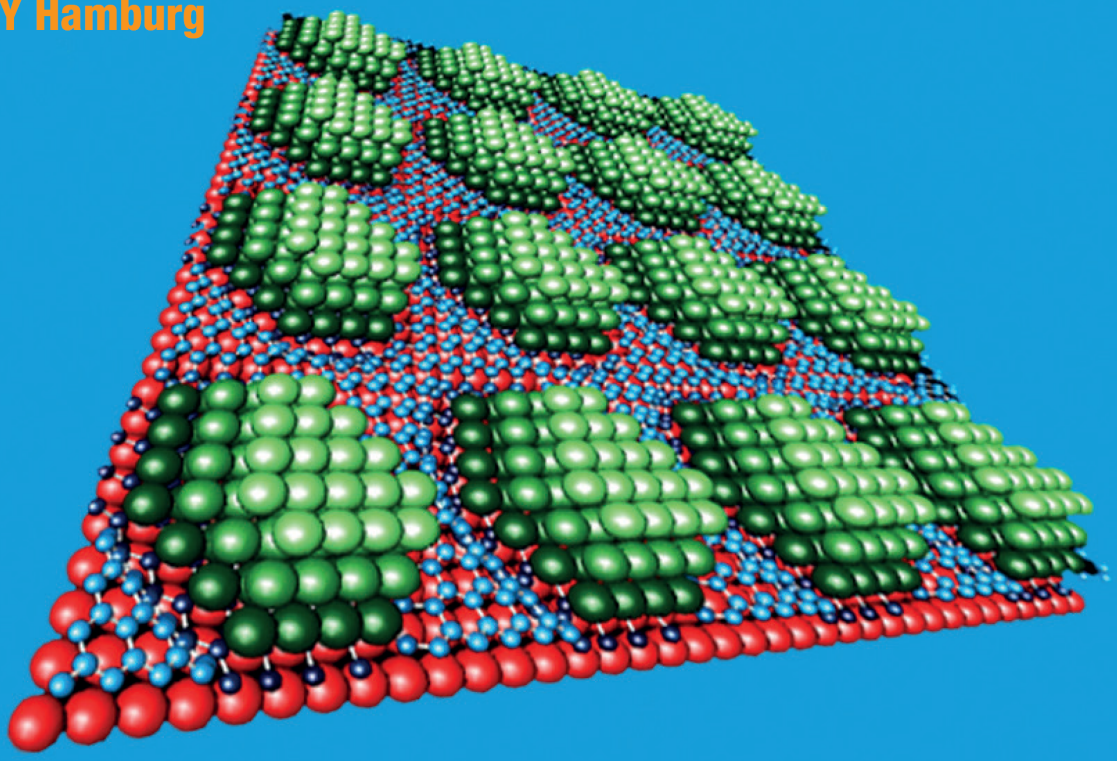
Nanoscience at modern X-ray Sources.

XVI. Research Course on X-Ray Sciences
1-3 March 2017, DESY Hamburg



- Quantum dots and nanomembranes
- Surfaces and Interfaces
- Bragg ptychography
- Nanoelectronics and nanomechanicss
- Light sources for nanomaterial studies
- Structure and function

BOOK OF ABSTRACTS

POSTER LIST

Speakers:
R. Blick (U Hamburg), W Hansen (U Hamburg), S. Hruszkewycz (ANL Chicago), U. Landman (Gatech, Atlanta), H.F. Poulsen (DTU, Lyngby), O. Schmidt (IFW Dresden), T. Schroeder (IHP, Frankfurt/Oder), A. Stierle (DESY), H. Weller (U Hamburg)

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Accelerators | Photon Science | Particle Physics

Deutsches Elektronen-Synchrotron
A Research Centre of the Helmholtz Association

DESY

Schedule

Wed March 1

	Speaker	Topic
12:45		Registration
13:45		Welcome
14:00	Stierle	*In the World of Dwarfs: Nano Catalysis and Oxidation*
15:00	Schmidt	*3d Assembly of Microtubular Nanomembranes: From Basics to Devices*
16:00		coffee break
16:30		facility visits
18:00		poster session

Thu March 2

09:00	Blick	*Nanomembranes for Mass Spectrometry*
10:00		coffee break
10:30	Schroeder	*Getting high performance Ge nanolayers and -structures ready for future Si Micro- and Nanoelectronics: Novel insights by innovative micro-XRD imaging studies*
11:30	Poulsen	*Multiscale 3D characterization with hard x-ray microscopy*
12:30		lunch break
14:00	Bester	*Towards a predictive theory of dynamical processes in nanostructures*
15:00		coffee break
15:30	Falkenberg	*Advanced Imaging by hard X-ray Scanning Microscopy*
16:00	Sprung	*Nano-Science at the Coherence Beamline P10*
16:30		facility visits
19:00		Dinner

Fri March 3

09:00	Hruszkewycz	*Coherent diffraction imaging of nanoscale strain in crystals*
10:00		coffee break
10:30	Weller	*Dynamics of nanocrystal formation and their use in technical and biomedical applications*
11:30	Hansen	*Epitaxial Quantum Dots and Quantum-Dot Molecules*
12:30		Closure

General information

Oral sessions The oral sessions will be held in the FLASH seminar room (Bldg. 28c).

Poster session The poster session will take place in the CFEL building (Bldg. 99) on Wednesday 18:00. There will be food and drinks for all participants.

Registration The registration will start on Wednesday 1 March 2017 at 12:45 in the lobby of the seminar room.

Social event The conference dinner will take place on Thursday 2 March 2017 at 19:00 at the DESY canteen.

Meals

Breakfast
If you stay at the Mercure Hotel "Hamburg am Volkspark", breakfast will be provided there. If you stay at the DESY guest house you may have breakfast at the DESY cafeteria (opens at 07:00, building 9) at your own expenses.

Lunch
You may have lunch at the DESY canteen (building 9) and/or the Café CFEL (building 99) at your own expenses.

Dinner
For the poster session we will serve light dinner. On Thursday, 2 March we will have the conference dinner (see above).

Supermarkets LIDL: From the main gate at Notkestrasse turn right and follow the street (700–800m).

PENNY: From the main gate at Notkestrasse walk straight down the street "Zum Hünengrab".

ATM You will find a cash machine in the foyer of the DESY canteen (Bldg. 9).

DESY WLAN An eduroam network is available on the DESY campus.

Guests without eduroam access will be mapped to our "Guest WLAN", it is a DESY Class-C Network which provides DHCP-Support. Before you will get internet access, you have to open your Internet browser with any requested Internet Site. Your request will be redirected to our Portal Server, a DESY form opens automatically. There you have to fill out the required fields. After submitting this form it will take about 1 minute before your requested Internet Site appears. Up to now you can use the Internet connectivity for a maximum of 90 days. **Note:** *The DESY-Guest WLAN is* ***unencrypted****. That means, for transferring sensitive data (e.g. passwords) secure protocols are mandatory (e.g. SSH and VPN).*

Abstracts

In the World of Dwarfs: Nano Catalysis and Oxidation

Andreas Stierle

DESY

At the nanoscale many materials behave differently as their bulk counterparts. In my presentation I will focus on altered chemical activity for reactions of nanoscale objects with defined size, shape and composition. I will highlight the properties of Gold clusters for heterogeneous catalysis, which as bulk material is a noble metal and completely inert. Further on, I will discuss the oxidation behavior of material in reduced dimensions, which differs significantly from the passivating mechanism of planar surfaces. This can have dramatic implications for the lifetime of nanoscale objects, such as magnetic nanostructures. I will demonstrate, how in-situ x-ray diffraction experiments performed at large scale facilities such as PETRAIII allow to record movies of nanoscale processes while they occur.

3D Assembly of Microtubular Nanomembranes: From Basics to Devices

Oliver G. Schmidt

IFW Dresden, 01069 Dresden, Germany

Nanomembranes are thin, flexible, transferable and can be assembled into 3D micro and nanoarchitectures. This makes them attractive for a broad range of applications and scientific research fields ranging from novel hybrid heterostructure devices to ultra-compact 3D systems both on and off the chip. If nanomembranes are differentially strained they deform themselves and roll-up into tubular structures upon release from their mother substrate. Rolled-up nanomembranes can be exploited to rigorously compact electronic circuitry, energy storage units and novel optical systems. If appropriate materials are chosen, rolled-up tubes act as tiny catalytic jet engines which in the ultimate limit may drive compact multifunctional autonomous systems for medical and environmental applications. If magnetic tubes are combined with flagella-driven sperm cells, such hybrid microbiorobots offer new perspectives towards artificial reproduction technologies. This lecture will shed light on the basic fabrication principles and explain how characterization and new device concepts are realized.

Getting high performance Ge nanolayers and -structures ready for future Si Micro- and Nanoelectronics: Novel insights by innovative micro-XRD imaging studies

Thomas Schroeder

IHP, 15236 Frankfurt (Oder), Germany

The increased brilliance of modern synchrotron radiation facilities - together with strong improvements on the performance of nano-focused X-ray beam experimental end stations (including fast modern 2D X-ray detector set-ups) ? enables the fast application of non-destructive, model-free X-ray diffraction imaging techniques to study the lattice tilt, strain as well as composition fluctuations of semiconductor heterostructures for micro- and nanoelectronic applications. In the present talk, we will report on the study of 300 mm strained Ge / SiGe / Si(001) wafers to verify the materials quality in order to match highest requests on homogeneity for future sub-10 nm CMOS applications [1]. Besides global Ge integration approaches by virtual Si wafer products from wafer companies, selective Ge nanoheteroepitaxy is pursued by integrated device makers (IDM) to set up lattice mismatched Ge / Si nanostructures with low defect densities. The nanoheteroepitaxy concept of compliance by nano-patterned Si wafer structures is revisited by anomalous X-ray scattering techniques to achieve coherent Ge / SiGe / Si nanostructures of potential interest for Tunnel Field Effect Transistor (TFET) applications [2].

[1] M.-I. Richard, M. H. Zoellner, G. Chahine, P. Zaumseil, G. Capellini, M. Häberlen, P. Storck, T. U. Schülli, and T. Schroeder, Structural Mapping of Functional Ge Layers Grown on Graded SiGe Buffers for sub-10 nm CMOS Applications Using Advanced X-ray Nano-Diffraction, ACS Applied Materials & Interfaces 7 (48), 26696 (2015).

[2] F. Montalenti, P. Zaumseil, M. Salvalaglio, A. Marzegalli, G. Capellini, T. U. Schülli, M. A. Schubert, Y. Yamamoto, B. Tillack and T. Schroeder, Misfit dislocation-free Ge nanostructures on compliant Si (001): Experiment and Theory, Physical Review B 89, 014101 (2014).

Multiscale 3D characterization with hard x-ray microscopy

Henning Friis Poulsen

Danmarks Tekniske Universitet (DTU), 2800 Kgs. Lyngby, Denmark

Most metals, ceramics, rocks and bio-minerals as well as many every-day components are organized hierarchically on a number of length scales. It is of great interest to be able non-destructively to "zoom" into such materials in 3D and characterize the changes in morphology as well as the local strain as function of time. In this way one can correlate what happens on the grain, domain and defect scale. This will help us improve multiscale materials models, with the ultimate aim of enabling materials design by computing.

Hard x-ray microscopy is a synchrotron based technique that enables such multiscale mapping of mm-sized specimens. An x-ray lens is used to magnify the diffraction signal in much the same way as a classical optical microscope works. Currently, at maximum zoom the spatial resolution is 50 nm. I will present the method along with examples of use ranging from ferro-electrics, metallurgy over semiconductors to battery materials. I will end by discussing the option for improved spatial resolution provided by the upcoming extreme bright x-ray sources.

Towards a predictive theory of dynamical processes in nanostructures

Gabriel Bester

Institut für Physikalische Chemie, Universität Hamburg & The Hamburg Centre for Ultrafast Imaging

While the ab-initio treatment of the static properties of matter have reached a level at which accurate predictions can be often made, the calculation of dynamical properties of matter remain challenging. This is especially true in the realm of nanostructures, as these are made of many, often more than 10000 atoms. I will cover different aspects of "dynamics" and describe available theoretical approaches.

Advanced Imaging by hard X-ray Scanning Microscopy

Gerald Falkenberg

DESY

The experimental conditions at the Hard X-ray Micro/Nano-Probe beamline P06 at the synchrotron radiation facility PETRA III are reviewed and demonstrated by some key applications. The Microprobe is a versatile experiment for scanning X-ray microscopy with X-ray fluorescence, X-ray absorption spectroscopy and X-ray diffraction contrasts. A KB system focusses a beam of 10^{11} photons/s down to 300 nm focus size in the energy range 5 - 21 keV. Advanced detector technology, namely the Maia X-ray fluorescence detector and the EIGER X 4M hybid photon counting detector, enable on-the-fly scanning schemes with millisecond dwell times per scan pixel. The ability to collect megapixel images in less than an hour facilitates series of 2D images for full 3D fluo-tomography, spectro-microscopy, time-resolved in-situ microscopy or other multi-dimensional microscopic experiments. The microprobe setup is frequently applied for biological applications including frozen hydrated tissue samples measured in a cryo-stream and some studies are addressed. Other examples are full 3D fluo-tomography on a catalytic particle and spectro-microscopy on Lithium-ion based battery electrodes. The Nanoprobe experiment utilizes nanofocusing lenses (NFL) for focusing the coherent part of the X-ray beam to typical beam sizes of 50-100 nm. It is designed for scanning coherent X-ray diffraction microscopy (ptychography), but is used also for nano-XRF and nano-XRD imaging.

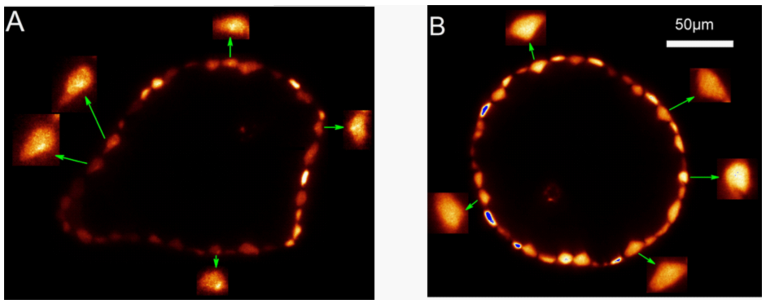

Figure 1:X-ray fluorescence microtomograms showing intra-cellular details of As distribution in leaves of C. demersum after 2 weeks of As treatment. A, 1 µM As exposed young mature leaf showing predominant accumulation of As in a single large cell organelle identified as nucleus; B, 5 µM As exposed mature leaf showing As storage in the large central the vacuoles. The arrows indicate enlarged views of selected cells to show intra-cellular details of As distribution. From: Analysis of sub-lethal arsenic toxicity to Ceratophyllum demersum: Subcellular distribution of arsenic and inhibition of chlorophyll biosynthesis Seema Mishra, Matthias Alfeld, Roman Sobotka, Elisa Andresen, Gerald Falkenberg, Hendrik Küpper; Journal of Experimental Botany, 67 (15) (2016), 4639-4646, DOI: 10.1093/jxb/erw2

Nano-Science at the Coherence Beamline P10

Michael Sprung

DESY

The Coherence Beamline P10/PETRA III with its various experimental opportunities will be introduced and a few recent research examples be highlighted. The first experimental hutch houses a large 6-circle diffractometer. In combination with sub-micron sized focused coherent x-ray beams and a fairly large sample-detector distance of about 2m, this setup allows for performing coherent diffraction imaging experiments of small crystallites to e.g. observe their strain distribution or to use XPCS like techniques to e.g. study domain wall fluctuations. In addition, the only vertical SAXS setup allows studying complex liquids in a (standard) rheometer.

The 2nd experimental hutch contains two further experimental setups. The 4-circle setup and the P10-GINIX instrument which was built by the group of Prof. Salditt of the University of Göttingen. The GINIX setup uses a KB focusing system to create about 300nm x-ray beams, which can be used directly or as input for secondary focusing systems to create even smaller beam sizes. A large variety of different imaging methods have been successfully used at this setup. The former setup enables coherent SAXS/WAXS experiments at a sample-detector distance of 5m using coherent beams of several micrometer sizes.

Coherent diffraction imaging of nanoscale strain in crystals

Stephan Hruszkewycz

Argonne National Laboratory, Lemont, USA

In this lecture, we will cover the basic principles governing phase retrieval in Bragg coherent diffraction imaging (BCDI) and Bragg ptychography (BP) that enable lattice defects such as strain to be imaged in nanoscale crystals. We will introduce coherent beams (focused and unfocused) and describe their interaction with crystals in the Bragg geometry. This interaction results in intricate interference patterns in the vicinity of a Bragg peak that encode elements of the morphology and strain state of the illuminated volume, whether measured with a tightly focused beam in an extended crystal (as in BP) or with a wide plane-wave beam illuminating a nanocrystal (as in BCDI). X-ray area detectors can be used to measure the intensity (but not the phase) of these fringes. We will discuss the basic numerical methods of phase retrieval that recover un-measured phases and enable strain-sensitive images of the crystal to be reconstructed. Throughout, we will examine examples from literature covering different scientific applications.

Dynamics of nanocrystal formation and their use in technical and biomedical applications

Horst Weller

Institut für Physikalische Chemie, Universität Hamburg & Centrum für Angewandte Nanotechnology & The Hamburg Centre for Ultrafast Imaging

Although nanocrystals are used already in many applications, the knowledge on their formation is still in its infancy. We will present results on the nucleation and growth of quantum dots obtained from uv-vis spectroscopy and x-ray scattering data obtained in a rapid continuous flow apparatus. Nanocrystals can be converted from one material to another under conservation of size and shape. We will give examples for these reactions, in which the sublattice of the cations can be completely exchanged against. Data on the dynamics of the ion transport within nanocrystals allow to identify the mechanism of ion transport via interstitials.

In the second part of the talk we give examples for applications in display and lighting technology, catalysis as well as biology and medicine and show how the nanocrystals must be modified to meet the respective requirements.

Epitaxial Quantum Dots and Quantum-Dot Molecules

Wolfgang Hansen

University of Hamburg

High-quality self-assembled semiconductor nanostructures can be fabricated with epitaxy methods like Stransky-Krastanov growth, droplet epitaxy, vapor-liquid-solid epitaxy, and overgrowth of patterned substrates. The methods will be illustrated with focus on growth in droplet-etched holes. Valuable characterization techniques like transport through quantum dots, capacitance spectroscopy, scanning tunneling microscopy and photoluminescence will be explained. Finally, recent results [1] as depicted in Fig. 1 on photoluminescence from single quantum dots and quantum-dot molecules will be presented and discussed.

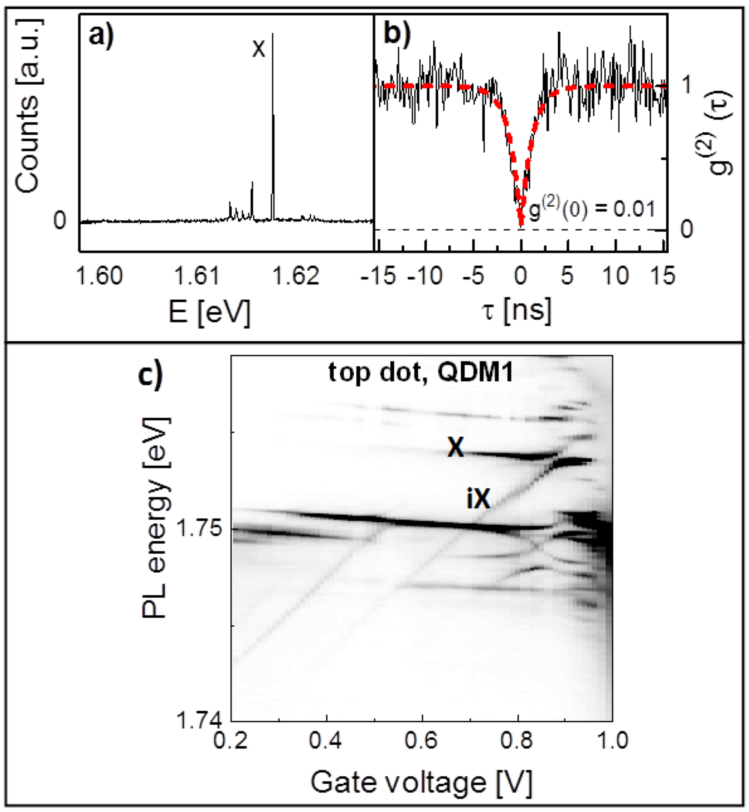

Figure 1: a) Low temperature single-dot PL spectrum from a GaAs quantum dot. The exciton peak marked with X has a narrow line width of 40 μeV. b) Auto-correlation measurement demonstrating single-photon emission from a GaAs quantum dot. c) Grey-scale encoded photoluminescence intensity from the top dot of a GaAs quantum dot molecule at varied gate-voltage. X denotes the direct and iX the indirect exciton. The anti-crossing between X and iX at a gate voltage of about 0.9 V clearly indicates a molecule-resonant state.

[1] A. Küster et al., Droplet etching of deep nanoholes for filling with self-aligned complex quantum structures, Nanoscale Research Letters 11, 282 (2016).

List of posters

Poster session

No.	Name	Title
1	Alipour, Akbar	Fluorescent Heterodoped Nanotetrapods as dual-mode contrast agent in MRI
2	Antoja Lleonart, Jordi	Si-based sustainable piezoelectrics
3	Bahariqushchi, Rahim	Structural and Optical study of Ge nanocrystals embedded in Si3N4 superlattice structure
4	Bißwanger, Timo	Preserving π-conjugation in covalently functionalized carbon nanotubes for optoelectronic applications
5	Bocharov, Dmitry	Interpretation of EXAFS spectra using first principles molecular dynamics
6	Boué, François	Small angle neutron and X ray scattering from mixed systems: from nanoparticles- biopolyelectrolytes to magnetic nanorods in polymer melts
7	Christensen, Christian Kolle	Operando scattering studies of Vanadium Oxide Nanotubes as Cathode Materials for Mg-ion batteries
8	Cintins, Arturs	X-ray absorption spectroscopy of ODS steels
9	Crea, Fucsia	Characterization of photoswitchable lipids
10	Domènech Garcia, Berta	Production and characterization of hierarchical, multifunctional ceramic / metal polymer material systems
11	Dzierzgowski, Kacper	Rare earth orthoniobates - RENbO4
12	Frenzel, Lara	Structure and Dynamics of concentrated PNIPAm microgels
13	Garcia Penas, Alberto	Remarkable competition between mesomorphic, monoclinic and trigonal phases in isotactic poly(propylene-co-1-pentene-co-1-heptene) terpolymers
14	Gizer, Gökhan	Structural Analysis on Mg(NH2)2-2LiH-xKH System
15	Hallmann, Jörg	Science at the Materials Imaging and Dynamics Instrument of European XFEL
16	Henriksen, Christian	How nanosizing could improve the rate capabilities of hydroxyl iron phosphates
17	Hornberger, Elisabeth	In Situ X-ray Stability Studies of Platinum Nanoparticles Supported on Metal Oxides for Hydrogen Fuel Cell Electrodes
18	Hosseini, Hemen	Design and Implementation of Data Acquisition and Control System on Powder X-ray Diffraction Furnace
19	Jarzebski, Maciej	NTA and DLS techniques for nanomaterials characteriztaion
20	Jensen, Nicholai Daugaard	Study of Layered Double Hydroxides Intercalated with Para-Aminosalicylate
21	Jonane, Inga	X-ray absorption spectroscopy study of nanocrystalline yttria
22	Jordt, Philipp	Nanofocus diffraction studies of strain in piezotronic ZnO microstructures
23	Kapusta, Ondrej	Magnetic properties of nanoparticles prepared within ordered porous matrix
24	Karatok, Mustafa	Methanol interaction with atomic oxygen on the unreconstructed Ag(111) surface

25	Kielgast, Fridtjof	Noncollinear spin arrangement in small, size-selected FeV clusters on Cu(100)
26	Kim, Chan	Bragg Ptychography Imaging of Phase-Ordering Fe-Al Alloys
27	Klingenhof, Malte	Investigations of manganese iron oxide nanoparticles as catalysts for the electrochemical water splitting reaction
28	Korculanin, Olivera	Anomalous structural response of nematic colloidal platelets subjected to Large Amplitude Stress Oscillations
29	Kurt, Merve	Understanding Exothermic Catalytic Decomposition of Ionic Liquids Under Anaerobic Conditions: New Structure Functionality Relationships
30	Lundehøj, Laura	A Solid-State NMR Study of CaAl- and MgAl-LDH Intercalated with Phosphate
31	Lutz-Bueno, Viviane	Techniques developed at cSAXS beamline
32	Lu, Wei	Development of a hard X-ray Split and Delay Line unit for the MID station at the European XFEL
33	Mackosz, Krzysztof	Local structure of dopants in Bi2Se3 and Bi2Te3 single crystals
34	Matusiak, Katarzyna	The in vivo study of the dynamics of elemental changes occuring in the liver after the iron oxides nanoparticles administration
35	Mazalski, Piotr	Synchrotron studies of Co nanostructures modified by ion irradiation
36	Mercurio, Giuseppe	X-ray standing wave experiments at FLASH
37	Merzdorf, Thomas	Synthesis and Characterization of Nickel-based Layered Double Hydroxide Electrocatalysts for the Oxygen Evolution Reaction
38	Moretti, Paolo	Conformational disorder of β - amyloid: Small Angle X-ray Scattering study
39	Mukharamova, Nastasia	Ultrafast melting of the colloidal crystals in the pump-probe experiment at LCLS
40	Nopens, Martin	Structural changes in nanoporous biopolymer composites
41	Novak, Sanja	Self-assembly of DNA-based anisotropic soft-patchy particles
42	Nowakowski, Michal	Modern approach of X-Ray spectroscopy to PrPc protein study
43	Osterhoff, Markus	Hard X-ray Imaging and Nano-Diffraction @ GINIX
44	Otte, Florian	Study of the thermal heat loads on the Si(311) Bragg-monochromator of beamline BL9 at DELTA for operation with a new high field wiggler
45	Pandey, Rishikesh	Nature of Stress and Electric-Field Driven Structural Transformation in (1-x)Bi(M/1/2M//1/2)O3-xPbTiO3 Solid Solution
46	Parisse, Pietro	Synchrotron Radiation and Free Electron Laser experiments on natural vesicles
47	Pfluegler, Nadine	New test method of die attach reliability assessment for future zero-defect electronic devices
48	Pitala, Krzysztof	Origin of ferromagnetism in nanocomposite oxide films
49	Ramesh, Arathi	Studying THz Time Domain Spectroscopy system based on Tera-SED THz antenna
50	Reinhardt, Juliane	Resonant Hard X-ray Ptychography for High-Sensitivity Imaging with Chemical Contrast

51	Ricci, Caterina	Aβ amyloid folding and interactions investigated by Small Angle X-ray Scattering
52	Roman, Marta	Physical properties of NbSeI compound
53	Rudek, Benedikt	Dose enhancement by gold nanoparticles in radiotherapy
54	Rysov, Rustam	Development of next generation hard X-Ray split and delay line
55	Santos-Silva, Teresa	Can nanoparticles be used for efficient CO delivery during inflammation?
56	Scholz, Maria	Microchip Characterization at a Synchrotron
57	Singh, Vijay	A cryogenic helium buffer gas source for producing cold beams of large biomolecules
58	Skoczen, Agnieszka	The chages of iron accumulation occurring in selected rat organs after IONPs administration.
59	Smekhova, Alevtina	X-rays for studies of the local structure and magnetism development through the phase transition in Fe60Al40 thin films
60	Smik, Michael	Nanoparticle supercrystals: structure and (some) insights into both macroscopic and microscopic magnetic behavior
61	Sørensen, Daniel Riskov	Operando Synchrotron PXD on Vanadium-Based Lithium Ion Batteries
62	Stepien, Joanna	Angle resolved XAS spectra of TM doped topological insulators
63	Tardillo Suarez, Vanessa Isabel	Fate of Ag nanoparticles in Hepatocytes revealed by combined nano-XRF/TEM imaging and nano-XAS
64	Valenta, Richard	GISAXS simulations of filamentary inhomogeneities with gradients in resistively switching SrTiO3
65	Vrankovic, Dragoljub	Nanostructured Silicon-Based Anode Materials for Lithium-Ion Batteries
66	Wang, Xingli	Controlling CH4/C2H4 Ratio by Changing Cu Nanoparticles Loading during CO2 Electroreduction Reaction
67	Wei, Yingfen	Ferroelectric Hf0.5Zr0.5O2 thin films
68	Winiarz, Piotr	Selected properties of titanium doped yttrium niobate
69	Witte, Ralf	Strain-induced magnetic nanostructures in epitaxial FeRh thin films
70	Yaman, Muammer	Moltan salt assisted self-assembly process to modify cadmium selenide sensitized titania based solar cells
71	Ziegert, Falko	Collective diffusion in binary mixtures of highly charged colloidal suspensions: a combined light scattering and Brownian Dynamics simulation study

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