X-RAY Spectrometry

Published online in Wiley Interscience:

(www.interscience.com) DOI 10.1002/xrs.1236

News

Sciences

Kβ/Kα intensity ratio in Cr, Fe and Ni (November 10, 2009)

Dr. I. Han (Adrı Ybrahim Çeçen University, Turkey) and his colleagues have published a paper on the relationship between the Kβ/Kα X-ray fluorescence intensity ratio and valence-electron configurations. For more information, see the paper, ''Valence-electron configuration of Fe, Cr, and Ni in binary and ternary alloys from Kβ-to-Kα X-ray intensity ratios'', I. Han *et al*., Phys. Rev. **A80**, 052503 (2009).

X-ray reflectivity analysis of self assembled nano patterns (November 9, 2009)

Foamlike, cellular structures of the monolayer of organic capped nanoparticles can sometimes be observed on liquid surfaces. Professor M. K. Sanyal (Saha Institute of Nuclear Physics, India) and his lab members studied the time evolution in the structure and morphology of transferred monolayers of gold-thiol nanoparticles, formed at the air-water interface at different surface pressure, on to a silicon surface. The research group employed two complementary techniques, X-ray reflectivity and atomic force microscopy (AFM), to see the whole drying-mediated self-assembly of nanoparticles. For more information, see the paper, ''Nanopattern formation in self-assembled monolayers of thiol-capped Au nanocrystals'', R. Banerjee *et al*., Phys. Rev. **E80,** 056204 (2009).

Soft and hard X-ray diffraction microscopy of frozen biological specimens (November 5, 2009)

So far, X-ray microscopy with many types of lens has achieved great success in the observation of biological cells. In order to extend the limits of spatial resolution and efficiency, X-ray diffraction microscopy (also called coherent X-ray diffraction imaging), which uses coherent X-rays and some image reconstruction algorithms instead of an optical lens system, is now considered as a promising procedure to see whole cells at once and pick out much smaller features, down to around 10 nm or even less. A research group led by Professor C. Jacobsen (Stony Brook University, USA) recently reported the results for yeast cells with 520 eV soft X-rays at the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory, USA. Dr. A. Madsen (European Synchrotron Radiation Facility (ESRF), Grenoble, France) and his colleagues observed the cells of the bacteria D. radioduran with 8 keV X-rays. The advantage of using hard X-rays is the ease of sample handling, and the validity of thin sample approximation for future 3D reconstructions through phasing a diffraction volume. In both cases, a rapid freezing technique (instead of previously used freeze-drying) was used to avoid the effects of radiation damage from synchrotron X-ray photons. The Stony Brook group plunged cells in their natural wet state into liquid ethane and maintained them at below $-170\,^{\circ}$C, leading to the reduction of artifacts due to damage from dehydration, ice crystallization, and radiation. In the ESRF setup, as absorption in air of 8 keV X rays is small, a nonvacuum environment was implemented for ease of sample handling. Similar to the system for macromolecular crystallography applications, they based the samples in a continuous cryogenic nitrogen gas jet at around $-165\,^{\circ}$C. The spatial resolution was 25 nm and 30–50 nm, for soft and hard X-rays cases, respectively. For more information, see the papers, ''Soft X-ray diffraction microscopy of a frozen hydrated yeast cell'', X. Huang *et al*., Phys. Rev. Lett., **103,** 198101 (2009), and ''Cryogenic X-ray diffraction microscopy for biological samples'', E. Lima *et al*., Phys. Rev. Lett., **103,** 198102 (2009)

Direct observation of $BaTiO_3$ polarization clusters by soft X-ray laser (November 5, 2009)

Nanometer scale dipole moments in the polarization clusters in $BaTiO_3$ are believed to be thermally excited and thermally relaxed within a picosecond time scale. However, so far, there have been no reports on the direct observation of the dynamics of these dipole moments in such a very short time scale. The limitation here is mainly due to the low spatial coherence of the X-ray beam, in particular when synchrotron radiation is used as a light source. Professor K. Namikawa (Tokyo Gakugei Univ, Japan) and his colleagues have recently obtained some interesting results. To measure the time correlation of speckle intensities, they employed a soft X-ray pulse laser (7 ps in pulse width, 3.5×10^{10} photons/sec/pulse, 13.9 nm in wavelength, band width 10^{-4}, angular spread 0.5 mrad) at Japan Atomic Energy Agency, Kizugawa, Japan, and a Michelson-type delay pulse generator as well as an X-ray streak camera. Spatial coherence in their system was estimated at more than 90%. The evolution of the relaxation time of the dipole moment near the Curie temperature (TC) was studied. It was found that the maximum relaxation time (~90 ps) appears at a temperature of 4.5 K above the TC, being coincident with the one where the maximum polarization takes place. For more information, see the paper, ''Direct observation of the critical relaxation of polarization clusters in $BaTiO_3$ using a pulsed X-ray laser technique'', K. Namikawa *et al*., Phys. Rev. Lett., **103**, 197401 (2009).

A method for evaluating the spatial coherence of an X-ray beam (November 5, 2009)

Professors T. Narayanan (ESRF, Grenoble, France), M. Giglio (XFEL, Hamburg, Germany) and their collaborators have recently published an interesting paper on a novel method to map the two-dimensional transverse coherence of an X-ray beam. The technique uses the dynamical near-field speckles formed by scattering from colloidal particles, which are executing Brownian motions. It is possible to measure the change of the interference fringes, and consequently the fluctuation of speckles. It was found that the coherence properties of synchrotron radiation from an undulator source are obtained with high accuracy. For more information, see the paper, ''Probing the transverse coherence of an undulator X-ray beam using Brownian particles'', M. D. Alaimo *et al*., Phys. Rev. Lett., **103**, 194805 (2009).

High resolution Ti Kβ'' and K$\beta_{2,5}$ spectra in PIXE (October 30, 2009)

One of the most important applications of X-ray spectroscopy is chemical state analysis. A research group led by Dr. M. Jaksic (Rudjer Boskovic Institute, Croatia) has recently reported chemical effects observed in high resolution Kβ spectra of Ti oxides and other compounds in the case of 2 MeV proton excitation. In addition to the determination of the oxidation number by the energy differences between K$\beta_{1,3}$ and Kβ_5, the sum of the relative intensities of K$\beta_{2,5}$ and Kβ'' can give information on the length of chemical bonds. The influence of self-absorption for thick samples on X-ray spectra is also discussed. For more information, see the paper, ''Chemical effects on the $K\beta''$ and $K\beta_{2,5}$ X-ray lines of titanium and its compounds'', L. Mandic *et al*., Phys. Rev. **A80**, 042519 (2009). Readers might be also interested in the recent synchrotron radiation studies on Ti oxides and other compounds reported by Dr. B. Beckoff's group (PTB, Germany), ''Evaluation of high-resolution X-ray absorption and emission spectroscopy for the chemical speciation of binary titanium compounds'', F. Reinhardt *et al*., Anal. Chem. **81**, 1770 (2009).

Novel X-ray phase-difference microscopy based on Talbot effects (October 28, 2009)

X-ray absorption microscopy is simple, but has low sensitivity in biological samples that are made of light elements. X-ray phase contrast imaging can provide contrast that is 3 orders of magnitude greater than X-ray absorption. However, phase contrast imaging has not been that widely used so far mainly because of the unusual requirements of the experimental

setup. Dr. W. Yashiro (The University of Tokyo, Japan) and his colleagues have recently proposed a novel setup that is feasible. The research group simply added a transmission grating to the setup for conventional X-ray absorption microscopy with a Fresnel Zone Plate (FZP) objective lens. Because of the self-imaging phenomenon in Talbot effects, a phase difference image can be produced by the transmission grating placed at the downstream of the back focus of the FZP. The experiment was done at beamline BL20XU, SPring-8. For more information, see the paper, ''Hard-X-Ray Phase-Difference Microscopy Using a Fresnel Zone Plate and a Transmission Grating'', W. Yashiro *et al*., Phys. Rev. Lett. 103, 180801 (2009).

Table-top soft X-ray undulator source (September 27, 2009)

Some readers might remember the news article, ''A compact synchrotron light source driven by pulse laser'', in X-ray Spectrometry, Vol. 37, No.2 (2008). The essential point is that a table top pulse laser can be used as an alternative to a linear or circular electron accelerator. The article above reported the first successful synchrotron radiation generation from laser-plasma-accelerated electrons, but the wavelength was only in the visible to infrared region. Recently, an international team led by Professors S. Karsch and F. Grunera achieved a new breakthrough. The team belongs to Munich's Cluster of Excellence ''Munich Centre for Advanced Photonics'' (MAP), in the Laboratory for Attosecond Physics (LAP) of Ludwig-Maximilians-Universitat (LMU) in Munich and the Max Planck Institute of Quantum Optics (MPQ) in Garching. In their experiment, the electron accelerator is driven by pulses from a 20 TW (850 mJ in 37 fs) laser system. Focused into a hydrogen-filled gas cell with a length of 15 mm, the laser pulses produce stable electron beams showing a quasi-monoenergetic energy spectrum with a stable peak in the range of 200–220 MeV and 7 pC of charge in the whole spectrum. In order to transport the electron beam from the plasma accelerator, the scientists employed a pair of miniature permanent-magnet quadrupole lenses, which have been found to be critical for stability. The spectrum of their 30 cm-long undulator typically consists of a main peak at a wavelength of 18 nm (fundamental), a second peak near 9 nm (second harmonic) and a high-energy cutoff at 7 nm. For more information, see the paper, ''Laser-driven soft-X-ray undulator source'', M. Fuchs *et al*., Nature Physics. **5,** 826 (2009).

Large chemical shift in Eu Lγ emission spectra (January 26, 2009)

Eu is one of the most interesting lanthanides, compounds of which often exhibit remarkable optical, electrical, and magnetic properties. Therefore, it is extremely important to develop a technique for chemical state analysis. The X-ray emission spectra of Eu had not been thought to exhibit significant chemical effects. A research group led by Professor H. Hayashi (Japan Women's Univ) firstly found a large chemical shift (~5 eV) in Eu Lγ_4 emission line, depending on the valence state. They discussed the feasibility of using this as a probe for spin- and valence-selective X-ray absorption fine structure spectroscopy. For more information, see the paper, ''Probe for spin- and valence-selective X-ray absorption fine structure spectroscopy: EuLγ_4 emission'', H. Hayashi *et al*., Anal. Chem., **81,** 1522 (2009).

Professional

The 4th Asada award and the special award 2009 (November 5, 2009)

The recipient of the 4th Asada Award, which is presented in memory of the late Professor Ei-ichi Asada (1924–2005) to promising young scientists in X-ray analysis fields in Japan, is Dr. Akiko Hokura (Tokyo Denki Univ., ''Study on accumulation of heavy metals in phytoremediation plant by synchrotron radiation micro XRF imaging and XAFS analysis''). From this year, the Discussion Group of X-ray Analysis, the Japan Society for Analytical Chemistry decided to establish the special award to recognize scientists who exhibit outstanding achievement and make a substantial contribution to the advancement of the X-ray analysis field. The recipient of the special award 2009 is Dr. Toshio Shiraiwa, who contributed greatly in the early days of X-ray absorption spectroscopy by means of his short-range order theory (''The theory of the fine structure of the X-ray absorption spectrum'', J. Phys. Soc. Jpn. 13, 847 (1958)) and also provided the basis of the fundamental parameter method in X-ray fluorescence by Fujino-Shiraiwa's formula (''Theoretical calculation of fluorescent X-ray intensities in fluorescent X-ray spectrochemical analysis'', Jpn. J. Appl. Phys. 5, 886 (1966)) The ceremony was held during the 45th Annual Conference on X-Ray Chemical Analysis, Japan, at Osaka City University, Osaka.

X-rays named top innovation by Science Museum London (November 4, 2009)

The discovery of X-rays was named the most important modern scientific achievement in a poll conducted for the Science Museum London, beating the Apollo spacecraft and DNA. Nearly 50,000 members of the public voted in the museum or online. The emblem of the London museum's centenary is now an X-ray machine. For further information, visit the museum's Web page, http://www.sciencemuseum.org.uk/

Nature News on the recent status of X-ray free electron lasers in Stanford and Hamburg (October 7, 2009)

A recent edition of Nature News featured the international race to build X-ray free electron laser facilities. At the Linac Coherent Light Source (LCLS), Stanford, USA, scientists have succeeded in lasing 8 keV X-rays and started to use them in their research since April, this year (2009). Meanwhile, soft X-ray laser FLASH, which is a pilot facility for XFEL at the European X-Ray Free-Electron Laser (XFEL), Hamburg, Germany, has been open for scientific use since 2005, and the main XFEL will be completed in 2014. Nature News interviewed various people both in Stanford (Joachim Stohr, Jerome Hastings and John Bozek) and Hamburg (Heinz Graafsma, Helmut Dosch and Massimo Altarelli). For more information, see the article, ''X-ray free-electron lasers fire up'', Eric Hand, Nature **461,** 708–709 (2009).

New Products

Solar Metrology launches line-mountable XRF tool for CIGS (November 18, 2009)

Solar Metrology (Hollbrook, NY, USA) has expanded its SMX XRF tool portfolio for film composition and thickness measurement of copper indium gallium diselenide (CIGS) photovoltaic deposition. For further information, visit the web page, http://www.solarmetrology.com/

Thermo Scientific's ARL OPTIM'X cement analyzer (November 11, 2009)

Thermo Fisher Scientific Inc. has announced the introduction of a new analytical package ARL OPTIM'X, designed specifically for the X-ray analysis of cement-related materials. For further information, visit the web page, http://www.thermo.com/

Amptek's new 129 eV energy-resolution Si drift detector (October 1, 2009)

Amptek Inc., has unveiled a new advanced Si drift detector (SDD). The new detector uses a sensor with an effective area size of 25 mm^2, while energy resolution and the peak to background ratio are 129 eV (FWHM at 5.9 keV) and 8000 : 1, respectively. This compares with 7 mm^2 and 136 eV for its previous product, the XR100-SDD. For further information, visit the web page, http://www.amptek.com/

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Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp
or sakurai@pas.tsukuba.ac.jp

X-RAY Spectrometry

(www.interscience.com) DOI 10.1002/xrs.1248

News

Sciences

MD simulation aids the analysis of local dynamics by EXAFS (January 22, 2010)

Extended X-ray absorption fine-structure (EXAFS) is a powerful tool for the analysis of atomic-scale structure around specific atoms. In addition to the determination of the atomic distance for the nearest neighboring atoms, it can give some information on the local dynamical properties of crystals. Recently, Dr. A. Sanson (Universita degli Studi di Verona, Italy) has published the results of the molecular dynamics (MD) simulation in the case of crystalline germanium. By comparing experimental EXAFS data, he could discuss the radial distribution functions of the first six coordination shells, as well as their parallel and perpendicular mean-square relative displacements as a function of temperature. For more information, see the paper, ''Local dynamical properties of crystalline germanium and their effects in extended x-ray absorption fine structure'', A. Sanson, Phys. Rev. **B81,** 012304 (2010).

Micro XRF analysis of industrial waste (January 21, 2010)

Professor M. A. Castro (Instituto de Ciencia de los Materiales de Sevilla, CSIC-Universidad de Sevilla, Spain) and his colleagues are proposing to employ micro X-ray fluorescence as a feasible and efficient solution to classify waste and also to survey the problems in the production process. For more information, see the paper, ''Application of micro-X-ray fluorescence analysis for the characterization of industrial wastes'', M. D. Alba *et al*., Ind. Eng. Chem. Res., Article ASAP (DOI: 10.1021/ie901716w).

Kβ satellites in EPMA (January 19, 2010)

Argentinian scientists have recently published a paper on the emission of X-rays in the Kβ region of Mg, Al, Si, Sc, Ti, Cr, Fe, Ni, and Zn induced by electron bombardment. The research includes the Kβ^{III} and Kβ^{IV} spectator hole transitions, the 1s $\rightarrow$ 3s quadrupole decay, the Kβ_2 and Kβ_5 diagram transitions, the structures related to radiative Auger processes, and the Kβ' and Kβ'' lines. For more information, see the paper, ''Kβ satellite and forbidden transitions in elements with $12 < Z < 30$ induced by electron impact'', S. P. Limandri *et al*., Phys. Rev. **A81**, 012504 (2010).

Diamond as a promising candidate for normal-incidence X-ray optics (January 17, 2010)

So far, it has been understood that the only way to realize hard-X-ray mirrors with near 100% reflectivity is the use of total external reflection at grazing incidence to a surface. Dr. Y. V. Shvyd'ko (Argonne National Lab, USA) and his colleagues have recently proposed to use Bragg reflections from synthetic diamond crystal. They discussed how it shows an unprecedented reflecting power at normal incidence with meV order narrow bandwidths for hard X-rays. The optics might be a good candidate for X-ray free-electron laser oscillators (X-FELO). For more information, see the paper, ''High-reflectivity high-resolution X-ray crystal optics with diamonds'', Y. V. Shvyd'ko *et al*., Nature Physics, doi:10.1038/nphys1506; published online, 17 January 2010.

Possibility of downsizing X-ray free electron laser (January 12, 2010)

Laser sources in the hard X-ray region have already become a reality at some free electron laser (FEL) facilities. However, typical hard X-ray FELs use an accelerator that is several km long to generate a ~10 GeV electron beam with ~kA peak current to drive the FEL. Dr. D. Xiang (SLAC National Accelerator Laboratory, USA) is proposing an alternative technique to generate an electron beam. He discusses the possibility of downsizing an X-ray FEL by this method. In his calculation, a 1.5 Å X-ray FEL with a saturation length within 30 m using a 3.8 GeV electron beam could be feasible. For more information, see the paper, ''Laser assisted emittance exchange: Downsizing the x-ray free electron laser'', D. Xiang, Phys. Rev. ST Accel. Beams **13,** 010701 (2010).

Resonant X-ray scattering with microbeam to explore liquid crystal (January 12, 2010)

A research group led by Professors Y. Takanishi (Kyoto University, Japan) and A. Iida (Photon Factory, KEK, Japan) has recently published its successful investigation into the local layer structure of bent-core liquid crystal, 4-Br-14-O-PIMB, which includes Br atoms. The group employed a monochromatic X-ray microbeam (3 μm × 4 μm), and observed X-ray scattering from the cell near the Br K absorption edge. They were able to discover some satellite peaks reflecting the superlattices. For more information, see the paper, ''Microbeam resonant x-ray scattering from bromine-substituted bent-core liquid crystals'', Y. Takanishi *et al*., Phys. Rev. **E81**, 011701 (2010).

X-ray studies on dynamics of micro phase separation in a block copolymer melt (January 7, 2010)

X-ray Photon Correlation Spectroscopy (XPCS) is a novel technique which reveals the slow dynamics of equilibrium and non-equilibrium processes in condensed matter systems. A group led by Professor N. P. Balsara (University of California, Berkeley, USA) has recently published research on a polystyrene-polyisoprene block copolymer melt in the vicinity of the order-disorder transition. The group combined several techniques in addition to XPCS; time-resolved small angle X-ray scattering and rheology. During their studies of ordering kinetics, it was found that two qualitatively different regimes exist, i.e., shallow and deep quench regimes, respectively. For more information, see the paper, ''Dynamic signatures of microphase separation in a block copolymer melt determined by X-ray photon correlation spectroscopy and rheology'', A. J. Patel *et al*., Macromolecules, Article ASAP (DOI: 10.1021/ ma902343m).

Ultimate hard X-ray focusing (November 22, 2009)

For many years, substantial effort has been devoted to developing a good mirror for preparing a small X-ray beam. Professor K. Yamauchi (Osaka University, Japan) and his colleagues have recently reported the breaking of the 10 nm barrier for hard X-rays. They employed a combination of two mirrors; the surface of the first mirror is deformable, in order to compensate for figure error of the second mirror. By such an adaptive optical system, the research group attained a beam size of 7 nm at 20 keV. The experiments were done at BL29XUL, SPring-8. For more information, see the papers, ''Breaking the 10 nm barrier in hard-X-ray focusing'', H. Mimura *et al*., Nature Physics doi:10.1038/nphys1457; published online: 22 November 2009; corrected online: 2 December 2009.

Picoliter droplets as reference samples for quantitative micro X-ray fluorescence (November 25, 2009)

Dr. G. J. Havrilla (Los Alamos National Lab., USA; one of the associate editors of *X-Ray Spectrometry* journal) and his colleague recently published a very interesting report on the analysis of picoliter droplets, which can be now accurately prepared using Hewlett-Packard's extremely sophisticated technology. The research targets application to analytical science, although the instrument is basically designed for inkjet printing and other similar purposes. It has been shown that dried deposits of single and multielemental solutions generated in picoliter volumes are able to

be used as references for micro X-ray fluorescence. Evaporation can have a strong influence on extremely small amounts at the picoliter level, but the research group successfully devised the optimal instrumental conditions by monitoring X-ray fluorescence intensity. For more information, see the paper, ''Picoliter droplet deposition using a prototype picoliter pipette: Control parameters and application in micro X-ray fluorescence'', U. E. A. Fittschen *et al*., Anal. Chem., **82,** 297 (2010).

Professional

Mars Rover *Spirit* loses battle to escape from sand trap (January 26, 2010)

Since 2004, NASA's Mars Exploration Rovers *Opportunity* and *Spirit* have continued to transmit a wealth of exciting images and extremely valuable analytical data on the surface of Mars, including several pieces of evidence pointing to the existence of water in sedimentary rock. Unfortunately, *Spirit* recently got stuck in a sand trap, from which it was helpless to extricate itself because two of its six wheels are not working any more. Scientists hope that, even in its marooned state, Spirit will be able to measure Martian gravity to determine if the planet is solid or liquid at its core. For further information, visit the Web page, http://www.nasa.gov/rovers

UK withdraws from European XFEL project (December 16, 2009)

The UK Science and Technology Facilities Council (STFC) has announced its withdrawal from the European XFEL project. Due to financial restrictions, the Council had to reprioritise its budget of ca. 2.7 billion Euro over the next five years. For more information, visit the UK's science programme prioritisation 2010–2015 web page,
http://www.scitech.ac.uk/About/Stats/Rev/intro.aspx

New Products

HSEASY Ver.2 - SII's new database tool for XRF spectra (December 16, 2009)

SII Nano Technology has released the HSEASY Ver.2, which provides an advanced software environment for a huge database of XRF spectra. For further information, visit the web page, http://www.siint.com/en/

Corporate

Horiba's CEO awarded French national order (January 26, 2010)

Mr. Atsushi Horiba, Chairman, CEO and President of Horiba Ltd., was recently awarded the *Ordre National de la Legion d'honneur*, which is a French order established by Napoleon Bonaparte as First Consul of the First Republic in 1802. For further information, visit the web page, http://www.horiba.com/us/en/ For further details of the *Ordre National de la Legion d'honneur*, see http://en.wikipedia.org/wiki/L%C3%A9gion_d'honneur

Thermo Fisher acquires Ahura Scientific (January 19, 2010)

Thermo Fisher Scientific Inc. announced that it has signed a definitive agreement to acquire Ahura Scientific, which is known for its field-deployed analytical instruments for human health and public safety. For further information, visit the web page, http://www.thermofisher.com/global/en/home.asp

Hamamatsu's new building at Toyooka site (January 7, 2010)

Hamamatsu Photonics K.K. has completed the construction of a new building at the main site of its electron tube division in Toyooka, Shizuoka, Japan, in order to expand its scintillator plate and light source business. For further information, visit the web page, http://jp.hamamatsu.com/en/index.html

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Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp or sakurai@pas.tsukuba.ac.jp

X-RAY Spectrometry

Published online in Wiley Interscience:

(www.interscience.com) DOI 10.1002/xrs.1259

News

Sciences

Chemometric analysis of X-ray absorption spectra helps understanding of Li battery (March 30, 2010)

Dr. M. Giorgetti (University of Bologna and Unita di Ricerca INSTM di Bologna) and his colleagues recently reported the successful application of the chemometric approach to a series of in-situ near edge X-ray absorption spectra of a $Cu_{0.1}V_2O_5$ xerogel/Li ion battery. The research group discusses how the multivariate curve resolution (MCR) technique and also fixed size windows evolving factor analysis (FSWEFA) are useful in determining the number of species and the ratio. It was found that three different species co-exist during battery charging. For more information, see the paper, ''Multivariate Curve Resolution Analysis for Interpretation of Dynamic Cu K-Edge X-ray Absorption Spectroscopy Spectra for a Cu Doped V_2O_5 Lithium'', P. Conti *et al.*, Anal. Chem., Article ASAP (DOI: 10.1021/ac902865h)

Ultra fast X-ray absorption spectroscopy of Ni during demagnetization (March 30, 2010)

A German group at BESSY II recently succeeded in studying the evolution of both the spin (S) and orbital angular (L) momentum of a thin Ni film during ultrafast demagnetization, by means of X-ray magnetic circular dichroism (XMCD). It was found that both S and L components decrease by irradiating a femtosecond laser pulse, and the time constant is 130 ± 40 fs. For more information, see the paper, ''Femtosecond x-ray absorption spectroscopy of spin and orbital angular momentum in photoexcited Ni films during ultrafast demagnetization'', C. Stamm *et al.*, Phys. Rev, **B81,** 104425 (2010).

Application of soft X-ray laser pulse to structure analysis of nano crystals (March 26, 2010)

Professor S. Techert (Max-Planck-Institute for Biophysical Chemistry, Goettingen, Germany) and his colleagues have reported on Bragg diffraction experiments with a soft X-ray laser (wavelength 8 nm, pulse width 30 fs, power 4×10^{11} photons/pulse) from the free electron laser at FLASH, Deutsche Elektronen-Synchrotron (DESY) in Hamburg. The research group studied Bragg diffraction patterns of single nano-crystal (20 nm $\times$ 20 nm $\times$ 20 µm) and powder with grain sizes smaller than 200 nm of silver behenate ($AgC_{22}H_{43}O_2$, chain length 5.8 nm). So far, many coherent X-ray diffraction studies have been done even with soft X-ray wavelengths, but the present research aims at the analysis of periodic structures that are usually targets of X-ray diffraction with hard X-rays. They showed an interesting comparison between the single nano crystal and the powder, and also discussed the influence of the extremely high peak power of laser pulses. For more information, see the paper, ''Diffraction Properties of Periodic Lattices under Free Electron Laser Radiation'', I. Rajkovic *et al.*, Phys. Rev. Lett. 104, 125503 (2010).

Novel feasible approach to refinement of atomic-scale structure of complex disordered systems (March 26, 2010)

There are still many unknown problems related to the structure of amorphous materials, because the X-ray diffraction technique has some limitations in the case of disordered systems. A research team led by Dr. A. L. Goodwin (Oxford University, UK) recently reported a new elegant general scheme to solve the structure by successfully demonstrating its application to molecular C_{60}, a-Si, and a-SiO_2. The team proposes to employ the information gained in spectroscopic experiments (such as EXAFS, Raman, NMR etc) regarding the number and distribution of atomic environments. The idea is that such information can be used as a valuable constraint in the refinement of the atomic-scale structures of nanostructured or amorphous materials from the pair distribution function (PDF), which is obtained by Fourier transform of the X-ray diffraction pattern. Although a conventional reverse Monte Carlo (RMC) approach is not always successful in obtaining the correct structure solution, the team showed that such difficulties can be removed by including the above variance term. For more information, see the paper, ''Structure Determination of Disordered Materials from Diffraction Data'', M. J. Cliffe *et al.*, Phys. Rev. Lett. 104, 125501 (2010).

Coherence theory of X-ray and neutron reflectivity (March 23, 2010)

A Dutch neutron research group at Delft University of Technology, Netherlands, recently published a paper describing the extension of their coherence theory on neutron scattering to X-ray reflectivity. For more information, see the paper, ''Coherence approach in neutron, x-ray, and neutron spin-echo reflectometry'', V. O. de Haan *et al.*, Phys. Rev. **B81**, 094112 (2010).

Atomic-resolution element mapping with energy-dispersive X-ray detector (March 8, 2010)

Professor L. J. Allen (University of Melbourne, Australia) and his colleagues have recently demonstrated atomic-resolution chemical mapping in a scanning transmission electron microscope (STEM). They obtained Sr and Ti images for $SrTiO_3$. Such images are directly interpretable mainly because the effective ionization interaction is localized. For more information, see the paper, ''Atomic-resolution chemical mapping using energy-dispersive x-ray spectroscopy'', A. J. D'Alfonso *et al.*, Phys. Rev. **B81**, 100101(R) (2010).

Production of coherent soft X-rays in storage ring (March 1, 2010)

With linac-based light sources, the electron beam has a high peak current and small energy spread, and this can be used to drive a seeded single pass free electron laser. On the other hand, the beams in a storage ring usually have a relatively low current and large energy spread. To generate ultrashort coherent radiation, the coherent harmonic generation (CHG) technique is a promising candidate. Dr. D. Xiang (SLAC National Accelerator Laboratory, USA) and Dr. W. Wan (Lawrence Berkeley National Laboratory, USA) have recently proposed a scheme to extend the harmonic number of the CHG technique by an order of magnitude using angular-modulated electron beams in the storage ring. The technique has the potential of generating femtosecond coherent soft X-ray radiation directly from an infrared seed laser. For more information, see the paper, ''Generating Ultrashort Coherent Soft X-Ray Radiation in Storage Rings Using Angular-Modulated Electron Beams'', D. Xiang *et al.*, Phys. Rev. Lett. **104,** 084803 (2010).

Accurate X-ray mass attenuation coefficients of zinc (February 22, 2010)

An Australian research group has recently published experimentally obtained X-ray mass attenuation coefficients of zinc for 7.2–15.2 keV X-rays with an absolute accuracy of 0.044% and 0.197%. For more information, see the paper, ''X-ray mass attenuation coefficients and imaginary components of the atomic form factor of zinc over the energy range of 7.2.15.2 keV'', N. A. Rae *et al.*, Phys. Rev. **A81**, 022904 (2010).

CTR analysis of Rubrene single crystal thin films (February 12, 2010)

Rubrene (5,6,11,12-tetraphenylnaphthacene, $C_{42}H_{28}$) is a red colored polycyclic aromatic hydrocarbon. As an organic semiconductor, the most

promising application is in organic light-emitting diodes (OLEDs) and organic field-effect transistors, which are the core elements of flexible displays. Recently, Professor Y. Wakabayashi (Osaka University, Japan) and his colleagues have studied the near surface structure of Rubrene single crystal by crystal truncation rod (CTR) scattering, which gives a modulated profile in the tail of a series of Bragg peaks (0 0 ζ). The research group employed coherent Bragg rod analysis (COBRA) rather than conventional curve fitting analysis to determine the electron density profile along the depth. The analysis has shown that the molecules at the surface are slightly expanded along the surface normal direction, while the second or deeper molecular layers are not affected by the existence of the surface. Their research can be extended to applications of other similar organic semiconductors. For more information, see the paper, "Sub-Å Resolution Electron Density Analysis of the Surface of Organic Rubrene Crystals", Y. Wakabayashi *et al*., Phys. Rev. Lett. **104,** 066103 (2010). For information on COBRA, see, for example, "Direct determination of epitaxial interface structure in Gd_2O_3 passivation of GaAs", Y. Yacoby *et al*., Nature Materials **1,** 99 (2002).

X-ray nanofocusing by kinoform lenses (February 1, 2010)

Dr. H. Yan (National Synchrotron Light Source II, Brookhaven National Laboratory, USA) has recently reported a comparative study on various kinoform lenses for X-ray nanofocusing. He employed the geometrical theory, the dynamical diffraction theory, and the beam propagation method, and showed that the geometrical theory becomes invalid. The influence of the edge diffraction effect from the individual lens element was studied in view of the limit of the focus size. It was also shown that the length of the lenses can be optimized to reduce the wave field distortion. For more information, see the paper, "X-ray nanofocusing by kinoform lenses: A comparative study using different modeling approaches", H. Yan, Phys. Rev. **B81**, 075402 (2010).

Professional

The 4th X-ray reflectivity school in Japan (March 16, 2010)

Demand for learning analytical techniques for surfaces and interfaces appears to be on the increase. In Tokyo, Japan, the 4th tutorial course on the analysis of thin films and multilayers by X-ray reflectivity was held on March 16. The first Japanese textbook that serves as an introduction to X-ray reflectivity was published in 2009 (also translated into Korean in 2010), and the 8 authors gave lectures as part of the course. Further information is available at http://www.nims.go.jp/xray/ref/(in Japanese only).

Japanese and US scientists awarded 2010 Japan Prize (January 15, 2010)

The Science and Technology Foundation of Japan has announced that Japanese and US scientists have been named as laureates of the 2010 (26th) Japan Prize. Dr. Shun-ichi Iwasaki, 83, Director of Tohoku Institute of Technology in Japan, and also Professor Emeritus, Tohoku University, has received the prize in this year's category of "Industrial production and production technology" for his contributions to high-density magnetic recording technology by developing a perpendicular magnetic recording method. Dr. Peter Vitousek, Professor of Biology, Stanford University in the United States, 60, was selected in the other prize category of "Biological production and environment" for his contributions to solving global environmental issues based on the analysis of nitrogen and other substances' cycles. 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 21st April, 2010. The prize categories for the 2011 (27th) Japan Prize will be "Information and communications" and "Bioscience and medical science". For further information, visit the Web page, http://www.japanprize.jp/en/index.html.

New Products

Bruker releases new D8 DISCOVER (March 23, 2010)

Bruker AXS has announced the introduction of its next-generation D8 DISCOVER diffraction system. It comes with a two-dimensional VANTEC-500 detector with 2048 × 2048 channels at 144 cm^2 active area. For further information, visit the web page, http://www.bruker-axs.de/new_d8_discover.html.

SII's new coating thickness gauge (March 15, 2010)

SII Nano Technology has announced the release of its SFT-110 coating thickness gauge, which determines the thickness of each layer by analyzing X-ray fluorescence intensity from each element. One newly introduced function is automatic positioning of the sample. The system includes software for analysis based on the fundamental parameter method. The price is around 6 million JPY. For further information, visit the web page, http://www.siint.com/en/.

PANalytical introduces 3D detector for X-ray diffraction (March 1, 2010)

PANalytical has announced the introduction of its new PIXcel^{3D} detector for its X-ray diffraction system. The PIXcel^{3D} detector is the result of the Medipix2 collaboration - a consortium of more than 16 leading particle physics research institutes across Europe, headed by CERN. It is the only detector that offers four modes – in addition to 0D (point detector), 1D (line detector), and 2D (area detector) modes, it has 3D mode. The new detector can be used for computed tomography (CT) on a diffraction platform. For further information, visit the web page, http://www.panalytical.com/.

Corporate

PANalytical and SODERN form alliance in neutron spectrometers (March 24, 2010)

PANalytical (Almelo, the Netherlands) and SODERN (Limeil-Brevannes, France) have recently agreed an alliance for the distribution and support of SODERN's neutron-based cross-belt analyzers, which are used in the cement, minerals and coal industries.

For further information, visit their web pages, http://www.panalytical.com/and http://www.sodern.com.

SpectroscopyNow.com

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

Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp or
sakurai@pas.tsukuba.ac.jp

X-RAY Spectrometry

(www.interscience.com) DOI 10.1002/xrs.1266

News

Sciences

Laser-based femtosecond X-ray pulse source (May 27, 2010)

A Chinese group led by Professor J. Zhang (President of Shanghai Jiao Tong University) recently published a report on the generation of X-ray pulses of around 3 keV by using an Ar clustering gas jet target (~3 mm dia.) and a Ti : sapphire laser (power 800 mJ, pulse width 28 fs, wavelength 800 nm, frequency 10 Hz). The intensity of the Ar K-shell emissions in the forward direction was found to be around 10^4 photons/mrad^2/pulse. The group emphasized the significance of laser contrast, which is a ratio of the main pulse and pre-pulse, and found that X-ray flux is reduced by 2 orders of magnitude if the laser pulse contrast decreases from 10^9 to 10^7 with constant laser pulse energy. For more information, see the paper, ''Intense High-Contrast Femtosecond K-Shell X-Ray Source from Laser-Driven Ar Clusters'', L. M. Chen *et al*., Phys. Rev. Lett. **104,** 215004 (2010).

Synchrotron X-ray fluorescence imaging of a 150 million year old dinobird (May 18, 2010)

An international team of paleontologists, geochemists and physicists led by Dr. R. A. Wogelius (University of Manchester, UK) recently employed X-ray fluorescence imaging to analyze a 150 million year old fossil of *Archaeopteryx*, which had dinosaur-like teeth and bird-like feathers. For many years, it was believed that the fossil contained nothing but bone and rock. However, the use of a brilliant synchrotron X-ray beam enabled the detection of chemical elements hidden within. It was found that the fossil still had elemental compositions that were completely different from the embedding geological matrix. The researchers completed the chemical map of the dinobird for 12 elements for the first time. Some phosphor and sulfur were found in soft tissue, as well as trace zinc and copper in bone. The experiment was done at wiggler beam line 6-2 at Stanford Synchrotron Radiation Lightsource (SSRL, California, USA). For more information, see the paper, ''*Archaeopteryx* feathers and bone chemistry fully revealed via synchrotron imaging'', U. Bergmann *et al*., Proc. Nat. Aca. Sci., 107, 9060 (2010).

X-ray studies on surface ordering in cold liquids (May 17, 2010)

Professor P. Dutta (University of Chicago) and his colleagues recently clarified that the surface density profile acquires layered structures at 0.2 T_c; T_c is the liquid-gas critical temperature. The present research was for dielectric liquids, pentaphenyl trimethyl trisiloxane, and pentavinyl pentamethyl cyclopentasiloxane. The X-ray reflectivity technique was employed to determine the surface profile experimentally. The research group had previously found similar phenomena for other liquid dielectric liquids as well as liquid metals. The present studies could strengthen their series of work. For more information, see the paper, ''Surface order in cold liquids: X-ray reflectivity studies of dielectric liquids and comparison to liquid metals'', S. Chattopadhyay *et al*., Phys. Rev, **B81,** 184206 (2010).

Atomic-resolution element mapping by combination of energy-dispersive X-ray detector and aberration-correction electron microscope (May 11, 2010)

Dr. C. H. Chen (National Taiwan University, Taiwan) and his colleagues recently published a report on ultra high resolution element mapping. The research group employed a scanning transmission electron microscope (STEM) with specially enhanced spherical aberration correction. The beam size was nearly 1 Å. A silicon drift detector (Bruker XFlash-5030) was employed and set with a solid angle of 0.13 steradian. The group studied InGaAs/InAlAs superlattices, and discussed the 1.47 Å dumbbell structure using both structural imaging and mapping of characteristic X-rays (In L, Ga K and As K). For more information, see the paper, ''Emergent Chemical Mapping at Atomic-Column Resolution by Energy-Dispersive X-Ray Spectroscopy in an Aberration-Corrected Electron Microscope'', M.-W. Chu *et al*., Phys. Rev. Lett. 104, 196101 (2010).

Efficient XRD analysis of combinatorial libraries (May 5, 2010)

Combinatorial materials synthesis is a promising new way of developing and finding novel functional materials. By the use of sophisticated thin film technology, it is possible to create compositionally graded samples on the same single substrate. To analyze this combinatorial library, some novel technique is required. A UK research group led by Professor K. D. Rogers (Cranfield University, UK) recently reported on high-throughput data collection and analysis using an X-ray diffraction (XRD) probe. In the research, an extended X-ray beam was used to illuminate the libraries, and a large area detector was used to collect the data. A new algorithm was employed to analyze the collected data and extract the crystallographic information. For more information, see the paper, ''High Throughput X-ray Diffraction Analysis of Combinatorial Polycrystalline Thin Film Libraries'', S. Roncallo *et al*., Anal. Chem., 82, 4564 (2010).

Coherent X-ray diffraction imaging of weak phase object by using a high aspect ratio aperture (April 27, 2010)

Coherent X-ray diffraction imaging is one of the hottest research topics in advanced X-ray physics. The method reconstructs a real-space image from an oversampled diffraction signal by using computer algorithms instead of lenses. So far, its application has been limited to fairly strong phase objects, mainly due to parasitic scattering from the optics used for limiting the beam. Korean researchers recently published an interesting report on its application to a nonisolated weak phase object, a one-dimensional trench structure fabricated on a Si substrate. In their discussion, the authors reported that such work was enabled by employing a special aperture with a very high aspect ratio of nearly 100 made of tantalum (1.7 μm × 2.2 μm aperture with a thickness of 130 μm). For more information, see the paper, ''Coherent hard x-ray diffractive imaging of nonisolated objects confined by an aperture'', S. Kim *et al*., Phys. Rev. **B81,** 165437 (2010).

Hard X-ray full-field microscopy with computer tomography capability (April 20, 2010)

A group led by Professor Ch. David (Paul Scherrer Institute, Switzerland) recently developed a synchrotron-based full-field microscope, which can work with hard X-rays, typically 10 keV. The instrument supports tomographic absorption and phase contrast imaging with a spatial resolution of 144 nm. The researchers demonstrated phase-contrast 3D imaging of a melanocortin-3 preosteoblast cell. For more information, see the paper, ''Phase-contrast tomography at the nanoscale using hard x rays'', M. Stampanoni *et al*., Phys. Rev. B 81, 140105(R) (2010).

Bragg X-ray Fourier transform holography (April 19, 2010)

Lens-less microscopy is now widely acknowledged to be an elegant solution to the so-called phase problem in X-ray crystallography. The method is based on the digital retrieval of the phase from the object's coherently diffracted intensity patterns, with the inversion being achieved through the use of time-consuming iterative algorithms. Fourier transform holography is a similar technique, but is essentially very quick and straightforward. Dr. V. Chamard (IM2NP, CNRS, Aix-Marseille Universite, France) and her colleagues recently demonstrated 3D imaging of a SiGe nanocrystal with Fourier transform holography. One unique point of the research is that they employed Bragg geometry, rather than forward scattering geometry, to obtain full 3D information. The technique requires that a reference crystal is placed near the object crystal to

be imaged, and that the two crystals need to have comparable lattice parameters. They were successful in determining the electron density and the displacement field in 3D without suffering convergence problems, which are often the case with lens-less imaging iterative algorithms. For more information, see the paper, ''Three-Dimensional X-Ray Fourier Transform Holography: The Bragg Case'', V. Chamard *et al*., Phys. Rev. Lett. **104,** 165501 (2010).

Professional

DOE approves upgrade of Advanced Photon Source, Argonne (May 3, 2010)

The Advanced Photon Source has received approval from the U.S. Department of Energy (DOE) for the first stage of an upgrade to the facility. Details of the upgrade program can be found in a downloadable movie, http://www.aps.anl.gov/Upgrade/CDR

Nature Materials interviews CEO of Diamond Light Source (May 1, 2010)

In the May 2010 issue of Nature Materials, Joerg Heber interviewed Professor G. Materlik, CEO of the Diamond Light Source, UK. The article features his answers to 7 wide-ranging questions that would be of particular interest to readers, such as ''What is the future of synchrotrons?'', ''How about free-electron lasers?'' and ''Are you worried about the general science budget in the UK and about Diamond's funding?'' For more information, see the article, ''Coherence comes full circle'', Nature Materials **9,** 375 (2010).

''What are X-rays?'' exhibition at Kyoto University, Japan (April 28, 2010)

Kyoto University Museum is staging a special exhibition called ''What are X-rays?'' from April 28 to August 29. For more than 100 years, X-rays have contributed significantly to many sciences and technologies including medicine, astronomy, archaeology and even forensic science. The exhibition presents a full history of X-rays and their wide variety of applications, as well the future outlook, in a comprehensive manner that is aimed at non-specialists. Some interesting X-ray images are displayed, such as scans of a 400-year-old picture of so-called hidden Christians (who continued to practice Christianity in secret despite suppression by the government of Japan at that time) and the mummy of a bird (Crested Ibis) from ancient Egypt. During this special event, 4 lectures will be given. The museum's web page is http://www.museum.kyoto-u.ac.jp/index_e.htm

New Products

Thermo's new WDXRF spectrometer (May 20, 2010)

Thermo Fisher Scientific Inc., has announced a new addition to its ARL 9900 IntelliPower series of X-ray spectrometers. For further information, visit the web page, http://www.thermoscientific.com/xray/

e2V detector for Japanese satellite en route to Venus (May 20, 2010)

The e2v CCD47-20 was selected as the ultraviolet imager for the Japan Aerospace Exploration Agency's (JAXA) Venus Climate Orbiter ''Akatsuki'' (formally known as PLANET-C) to study the planet Venus. This sensor is a frame transfer CCD, with 1024 × 1024 pixels, each 13 μm square. The device is back-illuminated, with optimised processing and coatings for performance in the 280-365 nm wavelength range. For further information, visit the web page, http://www.e2v.com/

Corporate

Agilent Technologies acquires Varian (May 14, 2010)

Agilent Technologies Inc. has announced the acquisition of Varian, Inc. for US$1.5 billion. For further information, visit the web page, http://www.agilent.com/

Oxford Instruments receives Queen's award (April 21, 2010)

Oxford Instruments NanoScience has been awarded The Queen's Award for Enterprise: Innovation.

For further information, visit the web page, http://www.oxford-instruments.com/

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Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp
or sakurai@pas.tsukuba.ac.jp

(www.interscience.com) DOI 10.1002/xrs.1274

News

Sciences

Micro-structure imaging using visibility contrast (July 26, 2010)

Dr. W. Yashiro (University of Tokyo, Japan) and his colleagues recently reported an interesting application of X-ray Talbot interferometry, which usually gives absorption and differential-phase images. As micro-structures of the sample distort X-ray wave fronts, the research group quantitatively discusses how visibility reduction is caused and influenced. They also experimentally demonstrate that this new type of experimental method using visibility contrast is feasible for imaging micro-structures, which have been studied by ultra small angle X-ray scattering so far. For more information, see the paper, ''On the origin of visibility contrast in x-ray Talbot interferometry'', W. Yashiro *et al*., Optics Express, **18,** 16 890 (2010). For more information on visibility contrast, see the paper, ''Hard x-ray dark-field imaging using a grating interferometer'', F. Pfeiffer *et al*., Nature Materials, **7,** 134 (2008).

Carbonates of iron-magnesium on the surface of mars (July 23, 2010)

NASA's Mars Exploration Rover Spirit has obtained some significant data on the detailed chemical composition of the rock exposed on the ground surface of the Columbia Hills of the Gusev crater. It was found that the rock is a Mg-Fe carbonate ($Mc_{0.62}Sd_{0.25}Cc_{0.11}Rh_{0.02}$, where Mc = magnesite, Sd = siderite, Cc = calcite, and Rh = rhodochrosite) and a forsteritic olivine ($Fo_{0.72}Fa_{0.28}$, where Fo = forsterite and Fa = fayalite). This could suggest extensive aqueous activity under near-neutral pH conditions that would be conducive to habitable environments on early Mars. On this occasion, in addition to a X-ray spectrometer, a Mossbauer (MB) spectrometer and Miniature Thermal Emission Spectrometer (Mini-TES) greatly contributed to the findings. For more information, see the paper, ''Identification of Carbonate-Rich Outcrops on Mars by the Spirit Rover'', R. V. Morris *et al*., Science **329,** 421 (2010).

A novel technique for high-resolution soft X-ray lensless imaging (July 23, 2010)

The recent advent of coherent soft and hard X-ray sources has facilitated the development of imaging techniques that are capable of being inverted to the real space information extremely quickly. A research group at the SLAC National Accelerator Laboratory, USA, recently developed a novel technique for soft X-rays, based on differential holographic encoding, termed holography with extended reference by autocorrelation linear differential operation (HERALDO). The technique has achieved superior resolution over other similar lensless techniques, such as X-ray Fourier transform holography, while maintaining the signal-to-noise ratio and algorithmic simplicity. The spatial resolution was 16 nm, and this was obtained by synthesizing images in the Fourier domain from a single diffraction pattern, which allows resolution improvement beyond the reference fabrication limit. In addition to the capability of instant high-resolution reconstruction, the technique is found to be robust against data imperfections. It reduces artifacts arising from the commonly-missing central low-q data. For more information, see the paper, ''High-Resolution X-Ray Lensless Imaging by Differential Holographic Encoding'', D. Zhu *et al*., Phys. Rev. Lett. **105,** 043901 (2010). For more information on the original idea of HERALDO, see the paper, ''Holography with extended reference by autocorrelation linear differential operation'', M. Guizar-Sicairos and J. R. Fienup, Optics Express, **15,** 17592 (2007).

X-ray reflectivity evidence of the existence of the gap between water and hydrophobic surface (July 16, 2010)

For many years, scientists have argued about the existence of a depletion gap between water and hydrophobic surfaces. Several recent reports based on high-resolution synchrotron X-ray reflectivity seemed to give a positive conclusion, but they were not in good agreement quantitatively, mainly because the amount being discussed was at experimental resolution. A research group led by Professor P. Dutta (Northwestern University, Illinois, USA) has recently reported some synchrotron X-ray reflectivity results on the interface between water and self-assembled monolayers. To enlarge the depletion gap (if any) as much as possible, they chose hydrophobic fluoroalkylsilane, $CF_3(CF_2)_5(CH_2)_2SiCl_3$ and $CF_3(CF_2)_{11}(CH_2)_2SiCl_3$, of which the contact angles were 111 deg and 120 deg, respectively. It was found that the depleted region width increased with contact angle and exceeded the resolution. They also concluded that the contribution of its fluctuation to the interface roughness was substantially smaller than has been considered so far. For more information, see the paper, ''How Water Meets a Very Hydrophobic Surface'', S. Chattopadhyay *et al*., Phys. Rev. Lett. **105,** 037803 (2010).

X-ray fluorescence gives new insight into leonardo Da Vinci's painting technique (July 14, 2010)

X-ray fluorescence has provided new information on the technique known as ''sfumato'', which Da Vinci and other Renaissance painters used to produce delicate gradations in tones or colors across the canvas. Dr. P. Walter (Laboratoire du Centre de Recherche et de Restauration des Musees de France, CNRS, France) and his colleagues recently performed quantitative chemical analysis on seven paintings from the Louvre Museum (including the Mona Lisa), by synchrotron X-ray fluorescence at the European Synchrotron Radiation Facility (ESRF). They were able to clarify how the painter made shadows on faces by the use of layers of glaze or a very thin paint, and by means of the nature of the pigments or additives. For more information, see the paper, ''Revealing the sfumato Technique of Leonardo da Vinci by X-Ray Fluorescence Spectroscopy'', L. de Viguerie *et al*., Angewandte Chemie International Edition (Published Online: Jul 14 2010, DOI: 10.1002/anie.201001116).

A short period cryogenic undulator for future compact X-ray FEL (July 13, 2010)

Short period, high field undulators can enable short wavelength free electron lasers (FELs) at low beam energy. A research group led by Professor J. Rosenzweig (University of California, Los Angeles, USA) has recently unveiled a new design based on an approach that utilizes cryogenic materials. For more information, see the paper, ''Short period, high field cryogenic undulator for extreme performance x-ray free electron lasers'', F. H. O'Shea *et al*., Phys. Rev. ST Accel. Beams **13,** 070702 (2010).

A novel soft X-ray diffractometer at diamond light source (July 12, 2010)

Soft X-ray resonant diffraction and reflectivity have become one of the most promising tools with which to study magnetic materials. At Diamond Light Source, Oxfordshire, UK, a novel instrument for single crystal diffraction

and thin film reflectivity experiments in the soft X-ray regime has been designed and constructed. It is basically a limited three circle (θ, 2θ, and χ) diffractometer with an additional removable rotation (ϕ), and is equipped with a liquid helium cryostat, and post-scatter polarization analysis. For more information, see the paper, ''RASOR: An advanced instrument for soft x-ray reflectivity and diffraction'', T. A. W. Beale *et al*., Rev. Sci. Instrum. 81, 073904 (2010).

How silicon X-ray optics can survive against FEL power (July 8, 2010)

A Brazilian research group recently discussed the thermal influence of soft X-ray free-electron-laser (FEL) pulses on silicon substrate. Such analysis is important, because the peak power of a single FEL pulse is roughly four orders of magnitude higher than that in conventional synchrotron light facilities. Their detailed time-evolution analysis indicates that in a worst case scenario, the second pulse could be adversely affected by dynamic thermal distortion induced by the preceding pulse. For more information, see the paper, ''Thermoelastic analysis of a silicon surface under x-ray free-electron-laser irradiation'', A. R. B. de Castro *et al*., Rev. Sci. Instrum. **81,** 073102 (2010).

''Hollow'' neon atom created by X-ray laser excitation (July 1, 2010)

What happens when an atom is excited by extremely strong X-ray photons such as an X-ray laser? A Stanford research group recently published a very exciting report on the ionization of neon (Z=10) by X-ray laser at the Linac Coherent Light Source (LCLS) housed at the SLAC National Accelerator Laboratory in California, USA. The laser used in this experiment is extremely powerful (10^{18} W/cm^2, 10^5 X-ray photons/Å^2), and the research group scanned the X-ray photon energy from 800 eV to 2,000 eV, as well as the pulse width from 80 fs to 230 fs. As the K absorption edge of neon is around 867 eV, below this energy, X-rays can strip some of the eight weakly bound electrons from the outer L shell of the neon atom. Such a process of peeling electrons from atoms would come as no surprise for readers of *X-ray spectrometry*. Above the absorption edge, K shell electrons are preferentially ejected, creating 1s vacancies that are refilled by electrons from the L shell. Before the relaxation occurs, the remaining K shell electron is even more tightly bound to the neon nucleus than in the ground state. Therefore, the K absorption edge for the system with a 1s vacancy is higher than usual. When the research team raised the X-ray photon energy to 993 eV, both electrons from the inner K shell were knocked out, ionizing the atom from the inside out – in other words, coring the atom. With this ''hollow'' neon then, a completely empty K shell has been created for the first time by X-ray photons, though similar phenomena may be possible by means of ultra-high temperature plasma, extremely high-energy collision processes etc. For more information, see the paper, ''Femtosecond electronic response of atoms to ultra-intense X-rays'', L. Young *et al*., Nature **466,** 56 (2010). In the same issue, there is an interesting account by Justin Wark, ''X-ray laser peels and cores atoms'', Nature **466,** 35 (2010).

Calculation of oxyzine K XAFS spectra to discuss hydrogen bond (June 30, 2010)

The nature of the hydrogen-bond network in water and ice is one of the most interesting scientific mysteries, as it is still unsolved and always keenly debated. Professor R. Car (Princeton University, New Jersey, USA) and his colleagues recently published their calculation of the X-ray absorption spectra of water and ice with a many-body approach for electron-hole excitations. Their calculation reproduces some experimental features, including the effects of temperature change in the liquid. The spectral difference between the solid and the liquid has been explained by considering short-range order effects, such as the breaking of hydrogen bonds and a non-bonded molecular fraction in the first coordination shell. For more information, see the paper, ''X-Ray Absorption Signatures of the Molecular Environment in Water and Ice'', W. Chen *et al*., Phys. Rev. Lett. **105,** 017802 (2010). For more information on the experimental XAFS spectra of water and ice, see the paper, ''The Structure of the First Coordination Shell in Liquid Water'', Ph. Wernet *et al*., Science, **304,** 995 (2004).

Successful combination of infrared and X-ray spectroscopic imaging in the analysis of minerals (June 22, 2010)

A research group led by Professor C-U. Ro (Inha University, Korea) has recently reported the combined use of two techniques, attenuated total reflectance FT-IR (ATR-FT-IR) imaging and a quantitative energy-dispersive electron probe X-ray microanalysis, low-Z particle EPMA, for the speciation of mineral particles. For more information, see the paper, ''Speciation of Individual Mineral Particles of Micrometer Size by the Combined Use of Attenuated Total Reflectance-Fourier Transform-Infrared Imaging and Quantitative Energy-Dispersive Electron Probe X-ray Microanalysis Techniques'', H-J. Jung *et al*., Anal. Chem. **82,** 6193 (2010).

Professional

10Th anniversary of series of workshops on buried interface science with X-rays and neutrons (July 27, 2010)

The 2010 workshop on buried interface science with X-rays and neutrons was held at Nagoya University, Japan, on July 25–27, 2010. This was the latest in a series of 15 workshops held since 2001; Tsukuba (December 2001), Niigata (September 2002), Nagoya (July 2003), Tsukuba (July 2004), Saitama (March 2005), Yokohama (July 2006), Kusatsu (August 2006), Kanda-Tokyo (December 2006), Sendai (July 2007), Sapporo (September 2007), Kanda-Tokyo (December 2007), Tsukuba (March 2009), Akihabara-Tokyo (July 2009) and Hiratsuka (March 2010). There are increasing demands for sophisticated metrology in order to observe multilayered materials with nano-structures (dots, wires, etc), which are finding applications in electronic, magnetic, optical and other devices. Solid-liquid interfaces are another very important research subject. X-ray and neutron analysis is known for its ability to observe in a non-destructive manner even buried function interfaces as well as the surface. In addition to such inherent advantages, recent remarkable advances in micro analysis and quick time-resolved analysis in X-ray reflectometry are extremely important. The present workshop gathered together those with different research backgrounds, i.e., from semiconductor electronics to chemical bio materials, and even theoretical groups were invited to give insights into unsolved problems on buried interfaces. The workshop proceedings will be published in IOP conference series: Materials Science and Engineering, no later than the end of 2010.

2010 Exsa award on outstanding career in X-ray spectrometry (June 24, 2010)

Professor Rene Van Grieken (University of Antwerp, the chief editor of *X-Ray Spectrometry* journal) received the European X-ray Spectrometry Association's ''Outstanding Career in X-Ray Spectrometry'' award during the European X-Ray Spectrometry Conference in Figueira da Foz, Portugal, on June 24, 2010.

New products

Rigaku's EDXRF application note adapted for rohs regulation (June 30, 2010)

Applied Rigaku Technologies, Inc. has published a new application report describing the elemental analysis of Cl and elements regulated by RoHS in plastics. Analysis is shown for polyethylene. Empirical calibration summary and detection limits are shown and instrument repeatability is demonstrated. For further information, visit the web page, http://www.rigaku.com/index_en.html

X-RAY Spectrometry

Corporate

Roenalytic appoints new XRF representative in north america (July 19, 2010)

Roenalytic GmbH has appointed Eastern Applied Research Inc as its exclusive service and support representative in North America. For further information, visit the web page, http://www.easternapplied.com/

Olympus acquires innov-x systems (July 2, 2010)

Olympus NDT has announced that it has acquired Innov-X Systems Inc., a manufacturer of portable X-ray fluorescence (XRF) analytical instruments based in Woburn, Massachusetts, USA. Innov-X Systems, Inc. will be operated as a business division of Olympus NDT, retaining its current management team and employee base. For further information, visit the web page, http://www.olympus-ims.com/en/

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Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp
or sakurai@pas.tsukuba.ac.jp

X-RAY Spectrometry

(wileyonlinelibrary.com) DOI 10.1002/xrs.1281

News

Sciences

3D nano-scale imaging without lenses: ptychographic X-ray computed tomography (September 23, 2010)

A research group led by Professor F. Pfeiffer (Technische Universitat Munchen, Germany) has recently reported an extremely powerful combination of X-ray tomography and ptychographic coherent imaging, which enables quantitative phase-contrast X-ray microscopy without any lenses. A refractive index in the X-ray region is usually expressed as $n = 1 - \delta - i\beta$, where δ and β are real and imaginary parts, and relate to the phase shift and the attenuation, respectively. The researchers developed a new method to give a 3D image of δ rather than β, because δ can give much higher visibility in samples based on low-Z elements, which are most likely in bio-medical applications. So far, phase-contrast X-ray imaging has had limitations in giving such quantitative information. The use of coherent X-ray diffraction is one of the most promising solutions, and ptychography is a further extension that enhances precision in recovering the phase by introducing scanning of the sample. As the spatial resolution of the computed images is no longer limited by the quality or resolving power of a lens, just a pinhole was used in the present research. By combining such image reconstruction to obtain nano-scale 2D images with other image processing based on a back-filtered projection algorithm, they have succeeded in obtaining 3D images on the 100 nm scale of bone structures such as the osteocyte lacunae and the interconnective canalicular network. The experiments were done at X12SA beamline, Swiss Light Source. For more information, see the paper, ''Ptychographic X-ray computed tomography at the nanoscale'', M. Dierolf *et al.*, Nature, **467,** 436 (2010). In the same issue, there is an instructive account, ''A new phase for X-ray imaging'', H. N. Chapman, Nature, **467,** 409 (2010). For the details of ptychography, see the paper, ''The Theory of Super-Resolution Electron Microscopy Via Wigner-Distribution Deconvolution'', J. M. Rodenburg and R. H. T. Bates, Phil. Trans. Roy. Soc. (London) A339, 521 (1992).

X-ray photon correlation spectroscopy of azopolymer (September 23, 2010)

Professor M. P. Fontana (University of Parma, Italy) and his colleagues have recently reported X-ray photon correlation spectroscopy (XPCS) studies on poly[[4-pentiloxy-3′-methyl-4′-(6-acryloxyexyloxy)]azobenzene], which is a kind of photosensitive azo-polymer and is softened by photoisomerization. XPCS uses coherent X-rays to measure small angle scattering, called a speckle pattern, which is caused by some inhomogeneities. It gives information on the slow dynamics of various equilibrium and non-equilibrium processes in condensed matter systems. The main advantage of using X-rays instead of other direct methods such as scanning probe microscopy is that it provides statistical information averaged over the whole sample as a function of the momentum transfer. This is essential for the analysis of dynamical heterogeneity and of nonequilibrium and aging effects in the observed dynamics. The research group measured the time correlation functions at different temperatures and momentum transfers (q) and under different illumination conditions (dark, UV or blue light). It was found that the correlation functions are well described by the so-called stretched exponential function with relaxation times that are proportional to the inverse of q. They were able to determine the scaling laws for equilibrium and nonequilibrium fluctuations on local space scales. For more information, see the paper, ''Slow dynamics in an azopolymer molecular layer studied by x-ray photon correlation spectroscopy'', D. Orsi *et al.*, Phys. Rev. **E82,** 031804 (2010).

Theory of X-ray cross correlation and local symmetry (September 20, 2010)

Some readers might remember the news article, ''A new technique with coherent X-rays to determine non-crystalline structures'', in X-ray Spectrometry, Vol. 38, No.5 (2009). The technique called X-ray cross correlation analysis (XCCA) is an extension of X-ray photon correlation spectroscopy, and is promising with respect to solving the atomic-scale structures of complicated disordered systems, which have for many years presented difficulties in terms of reaching a clear understanding of the structures. Recently, Dr. M. Altarelli (European X-ray Free-Electron Laser Facility, Hamburg, Germany) and his colleagues published a paper on the theoretical treatment of XCCA. They gave a general theory for the cross correlation function, and tried to interpret the experimental XCCA results for colloidal glass. The authors plan further publications to present the results of various simulations as well. For more information, see the paper, ''X-ray cross-correlation analysis and local symmetries of disordered systems: General theory'', M. Altarelli *et al.*, Phys. Rev. **B82,** 104207 (2010).

Synchrotron X-ray diffraction hints at presence of magma ocean deep underground (September 17, 2010)

A geoscientists group at the European Synchrotron Radiation Facility (ESRF, Grenoble, France), has recently found that a natural fertile peridotite, which is a characteristic material of the Earth's mantle, can be partially molten at a pressure of 140 GPa, when the temperature reaches 4,200 K. This could reinforce the hypothesis of the presence of a deep magma ocean. The experiments showed that the liquid produced during this partial fusion is dense and that it can hold multiple chemical elements, among which are important markers of the dynamics of the mantle. For more information, see the paper, ''Melting of Peridotite to 140 Gigapascals'', G. Fiquet *et al.*, Science, **329,** 1516 (2010).

A dimensional standard for micro X-ray computer tomography (September 16, 2010)

Dr. B. M. Patterson (Los Alamos National Laboratory, USA) and his colleagues have recently published an interesting paper on analytical problems arising from micro X-ray computer tomography. They discussed the use of a dimensional standard based upon NIST certified glass microspheres dispersed in a low density poly(styrene) matrix. For more information, see the paper, ''Dimensional Standard for Micro X-ray Computed Tomography'', B. M. Patterson *et al.*, Anal. Chem., Article ASAP (DOI: 10.1021/ac101522q Publication Date (Web): September 16, 2010).

Kα satellite spectra in electron beam excitation (September 16, 2010)

Argentinian scientists have recently published a paper on the emission of X-ray satellite lines in the Kα region of Mg, Si, Sc, Ti, Cr, Fe, Ni, and Zn induced by an electron beam. They studied Kα', Kα_3, Kα_4, Kα_5, Kα_6, and two transitions denoted here as Kα_{22} and Kα_{12}. The work is a continuation of their previous work (see, the previous article, ''Kβ satellites in EPMA'', in X-ray Spectrometry, Vol. 39, No.2 (2010).) For more information, see the paper, ''Kα satellite transitions in elements with $12 \leq Z \leq 30$ produced by electron incidence'', S. P. Limandri *et al.*, Phys. Rev., **A82,** 032505 (2010).

TXRF analysis of selenium in soils (August 18, 2010)

Determination of the selenium content of soils is an important issue from the viewpoint of environmental and earth sciences. The work presents a lot of technical difficulties due to low concentrations within complex matrices. Dr. E. Margui (Institute of Earth Sciences ''Jaume Almera'', CSIC, Spain) and her colleagues have recently explored the possibilities of several analytical approaches combined with total reflection X-ray (TXRF) spectrometry. While direct analysis of a solid suspension has a relatively poor detection limit of around 1 mg/kg, a dispersive liquid-liquid microextraction procedure (DLLME) before the TXRF analysis of the soil

digest provides much greater detection power. The detection limit is 0.05 mg/kg, which is comparable to or lower than previously published results. For more information, see the paper, ''Analytical Possibilities of Total Reflection X-ray Spectrometry (TXRF) for Trace Selenium Determination in Soils'', E. Margui *et al*., Anal. Chem., **82,** 7744 (2010).

A hard X-ray pulse source driven by short pulse laser (August 16, 2010)

Electrons accelerated by the interaction between an ultrashort laser pulse and a plasma and then injected into a cold target can create X-ray photons via bremsstrahlung as well as inner shell ionization. The burst of K X-ray fluorescence from a metallic target is typically up to 10^{12} photons/pulse with a duration of 100 $\sim$ 600 fs. Dr. F. Zamponi (Friedrich-Schiller-University Jena, Germany) and his colleagues have recently published an interesting report. Thin titanium foils were irradiated by ultraintense laser pulses at intensities up to $\approx 5 \times 10^{19}$ W/cm^2, and X-rays emitted from the front and rear sides were measured using a high-resolution imaging system, which allows spectral analysis. During the experiments, they found significant differences in intensity, dimension, and spectrum between front and rear side X-ray emission in the 3 $\sim$ 12 keV range. They explained such differences in terms of directional bremsstrahlung emission from fast electrons generated during the interaction process. For more information, see the paper, ''Directional Bremsstrahlung from a Ti Laser-Produced X-Ray Source at Relativistic Intensities in the 3–12 keV Range'', F. Zampon *et al*., Phys. Rev. Lett., **105,** 085001 (2010).

Pico-second time-resolved X-ray fluorescence analysis used to study spin-crossover system (August 9, 2010)

X-ray fluorescence spectra can give information on various chemical states, including spin states such as high-spin and low-spin. Recently, Dr. G. Venko (KFKI Research Institute for Particle and Nuclear Physics, Hungary) and his colleagues published their research on light-induced spin crossover transition. They studied the spin state of aqueous $[Fe(bpy)3]^{2+}$ (bpy=2,2′-bipyridine) molecules, 60 ps after an ultrashort laser pulse excitation by time-resolved X-ray fluorescence. The laser induces a low-spin to high-spin conversion, and then the system goes back to the low-spin state on a 0.1 ns timescale. For more information, see the paper, ''Picosecond Time-Resolved X-Ray Emission Spectroscopy: Ultrafast Spin-State Determination in an Iron Complex'', G. Vanko *et al*., Angew. Chem. Int. Ed. **49,** 5910 (2010).

Large area Fourier-Transform holography using a separated holographic mask (July 16, 2010)

Scientists led by Dr. N. Awaji (Fujitsu Laboratories, Japan) have recently reported successful large area imaging by Fourier transform holography in both soft and hard X-ray regions. The key was the separation of a holographic mask from the sample, enabling the sample to then be scanned to increase the observation area ($\sim$10 μm or even more), though the beam size was fairly limited ($\sim$1 μm) to maintain good coherence. They demonstrated some magnetic domain images of perpendicular magnetized film with soft X-rays (778 eV), and also some patterned samples and the cross-section of the Cu-interconnect-line with hard X-rays (5,500 eV). The spatial resolution for the above energies was 42 and 75 nm, respectively. The experiments were performed at SPring-8 (Harima, Japan). For more information, see the paper, ''Large Area Imaging by Fourier Transform Holography Using Soft and Hard X-rays'', N. Awaji *et al*., Appl. Phys. Express **3,** 085201 (2010).

Professional

CHESS receives $109 million in grants (September 30, 2010)

The Cornell High Energy Synchrotron Source (CHESS), at Cornell University (USA) has been granted a total of $109 million. The National Science Foundation (NSF) has received $77 million to continue its existing operation of the facility through 2014 and $32 million for research and development of prototypes for the Energy Recovery Linac (ERL). For further information, visit the web page, http://www.news.cornell.edu/stories/Sept10/ERLCHESS.html.

Denver X-ray conference awards (August 4, 2010)

The following awards were presented during the plenary session of the 59th Annual Denver X-Ray Conference: The 2010 Birks Award was presented to Victor Buhrke, Consultant, Portola Valley, CA to honor his significant contributions to the field of X-ray spectrometry. The 2010 Hanawalt Award was given to Takeshi Egami, University of Tennessee, Knoxville, TN and Simon Billinge, Columbia University, New York, NY. This award is presented every three years for an important, recent contribution to the field of powder diffraction.

Corporate

JEOL's ClairScope™ (JASM-6200), an atmospheric SEM receives 2 prizes (September 30, 2010)

ClairScope (JASM-6200), an atmospheric scanning electron microscope developed jointly by JEOL Ltd. and Japan's National Institute of Advanced Industrial Science and Technology, has won the MT-10 Award for Microscopy Innovation from Microscopy Today, a journal of the Microscopy Society of America, and the R&D 100 Awards sponsored by R&D Magazine. The MT-10 Award is given to the best new products and technologies in the field of microscopy. Winners are selected from a wide range of fields including optical microscopy, scanning probe microscopy, electron microscopy, ion microscopy, acoustic microscopy, micro analysis, and sample preparation, etc. The award ceremony was held at the Microscopy & Microanalysis 2010 meeting in Portland Oregon. The R&D 100 Awards identifies and celebrates the top high technology products of the year. Sophisticated testing equipment, innovative new materials, chemistry breakthroughs, biomedical products, consumer items, high-energy physics: the R&D 100 Awards spans industry, academia, and government-sponsored research. For further information, visit the web page, http://www.jeol.com/.

Bruker acquires Veeco (August 16, 2010)

Bruker Corporation (NASDAQ: BRKR) has announced the signing of an agreement to acquire the Scanning Probe Microscopy (SPM) and Optical Industrial Metrology (OIM) instruments business from Veeco Instruments, Inc. (NASDAQ: VECO) for $229 million in cash. For further information, visit the web page, http://www.bruker-axs.de/news.html.

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Kenji Sakurai
News Editor
sakurai@yuhgiri.nims.go.jp
or sakurai@pas.tsukuba.ac.jp