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News

Sciences

Compact X-ray free electron laser by transverse gradient undulator (November 16, 2012)

The X-ray free electron laser (XFEL) is a new type of light source, which can provide coherent, high-flux, ultra-short photon pulses in the soft and hard X-ray energy region. Until now, a long linear accelerator as well as long linear undulators have been thought indispensable, because the principle is based on the self amplified spontaneous emission (SASE). Indeed, both FLASH at DESY and LCLS at SLAC, which are the world's first X-FEL facilities in soft and hard X-rays, respectively, are facilities on a huge scale. Recently, Dr. Z. Huang (SLAC National Accelerator Laboratory, USA) and his colleagues have published a very interesting idea for a compact XFEL facility that uses an ultra-short pulse laser instead of an ordinary linear accelerator. It is known that laser-plasma accelerators can produce high energy electron beams with low emittance, high peak current but a rather large energy spread, which makes it difficult to consider XFEL applications. Their main strategy is the introduction of a transverse field variation into the FEL undulator. In their calculation, such a transverse gradient undulator together with a properly dispersed beam can greatly reduce the effects of electron energy spread and jitter on the performance of XFEL generation. For more information, see the paper, "Compact X-ray Free-Electron Laser from a Laser-Plasma Accelerator Using a Transverse-Gradient Undulator", Z. Huang *et al.*, Phys. Rev. Lett. **109**, 204801 (2012). DOI:10.1103/PhysRevLett.109.204801

Synchrotron FTIR and XRF imaging of liver cirrhosis (November 3, 2012)

A French group has recently published an interesting report on the analysis of cirrhotic liver tissue. At the Synchrotron Soleil, near Paris in France, scientists combined synchrotron Fourier transform infrared (FTIR) microspectroscopy and synchrotron micro-X-ray fluorescence (XRF) on the same tissue section. They found from FTIR that hepatocytes within cirrhotic nodules have quite highly concentrated esters and sugars, and in the same area, phosphorus and iron were detected by XRF. Also the research team studied their inhomogeneity. For more information, see the paper, "In situ chemical composition analysis of cirrhosis by combining synchrotron-FTIR and synchrotron X-ray fluorescence microspectroscopies on the same tissue section", F. Le Naour *et al.*, Anal. Chem., Just Accepted Manuscipt. Publication Date (Web): 3 Nov 2012. DOI:10.1021/ac302072t

Uncertainty estimates for EPMA (October 22, 2012)

Scientists at the National Institute of Standards and Technology, USA, have recently discussed some fundamental problems in quantitative electron probe X-ray micro analysis (EPMA). The main arguments center on two significant sources of uncertainty in the quantitative matrix correction models; the mass absorption coefficient and the backscatter coefficient. For more information, see the paper, "Uncertainty Estimates for Electron Probe X.ray Microanalysis Measurements", N. W. M. Ritchie *et al.*, Anal. Chem., Article ASAP, Publication Date (Web): 22 Oct 2012. DOI:10.1021/ac301843h

Further synchrotron X-ray spectromicroscopic studies on Van Gogh's paintings (October 10, 2012)

A research team led by Professor K. Janssens (Antwerp University, Belgium) has published several interesting results from their series of analytical work on Van Gogh's paintings. They were able to give more detailed insights on the chemical forms of cadmium yellow and chromium yellow, as well as the role of lead in the pigment. For more information, see the following 3 papers, "Combined use of Synchrotron Radiation Based Micro-X-ray Fluorescence, Micro-X-ray Diffraction, Micro-X-ray Absorption Near-Edge, and Micro-Fourier Transform Infrared Spectroscopies for Revealing an Alternative Degradation Pathway of the Pigment Cadmium Yellow in a Painting by Van Gogh", G. Van der Snickt *et al.*, Anal. Chem., Article ASAP, Publication Date (Web): 30 Aug 2012. DOI:10.1021/ac3015627, "The Degradation Process of Lead Chromate in paintings by Vincent van Gogh studied by means of Spectromicroscopic methods. Part III: Synthesis, characterization and detection of different crystal forms of the chrome yellow pigment", L. Monico *et al.*, Anal. Chem., Just Accepted Manuscript. Publication Date (Web): 10 Oct 2012 DOI:10.1021/ac302158b, and "The Degradation Process of Lead Chromate in paintings by Vincent van Gogh studied by means of Spectromicroscopic methods. Part IV: Artificial ageing of model samples of co-precipitates of lead chromate and lead sulfate", L. Monico *et al.*, Anal. Chem., Just Accepted Manuscript. Publication Date (Web): 10 Oct 2012. DOI:10.1021/ac3021592

Theoretical X-ray absorption spectra of water and ice (October 8, 2012)

One of the remarkable instances of progress in soft-X-ray spectroscopy recently is the successful high-resolution measurement of O-K edge absorption spectra of liquid water and ice, which have some disordered hydrogen-bonds. Professor R. Car (Princeton University) and his colleagues have recently reported their theoretical studies into the quantum dynamics of the nuclei and inhomogeneous screening effects. They found that the inclusion of quantum disorder is essential to bring the calculated spectra in close agreement with the experiment. In particular, the intensity of the pre-edge feature, a spectral signature of broken and distorted hydrogen bonds, is accurately reproduced, in water and hexagonal ice, only when quantum nuclei are considered. The effect of the inhomogeneous screening is less important but non-negligible, particularly in ice. For more information, see the paper, "Roles of quantum nuclei and inhomogeneous screening in the x-ray absorption spectra of water and ice", L. Kong *et al*., Phys. Rev. **B86**, 134203 (2012). DOI:10.1103/PhysRevB.86.134203

Cross sections for K-shell ionization (October 2, 2012)

An Argentinean group has reported the experimental determination of cross sections for K-shell ionization by electron impact for Al, Si, and Ti and their oxides deposited on carbon substrates, for incident energies between 2.5 and 25 keV. For more information, see the paper, "Experimental determination of cross sections for K-shell ionization by electron impact for C, O, Al, Si, and Ti", S. P. Limandri *et al*., Phys. Rev. **A86**, 042701 (2012). DOI:10.1103/PhysRevA.86.042701

Refractive X-ray imaging with multiple pencil beams (September 25, 2012)

When spatially coherent X-ray beams pass through a sample, edge-enhancement is observed in the transmission X-ray image because of the refraction effect. At Canadian Light Source (Saskatoon, Saskatchewan, Canada), Professor P. C. Johns (Carleton University) and his colleague have recently reported an interesting extension of this type of X-ray refractive imaging. They used multiple pencil beams (up to five) to create both transmission and refractive projection images, simultaneously, during the sample scan crossing the beams. The radial data were extracted from the overlapped image by a Maximum Likelihood-Expectation Maximization (MLEM) algorithm. For more information, see the papers, "Synchrotron-based coherent scatter x-ray projection imaging using an array of monoenergetic pencil beams", K. Landheer *et al*., Rev. Sci. Instrum., **83**, 095114 (2012). DOI:10.1063/1.4754124

High-repetition rate femtosecond pump-probe setup (September 13, 2012)

In time-resolved X-ray analysis based on the pump-probe scheme, an increase in the repetition rate is crucial for improving efficiency. At the same time, it is crucial to maintain or improve pulse to pulse stability. Recently a Swiss research team developed a fast multichannel detection system for pump-probe spectroscopy, capable of detecting single shot super-continuum spectra at the repetition rate (10-50 kHz) of an amplified femtosecond laser system. The setup is not for synchrotron X-rays, but many points discussed in the report will be useful. For more information, see the papers, "Femtosecond pump/supercontinuum-probe setup with 20 kHz repetition rate", G. Aubock *et al*., Rev. Sci. Instrum., **83**, 093105 (2012). DOI:10.1063/1.4750978

Calculation of resonance X-ray fluorescence spectra excited by X-ray free electron laser pulses (September 4, 2012)

Readers might recall several previous news articles on X-ray spectra of neon excited by ultra-short, high-intensity pulses from an X-ray free electron laser source at LCLS, Stanford ("Observation of non-linear resonances of inner-shell electrons by X-ray free electron laser", No.1, Vol. 41 (2012), "Calculation of X-ray emission from doubly ionized neon", No.1, Vol. 40 (2011), ""Hollow" neon atom created by X-ray laser excitation", No.5, Vol. 39 (2010) and "Removing all electrons from neon by X-ray laser", No.6, Vol. 38 (2009)). Recently, a research team led by Professor C. H. Keitel (Max-Planck-Institut für Kernphysik, Germany) has published its calculation of the resonance X-ray fluorescence spectra of neon, based on a so-called two-level model, which is used to study the transition of $1s2p_z^{-1} \rightarrow 1s^{-1}2p_z$ in Ne^+ at an energy of 848 eV. As X-rays induce Rabi oscillations so fast, they compete with Ne 1 s-hole decay. The research group discusses resonance X-ray fluorescence spectra for two different cases; the first is chaotic pulses, which are most likely based on the SASE principle employed in the present XFEL facilities, and the second is Gaussian pulses available from the more ideal types of X-ray lasers expected in the future. For more information, see the paper, "Resonance fluorescence in ultrafast and intense x-ray free-electron-laser pulses", S. M. Cavaletto *et al*., Phys. Rev. **A86**, 033402 (2012). DOI:10.1103/PhysRevA.86.033402

Professional

The 7th Asada award (November 2, 2012)

The recipient of the 7th Asada Award, which is presented by the Discussion Group of X-ray Analysis, Japan, in memory of the late Professor Ei-ichi Asada (1924-2005) to promising young scientists in X-ray analysis fields in Japan, is Dr. Shinsuke Kunimura (Tokyo Univ. of Science, "Development of a portable TXRF spectrometer with pg detection limits and its applications"). The ceremony was held during the 48th Annual Conference on X-Ray Chemical Analysis, Japan, at Nagoya University, Nagoya.

X-ray scientist named as SLAC director (October 24, 2012)

Professor Chi-Chang Kao has been named as the fifth director of the SLAC National Accelerator Laboratory, USA, which is one of the world's largest facilities for experimental particle physics. This reflects its change of mission from a dedicated particle physics lab to a multipurpose laboratory with an emphasis on X-ray studies. Similar policy can be a world trend - at DESY, Germany, Prof. Helmut Dosch, who is a world leader in X-ray surface physics and condensed matter physics, has already been a director since 2009. For more information, visit the Web page, http://www6.slac.stanford.edu/news/2012-10-24-DirectAnnounce-CCK.aspx

The SPring-8 Angstrom Compact free electron LAser (SACLA) - Japanese XFEL facility (June 24, 2012)

A new X-ray free electron laser facility at the SPring-8 campus in Harima, Japan, has started its user run. This is the world's second XFEL facility in the hard X-ray region after the LCLS at Stanford, USA. One of the most important properties of this new Japanese facility is the short wavelength of the X-ray photon; the shortest wavelength attained is 0.634 Å (63.4 pm), which is almost half that achieved at Stanford. The facility uses a 400 m linear accelerator as well as a short-gap and very long undulator (periodic length 18 mm, minimum gap 3.5 mm, total number of periods 4,986). The maximum power exceeds 10 GW with a pulse duration of 10-14 s. For more information, see the paper, "A compact X-ray free-electron laser emitting in the sub-angstrom region", T. Ishikawa *et al*., Nature Photonics, 6, 540 (2012). Also visit the Web page, http://xfel.riken.jp/eng/

New products

Rigaku introduces new compact WDXRF spectrometer, Supermini200 (September 5, 2012)

Rigaku has announced the release of the Supermini200 wavelength dispersive X-ray fluorescence (WDXRF) spectrometer. For further information, visit the web page, http://www.rigaku.com/

Shimadzu releases ultra high-speed camera (September 3, 2012)

Shimadzu has released its new ultra high-speed CMOS camera, HyperVision HPV-X. The maximum frame rate is 10 M fr./sec. For further information, visit the web page, http://www.shimadzu.co.jp/ (though Japanese only)

Corporate

Launch of the HORIBA Europe Research Center at Paris Saclay (October 4, 2012)

HORIBA has opened its brand new 7500 m^2 European research center near Paris, France close to the renowned French Ecole Polytechnique Campus. For further information, visit the web page, http://www.horiba.com/reset/

PANalytical relocates Houston office (September 24, 2012)

PANalytical Inc. has moved its Houston area office to a new and larger office at 4802 North Sam Houston Parkway West, Suite 100, in Houston, TX. For further information, visit the web page, http://www.panalytical.com/

Bruker sells thermal analysis instruments business in Japan (September 4, 2012)

The Netzsch Analyzing & Testing division and Bruker Corporation announced jointly that Netzsch Japan K.K. has acquired Bruker's Thermal Analysis instruments business in Japan. For further information, visit the web page, http://www.netzsch.com/en/home/

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News

Sciences

Ti Kβ and X-ray Raman spectra from $BaTiO_3$ nano particles (December 28, 2012)

Recently a research group led by Okayama University in Japan has reported the successful application of resonant X-ray emission spectroscopy (RXES) to $BaTiO_3$ nanoparticles of various sizes ranging from a bulk-like 200 nm to a paraelectric 50 nm. While it is well known that the crystal structure changes from tetragonal to cubic as the particle size decreases, some recent reports indicated that a very large enhancement of the dielectric constant was observed at a specific particle size of around 70 nm. The research was done to clarify the above problem. In the X-ray emission spectra measured with monochromatic excitation near the sharp peak of the Ti-K absorption edge, two small Raman peaks were observed between $K\beta_{2,5}$ (4962.6 eV) and elastic scattering of (for example, 4983.6 eV) peaks. It was found that the higher energy Raman peak (5.3 eV lower than incident X-ray energy) still exists at a size of 85 nm, even though the intensity basically diminishes for the small particle size $BaTiO_3$, which corresponds to the extraordinary large crystal structure change. The results suggest that Raman peak intensity is correlated to the large enhancement of the dielectric constant. For more nformation, see the paper, "Enhancement of dielectric constant of BaTiO3 nanoparticles studied by resonant x-ray emission spectroscopy", N. Nakajima *et al.*, Phy. Rev. B86, 224114 (2012).

Focusing XFEL pulses with mirrors (December 16, 2012)

In Japan, a research team led by Professor K. Yamauchi (Osaka University) and Professor T. Ishikawa (Riken, Harima, Japan) has recently succeeded in focusing ultra short X-ray laser pulses from the SPring-8 Angstrom Compact free electron LAser (SACLA). With reflective optics comprising elliptically figured mirrors with nm accuracy to preserve a coherent wavefront, they have obtained a focused small beam of $0.95 \times 1.20\ \mu m^2$ at 10 keV. The estimated achievable power density at the sample position is 6×10^{17} W/cm^2. For more information, see the paper, "Focusing of X-ray free-electron laser pulses with reflective optics", H. Yumoto *et al.*, Nature Photonics, 7, 43 (2013).

Aluminum Kα spectra obtained by extremely strong photons with the energy below the K absorption edge (December 13, 2012)

At Linac Coherent Light Source (LCLS), Stanford, USA, a series of experimental works has been carried out based on the core-level excitation and relaxation process. One recently published paper from Stanford reports the resonant generation of Kα emission from aluminum foil (1μm thick) in a solid-plasma state created by irradiating very strong X-ray free-electron laser pulses (less than 80 fs time width, 1.6×10^{12} photons/pulse). In the experiment, quasimonochromatic (0.5% bandwidth) X-ray pulses in the energy range of 1480-1580 eV (below and slightly above the K edge of ground state Al) were focused onto a 3μm diameter spot on the sample, with a corresponding peak intensity in excess of 10^{17} W/cm^2. To analyze the X-ray spectra, the research group employed a wavelength-dispersive X-ray spectrometer with a flat ADP (101) crystal and an X-ray CCD camera. Since the same atom can absorb multiple photons contained in the single pulse time width, with L-shell holes being created and leading to the excitation of a K-shell electron into one of these L-holes, the Kα X-rays are produced. The research group studied many such emission spectra produced by tuning the XFEL energy to the K-L transitions of those highly charged ions that have transition energies below the K edge of the cold material. It was also found that resonance emission peaks broaden significantly, and this was explained as opacity effects. Because of the intensity-dependent optical depth, the transparent sample at low intensity thickens optically with an intense XFEL pulse. For more information, see the paper, "Resonant Kα Spectroscopy of Solid-Density Aluminum Plasmas", B. I. Cho *et al.*, Phys. Rev. Lett., 109, 245003 (2012).

Theoretical mechanism of inner-shell resonant absorption effects (December 11, 2012)

A Chinese group recently published a paper proposing a new interpretation of neon's absorption of extremely strong X-ray photons from an X-ray free electron laser, which was experimentally studied at Stanford in 2010 (see, L. Young *et al.*, Nature, **466**, 56 (2010)). Although the ordinary absorption edge of neon is around 867 eV, the energy becomes higher than usual because of multiple ionization. Therefore, detailed studies were done between 800 eV and 2000 eV at Stanford at that time. The main discussion here is the large discrepancies between theory and experiment found at 1050 eV, where the rates of K-shell absorption $1s \rightarrow 4p$ of Ne^{6+} and $1s \rightarrow 3p$ of Ne^{7+} are larger than the direct single-photon ionization rates by more than one order of magnitude. The authors of this paper propose that the inner-shell resonant absorption (IRA) effects be considered as the mechanism. They showed that resonant photopumping of K-shell electrons to the L, M, or even higher bound orbitals can provide an interaction strength that is two or three orders of magnitude larger than that in the continuum level. Only when the IRA effects were taken into account were the observed charge state distributions explained well. For more information, see the paper, "Inner-shell resonant absorption effects on evolution dynamics of the charge state distribution in a neon atom interacting with ultraintense x-ray pulses", W. Xiang *et al.*, Phys. Rev. A86, 061401(R) (2012).

Simulation of X-ray laser by means of dissociative core-excited states (December 7, 2012)

The recent advent of the X-ray free-electron laser (XFEL) based on self-amplified spontaneous emission (SASE) has brought new opportunities in X-ray physics and many scientific applications. On the other hand, the shot-noise start-up in the SASE mechanism lends an inherent stochastic character to X-ray pulses, leading to rather large variations both in wavelength and intensity. One strategy to solve the problem is to use an XFEL pulse to create a population inversion in a medium which then lases in the X-ray region (See, N. Rohringer *et al.*, Nature, 481, 488 (2012)). Alternatively, resonant core excitation can be used as well. Recently, a theoretical chemistry group led by Professor F. Gel'mukhanov (Royal Institute of Technology, Sweden) has published a prediction of X-ray lasing based on resonant core excitation of a molecule to a state which is subject to ultrafast dissociation, i.e., a state in which dissociation precedes the femtosecond core hole decay. As an example, Cl $2p_{1/2} \rightarrow 6\sigma$ excitation of the HCl molecule by an XFEL pulse and the subsequent ultrafast dissociation were studied. For more information, see the paper, "Dissociative X-ray Lasing", Q. Miao *et al.*, Phys. Rev. Lett., 109, 233905 (2012).

Periodicity-resonant X-ray waveguide (December 5, 2012)

Dr. Okamoto (Canon, Japan) and his colleagues have reported X-ray waveguiding based on electromagnetism in photonic crystals, using a waveguide consisting of a pair of claddings sandwiching a core with a periodic structure. For more information, see the paper, "X-ray Waveguide Mode in Resonance with a Periodic Structure", K. Okamoto *et al.*, 109, 233907 (2012).

Use of partial coherence in coherent X-ray diffraction imaging experiments (December 3, 2012)

Coherent X-ray diffraction imaging is a promising new technique to observe samples in material science and biology with a spatial resolution of around 10 nm. However, the range of applications is still not very wide, because the method requires that the X-ray source be highly coherent both laterally and longitudinally. Thus, one of the most important questions for users is the feasibility of the technique when only a partially coherent source is available. A research group led by Professor K. Nugent (University of Melbourne, Australia) has recently reported some quite good news on this issue. So far, it has been often said that the lateral coherence length should be at least twice the greatest spatial extent of the object. The longitudinal coherence length is determined by the bandwidth of the monochromatic X-ray beam. According to the present study, one could relax the minimal criteria by a factor of 2 for both lateral coherence length and longitudinal coherence length, if the coherence properties are known either *a priori* or through experiment. In other words, more flux could be made available at the sample position for the coherent X-ray diffraction imaging experiments with the use of a partially coherent X-ray source. For more information, see the paper, "Diffraction imaging: The limits of partial coherence", B. Chen *et al.*, Phys. Rev. B86, 235401 (2012).

Grazing-incidence X-ray analysis to see buried structures (November 22, 2012)

Dr. B. Beckhoff (Physikalisch-Technische Bundesanstalt, Germany) and his colleagues have recently published some successful applications of grazing-incidence X-ray fluorescence and near-edge X-ray absorption fine structure to nano-scale thin layers of chemically vapor deposited $B_xC_yN_z$ on metallic Ni. For more information, see the paper, "Nondestructive and Nonpreparative Chemical Nanometrology of Internal Material Interfaces at Tunable High Information Depths", B. Pollakowski *et al.*, Anal. Chem., 85, 193 (2013).

Realtime X-ray phase and stress analysis (November 5, 2012)

A German group at Karlsruhe Institute of Technology has recently reported a quick X-ray diffraction experiment during laser surface hardening of materials. They employed a single exposure setup with two fast silicon strip line detectors (Mythen 1K, Dectris Ltd.), allowing for stress analysis according to the $\sin^2\psi$ profile, and the measurements were done at beamline P05, PETRA III, DESY, Hamburg in Germany. A 6 kW diode laser was used for hardening of the material at a heating/cooling rate of 1000 K/s. In the paper, they described how they can perform high-resolution strain analysis by separating elastic and thermal strains. For more information, see the paper, "Fast in situ phase and stress analysis during laser surface treatment: A synchrotron x-ray diffraction approach", V. Kostov *et al.*, Rev. Sci. Instrum., 83, 115101 (2012).

EXAFS analysis of negative expansion (February 23, 2012)

An interesting paper has been published showing the extended X-ray absorption fine structure (EXAFS) as evidence of negative expansion of CdTe crystal. Measurements were done for both the K edges of cadmium and tellurium, from 4.2 K to room temperature. For more information, see the papers, "Negative thermal expansion in crystals with the zincblende structure: an EXAFS study of CdTe", N Abd el All *et al.*, J. Phys.: Condens. Matter 24, 115403 (2012).

Professional

2013 International Symposia jointly organized by American MRS and Japanese Applied Physics Society (January 15, 2013)

The Japan Society of Applied Physics (JSAP) and the Materials Research Society (MRS) have announced the 2013 JSAP-MRS Joint Symposia, which will be held in Doshisha University, Kyoto, Japan on September 16-20, 2013. This meeting features 23 joint symposia from A to W, and readers should note that Symposium G concerns X-rays; "Exploring the Science of Exposed and Buried Interfaces with Advanced X-ray Techniques". For more information, see the Web page, https://www.gakkai-web.net/gakkai/jsap/jsap_mrs/hp/index.html

Canadian Light Source's scientists help the Middle East (January 14, 2013)

The Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) is the largest science project in the region and the only collaborative project involving several Arab nations, as well as Jordan, Turkey, Cyprus, Iran and Israel. Recently the Canadian Light Source has announced that their staff scientists are helping the project by providing experimental skills and knowledge. Experiments at the SESAME synchrotron are expected to begin in 2015. For more information, see the Web page, http://www.lightsource.ca/media/media_release_20130115.php

New products

Fujifilm's new digital X-ray imaging system (January 17, 2013)

Fujifilm Corporation has launched FCR Dynamix System for non-destructive testing. For further information, visit the web page, http://www.fujifilm.com/news/n130117.html

New application package for SPECTRO xSORT handheld XRF spectrometer (December 18, 2012)

SPECTRO has equipped the SPECTRO xSORT handheld XRF spectrometer with a new application package for the analysis of precious metals such as gold and silver. For further information, visit the web page, http://www.spectro.com/

Corporate

Hitachi acquires SII Nano Tech (January 1, 2013)

Hitachi High-Technologies Corporation (TOKYO: 8036, Hitachi High-Tech) has announced the acquisition of all shares of SII NanoTechnology Inc. from Seiko Instruments Inc. (SII). The new company name is Hitachi High-Tech Science Corporation. For further information, visit the web page, http://www.hitachi-hitec-science.com/en/index.shtml

Spectris acquires Analytical Spectral Devices Inc. (November 26, 2012)

Spectris plc (LSE: SXS) has announced that it has signed an agreement to acquire Analytical Spectral Devices Inc. for a debt and cash-free net consideration of $14 million. For further information, visit the web page, http://www.panalytical.com/SpectroscopyNow.com

For additional news about X-ray analysis and other spectroscopy sciences, please browse the Wiley website. http://www.SpectroscopyNow.com

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News

Sciences

Application of ptychography to visualization of dislocations in silicon single crystal (March 7, 2013)

Professor Y. Takahashi (Osaka University, Japan) and his colleagues have recently reported that coherent X-ray imaging using Bragg diffraction can aid the observation of nanoscale dislocation strain fields in a silicon single crystal. The experiments were done with 11.8 keV micro-focused X-ray photons, around 1 μm in both directions, using KB mirrors at BL-29XUL, SPring-8, Japan. In this research, a 1 μm thick silicon (100) single crystal was placed in the X-ray path so that X-rays could pass through it and the 220 Bragg reflection spot was observed by a CCD camera 2 m behind the sample. The sample was scanned in XY directions as well. The research team found phase singularities, i.e., two pairs of vortices with opposite directions in the phase map, that corresponded to the locally dark positions in the intensity map. It was concluded that this corresponded to the projection of the {111} dislocation loops. For more information, see the paper, "Bragg x-ray ptychography of a silicon crystal: Visualization of the dislocation strain field and the production of a vortex beam", Y. Takahashi *et al*., Phys. Rev. **B87**, 121201(R) (2013). DOI:10.1103/PhysRevB.87.121201

X-ray fluorescence holography with 50W low power X-ray source (February 28, 2013)

Dr. P. Korecki (Jagiellonian University, Poland) and his colleagues have recently published a fairly impressive, successful 3D analysis of Cu_3Au (001) single crystal by white-beam X-ray fluorescence holograms measured using a 50W tungsten X-ray tube (50 kV, 1 mA, with 0.8 mm Al filter). Primary X-ray photons at the aperture, which is placed at 340 mm from the source, are around 2×10^8 counts/sec. The sample was positioned 610 mm from the sample, and was rotated relative to the incident beam around two axes (θ, φ). The X-ray fluorescence intensity of Cu K and Au L lines was measured by a Si drift detector (SDD) with a 25 mm^2 effective area, placed at a distance of 12 mm from the sample. The typical counting rate was around 10^5 counts/sec, and the total acquisition time was ~90 h, i.e., 4 days. It was demonstrated that a 3D image of the sample was reconstructed from the recorded holograms. Readers might be surprised to know that such a non-efficient experiment can be done even with a low power source. As the authors claim at the end of this paper, the measuring time can be reasonably shortened by the use of more powerful laboratory X-ray sources. For more information, see the paper, "Element sensitive holographic imaging of atomic structures using white x rays", K. M. Da.browski *et al*., Phys. Rev. **B87**, 064111 (2013). DOI:10.1103/PhysRevB.87.064111

3D chemical mapping with confocal X-ray fluorescence spectro-microscopy (February 27, 2013)

Dr. B. Kanngießer (Technische Universität Berlin, Germany) and her colleagues have recently reported further advances in 3D chemical mapping using a confocal X-ray fluorescence setup. The research group has obtained nondestructive reconstruction of stratified systems with constant elemental composition but with varying chemical compounds. For more information, see the paper, "Three-Dimensional Chemical Mapping with a Confocal XRF Setup", L. Luhl *et al*., Anal. Chem., Article ASAP (DOI: 10.1021/ac303749b).

Accuracy and uncertainties of V Kβ spectral profile (February 26, 2013)

A team led by Professor C. T. Chantler (University of Melbourne, Australia) has published vanadium Kβ spectra from metallic foil, measured with medium energy resolution but with high accuracy. For more information, see the paper, "Characterization of the Kβ spectral profile for vanadium", L. F. Smale *et al*., Phys. Rev. **A87**, 022512 (2013). DOI:10.1103/PhysRevA.87.022512

"Measure and Sort" approach to reduce jitter in femtosecond pump-probe experiments (February 17, 2013)

In spite of the recent advent of few fs pulse X-ray free-electron laser sources, so far, synchronization between optical lasers and X-ray pulses has been challenging, and the jitter, typically, 100 ~ 200 fs r.m.s., has limited the time-resolution of the measurement. At the Linac Coherent Light Source (LCLS), Stanford, scientists have recently solved this problem by introducing a "measure-and-sort" approach, which records all single-shot data with time information to ensure resorting of the data. In the beamline, the same optical laser beam is split into three beams: with the first, the relative delay between laser and X-ray is encoded into wavelength by using a broadband chirped supercontinuum; in the second, the temporal delay is spatially encoded; in the third, pump-probe experiments are performed with time-sorting tools. It was concluded that the error in the delay time between optical and X-ray pulses can be substantially improved to 6 fs r.m.s., leading to time-resolved measurement with only a few fs resolution. For more information, see the paper, "Achieving few-femtosecond time-sorting at hard X-ray free-electron lasers", M. Harmand *et al*., Nature Photonics, doi:10.1038/nphoton.2013.11; published online, February 17, 2013.

Multiple ionization of krypton at around L edges by X-ray free-electron laser (February 19, 2013)

The extremely high peak power of an X-ray free electron laser pulse can be an attractive tool for clarifying the core-level excitation and relaxation process. Recently, Dr. B. Rudek and his colleagues have reported their time-of-flight ion spectroscopy studies on sequential inner-shell multiple ionization of krypton at photon energies at 2 keV and 1.5 keV, which are higher than the LI (~1.92 keV) and lower than the LIII (~1.67 keV) edges for ordinary neutral krypton, respectively. The experiments were done with two X-ray pulse widths (5 and 80 fs) and various pulse energies (from 0.07 to 2.6 mJ), at the Linac Coherent Light Source (LCLS), Stanford, USA. The highest charge state observed at 1.5 keV photon energy (below the LI edge) is Kr^{17+}; at 2 keV photon energy (above the LIII edge), it is Kr^{21+}. It was found that theoretical calculations based on a rate-equation model can explain the obtained experimental data for 1.5 keV, but fails to do so at 2 keV, where the experimental spectrum shows higher charge states. They discussed that this enhancement is due to a resonance-enhanced X-ray multiple ionization mechanism, i.e., resonant excitations followed by autoionization at charge states higher than Kr^{12+}, where direct L-shell photoionization at 2 keV is energetically closed. For more information, see the paper, "Resonance-enhanced multiple ionization of krypton at an x-ray free-electron laser", B. I. Cho *et al*., Phys. Rev. **A87**, 023413 (2013). DOI:10.1103/PhysRevA.87.023413

Energy shifts of Ti Kα induced by polarized ultrashort infrared laser pulse (February 13, 2013)

One promising application of laser-matter interactions is generating hot suprathermal electrons with keV-MeV energy, which enables excitation of the K shell of the target material. Recently, Dr. G. Cristoforetti (Intense Laser Irradiation Laboratory, Italy) and his colleagues have reported some interesting experiments on the laser pulse polarization effect on the Kα yield and line shape. The research group studied the interaction of an ultrashort laser pulse ($\lambda = 800$ nm, $\tau = 40$ fs) with a Ti foil under intense irradiation. The K X-ray emission was analyzed by a quartz crystal and a CCD camera, and it was found that the energy of Kα lines shift a few eV up to around 15 eV, depending on the pulse polarization. Such dependence can be discussed by considering the efficiency of hot electron generation. For more information, see the paper, "Spatially resolved analysis of Kα x-ray emission from plasmas induced by a femtosecond weakly relativistic laser pulse at various polarizations", G. Cristoforetti *et al*., Phy. Rev. **E87**, 023103 (2013). DOI:10.1103/PhysRevE.87.023103

Lens-less high-resolution imaging with partially coherent X-ray photons (February 7, 2013)

Coherent X-ray diffractive imaging has made remarkable progress over the past 15 years. The technique basically reconstructs real space microscopic images with the spatial resolution of *nm* without the use of lenses, mainly because of the ability to retrieve phases. However, it relies on the degree of high coherence of the available X-ray photon beam, and, until now, almost all experimental studies have been subject to some limits. It is not very easy to satisfy the ideal conditions, mainly because of the partial coherence of the beam itself and some decoherence caused by imperfect detection as well as the dynamic motions of the sample. Dr. P. Thibaut (Technische Universität München, Germany) and his colleague have recently reported their analytical studies into extending ptychography by formulating it as low-rank mixed states. The procedure is closely related to quantum state tomography and is equally applicable to high-resolution microscopy, wave sensing and fluctuation measurements. They concluded that some of the most stringent experimental conditions in ptychography can be relaxed, and susceptibility to imaging artifacts is reduced even when the coherence conditions are not ideal. For more information, see the paper, "Reconstructing state mixtures from diffraction measurements", P. Thibault *et al*., Nature, **494**, 68 (2013). DOI:10.1038/nature11806

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Final magnet girders installed at NSLS II, Brookhaven (March 6, 2013)

The construction of Brookhaven's National Synchrotron Light Source II is approaching its final stage. Recently the last of 150 magnet girders was installed in the storage ring. Magnets traveled from across the globe, supplied by ring magnet vendors based in six countries: Buckley Systems Ltd (New Zealand), Budker Institute of Nuclear Physics (Russia), Danfysik (Denmark), Everson Tesla Incorporated (U.S.), Institute of High Energy Physics (China), and Tesla Engineering (U.K.). In the experimental hall, meanwhile, 17 hutches have been delivered and constructed for seven beamlines; CSX1 and CSX2 (two branches of Coherent Soft X-ray Scattering and Polarization), CHX (Coherent Hard X-ray Scattering), IXS (Inelastic X-ray Scattering), HXN (Hard X-ray Nanoprobe), SRX (Submicron Resolution X-ray Spectroscopy) and XPD (X-ray Powder Diffraction). For further information, visit the Web page, http://www.bnl.gov/ps/news/news.php?a=23725

An explanation of the CSX beamline construction can be viewed on You Tube.

http://www.youtube.com/watch?feature=player_embedded&v=rximpW0aR9A

Three US scientists awarded 2013 Japan Prize (January 30, 2013)

The Science and Technology Foundation of Japan has announced that three US scientists have been named as laureates of the 2013 (29th) Japan Prize. Professors Grant Willson (University of Texas at Austin) and Jean Fre'chet (King Abdullah University of Science and Technology) have received the prize in this year's category of "Materials and Production" for their development of chemically amplified resist polymer materials for innovative semiconductor manufacturing process. Professor John Frederick Grassle (The State University of New Jersey) was selected in the other prize category of "Biological Production and Biological Environment" for his contributions to marine environmental conservation through research on ecology and biodiversity of deep-sea organisms. They will receive certificates of merit, and commemorative medals. There is also a cash award of fifty million Japanese yen for each prize category. The presentation ceremony is scheduled to be held in Tokyo on Wednesday 24th, April, 2013. The prize categories for the 2014 (30th) Japan Prize will be "Electronics, Information and Communications" and "Life Science". For further information, visit the Web page, http://www.japanprize.jp/en/index.html. Selected scenes from the 2012 ceremony can be viewed on You Tube.

http://www.youtube.com/watch?v=E6PhvtTdgt8&feature=youtu.be

New products

PANalytical's new XRF software (March 12, 2013)

PANalytical has launched new software for X-ray fluorescence (XRF) systems. Stratos is a brand new software package, for both the Epsilon 3 and Axios spectrometer ranges. The company will also be releasing an upgrade of the FingerPrint software for the Epsilon 3 range. For further information, visit the web page, http://www.panalytical.com/Home.htm

Rigaku introduces biological SAXS (February 15, 2013)

Rigaku Corporation has announced the introduction of the new BioSAXS-1000 AUTO, a leap forward for experimental biological SAXS (small angle X-ray scattering) workflow for the home lab. For further information, visit the web page, http://www.rigaku.com/

Corporate

Hitachi High-Tech Science relocates Tokyo sales office (March 15, 2013)

Hitachi High-Tech Science Corp. has announced that its sales department's Tokyo office will move to a new address, 24-14, Nishi-Shimbashi 1-chome, Minato-ku, Tokyo 105-0003, Japan, and commence operation from April 1, 2013. For further information, visit the web page, http://www.hitachi-hitec-science.com/en/

Bruker opens two new centers of excellence in Mumbai and Bengaluru (February 26, 2013)

Bruker has announced the grand openings of its new Mumbai and Bengaluru Centers of Excellence (CoE). For over 30 years, the company has grown sales and service capabilities in most major cities in India, including New Delhi, Mumbai, Bengaluru, Chennai, Kolkata, Lucknow and Hyderabad. For further information, visit the web page, http://www.bruker.com/

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