete destruction of the pollutants. The presence of intermediates arising from the photodegradation reaction could be more harmful than the pollutant itself. This inconvenience can be avoided by using the photocatalytic degradation. In this process, hydroxyl radicals (•OH) are generated when the photocatalyst is illuminated in the presence of water and air. , These ultra reactive species are able to achieve a complete mineralization of organic pol

Poster 26

Aluminosilicate microspheres surface reactivity in aqueous media

TODEA, Milica[1]; FRENTIU, Bogdan[1]; SIMON, Simion[1]; MARCU, Teodora[2]; POPA, Catalin[2]

[1]Faculty of Physics & Institute of Interdisciplinary Research in Bio-Nano-Sciences, Babes Bolyai University, M. Kogalniceanu no.1, 400084, Cluj-Napoca, Romania
[2]Technical University of Cluj-Napoca, Faculty of Materials and Environmental Engineering, Department of Materials Science and Technology, Muncii Avenue 103-105, 400641 Cluj-Napoca, Romania

Abstract:
The study aims at the manufacture and investigation of biodegradable aluminosilicate materials incorporated with yttrium potentially useful for biomedical application. The spherical shapes of the particles were obtained by spray drying method. The local structure of the samples due to their composition and the effect of aluminum and yttrium on the biodegradability process were evaluated by Fourier Transform Infrared (FT-IR) spectroscopy and X-ray photoelectron spectroscopy (XPS). Aluminosilicate microspheres bioactivity was investigated under in vitro conditions using simulated body fluid (SBF) for seven days. By partial substitution of Al2O3 with Y2O3, from XPS spectra an increase in covalency for silicon and aluminum atoms was observed. Therefore silicon and aluminum ions act as network former while yttrium acts as network modifier. The interaction with SBF led to the dissolution, network fragmentation and afterwards to the development on the microsphere surfaces of a nanostructurated layer by self assembly of ions from SBF solution [1-3]. This layer is better evidenced for the sample with yttrium pointing out that the surface composition definitely influences the reaction with aqueous media. The results indicate that the addition of yttrium to aluminosilicate microspheres influence the surface properties which therefore, induced a different behaviour of the samples in simulated body environments.

Poster 27

Luminescence-based scanning transmission x-ray microscopy

VAZ, Carlos[1]; MOUTAFIS, Christoforos[1]; QUITMANN, Christoph[1]; RAABE, Jörg[1]

[1]*Paul Scherrer Institut*

Abstract:
We demonstrate in this paper a new development in scanning transmission x-ray microscopy (STXM) whereby the absorption spectrum of a thin film system is measured through the x-ray induced optical luminescence from the substrate. We exemplify the potential of this method by imaging the magnetic domain configuration of cobalt thin film elements fabricated on MgO(001) single crystals. This method enables the measurement of the electronic and magnetic spectroscopic properties of single crystalline layers and buried heterostructures with nanometer lateral resolution and elemental sensitivity and opens scanning transmission x-ray microscopy to materials which cannot be grown on membranes or as freestanding thin films.

Poster 28

Polarization Selection Rule for Surface Enhanced Raman Scattering from Anisotropic Microstructured Surfaces

PAL, Anirban[1]

[1]*Tata institute of Fundamental Research, India*

Abstract:
We have made a detailed study of the polarization dependence of different classes of surface enhanced Raman scattering (SERS) modes from samples with varying degrees of local structural anisotropy. Such locally ordered regions are often observed in aggregated and self-assembled micro structures. The vibrational modes of the SERS probe molecules are sensitive to locally anisotropic structures. The analysis of the scattering profile of the individual vibrational normal modes of probe molecules gives us information about the local structural anisotropy as well as information regarding the interaction of the modes with the anisotropic structures. As a model system, we have used clustered metal nanorod arrays, in which the degree of anisotropy can be controlled by varying the size and shape of the nanorod clusters. We have studied the polarization anisotropy for the different vibrational modes of pyridine, used as a SERS probe. Our experiments indicate that the polarization dependence of SERS can be used as a quantitative measure of local topological anisotropies. More importantly, we also suggest a selection rule that lets us choose the appropriate modes that are expected to yield maximum polarization anisotropy.

Poster 29

Magnetisation Dynamics Studied with Scanning Transmission X-ray Microscopy

STEVENSON, Stephanie[1]; MOUTAFIS, Christoforos[1]; CHOPDEKAR, Rajesh[1]; HELDT, Georg[1]; HEYDERMAN, Laura[1]; QUITMANN, Christoph[1]; RAABE, Joerg[1]

[1]*Paul Scherrer Institut*

Abstract:
We report on the controlled break-up of the ground state domain pattern in Ni81Fe19 square islands due to high power RF excitation.

The magnetic domain pattern is imaged by scanning transmission X-ray microscopy (STXM) at the PolLux beamline of the Swiss Light Source. The STXM is equipped with a time-resolved detection setup utilizing an avalanche photodiode acting as a single photon X-ray detector. It allows time-resolved data acquisition with up to 1000 channels in time. Flexible excitation schemes can be produced with our recently installed arbitrary waveform generator (AWG), an example being sinusoidal continuouswave (CW) background with a superimposed single-period burst of higher amplitude to induce magnetisation switching. The AWG has a maximum output frequency of 4.8 GHz with a maximum sampling rate of 12 GS/s, providing a good match for typical excitation frequencies in our samples (~250 MHz).

Micrometer-scale magnetic Ni81Fe19 structures are lithographically prepared on Si3N4 membranes beneath a Cu stripline. For low amplitude (H0 ~1 mT) sinusoidal CW field we observe an amplitude of the domain motion which is linear in H0. For high amplitudes (> 2-3 mT), a breakup of the domain configuration into a complex metastable state occurs. This metastable state returns to the ground state when the excitation is removed. Micromagnetic simulations and experiment agree that the domain breakup nucleates from a high amplitude motion of the domain walls.

Poster 30

Production And Characterisation Of Activated Carbon And Nylon-6 Composite Ultrafine nano Fibrous structures

VADODARIA, Ketankumar[1]; STYLIOS, George[1]

[1]RIFLEX (The Research Institute for Flexible Materials), School of Textiles and Design, Heriot-watt University, Galashiels, U.K., TD1 3HF

Abstract:
Activated carbon (AC) powder was blended with nylon in formic acid. Composite nano fibres from AC/Nylon blend were electrospun successfully. Various parameters like AC/Nylon ratio, applied voltage, needle to collector distance and feed rate have been investigated to establish the effect of processing parameters on fibre morphology and property.

The FE-SEM images of electrospun fibre morphology showed various nano structures / shapes like; nano springs, nano '8' shapes, nano sinusoidal shapes, nano coils and nano zigzag shapes etc were observed. The results and production of these nano structures / shapes are discussed in this present paper. These shapes have been possible due to instabilities of the fibre jet during processing. AC/Nylon electrospun fibres were also examined for thermal behaviour in DSC, for carbon content by EDX and tensile strength. The EDX results showed clear peak of carbon.
In future (assuming ability of separation from nanomat and collection) these engineered shaped fibres may be potentially used for designing nano-machines contributing to nanoengineering and energy harvesting.

Poster 31

An instrument for tomographic X-ray nano imaging

HOLLER, Mirko[1]; RAABE, Jörg[1]; DIAZ, Ana[1]; GUIZAR-SICAIROS, Manuel[1]; QUITMANN, Christoph[1]; MENZEL, Andreas[1]; BUNK, Oliver[1]

[1]*Paul Scherrer Institut*

Abstract:
OMNY is an instrumention project under way at the Swiss Light Source aiming for 3D nanometric X-ray imaging. It uses scanning X-ray diffraction microscopy to obtain projections of a sample and tomography to access 3D information. In the final implementation it will be used to image biomaterial, materials science and physics samples in vacuum and at cryogenic temperatures.

We demonstrate the performance of a test-setup by imaging test structures at the cSAXS beamline in air at room temperature. The setup provides a stability between the sample and a beam defining pinhole of less than 10 nm. This position is measured and stabilized by laser interferometry. In 2D a resolution of 18 nm was achieved on a lithographic test pattern while the illuminating beam was approximately 3 microns in diameter. A resolution of 53 nm was achieved in a tomogram with dimensions of 9x9x5 microns^3 of an integrated circuit. Strategies to further improve the resolution are currently being implemented.

Poster 32

Polish PEEM at Swiss Light Source

SLEZAK,Michal[1] ; GIELA, Tomasz[2] ; WILGOCKA-SLEZAK, Dorota[2] ; KOZIOl-RACHWAl, Anna[3] ; SPIRIDIS, Nika[2] ; SLEZAK, Tomasz[1] ; MIYNCZAK, Ewa[2] ; ZAJaC, Marcin[4] ; CHROBAK, Maciej[1] ; CZAPKIEWICZ, Maciej[5] ; DOBRZAnSKI, Michal[1] ; KOIODZIEJ, Tomasz[1] ; KOZIOWSKI, Andrzej[1] ; WOJTYNIAK, Marcin[6] ; ZDYB, Ryszard[7] ; NOLTING, Frithjof[8] ; KLEIBERT, Armin[8] ; PILET, Nicolas[8] ; RAABE, Joerg[8] ; SARAFIMOV, Blagoj[8] ; QUITMANN, Christoph[8] ; KORECKI, Józef[2]

[1]Faculty of Physics and Applied Computer Science, AGH, Kraków, Poland
[2]Jerzy Haber Institute of Catalysis and Surface Chemistry, PAN, Kraków, Poland
[3]Faculty of Physics and Applied Computer Science, AGH, Kraków,Poland
[4]National SynchrotronRadiation Centre SOLARIS Jagiellonian University, Kraków, Poland
[5]Department of Electronics, AGH University of Science andTechnology, Kraków, Poland
[6]A. Chelkowski Institute of Physics, University of Silesia, Katowice, Poland
[7]Institute ofPhysics, Maria Curie-Sklodowska University, 20-031 Lublin, Poland
[8]SwissLight Source, Paul Scherrer Institut, 5232 Villigen-PSI, Switzerland

Abstract:

A PEEM III microscope with the energy analyzer from Elmitec, intended for the Polish synchrotron source SOLARIS, was successfully installed and tested for several weeks at the NanoXAS beamline (SLS) in cooperation between PSI and several Polish Laboratories. The microscope is equipped with a preparation chamber enabling in situ MBE growth of metal and oxide films. Despite the fact that the NanoXAS beamline doesn't perfectly fit to PEEM measurements, most of the X-PEEM features could be tested and verified, including chemical and magnetic sensitivity given by XAS, XPS, XMCD and XMLD methods combined with the high spatial resolution and the real time imaging. During five weeks long beamtime a wide range of materials, including bulk crystal surfaces, ultrathin films and self-organized as well as patterned nanostructures was studied.

I will present the exemplary results concerning magnetic phase transitions in bulk Fe3O4, magnetic domain structures in self-organized Fe islands on W(110) and during SRT in thin Fe films on W(110). Application of combined magnetic and chemical sensitivity of the X-PEEM technique will be shown for the case of Fe/NiO and Fe/CoO bi- and tri-layers grown on W(110). Some technical limitations and problems that were met during tests will be also concluded.

This work was supported in part by the SPINLAB project financed by the EU European Regional Development Fund and by the Team Program of the Foundation for Polish Science co-financed by the EU ERDF.

Author Index

HAN, Hyun Soo	Poster 19
HAPPO, Naohisa	Poster 15
HAYASHI, Kouichi	Poster 15 Poster 16 Wed_A2
HEIDLER, Jakoba	Tue_C2 Poster 12
HELDT, Georg	Poster 29
HELLWIG, Olav	Thu_B1
HEUN, Stefan	Thu_C2
HEYDERMAN, Laura	Poster 04 Poster 29
HO, Yen-hung	Wed_C3
HOLLER, Mirko	Poster 31
HONG, Kug Sun	Poster 19
HORIBA, Koji	Thu_D1
HOSOKAWA, Shinya	Poster 15
HOWES, Kara	Poster 20
HUANG, Shih-wen	Poster 12
HUG, Hans J.	Thu_D4
IACOVITA, Cristian	Tue_C1 Poster 20
IKEMOTO, Hiroyuki	Poster 15
IUGA, Cristina	Poster 23 Poster 25
JABBARI, E.	Poster 02
JALINK, Jeroen	Tue_A3 Poster 13
JEFIMOVS, Konstantins	Wed_D2
JUNG, Thomas A.	Tue_C1 Tue_C2 Tue_C3 Poster 20
KAFI, A.k.m.	Wed_B3
KAMBE, Takashi	Poster 09
KATSNELSON, Mikhail	Tue_A3
KAULICH, Burkhard	Wed_B2
KAWANO, Kenji	Thu_D3
KAZEMIAN ABYANEH, Majid	Wed_B2 Thu_D2
KAZNACHEEV, Konstantine	Thu_A3
KILCOYNE, David	Thu_A3
KIM, Ju Sung	Poster 19
KINOSHITA, Toyohiko	Thu_B3 Thu_D3
KIRILYUK, Andrei	Tue_A3 Poster 13
KISIEL, Marcin	Thu_C3
KISKINOVA, Maya	Wed_B2
KLEIBERT, Armin	Thu_B2 Poster 04 Poster 32
KOESTER, Sigrun A.	Tue_B2
KOIKE, Yoji	Poster 09
KOIODZIEJ, Tomasz	Poster 32
KORECKI, Józef	Poster 32
KOTSUGI, Masato	Thu_B3 Thu_D3
KOZIOI-RACHWAI, Anna	Poster 32
KOZIOWSKI, Andrzej	Poster 32
KRöMKER, Burkhard	Wed_C2
KUBOZONO, Yoshihiro	Poster 09
KULIKAUSKAS, Vaclav	Poster 06
KUMIGASHIRA, Hiroshi	Thu_D1
KUO, Chien-cheng	Wed_C3
LANGER, Markus	Thu_C3
LEBEDINSKIY, Yuriy	Poster 06
LI BASSI, Andrea	Tue_B3
LIN, Wen-chin	Poster 03
LIU, Yijin	Thu_A1
LOBO CHECA, Jorge	Tue_C1
LUO, Meng-fan	Poster 10
MAIA, Filipe	Thu_A3
MARCHISINI, Stefano	Thu_A3
MARCU, Teodora	Poster 26
MARTENS, Susanne	Tue_C3
MARTíNEZ, Miguel Angel	Poster 23
MARTINEZ-CRIADO, Gema	Thu_A2
MATENA, Manfred	Tue_C3
MATSUI, Fumihiko	Wed_C4 Poster 16
MATSUSHITA, Tomohiro	Wed_A2 Wed_C4 Thu_B3 Poster 16
MCNEILL, Christopher	Wed_B1
MEIJER, Gerard	Tue_A3
MEIRER, Florian	Thu_A1
MELE, Claudio	Wed_B2
MENZEL, Andreas	Poster 31
MEYER, Ernst	Thu_C3
MICHALOW-MAUKE, Katarzyna	Poster 14
MIYnCZAK, Ewa	Poster 32
MOHAJERI, S.	Poster 02
MONDRAGóN, Antonieta	Poster 23
MONTAGNE, Franck	Fri_A2
MOUTAFIS, Christoforos	Poster 27 Poster 29
MURO, Takayuki	Thu_B3 Thu_D3
NAGAMURA, Naoka	Thu_D1
NAKAMURA, Tetsuya	Thu_B3
NASI, Lucia	Tue_B1
NELSON, Johanna	Thu_A1

NOH, Jun Hong	Poster 19
NOJI, Takashi	Poster 09
NOLTING, Frithjof	Tue_C2 Thu_B2 Poster 04 Poster 12 Poster 32
NOWAK, Ulrich	Thu_B2
NOZAKI, Yukio	Thu_B3
OHKOCHI, Takuo	Thu_D3
OHKOUCHI, Takuo	Thu_B3
OKUDA, Taichi	Thu_B3
ONO, Teruo	Thu_D3
ORTIZ, Elba	Poster 25
OSAWA, Hitoshi	Thu_B3
OSHIMA, Masaharu	Thu_D1
OSTERWALDER, Jürg	Wed_C4
OTAL, Eugenio	Poster 14
OURA, Masaki	Thu_D3
OZAKI, Toru	Poster 15
PAL, Anirban	Poster 28
PARADISO, Nicola	Thu_C2
PARK, Jong Hoon	Poster 19
PARLINSKA-WOJTAN, Magdalena	Poster 14
PASSONI, Matteo	Tue_B3
PATTHEY, François	Wed_C1
PEDERSEN, Kasper S.	Tue_C2
PETERS, Lars	Tue_A3
PETROV, Dmitriy	Poster 06
PFEIFFER, Loren N.	Thu_C2
PIAMONTEZE, Cinthia	Tue_C2 Poster 12
PIANETTA, Piero	Thu_A1
PILET, Nicolas	Thu_D4 Poster 32
POPA, Catalin	Poster 26
PRIVEZENTSEV, Vladimir	Poster 06
QUITMANN, Christoph	Thu_D4 Poster 27 Poster 29 Poster 31 Poster 32
RAABE, Joerg	Thu_D4 Poster 07 Poster 27 Poster 29 Poster 31 Poster 32
RASING, Theo	Poster 13
RENNER, Christoph	Tue_B2
RODDARO, Stefano	Thu_C2
ROTH, Silvan	Wed_C4
RUSPONI, Stefano	Tue_C2 Poster 12
SAHEB, Nouari	Poster 05
SANCHEZ-CERVANTES, Eduardo	Poster 17
SANDOGHDAR Vahid	Wed_D1
SANYAL, Biplab	Tue_A3
SARAFIMOV, Blagoj	Poster 32
SCHERWITZL, Raoul	Poster 12
SCHIRMEISEN, Andre	Thu_C1
SCHOLDER, Olivier	Wed_D2
SEKIGUCHI, Takashi	Poster 11
SENDA, Megumi	Poster 09
SENNHAUSER, Urs	Wed_D2
SEPúLVEDA-GUZMáN, Selene	Poster 17
SHAPIRO, David	Thu_A3
SHCHERBACHEV, Kirill	Poster 06
SHIGEKAWA, Hidemi	Fri_B2
SHIN, Sun	Poster 19
SHINOHARA, Toshihiro	Thu_D1
SHISHIDO, Tohetsu	Poster 15
SHORUBALKO, Ivan	Wed_D2
SIEWERT, Dorota	Poster 20
SIMON, Simion	Poster 26
SLEZAK, Michal	Poster 32
SLEZAK, Tomasz	Poster 32
SOLEIMANI HAMIDY NEZHAD, Peyman	Poster 21 Poster 22
SOLIS CORREA, Hugo	Poster 25
SOLIS, Corina	Poster 23
SORBA, Lucia	Thu_C2
SPIRIDIS, Nika	Poster 32
STAUB, Urs	Poster 12
STEVENSON, Stephanie	Poster 29
STöHR, Meike	Tue_C1 Tue_C3 Poster 20
STYLIOS, George	Poster 30
TODEA, Milica	Poster 26
TOYODA, Satoshi	Thu_D1
TRISCONE, Jean-Marc	Poster 12
TYLISZCZAK, Tolek	Thu_A3
UESAKA, Akio	Wed_A2
VADODARIA, Ketankumar	Poster 30
VAN DIJK, Chris	Tue_A3
VAZ, Carlos	Poster 27
VERBEECK, Johan	Wed_A1
VIJAYARAGHAVAN, Saranyan	Poster 20

VOLK, János	Poster 11
WAECKERLIN, Christian	Tue_C2 Poster 20
WANG, Bo-yao	Poster 03
WATANABE, Kentaro	Poster 11
WATANABE, Yoshio	Thu_D3
WATTS, Benjamin	Poster 07
WEST, Ken W.	Thu_C2
WIEBE, Jens	Tue_A2
WILGOCKA-SLeZAK, Dorota	Poster 32
WINKLER, Konrad	Wed_C2
WOJTYNIAK, Marcin	Poster 32
WU, Shih-yu	Wed_C3
WU, Tsung-hsuan	Wed_C3
YAMADA, Keisuke	Thu_D3
YAMAGUCHI, Akinobu	Thu_B3
YAMAMOTO, Naoki	Wed_A3
YANES -DIAZ, Rocio	Thu_B2
ZAJAC, Marcin	Poster 32
ZAMIRIAN, Salma	Poster 21 Poster 22
ZDYB, Ryszard	Poster 32
ZUBKO, Pablo	Poster 12

List of participants

Name	Institution	e-mail
AHMED ALI, Fekri Abdulraqeb	King Saud University, SAUDI ARABIA	falhulidy@ksu.edu.sa
AKINGBILE, ADEKUNLE JOSEPH	FUFILLMENT EDUCATIONAL CONSULTANT, NIGERIA	fufillmentconsultant@gmail.com
ALAVI NIGJEH, MIR MOHAMMAD	IMAM KHOMEINI INTERNATIONAL UNIVERSITY, IRAN	drmm.alavi@gmail.com
AVETISYAN, Lilit	Synopsys Armenia-company, ARMENIA	avet_lilit@yahoo.com
BARADARAN MOHAJERI, Soha	Sharif University of Technology, IRAN	soha_posh@yahoo.com
BIANCO, François	University of Geneva, SWITZERLAND	francois.bianco@unige.ch
BLUM, Monika	SPECS Surface Nano Analysis GmbH, GERMANY	monika.blum@specs.com
BOJKO, Alexandre	CSEM/EPFL, SWITZERLAND	alexandre.bojko@csem.ch
BYTYQI, Arsim	Store Steel Company, SLOVENIA	arsim.bytyqi@hotmail.com
CARROZZO, Paolo	Politecnico di Milano - Department of Energy, ITALY	paolo.carrozzo@mail.polimi.it
CHU, Ming-Wen	National Taiwan University, TAIWAN	chumingwen@ntu.edu.tw
DESPONT, Michel	IBM Research - Zurich, SWITZERLAND	dpt@zurcih.ibm.com
DONATI, Fabio	EPFL, SWITZERLAND	fabio.donati@epfl.ch
DREISER, Jan	Swiss Light Source, Paul Scherrer Institut, SWITZERLAND	jan.dreiser@psi.ch
DUERIG, Urs	IBM Research - Zurich, SWITZERLAND	drg@zurich.ibm.com
EGUCHI (HORIBA), Ritsuko	Okayama University, JAPAN	eguchi-r@cc.okayama-u.ac.jp
EL MOUSSAOUI, Souliman	Paul Scherrer Institut, SWITZERLAND	souliman.el-moussaoui@psi.ch
FARDINDOOST, Somayeh	Sharif University of Technology, IRAN	somayyefardin@yahoo.com
FARHAN, Alan	Paul Scherrer Institut, SWITZERLAND	alan.farhan@psi.ch
GOBRECHT, Jens	Paul Scherrer Inst., SWITZERLAND	jens.gobrecht@psi.ch
GREGORATTI, Luca	Sincrotrone Trieste SCpA, ITALY	luca.gregoratti@elettra.trieste.it
GUENTHER, Steffen	Reishauer AG, SWITZERLAND	Steffen.Guenther@reishauer.com
HAN, Hyun Soo	Department of Materials Science & Engineering, Seoul National University, REPUBLIC OF KOREA	erichan@snu.ac.kr
HARTMANN, Elmar	JPK Instruments AG, GERMANY	cl.boettcher@jpk.com
HAYASHI, Kouichi	Institute for Materials Research, Tohoku University, JAPAN	khayashi@imr.tohoku.ac.jp
HEER, Charlotte	Paul Scherrer Institut, SWITZERLAND	charlotte.heer@psi.ch

Name	Institution	e-mail
HELLWIG, Olav	HGST, a Western Digital Company, UNITED STATES OF AMERICA	olav.hellwig@hgst.com
HEUN, Stefan	NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, ITALY	stefan.heun@nano.cnr.it
HOLLER, Mirko	Paul Scherrer Institut, SWITZERLAND	mirko.holler@psi.ch
HORIBA, Koji	The University of Tokyo, JAPAN	horiba@sr.t.u-tokyo.ac.jp
INAN, hakan	Gediz Univesity, TURKEY	hakan_inan@hotmail.com
IUGA, Cristina	Universidad Autonoma Metropolitana - Azcapotzalco, MEXICO	ciuga@xanum.uam.mx
JALINK, Jeroen	Radbound University Nijmegen, NETHERLANDS	jjalink@science.ru.nl
JUNG, Thomas	Paul Scherrer Institute, SWITZERLAND	thomas.jung@psi.ch
KAFI, A.K.M..	The University of Sydney, BANGLADESH	kafiakm@chem.usyd.edu.au
KAZEMIAN ABYANEH, Majid	Sincrotrone Trieste ScPA, SS-14, 163.5KM, Basovizza, Trieste-34149, Italy, ITALY	majid.kazemian@elettra.trieste.it
KINOSHITA, Toyohiko	Japan Synchrotron Radiation Research Institute, SPring-8, JAPAN	toyohiko@spring8.or.jp
KIRILYUK, Andrei	Radboud University Nijmegen, NETHERLANDS	a.kirilyuk@science.ru.nl
KISIEL, Marcin	University of Basel, SWITZERLAND	marcin.kisiel@unibas.ch
KLEIBERT, Armin	Swiss Light Source, Paul Scherrer Institut, SWITZERLAND	armin.kleibert@psi.ch
KOMLOSH, Arthur	Teva, ISRAEL	akomlosh@teva.co.il
KUO, Chien-Cheng	Department of Physics, National Sun Yat-sen University, TAIWAN	jcckuo@gmail.com
LIN, Wen-Chin	Department of Physics, National Taiwan Normal University, TAIWAN	wclin@ntnu.edu.tw
LUO, Meng-Fan	National Central University, TAIWAN	mfl28@phy.ncu.edu.tw
MAHAMED, Mohamed Abdi	GRDA, ETHIOPIA	xaadle@hotmail.com
MAIER, Urs	Ferrovac, SWITZERLAND	sales@ferrovac.com
MARTENS, Susanne	Institute of Physics, University of Basel, SWITZERLAND	susanne.martens@unibas.ch
MARTINEZ-CRIADO, Gema	ESRF, FRANCE	gmartine@esrf.fr
MATSUI, Fumihiko	Nara Institute of Science and Technology, JAPAN	matui@ms.naist.jp
MATSUSHITA, Tomohiro	Japan Synchrotron Radiation Research Institute, JAPAN	matusita@spring8.or.jp
MCNEILL, Christopher	Monash University, AUSTRALIA	christopher.mcneill@monash.edu
MICHALOW-MAUKE, Katarzyna	Empa, Lab. for High Performance Ceramics, SWITZERLAND	katarzyna.michalow@empa.ch
MOROZOV, Yurii	Taras Shevchenko National University of Kyiv, UKRAINE	yurmor@gmail.com
MOUKAPIR, AMINE	Faculté des sciences ben M'sik, Université HASSAN II, mohammedia, MOROCCO	amine.moukapir@gmail.com

Name	Institution	e-mail
Mrs. KHALAJ, Zahra	Plasma Physics Research Center, Science and Research Branch, Islamic Azad University,Tehran,Iran.P.O.Box:14665/678, IRAN	khalaj.z@gmail.com
NASI, Lucia	CNR-IMEM, ITALY	nasi@imem.cnr.it
NOLTING, Frithjof	Paul Scherrer Institut, SWITZERLAND	frithjof.nolting@psi.ch
OHKOCHI, Takuo	JASRI/SPring-8, JAPAN	o-taku@spring8.or.jp
OLUWASEUN AKINTUNDE, Adeyemo	TOLTIM ELECTRICAL ENGINEERING, SOUTH AFRICA	danerdely@gmail.com
PAL, Anirban	Tata institute of Fundamental Research, INDIA	tifr.anirban@gmail.com
PIAMONTEZE, Cinthia	Paul Scherrer Institut, SWITZERLAND	cinthia.piamonteze@psi.ch
PIANETTA, Piero	SLAC/SSRL, UNITED STATES OF AMERICA	pianetta@stanford.edu
PILET, Nicolas	Paul Scherrer Institut, SWITZERLAND	nicolas.pilet@psi.ch
QUITMANN, Christoph	Paul Scherrer Institut, SWITZERLAND	christoph.quitmann@psi.ch
RAABE, Jörg	Paul Scherrer Institut, SWITZERLAND	joerg.raabe@psi.ch
RAMZAN, Muhammad	University of Agriculture, PAKISTAN	ramzanone@yahoo.com
REBER, Sonia	Paul Scherrer Institut, SWITZERLAND	sonia.reber@psi.ch
SAHEB, Nouari	King fahd University of Petroleum and Minerals, SAUDI ARABIA	nouari@kfupm.edu.sa
SANDOGHDAR, Vahid	Max Planck Institute for the Science of Light, GERMANY	irene.weinzierl@mpl.mpg.de
SCHIRMEISEN, Andre	University of Giessen, GERMANY	schirmeisen@uni-giessen.de
SCHNEIDER, Michael	Technische Universität Berlin, GERMANY	mschneid@physik.tu-berlin.de
SCHOLDER, Olivier	EMPA, SWITZERLAND	olivier.scholder@empa.ch
SHIGEKAWA, Hidemi	University of Tsukuba, JAPAN	hidemi@ims.tsukuba.ac.jp
SHOKUHI RAD, Ali	Qaemshahr Branch, Islamic Azad University, IRAN	a.shokuhi@gmail.com
SINGER, Lea	MOD, ISRAEL	lea.singer@gmail.ccom
SLEZAK, Michal	University of Science and Technology, POLAND	mislezak@agh.edu.pl
SUNKIREDDY, Pavan	The Energy and Resources Institute, INDIA	pavansunkireddy@gmail.com
U, Satheesh	Bharathiar Univesity, INDIA	satheesh_us@yahoo.com
VAN DER VEEN, J. Friso	Paul Scherrer Institut, SWITZERLAND	friso.vanderveen@psi.ch
VAZ, Carlos	Paul Scherrer Institut, SWITZERLAND	carlos.vaz@psi.ch
VERBEECK, Johan	EMAT, University of Antwerp, BELGIUM	jo.verbeeck@ua.ac.be
VERMA, Ranjana	Tezpur University, INDIA	ranjanaverma700@gmail.com
WäCKERLIN, Christian	Paul Scherrer Institut, SWITZERLAND	christian.waeckerlin@psi.ch
WATANABE, Kentaro	National Institutes for Materials Science, JAPAN	WATANABE.Kentaro@nims.go.jp
WATANABE, Yoshio	Keio University/JST-ERATO, JAPAN	

Name	Institution	e-mail
WATTS, Benjamin	Paul Scherrer Institut, SWITZERLAND	benjamin.watts@psi.ch
WIEBE, Jens	Institute of Applied Physics, Hamburg University, GERMANY	jwiebe@physnet.uni-hamburg.de
WINKLER, Konrad	Omicron NanoTechnology, GERMANY	k.winkler@omicron.de
YAMAMOTO, Naoki	Tokyo Institute of Technology, JAPAN	nyamamot@phys.titech.ac.jp
ZAMIRIAN, Salma	Islamic Azad University, IRAN	zamirian2008@gmail.com

Zürich and Site Information

Transportation in Zürich

From Zürich Airport to Zürich (main station)

(Information about the airport: www.Zürich-airport.com)

After reclaiming baggage, follow the signs "Bahn/Railway" to ticket counters and machines.
There are English instructions on the machine; follow them or simply press the left (red) key at the bottom where it says "Zürich City". The machine accepts coins as well as banknotes and gives change. The machines with interactive screens also accept major credit cards.
The ticket is valid during the next 2 hours for any train to Zürich as well as for the trams and buses in the city (streetcar, Strassenbahn). Take an escalator down to the platforms 3 or 4.
Trains to city centre leave approximately every 10 minutes and take about 10 minutes to reach main station (main station : Zürich HB).

From main station to ETH

(Information about the railway station: http://mct.sbb.ch/mct/en)

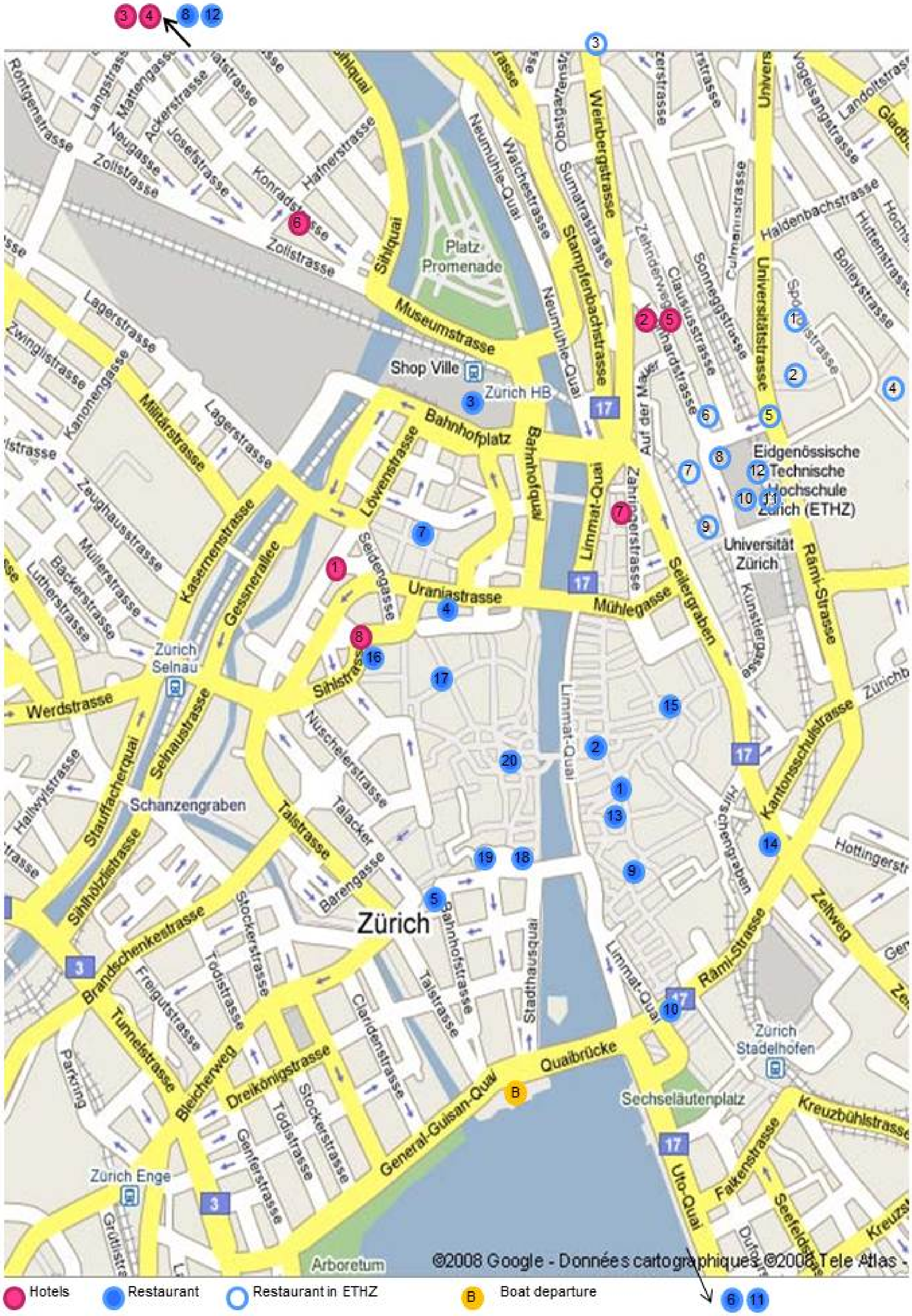
At the main station walk to the head of the train and follow any signs to "Bahnhofstrasse". Once outside the station walk about 50 meters up the street (Bahnhofstrasse) to the tram stop on the left-hand side.
If you haven't yet got a tram ticket (the ticket from the airport is still valid!), you must now buy one from the blue ticket machine. Press the yellow button to get a ticket (2,60 CHF) which is valid during one hour and in the centre (zone 10).
In six minutes with tram no. 6 (direction Zoo) from main station (Bahnhofstrasse) or with tram no. 10 (direction Seebach) from main station (Bahnhofplatz) to the stop ETH / Universitätsspital (the 3rd stop).
You are now standing exactly opposite the main building of ETH Zürich; as you enter the building you will see an information desk in the main hall on your right. (see www.ethz.ch)
In three minutes with tram n° 3 from main station (Bahnhofplatz) you reach the stop Central (1 stop); take the Polybahn (leaves every three minutes) up to the Polyterrasse.

In Zürich and Switzerland

Maps, timetables and prices for public transportation in Zürich are available on www.zvv.ch
"Zürich rollt" (http://zuerirollt.ch) rent a bike for free in the city. You will find it on the Velogate Hauptbahnhof (main train station), in front of the store Globus and at the Opera house.
The most convenient way to travel in Switzerland is to use public transportation. Trains, buses, trams, boats bring you to every town and village and also in the countryside and mountains. They are frequent, on time and comfortable.
The web-site www.sbb.ch (in English, German, French and Italian) is very efficient to find the right way to go everywhere and the timetables.

Emergencies in Zürich

- Police: 117
- Medical emergency: 144
- Pharmacy/drugstore :
  open 24 hours : Bellevue Apotheke – Bellevueplatz – Theaterstrasse 14
  open 7:00 – 24:00 : Bahnhof Apotheke – Bahnhofplatz 15


Hotels
Restaurant
Restaurant in ETHZ
Boat departure
Zürich HB
Shop Ville
Platz Promenade
Museumstrasse
Bahnhofplatz
Bahnhofquai
Limmat-Quai
Uraniastrasse
Mühlegasse
Seilergraben
Eidgenössische Technische Hochschule Zürich (ETHZ)
Universität Zürich
Universitätstrasse
Rämi-Strasse
Kantonsschulstrasse
Zürich Selnau
Schanzengraben
Zürich
Bahnhofstrasse
Talstrasse
Quaibrücke
General-Guisan-Quai
Sechseläutenplatz
Zürich Stadelhofen
Utoquai
Zürich Enge
Arboretum
Sihlquai
Löwenstrasse
Werdstrasse
Stauffacherquai
Dreikönigstrasse
Kreuzbühlstrasse
Hottingerstr
Zeltweg
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Hotels and restaurants in Zürich

Hotels

1. City-Hotel, Löwenstrasse 34
2. Hotel Comfort Inn Royal Leonhardstrasse 6
3. Hotel Etap, Zürich City-West Technoparkstrasse 2
4. Hotel Ibis, City-West Schiffbaustrasse 11
5. Hotel Leoneck Leonhardstrasse1
6. Hotel Montana, Best Western Hotel Konradstrasse 39
7. Rütli, Sorell Hotel Zähringerstrasse 43
8. Seidenhof, Sorell Hotel Sihlstrasse 9

Restaurants

Here is a suggestion list of some restaurants. Many good restaurants are in the City of Zürich and you will find more addresses on the site www.zuerich.com.

1. Bodega Espanola Münstergasse 15
2. Barrique Wine and Bar Marktgasse 17
3. Brasserie Federal Bahnhofplatz 15
4. Brasserie Lipp Uraniastrasse 9
5. Confiserie Sprüngli Bahnhofstrasse 21
6. Fischstube Bellerivestrasse 160
7. Globus Cafeteria Schweizergasse 11
8. Gnüsserei Giessereistrasse 18
9. Karl der Grosse Kirchgasse 14
10. Kronenhalle Rämistrasse 4
11. Lake Side Bellerivestrasse 170
12. LaSalle Schiffbaustrasse 4
13. Mère Catherine Nägelihof 3
14. Restaurant Kunsthaus Heimplatz 1
15. Restaurant Neumarkt Neumarkt 5
16. Take away Mishio Sihlstrasse 9
17. Widder Rennweg 7
18. Zunfthaus zur Meisen Münsterhof 20,
19. Zunfthaus zur Waag Münsterhof 8
20. Weggen Weggengasse 4

Restaurants and bars in ETHZ

http://www.gastro.ethz.ch/locations/eth_zentrum/index_EN

1 CHN bistrot
2 restaurant foodLab
3 Informatikbar
4 Gloriabar
5 Tannenbar
6 Clausiusbar
7 Mensa Polyterrasse
8 Cafeteria Polyterrasse
9 bQm
10 Dozentenfoye
11 Polysnack
12 Cafebar

About Switzerland

If you want to know everything about Switzerland like geography, history, politics, economy, culture, science etc consult the official web-site www.myswitzerland.com.

Currency

The Swiss currency is the Franc (CHF)
1 CHF is around 0,8 euros (€) or 1,1 dollar US (USD) (May 12)

Power supply

Electric power is supplied at 220 volts, 50 Hz.
The Swiss 3-pin plug is a unique domestic standard (Type J, standard SEV 1011 10A/250V).
Swiss sockets can take 2-pin europlugs (Type C, CEE 7/16).
More information on Wikipedia.(http://en.wikipedia.org)
Adaptations are sold in airport and main station shops in Zürich.

Post-Conference Travel Ideas

The following represent only the highlights of travel in Switzerland. For more details consult travel guides, web-sites and travel bureaus.
There is an excellent Travel Bureau in the Zürich Hauptbahnhof (Zürich's main train station).
The web-site www.myswitzerland.com has a great deal of information about Switzerland, including events.
Most of the web-sites have a choice of language, including English.
For the transportation by train, bus or boat, consult www.sbb.ch

Recommended Travel Guides:

- Eyewitness Travel Guides – Switzerland
- Michelin Green Guide – Switzerland

A Few Cities

- **Basel** – Excellent museums including the Beyeler and Tinguely museums, interesting old town. www.basel.com, www.beyeler.com, www.tinguely.ch
- **Bern** – Switzerland's capital, lovely old town. www.bern.com
- **Geneva** – Magnificent setting on the Lake of Geneva, headquarters of several international organizations, Jet d'Eau, Flower Clock. www.geneve-tourisme.ch
- **Interlaken** – Lovely city between two lakes, starting point for Jungfraujoch and Schynige Platte. www.interlaken.ch
- **Lausanne** – Olympic Museum, wonderful view of the French Alps, Chateau de Chillon nearby. www.lausanne-tourisme.ch
- **Lucerne** – Wonderful wooden bridge, mountains all around. Near Mt. Pilatus, Rigi, and the Glasi Factory. - www.luzern.com, www.gletschergarten.ch
- **Zürich** – A beautiful city on the Lake of Zürich. with many cultural events and cinemas. Different open air swimming facilities along the Limmat or the Lake. - www.zuerich.com, www.kulturinfo.ch, www.cineman.ch

Some Mountains

- **Jungfraujoch** – Top of Switzerland, train ride up through the Eiger, impressive mountain scenery, grand view of the Aletsch Glacier. - www.jungfraubahn.ch
- **Schynige Platte** – Alpine Flower garden, magnificent view of Eiger, Monch and Jungfrau. www.alpengarten.ch
- **Zermatt** – Justifiably famous views of the Matterhorn. - www.zermatt.ch
- **Glacier Express** - Train trip through the Alps. - www.glacierexpress.ch
- **Four Passes Tour** – Trip by car through high mountain scenery. Grimsel, Furka, St. Gotthard, and Nufenen Passes.

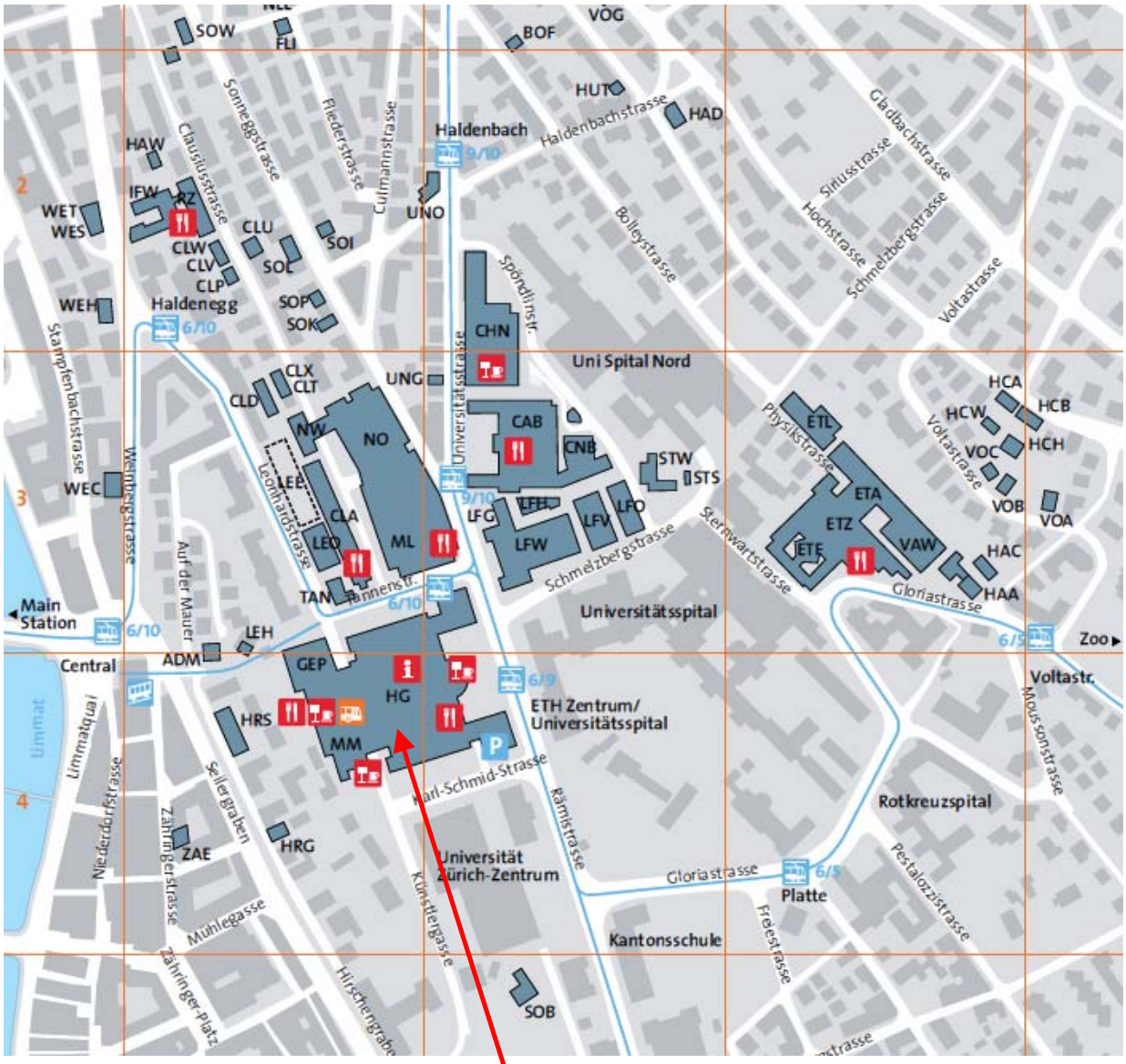
Several Museums

- **Ballenberg** – Open air museum with 100 historic rural Swiss buildings. Workshops with Swiss crafts. - www.ballenberg.ch
- **Château de Chillon -** www.chillon.ch
- **Paul Klee Museum** in Bern - www.paulkleezentrum.ch
- **Technorama** – Hands-on science museum in Winterthur - www.technorama.ch

Items of interest just over the border in Germany

- **Insel Mainau** – Flower garden island near Konstanz - www.mainau.de
- **Zeppelin Museum** – Friedrichshafen - http://www.zeppelin-museum.de
- **Black Forest** – www.blackforestinfo.com

Getting to the ETH Zürich, Main Building (HG)



ETH main building

By foot from main station : 10 – 15 min.
By tram from main station to ETH/Universitätsspital: 6 min.
N° 6 : (direction Zoo)
N° 10 (direction Seebach)

ETH-Zürich: Main Building Groundfloor