$Pb_{1-x}Sn_xSe$ topological crystalline insulator: a new kind of quantum material

A synchrotron-based Polish-Swedish collaboration results in experimental evidences for recent theoretical predictions

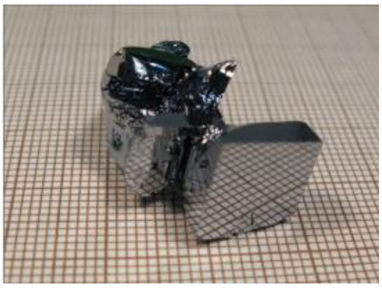

Figure 1. A monocrystal of $Pb_{0.77}Sn_{0.23}Se$ obtained by the self-selecting vapour growth method.

The existence of topologically protected surface states with the Dirac-like dispersion on the (100) surface of $Pb_{1-x}Sn_xSe$ monocrystals has been recently proven by the angle-resolved photoelectron spectroscopy (ARPES) experiments [1].

The discovery of new quantum materials – topological insulators (TI) (one of the most important recent developments in condensed-matter physics) showed that time-reversal symmetry and strong relativistic (spin-orbit) effects led to presence of metallic helical Dirac-like electronic states on surfaces of some particular crystals, like Bi_2Te_3 or Bi_2Se_3.The further theoretical developments in analysis of conditions necessary for occurrence of particular properties characteristic of TI led to widening the class of suitable materials by topological crystalline insulators (TCI), in which specific crystalline symmetries warrant the topological protection of metallic surface states [2,3]. A group of IV-VI semiconductors, in particular SnTe, was indicated as possible examples of TCIs [3]. $Pb_{1-x}Sn_xSe$ monocrystals (Fig. 1) grown in the Institute of Physics, Polish Academy of Sciences, and chosen for the experiments reported in [1], offer advantageous conditions for search for surface states of the TCI phase. The increasing Sn content leads to closing the energy gap at some specific crystal composition x_c. For higher Sn contents, the gap opens again but the parity of electronic states at band edges is reversed. Therefore, the idea was developed in the Institute of Physics, Polish Academy of Sciences to perform thorough investigations of the band structure evolution in these materials. As the topological phase transition can also be easily tuned by temperature, in these crystals it is possible to study in one ARPES experiment both the open-gap topologically trivial case (Fig. 2a) and open-inverted-gap with topologically nontrivial properties (Fig. 2b).

In the ARPES studies carried out for crystals with Sn composition of x=0.23 in the synchrotron laboratory MAX-lab, Lund, Sweden and in the photoelectron spectroscopy laboratory of KTH, Kista, Sweden the band inversion was achieved at T_C = 150 K. Below the inversion temperature one observed the formation of topological states with Dirac-like energy dispersion and the Dirac cone centered in the vicinity of the $\bar{X}$ point of the surface Brillouin zone [3]. Thus, the presence of the gapless Dirac-like states on the surface of $Pb_{1-x}Sn_xSe$ proved that this narrow-gap semiconducting solid solution belongs to the new class of TCI.

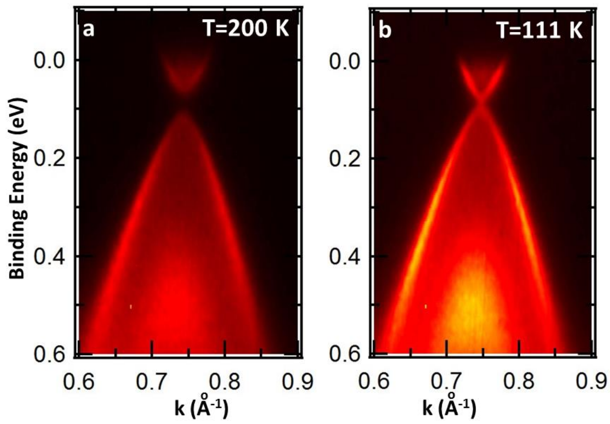

Figure 2.

(a) ARPES spectrum of the surface states taken for the gapped semiconductor phase of $Pb_{0.77}Sn_{0.23}Se$ across the point at which the topologically protected surface states of TCI (with the Dirac-like dispersion) occur in the vicinity of the $\bar{X}$ point of the surface Brillouin zone (see (b)).

(b) ARPES spectrum across the topologically protected surface states of TCI $Pb_{0.77}Sn_{0.23}Se$ observed in the vicinity of the $\bar{X}$ point.

The subsequent spin-resolved ARPES experiments allowed to show also the existence of spin polarization around the $\bar{X}$ point in the surface Brillouin zone in the TCI phase of $Pb_{0.73}Sn_{0.27}Se$. The results were consistent with the results of tight binding band structure calculations [4].

B.J. Kowalski, R. Buczko, and T. Story
Institute of Physics PAS

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CONTENTS

Polish in-kind contribution to European X-ray Free Electron Laser (XFEL): Status in spring 2013

E. Pławski[1] , J. Sekutowicz[2], W. Grabowski[1], K. Kosiński[1], J. Lorkiewicz[1*], M. Wojciechowski[1], Z. Gołębiewski[1], K. Meissner[1], G. Wrochna[1], O. Chołuj-Dziewiecka[1], P. Borowiec[3], M. Duda[3], M. Jeżabek[3], K. Kasprzak[3], A. Kotarba[3], K. Krzysik[3], M. Stodulski[3], J. Świerblewski[3], M. Wiencek[3],

(on behalf of IFJ-PAN group at DESY)

M. Chorowski[4], E. Rusiński[4] J. Fydrych[4], A. Iluk[4], K. Malcher[4] J. Poliński[4], P. Duda[4], J. Głowinkowski[5], P. Wilk[5] M. Winkowski[5], P. Grzegory[6], and G..Michalski[6]

[1] *National Centre for Nuclear Research (NCBJ), ul. Andrzeja Sołtana 7, 05-400 Świerk-Otwock, Poland*

[2] *Deutsches Elektronen Synchrotron (DESY), Notkestrasse 85, D-22607 Hamburg, Germany*

[3] *Institute of Nuclear Physics PAN (IFJ-PAN), ul. Radzikowskiego 152, 31-342 Kraków, Poland*

[4]*Wrocław University of Technology (WUT) , ul. Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland*

[5] *Wrocław Technology Park (WPT), ul. Muchoborska 18, 54-424 Wrocław, Poland*

[6] *Kriosystem Sp. Z o.o., ul. Muchoborska 18, 54-424 Wrocław,Poland*

Abstract In the years 2010-2011 Polish research institutes - members of the European-XFEL consortium, took responsibility for production and delivery of important components and test procedures for the superconducting linear electron accelerator (linac) of the X-ray free electron laser at DESY (Hamburg).. The paper briefly summarizes the progress of the work on cryogenic installation, test procedures for linac components and high order mode couplers and absorbers reached by WUT, IFJ-PAN and NCBJ groups with their subcontractors, respectively.

Keywords: superconducting linear electron accelerator, radio frequency (RF) field, high order mode (HOM) of RF field, RF cavity, cryogenic installation

* e-mail: jerzy.lorkiewicz@ncbj.gov.pl

1. Introduction

The manufacturing of 103 accelerating modules for the linear electron accelerator of the European XFEL free electron laser is an international project organized in different work packages [1]. Each module contains among other things 8 superconducting (sc) nine-cell niobium cavities based on TESLA technology, placed in a liquid helium vessel and a single magnet package with a sc, super-ferric quadrupole magnet and two dipole magnets [2]. The magnet packages are also placed in a liquid helium bath. Every cavity is equipped with two high order mode (HOM) couplers. Parasitic high order modes in RF field are excited by the beam. They have to be coupled out by coaxial HOM couplers and transferred via cables to loads outside the module [3]. In addition a single beam line absorber (BLA) is installed in each of intermodule connections to absorb the travelling HOMs. Each cavity is equipped with a single pick-up (PU) antenna – a microwave field probe used by the RF control system to regulate the amplitude and phase of the accelerating field.

The following Polish institutions and their subcontractors contribute in-kind to the project with their capacity for facilities, work and with components:

- A group of NCBJ is responsible for design, production, testing and delivery of 1648 HOM couplers, 824 PU antennas and output lines and 110 HOM beam line absorbers (BLAs).
- A team of IFJ-PAN is in charge of preparation and performance of acceptance tests for XFEL-type cavities, complete accelerator modules, cold magnets and their current leads. During the preparation phase the team: takes part in development of the measuring software and hardware, tests prototype and pre-series units and elaborates test procedures. Then the IFJ PAN team starts to perform serial tests of 816 cavities, and 100 cryo-modules, 100 cold magnets and 100 magnets' current leads. The serial tests in Accelerator Module Test Facility (AMTF) hall at the DESY site will be continued within next three years.

- WUT is responsible for design and WPT with its subcontractors are responsible for manufacturing and installation of a 165 m long XATL1 cryogenic transfer line for supercritical helium transport from the HERA refrigerator at DESY to the AMTF hall and of two vertical cryostats for low power acceptance tests of cavities.

The current status of implementation of the above listed tasks is reported in the following paragraphs.

2. Production and installation of the XATL1 cryogenic line and two vertical cryostats.

The cryogenic transfer line XATL1 is destined for the transport of cooling media at two temperature levels: 4.5 K and at 40/80 K. It is accomplished by the transport of streams of supercritical helium and cool gaseous helium in two different circuits which are placed in a cylindrical thermal radiation shield. The 40/80 K gas circuit is used to maintain a sufficiently low temperature of the shield, whereas the supercritical helium is further cooled and delivered to test stands inside the AMTF hall. XATL1 is a vacuum-isolated transfer line and all the processing tubes are installed inside an external vacuum envelope. The processing lines and radiation shield are covered with multilayer thermal isolation. The construction is based on design calculations, technical specification and hazard analysis prepared at WUT which was also involved in design of the two vertical test cryostats and two additional transfer lines connecting cryostats with a subcooler (liquid helium distribution system in AMTF).

A vertical cryostat is composed of a liquid helium storage vessel equipped with an "insert" structure to facilitate installation of four cavities tested in a single run and a thermal shield surrounding the vessel . This structure is placed in a vacuum tank which contains also tubing and valves for cold circuits as well as a counter-flow heat exchanger and cold terminals for transfer lines connection. 4.7 K liquid helium from the subcooler is pre-cooled in the heat exchanger to 2.2 K and further cooled down to its working temperature of 2 K inside the vessel by iso-enthalpic expansion on a Joule-Thomson (J-T) valve. Each cryostat is equipped with necessary safety systems.

Both, cryogenic line and the cryostats had to comply with European norms and be certified by TÜV Nord company based in Germany.

Cryogenic transfer line and the cryostats were produced in the years 2010-2012 by WPT and its subcontractors: Kriosystem and KATES Poland and delivered to DESY. The transfer line was mounted on a tube bridge and connected to the HERA refrigerator on the one end and to the subcooler in the AMTF on the other (Fig. 1a). It underwent successfully high pressure and leak tests. One of the cryostats (Fig. 1b) was installed in the hall in February 2013 and is currently used for serial cavity tests. Installation of the other was completed in May 2013. The final commissioning of these devices is foreseen in 2013.

3. Test procedures and personnel training for the tests of 1.3 GHz superconducting cavities, complete accelerator modules and superconducting magnets.

The tests of 22 prototype cavities, 3 cryomodules, and 25 sc magnet packages were performed so far by the IFJ PAN team at DESY. Required documents were also written and delivered as a quality plan, risk assessment and test procedures. Elaboration of the test procedures included development of measuring hardware, software and local databases as well as their communication with user interfaces. The created procedures and documents were loaded to EDMS (Engineering Data Management System) – a central documentation and collaboration platform at DESY [4]. Efforts are taken to integrate and to test management and control system with other systems like DOOCS (Distributed Object Oriented Control System) and Oracle database.

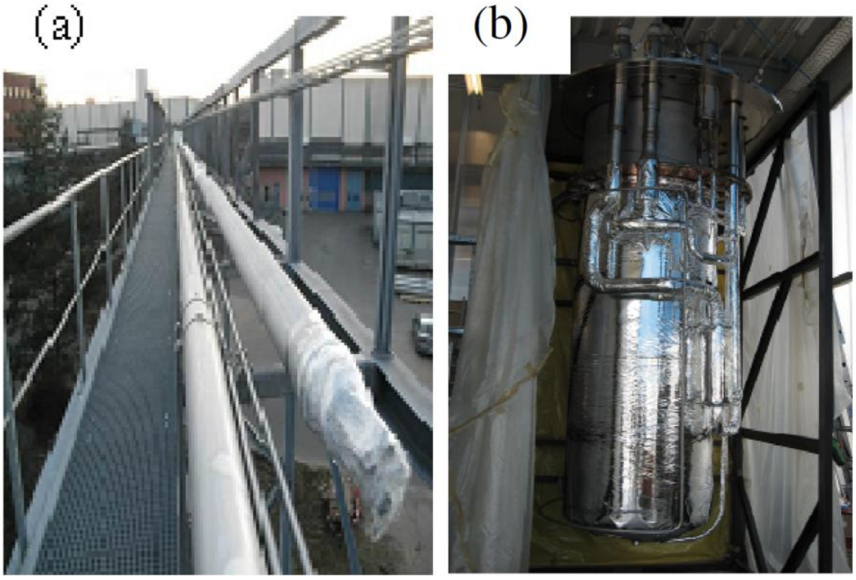

Figure 1. XATL1 cryogenic line under construction in April 2012 (a) and a view of one of the vertical cryostats during mounting of thermal insulation on the cryostat cold circuit and helium storage vessel (b).

A set of four TESLA-type cavities installed in a prototype insert of a vertical cryostat is shown in Fig. 2. In particular testing procedures for cavities included: cavity inspection and preparations for tests, cryogenic and vacuum operation and RF measurements like cavity spectrum measurement or quality factor measurement vs field gradient (see the plot in Fig. 2). The latter is connected with an important validation criterion for cavities: it is assumed that unloaded quality factor Q_0 of more that 10^{10} is reached for accelerating gradient up to 23.6 MV/m. It corresponds to 20 GeV maximum electron energy of the linac.

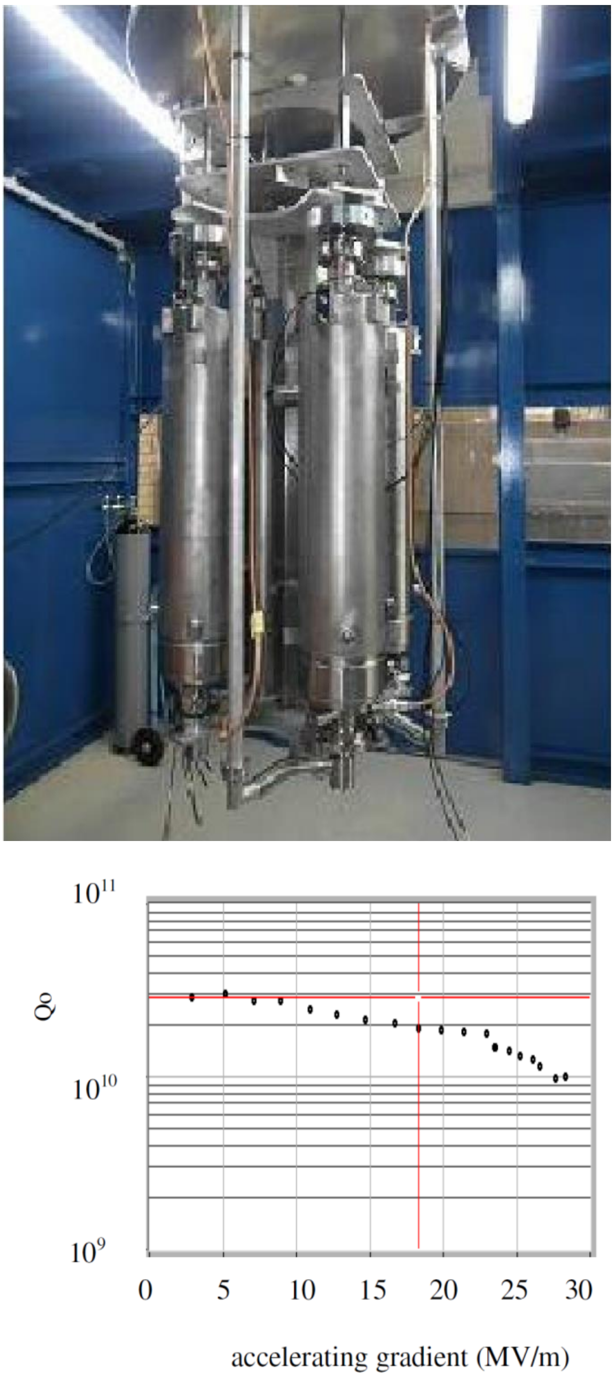

Figure 2. Four cavities installed in a prototype insert of a vertical cryostat (top) and a measured dependence of unloaded quality factor Q_0 on accelerating gradient for a cavity.

So far 18 procedures for cavity tests were prepared and at least 20 reference cavities, including the cavities dedicated for the pre-series cryomodules, were tested so far to verify these procedures.

A software for cavities: “Spectrum measurement” and “HOM tuning” created by the IFJ-PAN team was made available to the CEA Saclay group (France) which is responsible for the cryomodules assembly.

Works on cryomodules (Fig. 3): inspection and preparation for assembly, their cryogenic operation and the modules’ high- and low-power RF tests are included in 146 procedures. They were checked during tests of three prototype cryomodules performed so far at DESY and at Saclay with the participation of the IFJ-PAN team.

Sc magnets testing steps were described in 7 procedures. They comprise check procedures of feedthrough flanges and current leads and check of the magnets at 300 K and 2 K (e.g. harmonics and harmonic hysteresis measurement or stretched wire measurement). Magnets tests are aimed at measuring field quality, saturation effects, magnetic axis and roll angle. The magnets tests are performed in collaboration with another group of DESY.

This effort resulted in personnel training and fulfilling the criteria of the production readiness review which certifies the group’s ability to perform the in-series RF tests of cavities, cryomodules and superconducting magnets for the XFEL electron linac.

Figure 3. Prototype of XFEL cryomodule on a trolley in AMTF hall.

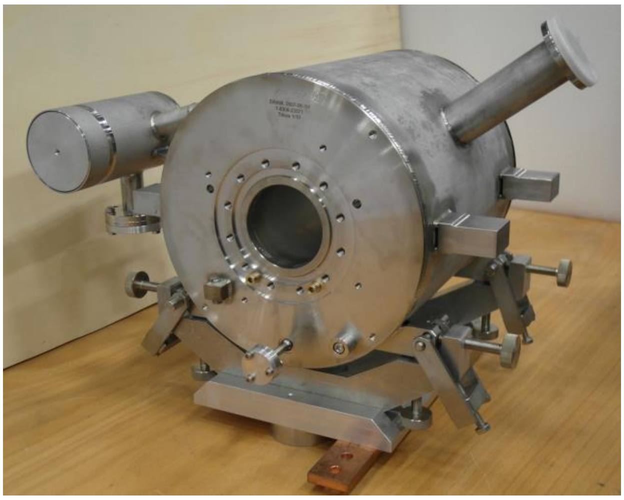

Figure 4. XFEL superconducting magnet.

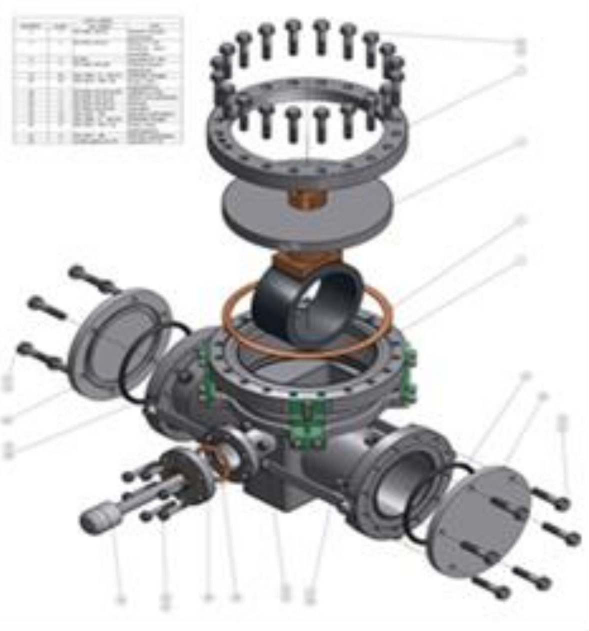

Figure 5. A scheme of the beam line absorber.

4. Design, production, testing and delivery of HOM couplers, PU output lines and HOM beam line absorbers (BLAs).

The types of HOM couplers and PU antennas were agreed on between NCBJ, DESY and Kyocera company (NCBJ subcontractor). The choice of cables for HOM damping which connect the couplers and 50 Ω external loads was based on calculation of RF match between these components and on cable attenuation measurements.

BLAs design completion (Fig. 5) required certain structure modifications based on computation of fatigue resistance of compensation bellows (used for thermal stress release) and precise materials selection. In particular the choice of the material of the ceramic ring for HOM absorption was based on measurements of high order modes attenuation and dc resistivity. The measurements were performed on samples of different ceramic materials at 300 K and 70 K. The obtained results led to the choice of AlN-based CA137 composite produced by Ceradyne, Inc. (USA).

Delivery to DESY of 300 HOM couplers with 150 PU antennas plus auxiliaries and two BLA prototypes (for testing) as well as contracting most of the materials allowed beginning of the serial production.

Until now all the components for HOM couplers and PU antennas have been contracted or purchased and most of them are delivered or in stock. A system for HOM couplers quality check was installed at NCBJ. Manufacturing of 103 BLAs is contracted together with its components. According to the time schedule, installation of the above elements and the final commissioning should be reached in June 2014.

5. Significance of the Polish in-kind contributions.

The key role of the tasks of Polish groups involved in construction of European XFEL superconducting linac is obvious. Completing within the last 12 months of the cryogenic installation and reaching the readiness for serial tests and serial production of HOM couplers and absorbers enabled other teams of DESY and CEA Saclay to start cryomodules assembly. The first pre-series cryomodule was delivered to the AMTF hall in June 2013.

The elaborated test procedures for RF cavities and the modules combine previous experience gained by many IFJ PAN groups which worked at DESY within Tesla Test Facility project (in the two previous decades) with recent modifications connected with the prospect of testing in a tight time schedule of long series (on average: 8 cavities and one module per one week!).

The cryogenic installations (produced by WPT, Kriosystem and KATES Poland) and the beam line absorbers (Lamina state enterprise) were positively assessed and certified in the light of design criteria.

6. Future prospects for the European XFEL.

Apart from the underground electron linac facility of nominal electron energy equal 17,5 GeV (maximum design energy 20 GeV) the European XFEL will comprise a collimating and a beam distribution systems, a set of undulators including three which make use of self-amplified simulated emission (SASE-type), five X-ray optical lines placed in underground tunnels and an experimental hall. The 17.5 GeV electron energy corresponds to 0.1 nm photon wavelength which can be reached in two of the planned SASE undulators.

According to the XFEL directorate generating the first X-ray photon beam is expected in 2016.

Acknowledgments: Thanks are due to all the many collaborators and subcontractors who participated in the accomplishment of the in-kind contributions.

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Investigation of performance of x-ray capillaries internally covered with a lacquer-metal reflectivity layer

R. Mroczka[1,2*]

[1] *Department of Chemistry, The John Paul II Lublin Catholic University, Al. Krasnicka 102, 20-718 Lublin, Poland*
[2] *Laboratory of X-ray Optics, Interdisciplinary Centre of Scientific Research, The John Paul II Lublin Catholic University, Al. Krasnicka 102, 20-718 Lublin, Poland*

The metallic parabolic capillary with an internal lacquer/gold layer for hard X-ray optics was manufactured by (i) deposition of a layer of acrylic lacquer (2μm) on a copper mandrel, (ii) deposition of a layer of gold with a thickness of 100 nm by vacuum evaporation, (iii) electrodeposition of a nickel layer (100 μm), and (iv) removing the copper mandrel. The surface roughness of the copper mandrel was reduced approximately 10 fold to approximately 1.5 nm and did not increase after the deposition of the gold layer (ii). In this manner, the capillary obtained in step (iv) has an inner lacquer/gold layer with interface roughness of about 1.5 nm. The geometric parameters of the surface were measured using an atomic force microscope (roughness), optical profilometer (waviness), and a laser scan micrometer (figure error). Because of the difficulty in removing lacquer layer from the inside of the capillary after step (iii), the curvature of the parabola was optimized in a way allowing complete transmission of the X-ray beam with energy of 21 keV through the lacquer layer. In order to design a proper parabolic curve of X-ray, reflectometric curves were calculated for the lacquer/gold bilayer with thickness and roughness obtained for the manufactured capillaries. The capillaries were tested on the L line (DORIS, Hamburg) using energy 21 keV. For one of the capillaries, the flux gain of 1.6 was recorded. The poor efficiency of the capillaries is mainly caused by waviness that leads to an increase in the incident angles. In consequence, reduction of beam intensity and beam diffusion occurs.

Keywords: x-ray metallic capillary optics, roughness, waviness

*e-mail: rmroczka@kul.pl

1. Introduction

X-ray capillary optics require a very smooth surface for efficient x-ray reflection. Glass capillaries produced in a traditional way by drawing from a piece of tube are characterized by a smooth usually ca. 1-nm surface, depending on the surface size [1,2]. Manufacturing of metallic X-ray optics requires using different techniques, such as electroforming or replication [7]. In this method, the metallic mandrel is replicated into a final X-ray focusing element. In comparison with the very sophisticated, time-consuming, and expensive method of polishing metallic surface, the lacquering technique seems to be cheap and relatively easy to apply. In this method, a thin acrylic layer is uniformly applied on the surface and then dried. The lacquer-coating technique was used for diamond-turned polishing of surfaces [3,4]. Kopecky et al. [5] showed that acrylic lacquer is an effective way of polishing figured optics to obtain X-ray reflectivity. However, they noticed that prior to electroforming application complete removal of remaining lacquer without damaging the mandrel surface may be required due to the very high cost of manufacturing of the mandrel. In our technology, the mandrel is formed with the electroplating method, which is very cheap and non- time-consuming [6]. To address the problem with complete solving the remaining lacquer inside capillaries, we produce capillaries with a lacquer-metal internal reflectivity bilayer. We concentrated our effort on deposition a lacquer layer with a uniformly distributed thickness below 2 μm.

2. Experimental

Acrylic lacquer was deposited on the electrolytic copper surface using the dip-coating method. The speed of withdrawal of the mandrel from the lacquer solution was 20 mm/min. After deposition, lacquer was dried at 60 ºC for 30 min. Copper had been previously electrodeposited on a stainless steel wire (304 grade, supplied by Knight Wire, England) with a diameter of 0.2 mm.

Then, a gold layer with a thickness of about 100 nm was deposited by vacuum evaporation. Roughness on the interface lacquer/gold was maintained during this process. Finally, a nickel layer without internal stress (~ 100 μm) was electrodeposited. The mandrel (a stainless steel wire together with the copper layer) was mechanically removed due to very low adhesion between copper and lacquer. In consequence, the capillary had a lacquer (2 μm)/Au(100 nm)/Ni(100 μm) structure.

Roughness of the deposited copper and lacquer layers was examined using an AFM (5600LS AFM, Agilent Technologies) in non-contact mode (tip radius < 7 nm, resonance frequency 280 kHz) with a resolution of 512×512 and scan area of 20 μm×20 μm. The measurements were carried out at 30 places, located

2 mm apart along the mandrel wire. The separation corresponded to the 1.5 – 1.6 µm increase in copper layer thickness due to the parabolic curvature of the mandrel. The surface roughness, S_q, – the root mean square of arithmetic average of the absolute values of the surface roughness – was calculated using the Scanning Probe Image Processor (SPIP) v. 5.1.4 software (Image Metrology A/S, Denmark) according to the formula

$$S_q = \sqrt{\frac{1}{MN}\sum_{k=0}^{M-1}\sum_{l=0}^{N-1}\left[\,z(x_k, y_l)\right]^2}$$

where x and y are the coordinates, z is the perpendicular deviation from the ideally smooth surface, M is the number of points in the x direction, and N is the number of points in the y direction.

A laser scan micrometer (LSM 500H, Mitutoyo) and an optical profilometer (WYKO NT9800, Veeco) were used to determine surface waviness, the shape of the mandrel, and the thickness of acrylic lacquer. Figure 1 shows a representative mandrel roughness after lacquering. Figure 2 shows a roughness of the mandrel before (red line) and after (blue line) deposition of acrylic lacquer. The roughness of the mandrel was reduced about 10 times after deposition of the lacquer layer.

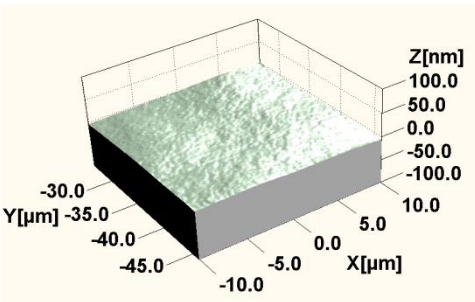


Figure 1. AFM micrograph of mandrel surface after lacquering. Sq = 1.9 nm.

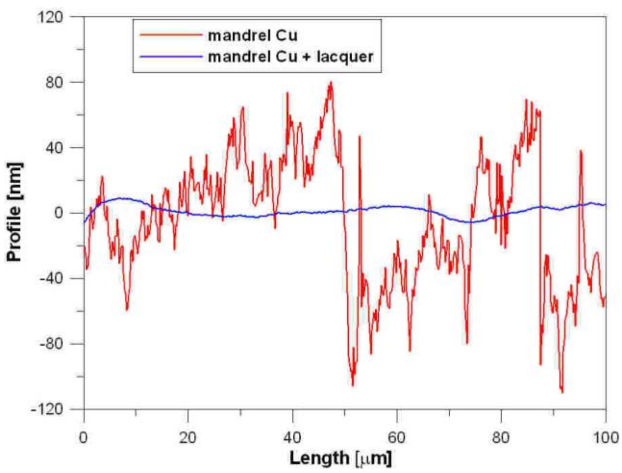


Figure 2. Profile of the surface before (red line) and after (blue) lacquering.

It is clearly seen that the levelling abilities of lacquering reduce surface roughness significantly (about ten times). Another relevant factor is uniformity of lacquer thickness distribution over the whole surface of the mandrel. This is shown in Fig. 3. It can be seen that the mean thickness is about 1.5 µm. The thickness of the lacquer layer was calculated by subtraction of the mandrel profile after and before lacquering. Data from the laser scan micrometer and optical profilometer were used for this operation. Waviness and thickness of the lacquer layer was measured after deposition of a 100-nm gold layer by vacuum deposition owing to the transparency of the lacquer layer.

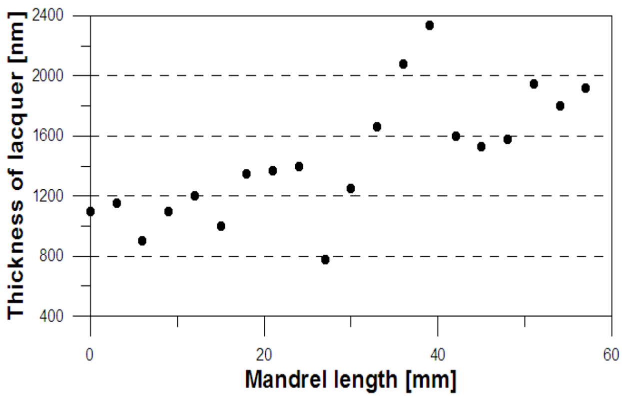
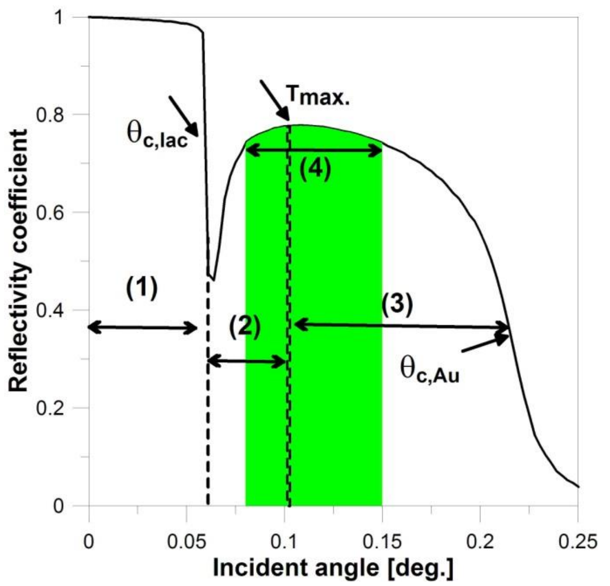


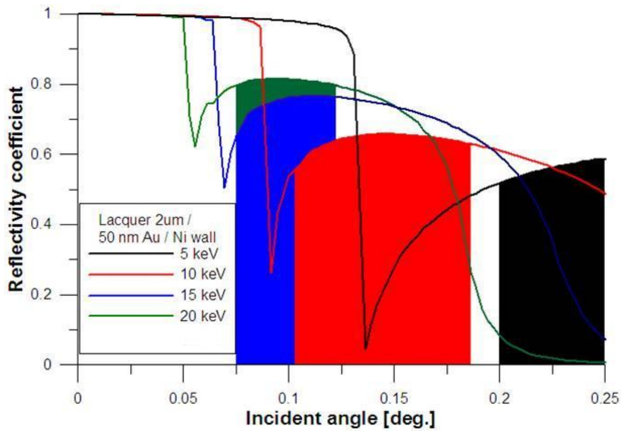
Figure 3. Distribution of acrylic lacquer thickness over the mandrel

3. Calculations of X-ray reflectivity of capillaries

X-ray reflectivity calculations (http://www.cxro.lbl.gov) were performed to determine transmission of X-rays through the lacquer/Au interface present on the internal wall of the metallic capillaries. Figure 4a shows X-ray reflectivity of 21 keV on the acrylic lacquer/gold bilayer. We can distinguish four characteristic regions for the X-ray reflectivity curve. The first region (1) represents X-ray reflectivity from acrylic lacquer with 2-µm thickness. X-rays are totally reflected below the critical angle ($\theta_{c,lac.}$) characteristic for acrylic lacquer. At $\theta_{c,lac,}$ the intensity of x-rays falls to 1/e of its value at the surface of lacquer. Above the critical angle $\theta_{c,lac}$ (region (2)), X-rays are not reflected from the lacquer surface but the transmission coefficient gradually increases up to point T_{max} and simultaneously X-rays are reflected from the gold layer. Starting from point $T_{max,}$ the shape of the X-ray reflectivity curve becomes very similar to the curve characteristic for X-ray reflection from a single gold layer. If we assume that our requirement is reflectivity e.g. above 70% for the entire internal surface of the capillary, the incident angle has to range from ~ 0.075 to 0.15 ^{0} (region (4) green fill), which corresponds to the specific curvature of the parabolic shape. Fig. 4b shows the reflectivity coefficient as a function of the incident angle for X-ray energy of 5, 10, 15 and 20 keV. The solid backgrounds correspond to optimal X-ray reflectivity regions for different X-ray energy. Different incident angles correspond to different curvature of capillaries, e.g. the angles ranging from 0.05 to 0.07 correspond to maximum output beam divergence about 4 mrad. This region of X-ray reflectivity is not useful, as it covers the absorption edge (~ 0.06 ^{0}) for 20 keV. For 20 keV, it is recommended that the incident angles should be located between 0.08 and 0.12, which corresponds to a capillary with maximum output beam divergence about 8 mrad. Taking this fact into account, the curvature of parabolic capillaries was adjusted in order to receive an incident angle in capillaries in the range between 0.09 and 0.12 degrees.



(a)



(b)

Figure 4.

(a) X-ray reflectivity from the acrylic (2 μm) /Au (50 nm) bilayer deposited on Ni substrate for 20 keV X-ray energy as a function of the incident angle. Roughness (rms) of the acrylic/gold interphase - 1.5 nm.

(b) X-ray reflectivity from the acrylic (2 μm) /Au (50 nm) bilayer deposited on Ni substrate for different X-ray energy as a function of the incident angle. Roughness (rms) of the acrylic/gold interphase - 1.5 nm. function of the incident angle. Roughness (rms) of the acrylic/gold interface - 1.5 nm.

According to X-ray reflectivity calculations for these values of angles (see Fig. 4), X-ray beams with energy of 20 keV can be transmitted through 2 μm-thick acrylic lacquer with transmission at ca. 80% from the top gold layer (rms roughness of gold equal 1-1.5 nm). In our experiment, the acrylic lacquer had 1.1 g/cm3 density and 1 – 2.7 μm thickness

4. Focusing properties of metallic capillaries – results and discussion

The main aim of the experiment on the capillary focusing abilities was to investigate the performance of a single-bounce lacquer-metallic capillary at beamline L (DESY, DORIS III) as a focusing element for hard X-ray synchrotron radiation providing an alternative to single glass capillaries. Four capillaries were prepared for measurements. The shape of capillaries was parabolic and the maximum output beam divergence was about 8 mrad. Other parameters of capillaries are listed in Table 1. All the capillaries were tested using a monochromatic synchrotron beam with photon energy 21 keV. Since no ring structure was observed in the far-field image, scans were performed using a 4-μm thick tungsten wire in the location of a potential focusing point to determine the beam parameters.

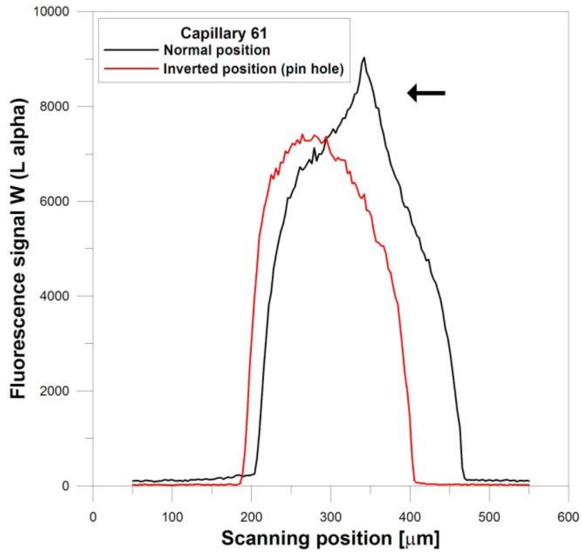


Figure 5. Profile of the beam in the focus point for capillary 61. Black line – beam from capillary No 61 in the normal position, red line – in the inverted position. Fluorescence signals (L alpha) from W wire were recorded.

Two measurements were made for each of the capillaries. One measurement was performed when the synchrotron beam entered the capillaries from a bigger aperture (normal position) and the other - in an inverted mode, when the entrance had a smaller aperture. After normalization of the beam profile in the potential focus point, both cases were compared. For three capillaries, the profiles recorded in the normal and inverted positions were nearly the same, which implies that the capillaries work as a usual collimator. A peak formed by the focusing beam was observed for capillary 61 (Fig. 5, black arrow). In this case, the maximum intensity is a little higher in the normal than in the inverted position of the capillary. Based on this result, the gain for the capillary was estimated as equal to 1.6. Such poor performance of the capillary is mainly determined by the waviness. In comparison to glass capillaries, the waviness is about one order of magnitude higher. The two basic sources of waviness include (i) waviness of the substrate (stainless steel wire) that was used for electroplating and (ii) waviness of the electrodeposited copper layer (for the mandrel). The best result obtained up to now is close to 1.2 mrad for the tested capillaries but recently we have reduced these values to 0.5 mrad (the capillaries have not been tested yet). Importantly, deposition of acrylic lacquer in the best case does not improve the waviness but only reduces roughness by ca. ten times. Therefore, there is a need for further studies focused on reduction of waviness by at least one order of magnitude to obtain better performance of metallic capillaries than that of the glass ones.

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Table 1. Parameters of gold/lacquer metallic capillaries.

No	Material of reflecting surface	Length [mm]	Aperture of entrance diameter [μm]	Aperture of exit diameter [μm]	Waviness [mrad]	Mean roughness rms [nm]	Lacquer thickness [μm]
60	gold	40	350	220	1.75	2.1	2.7
61	gold	69	330	220	1.8	1.9	2.0
63	gold	65	332	220	1.35	2.0	2.7
66	gold	70	335	220	1.28	-	1.0

Strain state in Mn-implanted silicon annealed at high temperature

P. Romanowski, J. Bak-Misiuk[1*], K. Sobczak[1], R. Jakiela[1], and A. Misiuk[2]

[1] *Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, PL-02668 Warsaw, Poland*
[2] *Institute of Electron Technology, al. Lotnikow 32/46, PL-02668 Warsaw, Poland*

Keywords: **Mn-implanted silicon, nanoinclusions, X-ray diffraction**

[*] E-mail address: bakmi@ifpan.edu.pl

In this work an influence of thermal annealing of Mn-implanted silicon on strain state of silicon matrix is presented. During post-implantation annealing, nanocrystalline tetragonal Mn_4Si_7 compound is formed. A strong correlation between the size of nanoinclusions and the matrix strain state is detected.

1. Introduction

In recent years, much interest has been devoted to materials called diluted magnetic semiconductors (DMS): mixed crystals based on classic semiconductors, with a controlled fraction of nonmagnetic cations substituted by the magnetic ones [1]. Silicon-based DMS would be the preferred spintronics material due to existing technology used in Si-based microelectronics and wide availability of high quality Si single crystals. Dietl et al. [2] predicted a carrier-mediated ferromagnetism for silicon doped with 5 % Mn. For wide commercial application room-temperature ferromagnetism in DMS is desired. Zhang et al. [3] reported the $Mn_{0.05}Si_{0.95}$ alloy with Curie temperature, T_C, of about 400 K.

Ion implantation is one of the methods utilized to achieve ferromagnetic properties of semiconductors. Ferromagnetic ordering in Mn-implanted Si has been reported recently (e.g. [4-7]. For Si:Mn produced by implantation with Mn^+ doses, $D = 10^{15} – 10^{16}$ cm^{-2}, at energy, E = 300 keV, T_C exceeds 400 K after its rapid thermal annealing at 800°C [4]. Randomly distributed Mn atoms play twofold role: promote the formation of local magnetic moment and supply free carriers (holes) which mediate exchange interaction between the local moments). It has been suggested that the ferromagnetic exchange is carrier mediated.

However, due to low solubility of Mn in Si and easy Mn reaction with Si, the formation of manganese silicide in Mn-implanted Si is often observed. It has been found that high-temperature-pressure annealing of Si:Mn produced by implantation results in a creation of Mn_4Si_7 inclusions [8,9]. However, these Mn_4Si_7 nanoinclusions in Si show ferromagnetism with magnetic moment higher than that of the bulk ($T_C \approx 45$ K, according Ko et al. [10]). Therefore, the Mn_4Si_7 phase rather cannot be considered as a main source of ferromagnetism at or above room temperature. Our last results indicate on an influence of the Mn_4Si_7/Si interface on magnetic ordering of Mn^+-implanted silicon [9].

The inclusions formed during post-implantation thermal processing may influence the strain state of the crystals (see, e.g. [11]). The aim of the present work is to determine the influence of the Mn-containing inclusions on the silicon matrix strain state.

2. Experimental

Czochralski and Floating-zone **(001)-**oriented silicon single crystals were implanted with 160 keV Mn^+ ions to a dose of 1×10^{16} cm^{-2}. Such implantation causes a creation of quasi three-layers structure composed, in sequence, of the damaged near-surface Si layer (thickness ~100 nm), the Mn-implanted Si layer (~50 nm) and the almost undamaged Si substrate. Maximum concentration of the Mn-implanted ions equal to about 1.2% is observed at the depth of ~140 nm. To modify the defect structure of Si:Mn and rebuild the damaged material, the samples were annealed for 1 h at temperatures up to 800°C under ambient pressure of 10^5 Pa.

The phase composition of polycrystalline layers created during the processing at the near-surface areas was measured using X-ray diffraction techniques and synchrotron radiation. The results presented earlier [8,9] showed that Mn-containing nanoinclusions, identified as the tetragonal Mn_4Si_7 compound, are formed. Using transmission electron microscopy technique as well as by study the slopes of the diffraction rocking curves it has been found that the sizes of the inclusions increase with annealing temperature, whereas their concentration decreases [9].

High-resolution Philips Material Research Diffractometer equipped with a standard laboratory source of Cu$K_{\alpha1}$ radiation was used to study the strain distributions in the silicon matrix. Secondary ion mass spectroscopy (SIMS) depth profiles of Mn were measured using the CAMECA IMS6F spectrometer.

3. Results

Strain distribution in the Si matrix was determined from the analysis of the shape of X-ray diffraction peak. Unsymmetrical shape of the 004 X-ray diffraction peaks shows on a distribution of the matrix lattice parameter (see Fig. 1 and 2). This effect is the same for Czochralski and Floating-zone Si:Mn samples and disappears after 800°C processing. For this temperature the particle sizes exceed 20 nm [9]. These particles become incoherent in respect to the silicon matrix and so strain disappears (the tensile strain occurs below the 15 nm size). Simultaneously, the SIMS technique showed that the diffusion of Mn ions in effect of temperature processing was insignificant (Figs 3 and 4). It means that there exists a strong correlation between the size of nanoinclusions and the matrix strain state.

Numerical simulation of the X-ray diffraction peaks, using the Epitaxy 4.0 made Panalytical B.V by softwer, has been performed and depth distribution of the Si-matrix strain has been obtained (Fig. 5). The maximum strain appears at the depth corresponding approximately the maximum Mn concentration. Stress connected with the mentioned above Si matrix strain (the Hook law) can result in a creation of the inclusion-related strain, e.g. [11]. Therefore, Mn_4Si_7 inclusions can be deformed in respect to the bulk material. To distinguish this possibility, precise measurements of the lattice constant of inclusions must be performed in future.

4. Conclusions

Using various experimental methods, including synchrotron radiation measurements, correlation between dimensions of Mn_4Si_7 inclusions and strain state of the Si matrix was found. It occurred to be possible to find the critical values of these dimensions for the case they become incoherent in respe ct to the Si matrix.

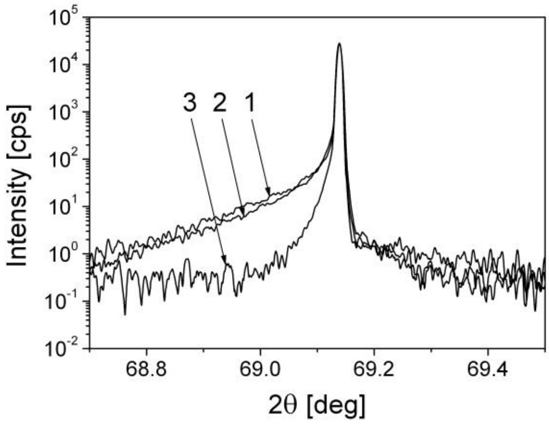

Figure 1. 2*θ*/*ω* X-ray diffraction patterns (004 Si reflection) for Czochralski Si:Mn samples annealed for 1 h at 340°C (1), 600°C (2) and 800°C (3).

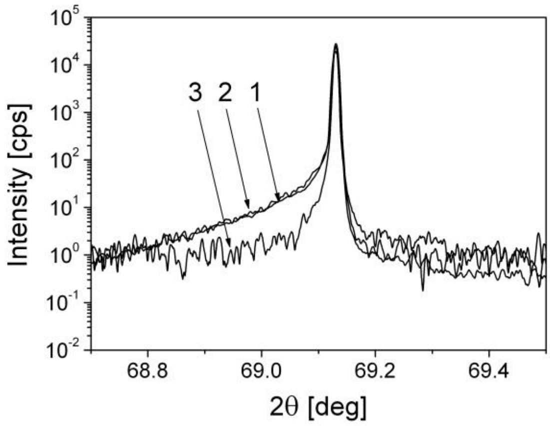

Figure 2. 2θ/ω X-ray diffraction patterns (004 Si reflection) for Floating-zone Si:Mn samples annealed for 1 h at 340°C (1), 600°C (2) and 800°C (3).

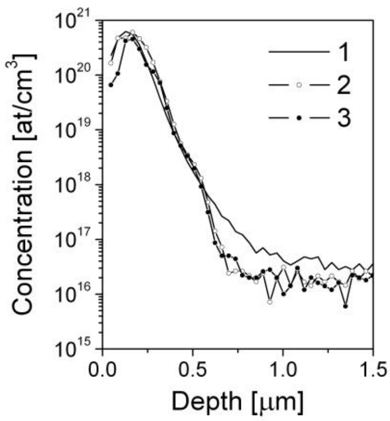

Figure 3. SIMS Mn depth profiles for Czochralski Si:Mn: as-implanted sample (1) as wellas for samples annealed for 1 h at 600°C (2) and 800°C (3).

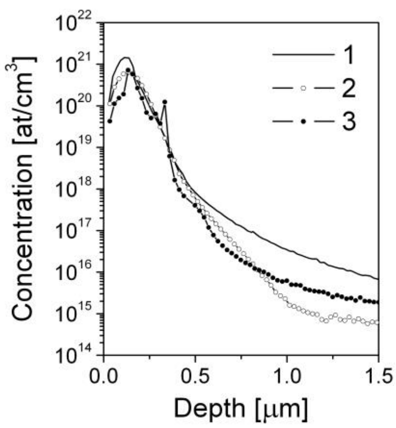

Figure 4. SIMS Mn depth profiles for Floating-zone Si:Mn as-implanted sample (1) as well as for samples annealed for 1 h at 340°C (2) and 800°C (3).

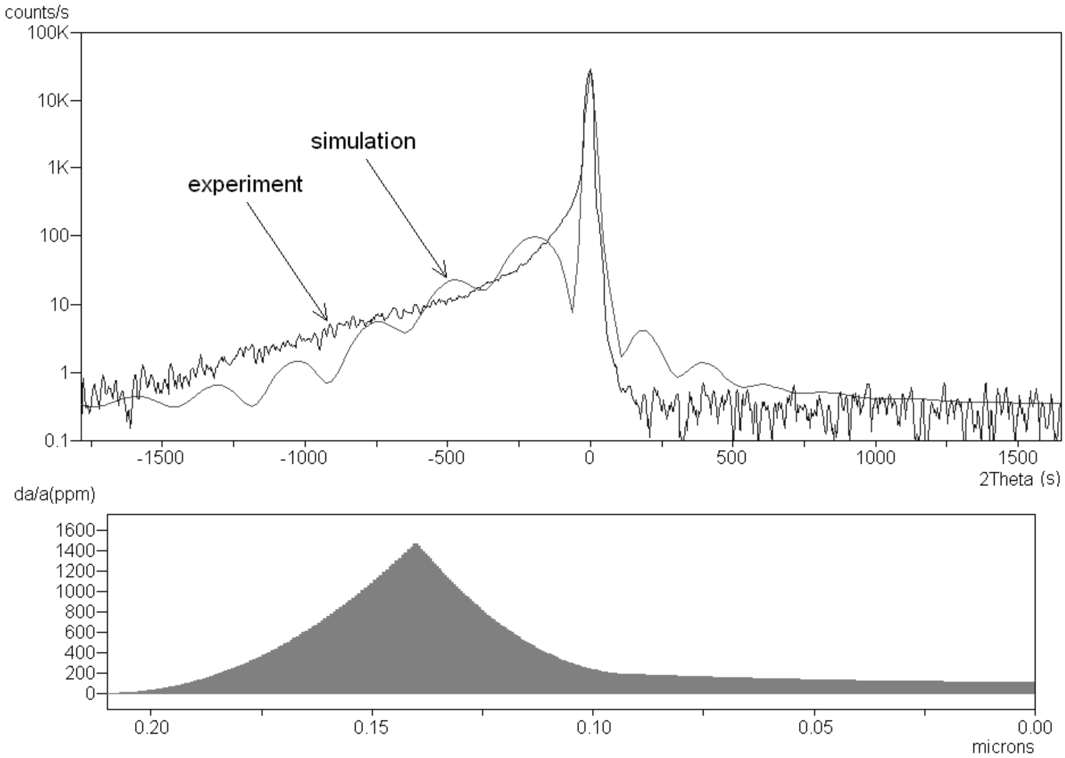

Figure 5. Numerical simulation of $2\theta/\omega$ X-ray diffraction pattern (upper) and depth distribution of the Si-matrix strain (lower) for Czochralski Si:Mn sample annealed for 1 h at 340°C.

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SOLARIS: Bright light at the end of the tunnel. Keep your fingers crossed!

H. Oyanagi, A. Kisiel, W. Rypniewski, C. Bocchetta, and M. Stankiewicz
tell us about the future of the Polish synchrotron

High brilliance and good investment

Hiroyuki Oyanagi

[W.P.] Do the users need 1.5 GeV synchrotrons?

If the current storage rings are categorized, there are three types. First, high energy (6-8 GeV) storage rings to achieve high brilliance x-rays over a wide energy range, 5 – 60 keV using higher harmonics radiation of undulator (Category I). The concept is based on the principle that ultra low emittance is achieved by a large circumference, a function of number of bending magnets. The same concept is now achieved by improved focusing technology, rendering the required storage ring energy much lower, i.e., 3 – 3.5 GeV with a lower high energy limit. As the cost performance is best in this second category (Category II, medium-energy-class light sources), the recently built storage rings were mostly based on this design rule. The third category (Category III) is a more compact medium-low energy machine (1.2 – 1.5 GeV) which is also popular as it offers an energy-saving cost-effective machine. In fact, the upgrading plan of SPring-8 downgrades the energy from 8 GeV to 4.5 – 6 GeV. Beijing's new storage ring will be 5 GeV.

The choice of storage ring energy is a result of the power balance between spectroscopic users who prefer lower energy (<30 keV) and crystallographers who require higher energy (<60 keV). Thus the Category III machines try to extend the high energy limit, making special efforts such as higher harmonics of undulator radiation, a superconducting wiggler or a superbend. The last category (Category IV) is a low energy (<1 GeV) compact VUV light source. The last category is dedicated to spectroscopy users and the high-energy limitations do not exist. Machine people often aim at the highest specifications such as ultimate synchrotron radiation (USR) but the realistic specifications must reflect the user community's demand.

Unfortunately, reflecting the current and future economic situation, high-end machines (Category I) are unlikely to be planned. Moreover, the same brilliance is now available by the use of the in-vacuum undulator and the need for Category I light sources is decreasing. That is the reason why so many 3 GeV storage rings have been constructed recently and are, proliferating all over the world. Spectroscopy users may prefer even lower energy 1.2 – 1.5 GeV and by using undulators their energy range preference is easily covered, while extending the higher energy limit is a matter of negotiation with crystallographers. Higher harmonics of the undulator, superconducting wiggler or superbend technologies can be used, depending on the requirements of crystallographers. Currently, in Japan there are two recently-built Category II machines, SAGA Light Source (1.5 GeV), and Aich SR (1.2 GeV). They are based on the same design rule, which limits the storage ring energy to Category II and the extended energy limitation by superconducting wiggler and superbend, respectively. The HALS (Hefei Advanced Light Source, 1.5 GeV) is also based on the same category policy, higher harmonic undulator radiation that makes the use of hard x-ray (<8 keV) with an ultra low emittance (<1 nmrad) and even hard x-ray below 10 keV from a bending magnet.

[W.P.] How many thousand users are in Japan?

Both Photon Factory and Spring-8 have about three and five thousand proposals per year, respectively. There are seven other facilities for open use and the total number of proposals could be about ten thousands. The number of registered members of synchrotron radiation society is about one thousand. The number of users and helpers is roughly ten times that of society members, which is roughly in agreement with the number of proposals.

[W.P.] But there are also occasional helpers, students... The total number is certainly higher.

The number of proposals is equivalent to the number of experimental leaders. Usually one experimental group consists of about five on-site experimenters for whom (?) the collaborators (sample preparation group) are not counted, a safe estimation is about ten times that of the number of proposals, which is about hundred thousands.

[W.P.] Experienced people...

In the beginning (start-up period), experienced researchers design the beamlines and stations to which some motivated users should give support representing a research community. It is necessary for the facility to understand the requirements directly from users to avoid over-specification of the instrumentation. Usually a station- or beamline-base working group is formed and the specifications are determined. Staff (if the number of motivated users is too small) should carefully evaluate the proposed specification and make the final decision. Because of the travel budget, the facility site should be decided taking transport into account.

[W.P.] Do you think that SOLARIS is a good investment for our country?

Yes, I think so. Please note that synchrotron radiation facilities can be a driving force of science and industry, not only giving them solutions but also finding new problems. I would like to stress that the latter cannot be replaced by spending money on other investments. It can be called an investment in knowledge, which should never end.

[W.P.] I agree. Thank you very much.

Broad cooperation and new horizons

Andrzej Kisiel

[W.P.] What is the situation of Polish experimental physicists in Poland? Just from the point of view of a researcher who initiates research here, using the synchrotron beam as a tool?

[A.K.] In my view, the situation of Polish physicists using synchrotron radiation is favorable. First of all, we have already developed a "personal base". Many well-educated professionals in Poland carry out and develop broad scope of research requiring the use of the synchrotron. It seems that this trend in experimental physics is likely to continue.

[W.P.] How can you assess the accessibility, to Polish researchers, of synchrotron facilities: both the foreign facilities and – in future – the Polish source?

[A.K.] When it comes to foreign sources, the matter is dynamic, due to the ever-changing rules for granting access to synchrotron radiation. Therefore, the demand for the Polish synchrotron beamtime may be significant.

[W.P.] But can that satisfy our needs?

[A.K.] Certainly, development of experimental physics using synchrotron requires continuous activity by researchers. In retrospect, Polish researchers who moved early to synchrotron radiation facilities were often highly valued as initiators of new ideas and research directions, which were later developed by them and by the collaborating synchrotron radiation staff. This happened in many cases. In the 1970s and 1980s, Poland was very active providing new ideas in materials science and technology. New specialized materials were developed in several laboratories of universities and in institutes of the Polish Academy of Sciences. In this regard, the leading role was played by the Institute of Physics of Polish Academy of Sciences, developing new technology for crystal growth of various single crystals of compound semiconductors. The availability of these new unique materials was a seed of many very valuable research ideas. These ideas were transposed to very modern laboratories – the centers using synchrotron radiation produced very tangible results for both parties and the concept-research accomplishment time was very short. Currently, I think, the situation has not changed very much, since material science in Poland is still very strong. New projects based on the possessed technology continue that effective cooperation. I think that it is an opportunity that will be further exploited.

[W.P.] What can the SOLARIS source give Polish scientists?

[A.K.] First of all, the source will enable us to undertake (i) a series of investigations and (ii) test studies before still more advanced measurements abroad. But it also has the advantage, not to be underestimated, of an important training center.

[W.P.] An educational center?

[A.K.] Yes. It fulfills also educational tasks. Often for financial reasons, the graduate or doctoral students cannot be sent to work abroad at synchrotron radiation facilities. However, you can afford to send them to the national source, where they can do adequate measurements and will learn synchrotron radiation techniques. SOLARIS will have the potential to be a training centre for those who require stronger sources.

[W.P.] Can SOLARIS attract foreign scientists?

[A.K.] In my view, it is absolutely necessary. We have to engage in very serious work that encourages outside researchers to participate in research programs in Poland. At this moment, the current number of Polish specialists using synchrotron radiation is not large enough to fill the beamtime at SOLARIS. A good example of solving this problem has been the Polish-Italian cooperation with professor Franco Bassani, director of the Italian program PULS, that started at the ADONE storage ring in Frascati. He came to Kraków in 1975 and persuaded the rector of the Jagiellonian University to prepare and sign an agreement granting access of the Institute of Physics of the Jagiellonian University to the PULS program. Given that the program PULS was supposed to start in 1979, it was an early step in the right direction.

[W.P.] But did both parties profit from this?

[A.K.] Yes. From the start of the studies in 1979, the Polish program was part of PULS and the first results were already published just 2.5 years after the start of the x-ray experimental beamline. So it seems that this type of pre-emptive move is necessary to fill the beamtime schedule of the Polish synchrotron right from the start.

[W.P.] Can the synchrotron beam be seen as a better source of light to improve existing research capabilities, or rather as a tool to open up new research horizons. Or both?

[A.K.] The answer is "yes" to both questions. Of course, synchrotron radiation in all spectral regions is a much better source of light than the standard sources. Therefore, through this versatility it is easier to correlate studies in different fields of physics. An example would be the use of EXAFS analysis of the local structure of the diagnostic material. The local structure can also be studied through the analysis of the phonons in the far-infrared – also using synchrotron radiation. In fact, two distinct measurement techniques meet to analyze related properties of a solid.

However, when we look for new horizons, undoubtedly a synchrotron opens the door to modern technology. This opening lays in the fact that synchrotron radiation sources have a very large modern experimental base. The beamlines incorporate modern peripheral devices operating quickly, reliably and with huge scope for a range of possible uses. This is one of the reasons that scientists, physicists, chemists, biologists, doctors are grouped around these very modern measuring lines and they use the latest technology which is constantly stimulated by new advances.

[W.P.] And how important is the interaction of different groups from different countries who meet at the beamlines?

[A.K.] Obviously – it is very high. They meet to exchange ideas and build closer cooperation. However, the cooperation requires an active attitude. Each participant brings his/her own individual research skills that result in great interaction and advances of the research programs.

[W.P.] Would you say that the work at the synchrotron beamline stimulates the collaboration between centers?

[A.K.] Yes. In the past – a lot. Use of the synchrotron radiation often generated an exchange between research groups. The same researchers could use beamlines at different synchrotrons. It has stimulated strong cooperation between centres. Currently, due to better and more versatile beamlines this kind of joint research has become obsolete.

[W.P.] As concerns the 90's?

[A.K.] Yes, then the "scientific tourism" meant mixing of communities and transfer of experience. There are a number of examples. The one already given concerns the excellent semiconductor material technology of the 60s – 70s in Poland. It has resulted in a number of research programs using a variety of techniques at many synchrotrons in the world. The photoemission studies explored good quality materials from national laboratories. Similarly, in the field of X-rays, XANES, EXAFS and in the electronic structure vacuum study in ultraviolet. It should be stressed that the advanced studies using synchrotron radiation require a vast theoretical base.

Good quality experimental results are obtained relatively quickly. Theoretical development often requires prominent experts in the field and time-consuming calculations. This is an important point in the overall research design. To overcome this the interaction between experimentalists and theoreticians is necessary. We need theorists who, in addition to the general own interests are working to resolve the specific theoretical problems raised by the results of advanced experiments. For example, in the analysis of the electronic structure of a material, difficult theoretical band structure calculations have to complement the experimental results, to compare and understand them e.g. for the ultraviolet optical reflectance spectra obtained in the vacuum and for XANES. These must be really very good and advanced theoretical calculations. In short, a close relation between research of the experimentalist and theorist is necessary.

[W.P.] Besides these questions, would you like to add something in the context of Polish synchrotron, or to comment-on other issues?

[A.K.] I would wish for this synchrotron to open and run according to the schedule, within the designed technical parameters. Here I recall a significant problem observed in the activity of new foreign synchrotrons. Always at some point the policymakers financing the construction and maintenance of synchrotron start to demand a lot of results and publications as the accountable results of these studies. They convert the funds spent to scientific results and calculate activity and efficiency. Therefore, it is in fact essential to build two types of experimental beamlines:

1. beamlines used for routine analysis of materials by X-ray diffraction or X-ray absorption spectroscopy (EXAFS and XANES methods). For this type of research there is still a huge demand for all synchrotrons in the world and the scientific value of these studies is very high.

2. the experimental lines, which by definition have very high and ambitious requirements leading to specialized scientific results. These lines are generally more expensive and are used by highly specialized advanced groups.

[W.P.] Type 1 may require an extended comment: is it important to have automated access, so that the standard samples can be quickly measured automatically?

[A.K.] Yes, but it is not absolutely necessary in the first phase of the Polish synchrotron. You can try to gradually automate the line that is very heavily exploited.

[W.P.] When we are building a beamline, how to plan its future staffing? Is just one scientist on one line a good choice, or maybe we need a group that will take care of all experiments and, also, perform its own research?

[A.K.] This is a very complex issue. From my observations you need a rather large group of people who work together on a regular basis. Such a group of more than 10 may include interns and outside regular collaborators supplying fresh ideas. Then, the cooperation is most effective.

[W.P.] From my observations, a good beamline has three experienced researchers and several interns, young people who are learning there, and only then the beamline produces a true scientific output.

[A.K.]You are right. A few scientific beamline caretakers are required. The working experience on the line should be provided by people who work there on a permanent basis. This is particularly important in the 24-hour and 12-hour work cycles at beamlines. Those who come for measurements for a short time, have a little experience. Effective progress is achieved when good ideas come from regularly collaborating teams. It is best if the research ideas come from groups that have a strong theoretical background. Then the results are processed in a short time. I know cases where the results obtained on the synchrotron line waited for the theoretical elaboration for nearly five years.

[W.P.] This is disadvantageous...

[A.K.] Yes. The long delay in publication is very unfortunate. It may happen that very similar experimental results are published sooner by someone else, because others also come up with similar ideas. The ideas in science are derived from the state of science at the time. This is why the "hot topics" usually attract collaboration of more groups to speed up the solution. If someone comes up with a good idea today, it is very likely that someone else already has the first results of the study.

Light for biology and medicine

Wojciech Rypniewski

[W.P.] How do Polish molecular or structural biologists view the construction of the Polish synchrotron? Or how do you see it? It is important that we have a synchrotron in Poland or do we already have access to such good sources, so that it is unnecessary?

[W.R.] It is very important and it is good that you ask a biologist, because biologists are a major part of synchrotron users everywhere in the world. It is hard to imagine the Polish synchrotron without biological applications. It is fair enough that physicists have the initiative in initiating the synchrotron project, but I am happy that you remember about the biologists.

[W.P.] And what difference will the Polish synchrotron make to biologists? You already have some access to other light sources, so will things improve for you? Is ready access important for you and is it needed?

[W.R.] It is needed and in the future it will be necessary, because the sources that we have been using, were generously supported by international programmes in the past, which made the beamlines available to us for free and in addition refunded our travel costs. Those international programmes are now changing into national programmes...

[W.P.] You mean, the programme Calipso which provides financial support for the next three years is just temporary?

[W.R.] All these programmes are temporary and depend primarily on the EU policy. We have got used to them but the truth is that the EU sees itself as an organisation that initiates certain projects but when they start working well, the EU withdraws support. EU does not provide constant support but rather acts as a catalyst until the supported project starts to live its own life. Then EU stops supporting it. This is what we are witnessing now. The EU turns to other projects and the synchrotrons, which really played an essential role in structural science, will have to find other ways to finance their operations.

[W.P.] Don't we need access at the same level as the Japanese, which have a synchrotron for every 7 million people, whereas we have 40 million and no synchrotron ay all!

[W.R.] It's an important point, that in our part of Europe there is no synchrotron. And we have to ask why. You can draw a line going north to south, through Lund, Berlin and Trieste, and to the east of this line there are no synchrotrons in Europe.

[W.P.] Except in Russia. The Russians have some but their synchrotrons do not work very well.

Yes, there are some in Russia but we don't use them. It's not so simple. We need our own synchrotron for several reasons. And once we have it, we'll have good access and we'll certainly use it well.

[W.P.] We are talking about biology but probably we should consider medical applications. The progress in medicine is important and strongly promoted by the European governments, including our own.

[W.R.] Certainly. You have to remember, though, that there is no clear borderline because biologists' work in biomedical fields even if they are not medics.

It is important to have a synchrotron for several reasons. Our community of biological researchers using synchrotrons is growing very fast in Poland. When heard several years ago that we could have a synchrotron, we made a quick calculation how we could use a beam line if we had it to ourselves. It turned out that we could use it then. Today I think it would be fully occupied.

[W.P.] It will be crowded...

[W.R.] And in a few years it will be overcrowded. You see, such facilities are really needed. There are two aspects to consider. People who make scientific policy in developed countries take two approaches. They look at the current needs or they look strategically into the future and decide which facilities should be developed. It is called technology-driven research. We also need to look strategically. The synchrotron will catalyse developments, it will generate need and it will make people think in new ways.

[W.P.] Like with space or military technologies – they offer new possibilities and even if we cannot foresee how they will be applied, they will certainly find uses in the future.

[W.R.] And this will really place us in a good way on the map of Europe, in the fields of physical and biological research.

[W.P.] Perhaps it will remove the traces of the Iron Curtain?

[W.R.] Yes. And another issue: I was a synchrotron scientist in Hamburg for 10 years. When you are only a user travelling from elsewhere, you plan your experiment, you know what you can do, you mount your samples, you measure them one by one because every hour is precious. On the other hand, when you are working at the synchrotron, when it is at hand, you begin to think in different ways. You think of experiments that are impossible to do in 8-hour shifts. This is a different kind of research, more long-term.

[W.P.] If you had a synchrotron beam line, what kind of staff would you need and how many?

[W.R.] For continual support of users and also to ensure that the staff are not just providing service but carry out their own research, you need approximately five scientists per beam line.

[W.P.] Counting both, permanent staff and Ph.D. students?

[W.R.] You need different kinds. A couple of experienced scientists and a few junior ones. This is a place of learning and exchanging knowledge and experience.

SOLARIS: Cost effectiveness at the forefront

Carlo Bocchetta

[W.P.] Why is SOLARIS better, how can you compare it to others you've constructed?

[C.B.] Solaris is based on MAX IV technology, which is state of the art, and we are building a replica. It is a very bright source for the size of its circumference, the optics of the machine is exceptional, and it is extremely cost effective. The technology being used at MAX IV is highly innovative, especially for the magnets, vacuum chamber and radio frequency system. The new technology also means we can build the accelerator on a reduced budget. When we switch it on, it will be at the forefront of accelerators of comparable size both in Europe and in the world.

[W.P.] I noticed that Solaris will be commissioned before the MAX IV ring. Will it be a test for MAX IV?

[C.B.] Yes and no, MAX IV is concentrating on the 3 GeV ring first because their facility at MAX-lab already serves the users with light from their old accelerator. So here we will be building their new 1.5 GeV while they first concentrate on the 3 GeV ring. Our two projects benefit from sharing common resources in Poland and Sweden. Of these two projects the first ring to be switched on will be Solaris here in Poland.

[W.P.] But how do you compare this ring to other ones you have constructed already? Is there big progress?

[C.B.] Huge progress, it is the future of light sources. The ring uses innovative technology that has been designed in research facilities and developed in industry over the last twenty years. The technologies have evolved greatly in this time and so this ring is very different from the ones before it. But Solaris and the MAX IV rings will be the working prototypes for future light sources.

[W.P.] Can we call it "4th generation"?

[C.B.] 4th generation is the Free Electron Laser. Solaris is a very good 3rd generation light source, however, it has the possibility of becoming 4th generation since the facility and injector have been designed with this future goal in mind.

Atomic and molecular surgery

Marek Stankiewicz

[W.P.] What are the real prospects for putting the Polish synchrotron into service? What is the timetable? And what will happen later?

[M.S.] The project completion date is the end of 2014. Next year the building should be finished.

By the end of 2012 it should be under sealed conditions. At the end of 2013, we will begin the installation of the first pieces of equipment. At the end of 2014 we will start up the synchrotron. I hope that it will be functional at the beginning of 2015 and, if all goes well, the first experiments on the first beamline included in the project budget will begin in 2015.

I also assume that there will be opportunities to finance additional beamlines and the synchrotron at the beginning of 2015 will have 3 – 4 lines instead of just the one provided for in the budget.

[W.P.] Who should look for funding for the new beamlines? I do not mean the projects, but the financing. Should the initiatives come from the grassroots, or should they come from the synchrotron administration?

[M.S.] I expect them to come from the grassroots but coordinated jointly by the coordinating body, you can call it a scientific committee. However, they should match the requirements of the scientific environment, which should also be aware of the potential of the synchrotron.

[W.P.] Can the synchrotron beam be seen as a better source of light to improve existing research capabilities, or rather as a tool for opening new research horizons? Something completely new?

[M.S.] Both, but the second is more important. Sure, you can treat it in some applications as a better source of light than the existing traditional sources. By the light we understand here the entire range of electromagnetic radiation. But it also opens up completely new opportunities due to its characteristics, e.g. the collimation and intensity.

[W.P.] Can you give a striking example of new opportunities to convince our readers that this is very important?

[M.S.] Let us consider the protein crystallography – this is only possible with synchrotrons, as well as just any type of "molecular surgery" and "atomic surgery" studies when we can address the energetic transitions in molecules very precisely and see what reactions are triggered by such transitions. This is provided by synchrotron radiation wavelength tunability.

[W.P.] Probably also the physics of very small objects.

[M.S.] Of course.

[W.P.] Returning to the funding, what are the prospects of financing the experimental beamlines in the context of the economic crisis in the European Union and at the same time, the rather good state of the Polish economy?

[M.S.] I would wish I could say something, but it is rather difficult. It seems to me that the atmosphere is not bad and money for the research, for the research infrastructure, exists.

[W.P.] Here or in the European Union?

[M.S.] Here it is not so bad, the synchrotron can be a good example. The budget of the synchrotron is small in the scale of spending on the whole research infrastructure. The problem is to channel that money well, so it goes to the flagship projects. Synchrotron is present on the map of the Polish research infrastructure, on the road map, and I hope that soon this presence will have expected consequences. Up to now – one year has passed and there has not been even the slightest effect. However, it looks like the signs are being noticed by the right people, that the consequences will be positive and that there will be special funding of the projects which are on the road map.

[W.P.] Would you say that the synchrotron costs as much or less than a stadium? The shape is similar...

[M.S.] Much less than one stadium, at the moment I do not remember what the costs of the National Stadium were, which was the flagship project for EURO 2012.

[W.P.] Hundreds of millions.

[M.S.] Maybe even a billion. Here we have 140 million PLN (40 million EUR), it is comparable with the cost of four kilometers of a highway.

[W.P.] There will also be the operational costs but you have to consider the fact that we will educate new people, new staff members, it is difficult to convert this into money.

[M.S.] I hope that the public accepts this type of spending, and doesn't just look at the construction of highways.

[W.P.] A final comment?

[M.S.] Please keep your fingers crossed that everything is going well. Let there be no external trouble, such as a period of bad weather...

[W.P.] An earthquake...

[M.S.] Or an earthquake...!

The interviews were conducted by Wojciech Paszkowicz [W.P.] in May 2012, during the ISSRNS meeting in Kraków. The title and subtitles originate from the interviewer.

Interlocutors:

Hiroyuki Oyanagi [H.O.]
Professor, Photonics Research Institute, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki, Japan

Marek Stankiewicz [M.S.]
Professor, Jagiellonian University, Kraków, Director of SOLARIS

Carlo Bocchetta [F.B.]
Professor, Jagiellonian University, Kraków, Technical Director of SOLARIS project

Andrzej Kisiel [A.K.]
Professor emeritus, Jagiellonian University, Kraków, first President of Polish Synchrotron Radiation Society

Wojciech Rypniewski [W.R.]
Professor, Institute of Bioorganic Chemistry of the Polish Academy of Sciences, Poznań

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SYNCHROTRON LIGHT NEWS

VARIA

MAX-IV - Future Opportunities. MAX IV synchrotron soon (in 2016) will become the strongest synchrotron-radiation source in the world, offering the opportunity to conduct research using the radiation in a wide energy range. On 18-19 June, the International Conference "MAX-IV - Future Opportunities" was held in Lund (Sweden). It was devoted to the future of synchrotron MAX IV being now under construction. A part of the meeting took place at the MAX IV site; the participants had opportunity to spot familiar with the progress of the construction of a linear accelerator and a large MAX-IV storage ring. The applied technology there are a pioneering and unique in the world. The conference was attended by MaxLab users and by representatives of ministries of science of the Baltic countries Sweden, Norway, Denmark, Finland, Estonia and Poland. Data on the scientific community interested in synchrotron radiation research were presented as well as the policy guidelines concerning the construction and use of the new synchrotron.

2014 Year of Crystallography. the United Nations yesterday declared that 2014 will be the official International Year of Crystallography, following the initiative of International Union of Crystallography

SOLARIS, the first synchrotron in East-Central Europe under construction. On May 16th, 2012, the corner stone of Solaris, the first synchrotron in East-Central Europe, was laid. This moment and the talk by Professor Karol Musial, Rector of the Jagellonian University, is available at http://www.youtube.com/watch?v=vNLPSe3bNjA. Now, the Solaris building is ready for installation of the equipment.

The audience during the introductory talk of prof. Karol Musiol, Rector of the Jagellonian University.

Lectures on synchrotron radiation in Cracow. Each year at the Jagellonian University the students and PhD students have the opportunity to attend the lectures on synchrotron radiation and its application. Information (in Polish) is available at https://www.usosweb.uj.edu.pl/kontroler.php?_action=actionx:katalog2/przedmioty/pokazPrzedmiot(prz_kod:WFAIS.IF-Y326.0)

Polish contribution to ESRF. Completing of Polish contribution to ESRF will be possible after acceptance by the Parliament the changes in regulation of financial rules in science, planned for the autumn 2013. The ESRF is still accepting Polish proposals.

Kai Siegbahn prize awarded to Claudio Masciovecchio
Kai Siegbahn prize was awarded to Claudio Masciovecchio from the Elettra Synchrotron Light Laboratory in Italy. “for combining the development of new instrumental facilities based on light scattering concepts, both on the ELETTRA storage ring and at FERMI@Elettra free electron laser, reporting results of significant value in the field of dynamics of disordered matter, bio-protector materials, and nanostructured materials”. The award ceremony took place at the University of Uppsala on 10 September 2012.

EPS launches new prizes
EPS launches new science of light research prizes:
- in the field of electromagnetic science, and
- in the field of laser science and its application.

The Aminoff Prize 2012
The Royal Swedish Academy of Sciences has awarded The Gregori Aminoff Prize in crystallography 2012 to Marat Yusupov and Gulnara Yusupova (France) and Harry F. Noller (USA) “for their crystallographic studies on ribosomes, translators of the code of life”.

The Aminoff Prize 2013
The Royal Swedish Academy of Sciences (RSAS) has awarded the Gregori Aminoff Prize in Crystallography 2013 to Carlo Gatti (Italy) Mark Spackman (Australia) “for developing experimental and theoretical methods to study electron density in crystals, and using them to determine molecular and crystalline properties”.

PSI facility news:
http://www.psi.ch/print/info/psi-user-facilities-newsletter-i2013

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FUTURE CONFERENCES & WORKSHOPS

26th Annual MAX-lab User Meeting, will take place September 23-25, 2013 in Lund, Sweden.

Annual AVS International Symposium and Exhibition (AVS 2013) will take place from Oct 27 to Nov 1, 2013 in Long Beach CA. For the first time, the Symposium will hold a series of sessions focused on particular synchrotron-related techniques (named Synchrotron Analysis Focus Topic).

Contribution of Estonian Research Community at European Infrastructures – MAX-IV Lab, ESS and CERN and facilitating is announced (M. Kirm, Proc. "Functional materials and nanotechnologies" FM&NT-2012).

More news at: *http://www.lightsources.org/cms/*.

prepared by W.Paszkowicz

10 Jubileuszowe Krajowe Sympozjum Użytkowników Promieniowania Synchrotronowego KSUPS-10, Stalowa Wola, 9-11.09.2013

Tegoroczne Sympozjum jest wyjątkowe. Po pierwsze, właśnie jubileuszowe, dziesiąte z rzędu i przez to już zaświadczające o nieustannym zainteresowaniu polskich uczonych technikami synchrotronowymi i ich aplikacjami. Drugi powód jest nawet ważniejszy. Zasadnicza konstrukcja źródła światła SOLARIS jest o krok od skończenia, pierwsza i być może druga stacja badawcza są w fazie przygotowań i co ważniejsze - finansowania. Uczestnicy Sympozjum mają sposobność przedyskutowania swoich oczekiwań odnośnie obu wymienionych stacji i zdecydowania o pozostałych - na jakie się zdecydować, jakie parametry zapewnić i jakie wyposażenie zapewnić. Przewidziany jest panel ekspertów dedykowany omówieniu wizji SOLARIS-a a uczestnicy Sympozjum szczególnie serdecznie są zapraszani na to wydarzenie. Namawiamy w imieniu organizatorów do przygotowania się do dyskusji, czasu jest dosyć, ale pod warunkiem utrzymania dyscypliny wypowiedzi.

Tyle o nadzwyczajności tegorocznej konferencji. Jest też jej normalna strona, możliwość zaprezentowania wykładów, prezentacji i posterów. Organizatorzy i publiczność są zainteresowani nowymi badaniami i odkryciami, z użyciem promieniowania synchrotronowego, ale nie tylko. Ponieważ polskie jednostki naukowe wzbogaciły się wydatnie w ostatnich latach w nowoczesną aparaturę naukową, wysłuchamy zapewne interesujących relacji o nowych rezultatach, które - o ile to możliwe - da się niekiedy porównać, zestawić, uzupełnić z badaniami synchrotronowymi. Uczestników konferencji mamy około 70, od fizyków, chemików, przedstawicieli nauki o materiałach aż do stomatologa. Tak więc różnorodność przedstawianych badań jest ogromna, z przewagą chyba badań materiałowych, ale wyodrębniliśmy także duży wkład badań biologiczno-medycznych, jest nawet specjalna sekcja temu poświęcona. Tradycyjnie już polskie badania w zakresie dyfrakcji różnych materiałów będą stanowiły ważną część referatów i posterów. Nie można zapominać o kilku ważnych opisach stanu konstrukcji synchrotronu, linii i stacji badawczych. Uczestnicy są z wielu ośrodków naukowych w kraju. Lista instytucji uczestniczących w Sympozjach wydłuża się. Nawet wybór miejsca Konferencji świadczy, że nowe i wschodzące ośrodki naukowe też włączają się do aktywności na polu synchrotronowym. Bardzo obiecujące jest to, że przeważają badacze młodzi, u progu karier. Ponieważ działanie SOLARIS jest przewidziane na lata, to ci młodzi uczestnicy będą odgrywać coraz większą rolę w badaniach.

Wiele firm weźmie udział w naszym wydarzeniu. Cieszymy się z tego. Firmy wsparły nas znacząco i za to jesteśmy wdzięczni. Ale interes is obustronny. Firmy mogą uczestniczyć w dostawach sprzętu do SOLARIS, ale i do innych laboratoriów. Mogą się zorientować w naszych potrzebach i wzmocnić kontakt z wielu uczelniami. To jest szczególnie ważne, gdy rozważymy nowe tendencje w sterowaniu nauką w Europie i w Polsce i nowy impuls dla kooperacji nauki i przemysłu.

Na końcu, kilka słów o Stalowej Woli. Jest to nowoczesne miasto, wybudowane w ostatnich latach przed II wojną światową. Była to jedna z wiodących inwestycji II Rzeczpospolitej, ważne centrum przemysłowe o orientacji militarnej. Po wojnie miasto dalej się rozbudowywało. Znaczne zmiany nastąpiły po 1989 roku, towarzyszyła im znacząca redukcja skali przemysłu najcięższego, ale też i pojawienie się bardziej wysublimowanej produkcji, jak elektronika, mechanika precyzyjna i inne. Ten nowy progres sprzągł się z początkiem działalności akademickiej i naukowej, gdzie na horyzoncie przewidujemy ścisłe współdziałanie nauki i przemysłu. Katolicki Uniwersytet Lubelski Jana Pawła II otworzył już Instytut Inżynierii Środowiska, otwiera Instytut Inżynierii Materiałowej a w tle mamy też rozwój Inkubatora Przedsiębiorczości, instytucji związanej z miastem i wyposażanej aktualnie w nowoczesną aparaturę. Całe to nowe centrum naukowe będzie uczestniczyło w aktywności SOLARIS.

Witamy serdecznie Uczestników Sympozjum i jesteśmy pewni, że to wydarzenie będzie zarówno impulsem dla rozwoju projektu SOLARIS, konsolidacji krajowej społeczności synchrotronowej jak i dla rozwoju Stalowej Woli jako centrum edukacji i nauki.

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Harmonogram Sympozjum

I dzień, 9.09.2013, poniedziałek

9.00 – 10.00 – Rejestracja uczestników

10.00 –10.15 – Otwarcie Sympozjum

10.15 – 11.45 – Referaty plenarne

11.45 – 12. 15 – Przerwa na kawę

12.15 – 13.45 – Referaty

13.45 – 15.45 – Przerwa obiadowa

15.45 – 19.00 – Sesja plakatowa

17.00 – 17.30 – Przerwa na kawę

19.15 – 20.00 – Zwiedzanie laboratoriów Inkubatora Technologicznego w Stalowej Woli

19.15 – 21.00 – Welcome party

II dzień, 10.09.2013, wtorek

8.30 – 10.00 – Referaty plenarne

10.00 – 10.30 – Przerwa na kawę

10.30 – 12.00 – Obrady w sesjach równoległych: „Polski dorobek w zakresie optyki rentgenowskiej", „Styk dyfrakcji rentgenowskiej z EXAFS i XANES" oraz „Kombinacja badań konwencjonalnych i synchrotronowych dla tkanek twardych"

10.30 – 11.00 – Wykład w sekcji

11.00 – 12.00 – Komunikaty w sekcjach

12.00 – 12.30 – Wykłady i prezentacje przedstawicieli firm

12.30 – 13.30 – Przerwa obiadowa

13.30 – 15.00 – Walne zgromadzenie członków PTPS

15.00 – 19.30 – Wycieczka do Baranowa

20.00 – 24.00 – Uroczysta kolacja

III dzień, 11.09.2013, środa

9.00 – 11.00 – C.d. obrad w sekcjach równoległych

11.00 – 11.30 – Przerwa na kawę

11.30 – 13.00 – Panel dyskusyjny „Polski synchrotron a stan polskich badań materiałowych"

13.00 – 14.00 – Przerwa obiadowa

14.00 – 16.30 – Prezentacja stanu realizacji projektu SOLARIS, dyskusja, dyskusja nad projektami stacji badawczych

16.30 – 17.00 – Przerwa na kawę

17.00 – 17.15 – Zakończenie Sympozjum

L-01

Progress on the world-leading X-ray and neutron facilities, MAX IV and ESS, being constructed on Poland's doorstep

Colin Carlile

European Spallation Source ESS AB,
P.O. Box 176, SE-221 00, Lund, Sweden

Keywords: synchrotron, neutron spallation source

The European Spallation Source (ESS) will be a multi-disciplinary research centre based upon the world's most powerful neutron source. This new facility will be around 30 times brighter than today's leading facilities, enabling new opportunities for researchers in the fields of life sciences, chemistry, energy, environmental technology, cultural heritage and fundamental physics.

The ESS has been on the drawing board for twenty years and was on the verge of dying a slow death. Thanks however to the work of many and the determination of a few, the many hurdles in the way of achieving a decision to firstly find a site and then to get the green light to start to build have been quite an adventure.

Costing 1.84 B€ to build and 140 M€ a year to operate naturally meant that extremely persuasive arguments had to be put at all levels.

MAX IV, as its name implies, is the fourth of a series of synchrotron sources to be built in Lund. MAX IV will be located on the same large common site shared with ESS, 4 km from the city centre. It will have unprecedented brilliance thanks to an innovative concept of constructing the magnets and to the extremely low vibrational spectrum of the ground, that lead to the resultant very low emittances of the beams. It will in fact consist of two rings, one inside the other, the second inner ring being an upgrade to the currently operating MAX II ring. Poland and Sweden are collaborating on the design and manufacture of MAX II since twin versions are to be built – one in Lund and one in Krakow - Solaris. For this (and other) reasons there is a real opportunity for the broad Polish community to cooperate not only in machine building, but also in instrument building and scientific use, to mutual benefit.

On the 17 hectare piece of land another project is taking shape and that is Science Village. Science Village will have a number of important functions:

- Firstly it will be the location of common resources for ESS and MAX IV such as restaurants, hostel, meeting places for the user community and shared administrative functions including user reception,
- Secondly it will house specialised science laboratories that will enable users to get added value from their beam time. It is essential that users from the many diverse scientific disciplines that will use the x-ray and neutron beams at ESS and MAX IV are dealt with by scientists who understand their specialist needs and where they can find equipment necessary for the manipulation of their samples and sample environments.
- Thirdly, it will be a showcase for the science that is being done by the research communities, and will house exhibitions that will inform specialist and non-specialists alike. It is an equally important aspect of our work to communicate with the public – the tax-payers who fund our work.

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Finally I hope that my talk will stimulate discussion amongst participants as to how Poland can satisfy its particular scientific needs and hopes for these two facilities. Now is the time to make those wishes known.

O-01

XPS spectra of uranium (VI) adsorbed on red clay

M. Majdan*, E. Grabias, and A. Gładysz-Płaska

Faculty of Chemistry UMCS,
20-031 Lublin, pl. M. Curie-Skłodowskiej 2, Poland

Keywords: XPS spectra, uranium, clay

*email: m052004@yahoo.com

XPS spectra of uranyl acetate $UO_2(CH_3COO)_2$ adsorbed on red clay were registered. The bands in the spectra: U 4f7/2 i U 4f5/2 were deconvoluted into two components, which were attributed to the adsorption of U(VI) ions on silanols ≡Si-OH and aluminols ≡Al.-OH. The spectra registered for the samples prepared in the presence of phosphates in the aqueous phase have different character showing only one component for the pH 5.2-5.3 and this probably results from the formation of surface complexes U(VI)-PO_4^{3-}-≡Si-OH lub U(VI)-PO_4^{3-}-≡Al-OH.. Both uranyl ions and phosphates can play the bridging role in these complexes [1].

It results from the equilibrium data for U(VI) sorption on red clay that the sorption percentage is enhanced when compared with the case of phosphates absence and from this one can conclude about potential application of red clay as geological barrier in the immobilization of uranium originating from nuclear wastes.

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L-02

Investigation of the electronic states of $FeTiO_3$ by X-ray photoemission, X-ray absorption and Auger electron spectroscopy

J. Kubacki [1], D. Kajewski [1], J. Szade [1], and K. Schulte [2]

[1] *A. Chelkowski Institute of Physics, University of Silesia, 75 Pułku Piechoty 1 Str, 41-500 Chorzów, Poland*
[2] *Maxlab, University of Lund, Lund, Sweden*

Keywords: ilmenite, resonant photoemission, x-ray absorption, auger electron spectroscopy

*e-mail: jerzy.kubacki@us.edu.pl

Ilmenite ($FeTiO_3$) is a wide band gap p-type semiconductor with a band gap of about 2.5 eV [1]. Solid solution hematite (α-Fe_2O_3) and ilmenite ($FeTiO_3$) is one of the interesting material for spintronics applications [2,3]. The electronic structure of the $FeTiO_3$ is considered as the mixed valence Fe^{2+} and Fe^3+ assuming nominal state +4 of titanium. However, some experimental data suggested the presence of titanium with valency +3 due to the charge transfer from Fe^{2+} to Ti^{4+} [4].

In order to verification of the real electronic structure we performed the resonant photoemission study (RESPE) of the valence band combined with x-ray absorption study (XAS) for natural ilmenite material. The XAS spectra were obtained on the $L_{2,3}$ edge of titanium and iron. The valence band spectra were obtained for the photon energies corresponding to in- and off- resonance of iron and titanium. Our results show that iron existed in two different +2 and +3 oxidation states, and valence of titanium is +4. The ilmenite was also study by standard x-ray photoelectron spectroscopy (XPS) after Ar+ ion bombardment at higher temperature. The metallic behavior of the surface was detected. The small nanocrystals on the surface were observed and analyzed by electron microscope and auger electron spectroscopy (AES).

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L-03

Plasma–cathode interface of glow discharges as medium of particles activation for material spectrometry

Z. Wroński

Institute of Environmental Engineering
Catholic University of Lublin,
6, Ofiar Katynia Str, 37-450 Stalowa Wola, Poland

Keywords: glow discharge plasma, optical and mass spectrometry

*e-mail: zwronski@kul.lublin.pl

Optical emission spectroscopy (ES) and mass spectrometry (MS) often use the plasma of large range of glow discharges for both optical activation and ionization of matter molecules appearing at all aggregation states even for solid evaporation to the plasma phase.

The plasma–cathode (P-C) interface of glow discharges under low gas pressure is a “subtle” object where a distinct phase boundary appears between the solid state (cathode) and the gaseous phase (plasma). This boundary exists in spite of the presence of both high energy electrons and ions (even hundreds of eV). These energies are extremely high if compared with the energy 0.3 eV that corresponds to the temperature of carbon melting.

Activation of the P-C interface is much affected with classical processes, ionization and excitation, which have well determined cross sections, but also with specific processes such as the Penning ionization and excitation whose cross sections are generally unknown.

Application of glow discharge plasmas for material spectrometry has a few well developed scientific descriptions for the use in both engineering and physical chemistry. The monograph [1] is an excellent example of the above statement. However such treatment assumes glow discharge plasma as a homogeneous object existing under a local thermodynamic equilibrium. This allows the simple relation between optical line intensities and ionization efficiency and plasma temperature. However, this treatment fails in the case of the P-C interface because of large discrepancies between the average energies of each plasma component.

Mechanism of P-C plasma activation is complex and possible to be described and optimized by the theoretical modelling of the space-electro-dynamic structure (**SEDS**) of the P-C interface as well as the space–mass-energy distribution $\boldsymbol{F(s, m, \varepsilon)}$ of both activating and activated particles. This modelling must relate **SEDS** and $\boldsymbol{F(s, m, \varepsilon)}$ characteristics to the outer discharge parameters easily measured: gas pressure $\boldsymbol{p}$, voltage $\boldsymbol{U_{ac}}$ on the P-C interface, discharge current density $\boldsymbol{j_d}$, etc., which are characteristic of the studied P-C interface.

The results of both analytical and numerical modeling of the S**EDS** structure and $\boldsymbol{F(s, \varepsilon)}$ of glow discharges working under low pressures $\boldsymbol{p} \approx 1$ Tr will be presented, which are important from the point of view of molecules activation. Moreover, the results of the measurements of the $\boldsymbol{F(s, m, \varepsilon)}$ distributions made by the MS spectrometry of ions formed at the P-C interface as well as those of the space-line distributions $\boldsymbol{I(\lambda, s)}$ of the light emitted by the molecules of the **P-C** interface will be presented, see [2,8,9].

On the basis of the interpretation of the experimental results in the light of the above modelling the peculiar properties of the P-C plasma will be explained, which are important from the point of view of MS i OES spectrometries. These properties are as follows: dependence of $\boldsymbol{I(\lambda, s)}$ distribution on density $\boldsymbol{j_d}$ and the characterristics of “selecting” excitation of some molecules, etc.

Moreover, the effect of the Penning processes on $\boldsymbol{I(\lambda, s)}$ distributions as well as that without-emission deexcitation of molecules during their leaving the hot cathode surface will be discussed, see [3,4].

Complex character of the measured $\boldsymbol{F(s, m, \varepsilon)}$ distributions of ions passing through the extraction hole of cathode will be also explained, see [2]. Special attention will be paid to a peculiar lack of low energy ions in the $\boldsymbol{F(s, m, \varepsilon)}$ spectra experimentally observed, see [5]. These ions are predicted by the theoretical modelling of the S**EDS** structure to be dominating ions. This fact is a serious deficiency of the P-C interface when used for MS spectrometry. Some reduction of this deficiency will be proposed.

The presentation is the review work, hence it is based on the scientific material taken from the papers of other physicists in part. However, main material of the proposed presentation contains original results of theoreticcal and experimental studies of the P-C interface physics by the author. The papers, the most connected with this abstract, are enclosed below.

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L-04

First beamline at Solaris

M. Zając[1*], A. Bianco[2], C.J. Bocchetta[1], E. Busetto[2], P. Goryl[1], J. Korecki[3,4], K. Kubal[1], F. Melka[1], M. Ostoja-Gajewski[1], M. Sikora[3], M.J. Stankiewicz[1], Ł. Walczak[1], A.I. Wawrzyniak[1], K. Wawrzyniak[1], and Ł. Żytniak[1]

[1]*National Synchrotron Radiation Centre SOLARIS at Jagiellonian University, ul. Gołębia 24, 31-007 Kraków, Poland*
[2] *Synchrotron ELETTRA, Strada Statale 14, 34149 Basovizza, Trieste, Italy*
[3] *Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Al. Mickiewicza 30,30-059 Kraków, Poland*
[4] *Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, ul. Niezapominajek 8, 30-239 Kraków, Poland*

Keywords: synchrotron radiation, beamline, energy resolution

*e-mail: mar.zajac@uj.edu.pl

The first beamline built in the National Synchrotron Radiation Centre Solaris will use bending magnet radiation. The planned beamline is optimized for the soft X-ray photon energy range 200 - 2000 eV. The calculated energy resolving power (E/ΔE) is of the order of 4000 or higher. The chosen optical design based on plane grating monochromator working in the collimated light has been studied by the Elettra group. The results of the optical configuration ray-tracing and energy resolution calculations are presented and discussed. Additionally, detailed explanation of the purpose of each optical element is reported. The dimensions of the focalized beam at the end station, which will host a Photoemission Electron Microscope (PEEM), are 100µm x 50µm. In the future additional refocusing device can be installed to increase the photon flux density on the sample for more demanding experiments.

Within the framework between Jagiellonian University and Jerzy Haber Institute of Catalysis and Surface Chemistry PAS, the Photoemission Electron Microscope will be main end station of the first beamline. The PEEM was successfully tested at the Pollux beamline in the Swiss Light Source. The magnetic contrast was easily seen for the few nanometer thick iron nanostructures. Exchangeable with microscope we foresee to use separate chamber for X-ray absorption spectroscopy measurements. It will be dedicated to biology, chemical, material science and physics experiments. In the future spectroscopy chamber can be adapted to the scanning transmission x-ray microscope chamber by introducing focusing device in front.

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L-05

Three-dimensional strain distribution of lithium manganese spinels

J. Darul[1], A.D. Evans[2], and P. Piszora[1*]

[1] *Dept. of Materials Chemistry, Faculty of Chemistry, Adam Mickiewicz University, Grunwaldzka 6, 60-780 Poznan, Poland*
[2] *European Synchrotron Radiation Facility (ESRF), Grenoble 38043, France*

Keywords: synchrotron radiation, $LiMn_2O_4$, microstrain, line profile analysis

*e-mail: pawel@amu.edu.pl

The information regarding the local disruption of the structure is contained in the shapes and breaths of the diffraction profiles and the effects of the microstructure and local atomic environment on X-ray diffraction has been studied extensively experimentally and with numerical simulations [1-3]. During intercalation, the addition of interstitial species causes a change in the unit-cell volume of the lithium-manganese oxides. This leads to strain and stress in the battery system [4]. Stress maps for insertion of lithium into the particle can be plotted.

Synchrotron measurements of the microstrain were performed on ID31 beamline (ESRF). The energy of the monochromatic synchrotron beam was about 30 keV (0.41274 Å wavelength). Rietveld refinements were performed using the program GSAS. Anisotropic peak broadening mainly caused by lattice strain was observed with broadening of the diffraction peaks. The phenomenological microstrain model of Stephens with 4 and 2 refinable parameters for tetragonal and cubic symmetry respectively was used to model the anisotropy in FWHM of the individual peak profiles. This microscopic picture is completed by analyzing the isosurface of the anisotropic microstrain which reflects the strong shear strain of neighboring coordination polyhedra in the lithium manganese structure.

Acknowledgments: We acknowledge the European Synchrotron Radiation Facility for provision of synchrotron radiation facilities and we would like to thank Dr Michela Brunelli for assistance in using beamline ID31.

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L-06

Overview and current status of Solaris synchrotron light source

A.I. Wawrzyniak[1,2*], C.J. Bocchetta[1], P. Borowiec[1], P. Bulira[1], P. Czernecki[1], D. Einfeld[1,3], P.P. Goryl[1], K. Królas[2], K. Kubal[1], R. Nietubyć[1,4], M.P. Nowak[1], F. Melka[1], M. Ostoja-Gajewski[1], J. Potoczny[1], P. Tracz[1], M.J. Stankiewicz[1,2], P. Szostak[1], Ł. Walczak[1], K. Wawrzyniak[1], J. Wiechecki[1], M. Zając[1], T. Zawierucha[1], and Ł. Żytniak[1]

[1]National Synchrtoron Radiation Centre SOLARIS, Jagiellonian University, 7, Gronostajowa, 30387 Kraków, Poland
[2]Institute of Physics, Jagiellonian University, 4, Reymonta, 30-059 Kraków, Poland
[3]MAXIV Laboratory, Lund, 1, Ole Römers Väg, 22363 Lund, Sweden
[4]National Centre for Nuclear Studies, Świerk,, 7, Andrzej Sołtan, 05400 Otwock, Poland

Keywords: linac, storage ring, electron gun

*e-mail: adriana.wawrzyniak@uj.edu.pl

Solaris synchrotron light source accommodates 60 m long 600 MeV linear accelerator with thermionic electron RF gun and vertical transfer line, the 1.5 GeV storage ring with a circumference of 96 m, which is a replica of the MAXIV 1.5 GeV storage ring [1-3], and one bending magnet beamline in Phase I of the project.

Since Solaris linac is not a full energy injector, the electron beam is ramped up to the final operating energy in the storage ring[4].

The construction of the Solaris facility has started in 2010 and is planned to be finished in the last quarter of 2014. Majority of the machine components have been procured and some of them have already been delivered according to the schedule. In autumn 2013, right after building handover, the installation of the linac will start. This paper gives an overview and update on the facility status and installation time plan.

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L-07

X-ray refractive optics

A. Andrejczuk[1*]

[1]Faculty of Physics, University of Białystok, Lipowa Str. 41, 15-424 Białystok, Poland

Keywords: X-ray refractive optics, compound refractive lens,

*e-mail: andra@alpha.uwb.edu.pl

The utilization of refraction in the focusing of the X-rays started at 1996 when Snigirev and coworkers published first experimental proof of the use of Compound Refractive Lens (CRL) [1]. Presently many synchrotron and free electron leaser beam lines use refractive lenses for different purposes.

The advantages of refractive optics are: focusing along the primary beam axis, easy alignment, lower requirement for surface roughness, so they are easy to manufacture and are not expensive. In addition the refractive lenses can withstand powerful beam and, if necessary, can be easily cooled. The disadvantage of CRL is small effective aperture (~0.5 mm), however, taking to account small divergence of the radiation from modern undulators the loss of the flux is not big.

In the presentation the basic idea of the refractive optics is discussed. As the experimental example the refractive lens made of nickel used for Compton scattering experiments is shown [2, 3]. The review of the ideas of the increase of the effective aperture of CRL is finally presented.

Acknowledgments: The experiment was performed with approval of JASRI (Proposal No.2006B0097 and 2007B0097).

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L-08

Investigation of performance of x-ray capillaries with a lacquer-metal reflectivity layer

R. Mroczka[1,2*]

[1] *Dept. of Chemistry, The John Paul II Lublin Catholic University, Al. Krasnicka 102, 20-718 Lublin, Poland*
[2] *Laboratory of X-ray Optics, Interdisciplinary Centre of Scientific Research, The John Paul II Lublin Catholic University, Al. Krasnicka 102, 20-718 Lublin, Poland*

Keywords: x-ray metallic capillary optics, roughness, waviness

For the ful text see page 6 of this issue.

L-09

Integrated magnets of double bend achromat for Max IV 1.5 GeV and Solaris storage rings

R. Nietubyć[1,2] and M. Johansson[3]

[1]*National Centre for Nuclear Research Świerk, Sołtana 7, 05-400 Otwock, Poland*
[2]*National Synchrotron Radiation Centre Solaris, Jagiellonian University, Gołebia 7/P.1.6, 30-387 Kraków*
[3]*Max IV Laboratory, 22100 Lund Sweden*

Keywords: accelerator magnets, Max IV, Solaris.

*e-mail: r.nietubyc@ncbj.gov.pl

Integrated magnets technology has been developed at Max IV Laboratory and chosen for construction of Max IV and Solaris storage rings [1]. Challenging task of design the complex magnets structure machined out of a single iron block has been achieved. That was required for highly precise adjustment of magnetic elements and small aperture, which allow for low beam emittance [2] as well as for reduction of the construction and operational costs of the light source.

Our contribution presents the operation principles and current status of manufacturing of Max IV 1.5 GeV and Solaris double bend achromat.

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L-10

X-ray absorption spectroscopy – tool to resolve structure

M.T. Klepka[1*], A. Wolska[1], A. Drzewiecka,[1] and K. Lawniczak-Jablonska[1]

[1]*Institute of Physics PAS, Warsaw, al. Lotnikow 32/46, PL- 02668 Warsaw, Poland*

Keywords: XAFS, EXAFS, XANES, XRD, synchrotron radiation

*e-mail: Marcin.Klepka@ifpan.edu.pl

X-ray absorption fine structure (XAFS) spectroscopy is a powerful spectroscopic technique that attracts attention of scientists from many different fields. Development of new generation synchrotron sources and theoretical tools opened the potential of XAFS not only to the physicists but also to the chemists, biologists, engineers and others.

X-ray diffraction (XRD) provides information only about crystalline part of investigated materials. However, there are materials with high disorder or amorphous fraction where classical methods are insufficient and another tool is needed. In many cases XAFS can offer desired information.

XAFS uses X-rays from a synchrotron source for probing the structure of a matter at local atomic scale around almost any element in the periodic table (except the lightest). Main advantages of the XAFS are the elemental selectivity and sensitivity. Moreover, the measurements can be performed regardless the physical state of the investigated material. XAFS is usually being divided into two regions: X-ray Near Edge Structure (XANES) and Extended X-ray Absorption Fine Structure (EXAFS).

XANES directly probes the angular momentum of the unoccupied electronic states what provides information about the chemical bonding of the element [1-3]. The energy position of the edge can be treated as a fingerprint of the oxidation state of the absorbing atom.

EXAFS oscillations are used to determine the kind of elements, distances and the number of the atoms in coordination spheres around the investigated element [4].

During presentation results obtained for different kind of materials like natural minerals e.g. ilmenites, and metal-organic ligand complexes, with pharmacological potential will be discussed. Complementarity of the XAFS to the XRD studies will be shown.

Ilmenites are naturally occurring minerals used industrially to obtain white pigment. In order to optimize production process the knowledge about the minor and major phases present in an ore is essential. Standard procedure includes X-ray fluorescence (XRF), XRD or electron probe micro analysis (EPMA). However, these techniques occurred to be not sensitive enough particularly for minor phases and elements. To solve this problem XANES, together with linear combination analysis LCA, was used. Such approach allowed to identify and estimate content of the phases in an ilmenite ore [5].

Several examples of the metal-organic ligand complexes will be also discussed. Interest in such compounds is due to a fact that complexes demonstrate enhanced biological activity in comparison to parent organic ligand. However, in case of such compounds the main difficulty is to obtain single crystals for diffraction studies. To find the metal coordination sphere of non-crystalline compounds the XAFS can be applied. The combination of EXAFS and XANES techniques can provide detail information about metal-organic ligand interactions.

Examples of metal complex with: (*i*) hydroxybenzo[*b*]furan, (*ii*) benzo[*b*]furancarboxylic acid, (*iii*) benzoic acid, (*iv*) phenoxyacetic acid, (*v*) cinnamic acid will be shown [6].

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L-11

Complementary studies of the structural properties of highly disordered materials by x-ray absorption and diffraction

K. Lawniczak- Jablonska[1*], I.N. Demchenko[1], E. Dynowska[1], A. Chruściel[2], and J. Janik[2]

[1] *Institute of Physics, Polish Academy of Sciences, Lotnikow Str 32/46, 02 668 Warsaw, Poland*
[2] *Scientific Consortium ADVANCE DMC, MEXEO, 47 225 Kędzierzyn-Koźle, Energetykow Str 9, Poland*

Keywords: DMC catalysts, magnetic semiconductors, XRD, XAFS
*e-mail: jablo@ifpan.edu.pl

Nowadays technology very often takes advantage of the diversity of useful properties observed in highly disordered materials. The reliable characterization of such materials requires application of several methods providing complementary information. The complementary application of x-ray diffraction and absorption studies will be discussed basing on a few examples. One of them will be the group of non-stoichiometric composite transition metal complex salts, known as double metal cyanides (DMC). These materials are used as the industrial catalysts and form an interesting family of porous molecular materials with large fraction of the amorphous phase. This fraction may be obtained by introduction to the crystalline zinc hexacyanocobaltate (III) ($Zn_3[Co(CN)_6]_2 \cdot nH_2O$) organic ligands of different size. Depending on the type of ligands the catalysts exhibit different levels of activity. The crystalline zinc hexacyanocobaltate exhibits only very weak catalytic properties. Although they are frequently used in chemical industry the mechanism of catalytic activity is not known.

The other examples will concern magnetic semiconductors with intentionally introduced inclusions of secondary phases [1]. The structural and magnetic properties of such composites will be overviewed and advantage of applying for the same pieces of material several nondestructive techniques will be emphasized. In many cases the absence of diffraction peaks cannot guarantee the absence of other phases particularly when they result from the disordered nano-inclusions. The advantage of synchrotron based diffraction will be demonstrated in such a case.

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L-12

High-pressure diffraction studies at synchrotrons and in laboratories

D. Paliwoda[1*] and A. Katrusiak[1]

[1]*Faculty of Chemistry, Adam Mickiewicz University, Umultowska 89b, 61-614 Poznań, Poland*

Keywords: high pressure, synchrotron radiation, X-ray diffraction, structural studies

*e-mail: damianp@amu.edu.pl

Since the late 1950's high pressure crystallography has become an efficient technique for crystal structure determinations and for monitoring phase transitions. The diamond-anvil cell was then designed and can be routinely applied in laboratories and dedicated beamlines of synchrotron and neutron facilities.

Synchrotrons provided new quality in X-ray diffraction and particularly in these experiments where very high intensity of the radiation is needed. It can be especially advantageous at high pressure crystallography, where the size of the sample is reverse to the attainable pressure. Moreover, because of the very high background, the time of data acquisition is often very long before sufficient signal-to-background ratio is obtained. In our research we study organic and organometallic compounds and the scattering of light atoms is relatively weak. Examples of single-crystal data measured in the lab with sealed X-ray tube and of the data collection repeated at the synchrotron will be compared. It can be shown that synchrotron is advantageous not only because of the beam intensity but also because of a tunable X-ray wavelength, low-beam diversion and small beam diameters. The disadvantages of high polarization and fluctuations in intensity in the synchrotrons can be easy corrected.

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L-13

Synchrotron radiation in the study of biostructures and life processes: New achievements and challenges

J.B. Pełka

Institute of Physics, Polish Academy of Sciences, al. Lotników 32/46, 02668 Warsaw, Poland

Keywords: synchrotron radiation, life sciences, structural biology, medicine

*e-mail: *pelkay @ifpan.edu.pl*

More than thirty years ago, a wide access to the 3rd generation synchrotron sources has opened up new exciting era in research of the biological structures and processes, leading to a substantial progress in the fields. The history repeats in the last decade, due to a rapid development of the 4th generation sources of synchrotron radiation, the short-wavelength (SASE) FEL lasers.

SASE-FELs can produce a fully tunable monochromatic radiation in ultrafast femtosecond pulses with a peak power up to several GW, in the wide range of wavelength, including hard X-rays. With the new methods emerging to fully exploit unique emission properties of the FELs, a new qualities in probing the secrets of life are expected.

Some of the key experimental techniques have already been implemented and their invaluable potential confirmed. Included are, among other, new techniques of structure determination without the need of conventional crystallization, applicable both to large biomolecules and molecular complexes, a possibility of obtaining the precise structural information collecting diffraction patterns of a large number of small nanocrystals (so-called serial nanocrystallography) and imaging of small objects with unprecedented atomic spatial resolution. Underway are also developments of new pump and probe techniques dedicated to ultrafast dynamic study of biochemical processes.

The aim of this presentation is to draw the current state of research in the field and to show the emerging new trends and challenges, basing on examples of particular applications. Opportunities of research with the new classes of SR sources for the Polish scientists will be also discussed.

L-14

Review of the ongoing efforts dedicated to Polish free electron laser POLFEL

R. Nietubyć[1,2], W. Grabowski[1], R. Mirowski[1], J. Lorkiewicz[1], J. Sekutowicz[3], T. Wasiewicz[1], and J. Witkowski[1]

[1]*National Centre for Nuclear Research Świerk, Sołtana 7, 05-400 Otwock, Poland*
[2]*National Synchrotron Radiation Centre Solaris, Jagiellonian University, Gołębia 7/P.1.6, 30-387 Kraków*
[3]*Deutches Elektronen Synchrotron, Notkestrasse 85, 22607 Hamburg, Germany*

Keywords: FEL, XUV, IR, THz.

*e-mail: r.nietubyc@ncbj.gov.pl

The free electron laser POLFEL at National Centre of Nuclear Research, Świerk, has been proposed in continuation of efforts to establish in Poland modern facilities providing coherent radiation for science and technology, which will follow the soft x-ray synchrotron in Krakow. The initiative has been risen by the accelerator physicists involved in collaboration on the continues wave and long pulse operations of European XFEL. These new operation modes, which are the main innovative feature of POLFEL, have been recognized as a desired objective of the future European XFEL upgrade.

Ultimately POLFEL is planned as 1 GeV accelerator feeding undulator, which emits XUV ranged radiation to five experimental stations. In order to accommodate such a large enterprise to technological budgetary capabilities, the project has been split in two stages. Terahertz and infrared source will be built at first, which will provide the linear polarized radiation ranged over 6 – 1000 μm in wavelength and of 25 W in average power. In the second stage, the linac will be extended and an elliptical undulator will be installed to reach few Watts at 10 nm fundamental wavelength.

Design studies have been launched at NCBJ dedicated to key issues of planned facility: construction of fully superconducting electron injector, beam dynamics and design of the undulator. These will be discussed in our contribution.

O-02

XRPD structural studies of new group of coordination polymers

M. Grzesiak-Nowak[1*], A. Szymańska[1], G. Appleby[2], and W. Łasocha[1,3]

[1]*Jerzy Haber Institute of Catalysis and Surface Chemistry PAS, 8, Niezapominajek Str, 30-239 Kraków, Poland*
[2] *Deutsches Elektronen-Synchrotron DESY, 85, Notkestraße Str, D-22607 Hamburg, Germany*
[3]*Dept. of Chemistry Jagiellonian University, 3, Ingardena Str, 30-060 Kraków, Poland*

Keywords: synchrotron radiation, coordination polymer, X-ray powder diffraction

*e-mail: ncgrzesi@cyf-kr.edu.pl

In our study we have synthesized a group of new coordination polymers with general formula CdX_2R_2, where X is Br, Cl or I, and R is aliphatic or aromatic amine. According to the kind of central atom and inorganic anion X used, there is a possibility of obtaining structures with different spatial arrangement. Obtained compounds form various structures, from isolated molecules similar to cis-platinum, isolated polymeric chains, polymeric chains crosslinked into layers to three dimensional systems.

Powder diffraction experiments were carried out using synchrotron radiation on synchrotron PETRA III. The usage of synchrotron radiation has led to a proper solution of investigated structures from powder data. Crystal structures were solved using EXPO [1] program, Rietveld refinement was performed using Jana2006 [2].

Presented group of coordination polymers consist of six compounds, all crystallize in monoclinic crystal system. Compounds of $CdCl_2$ and $CdBr_2$ with linear amines form systems of cadmium-halide chains bridged by diamines. $CdCl_2(NH_2C_6H_4NH_2)_2$ creates a three dimensional structure in which aromatic amines connect inorganic chains. In the case of $CdI_2(NH_2C_6H_4NH_2)_2$ isolated chains are formed, in which each aromatic amine bridges two cadmium atoms.

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L-15

Application of synchrotron data to PDF-based structure refinement

Marcin Oszajca[1] and Wiesław Łasocha[1,2]

[1]*Faculty of Chemistry, Jagiellonian University, ul. Ingardena 3, 30-060 Kraków*
[2]*Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, ul. Niezapominajek 8, 30-239 Kraków*

Keywords: atomic pair distriburion function - PDF, structure refinement, polymolybdates

*e-mail: oszajcam@chemia.uj.edu.pl

Atomic pair distribution function (PDF)[1] is a direct space-based relation between interatomic distances and the number and scattering power of atoms corresponding to said distance. PDF is directly obtainable from properly normalized and corrected powder diffraction data registered in a wide Q range ($Q=4\pi/\lambda\sin\theta$). Necessity for a wide Q range arises from the truncation errors in the Fourier series summation observable as ripples in resulting function. In inlab experiments, Mo or Ag sources have to be employed to allow for a sufficient data range. Another choice is synchrotron radiation with its superior intensity and selectable measurement wavelength.

PDF contains diffuse scattering information (if present) and may be used in studying structures with local ordering. Also, nanocrystalline samples as well as amorphous phases are studied with PDFs.

Results of crystal structure refinements using PDFGUI[2] based on the PDFs obtained with PDFGETX3[3] from synchrotron data are presented.

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L-16

X-ray diffraction and topographic studies of silicon epitaxial layers grown on the substrate with introduced porous silicon layer

K. Mazur[1] K. Wieteska[2], W. Wierzchowski[1*], J. Sarnecki[1], and C. Paulmann[3]

[1] *Institute of Electronic Materials technology, ul. Wolczynska 133, 01-010 Warsaw,Poland*
[2] *National Centre for Nuclear Research, Soltana 7, 05-400 Otwock, Poland*
[3] *HASYLAB at DESY, Notkestr. 85, 22603 Hamburg, Germany*

Keywords: silicon, porous layers, epitaxy, diffraction
*e-mail: Presenting.wierzc_w@itme.edu.pl

Recent applications of porous silicon in technology of solar cells concern manufacturing of exfoliated silicon epitaxial layers [1]. The samples prepared for obtaining exfoliated layers, containing two layers with different porosity were studied in the present case. Similarly as in [2] the investigation included white beam Bragg-case projection and section topography and monochromatic beam topography with recording of local rocking curves at HASYLAB. The samples were also studied with conventional HRD and reflectometric methods.

The porous layers without epitaxial deposition provided strong and narrow maximum at low angle side of the substrate maximum. After the deposition we observed the decrease of lattice parameter in the top layer with lower porosity while the layer with higher porosity still contained the material with larger lattice parameter. The topographic investigation in practically all samples revealed irregular contrasts which can be the dislocations generated at the annealed porous substrate. Other common defects were craters in the annealed porous layer overgrown and filled in the epitaxy. In layers of large thickness, we also observed narrow black and white stripes along <110>, most probably stacking faults with imperfect dislocation loops.

The exfoliated layers exhibited significant curvature. The most effective method of revealing defects in such layers were Bragg-case projection topographs and "zebra" pattern monochromatic beam topographs providing a map of sample curvature.

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L-17

Structure in solution of HopQ1 protein, type three effector from *Pseudomonas syringae*

Maciej Kozak[1]*, Michał Taube[1], Fabian Giska[2], Marcin Piechocki[2], Rafał Hoser[2], Jacek Hennig[2], and Magdalena Krzymowska[2]

[1] *Dept. of Macromolecular Physics, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland*
[2] *Laboratory of Plant Pathogenesis, Institute of Biochemistry and Biophysics, Polish Academy of Science, Pawinskiego 5a, 02-106 Warsaw, Poland*

Keywords: small angle X-ray scattering, HopQ1 protein, 14-3-3 protein, low resolution structure

*e-mail: mkozak@amu.edu.pl

Many bacterial pathogens have evolved ingenious mechanisms to overcome the host defense response, and these methods include the delivery of type III effectors into host cells. HopQ1 (also known as HopQ1-1) represents one of 59 type III effector protein families identified in *Pseudomonas syringae*, a Gram-negative plant pathogenic bacterium [1].

The aim of this study was to characterize the structure of the monomeric form of HopQ1 protein from *Pseudomonas syringae* pv. *phaseolicola 1448A* and the complex of HopQ1 with 14-3-3a protein from *Nicotiana tabacum* as well as to analyze the interactions stabilizing different oligomeric forms of HopQ1

We decided to study the structure of HopQ1 in solution by the use of small angle scattering of synchrotron radiation (SAXS) technique supported by molecular modeling, confocal microscopy and circular dichroism.

The low resolution structure in solution of HopQ1 monomeric and dimeric forms determined by two independent programs DAMMIN [2] and GASBOR [3] as well as the HopQ1 complex with 14-3-3 protein will be presented. The overall shape of HopQ1 chain-like model resembles bulky and slightly flattened bottle and the predicted (by bioinformatics) structure fits perfectly to this model.

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O-03

Influence of selected gemini surfactants and sulfobetaines on structure of BSA and lysozyme

W. Gospodarczyk[1*] and M. Kozak[1]

[1]*Faculty of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznań, Poland*

Keywords: synchrotron radiation, beamline, electron

*e-mail: w.gospodarczyk@gmail.com

Protein aggregation is a major problem investigated by scientists nowadays. This phenomenon is directly connected with numerous human neurodegenerative diseases, e.g. Alzheimer disease. Moreover, protein aggregation is often regarded as an undesired effect in biochemistry or biotechnology. Substances that hamper growth of protein agglomerates are of substantial significance and are therefore intensively sought for.

Besides sulfobetaines, dicationic surfactants, called gemini surfactants, are a promising group of aggregation inhibitors. They have very low critical micellar concentration (cmc), exhibit easy adjustment of properties due to their considerable diversity and they also form micelles similar in structure to cell membranes.

Bovine serum albumin (BSA) plays an important role in binding and transporting various substances within bovine blood vessels as well as is often used as model protein. Also lysozyme is a model protein suitable to perform aggregation examination.

Surfactant-protein samples were measured with use of two techniques: small angle X-ray scattering (SAXS) at DESY synchrotron, Hamburg, Germany, and circular dichroism (CD). The results of these experiments will be presented on the conference.

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P-01

Studies of selected gemini surfactants complexes with DNA and siRNA *using biophysical methods*

W.J. Andrzejewska[1], Z. Pietralik[1], M. Taube[1], and M. Kozak[1]

[1] *Dept. of Macromolecular Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland*

Keywords: gene therapy, surfactants, DNA, siRNA, synchrotron radiation

*e-mail: andrzejewskaw@gmail.com

Gene therapy is currently the most promised method of treatment for diseases of genetic origin. Unfortunatelly the sucessful transfection of genetic material into the cell is very difficult. Hopes, however, give gene therapy [1].

The promising new class of compounds, capable of forming the structural forms desired for the transport and protection of genetic material are dicationic surfactants (gemini surfactants) [2].

This study aimed to investigate the complexation of ten gemini surfactants C12J-Cn type with DNA and siRNA using the circular dichroism (CD), small angle X-ray scattering (SAXS) and gel electrophoresis methods.

This research found, that the complex formation process occurs as well as demonstrated that these complexes are capable of efficient transfection of live cells [3].

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P-02

Influence of segregation of divalent europium on magnetic and transport properties of MBE grown Eu-Fe thin films

K. Balin[1,2] J. Szade[1], M. Wojtyniak[1], D. Wilgocka-Ślęzak[3], T. Giela[3], J. Korecki[4], M. Ślęzak[4], and Z. Celinski[2]

[1] A.Chelkowski Institute of Physics, University of Silesia, 40-007 Katowice, Poland;
[2] Center for Magnetism and Magnetic Nanostructures, University of Colorado at Colorado Springs, Colorado Springs, CO 80918, USA
[3] Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, 30-059 Kraków, Poland
[4] Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, 30-239 Kraków, Poland

Keywords: synchrotron radiation, europium valency, thin films

*e-mail: katarzyna.balin@us.edu.pl

Due to potential ability of controlling the Eu valency and consequently switching between non-magnetic (Eu^{3+}) and magnetic (Eu^{2+}) states we examined the electronic structure as well as magnetic and transport properties of MBE grown Eu-Fe thin films. We considered that such Eu-based materials, in which the control of the valency of Eu would be possible, may be applied into new classes of spin-based sensor, memory or logic devices.

20-30 nm thick Eu-Fe films were grown on Si or GaAs (with a 50 nm thick buffer layer of Mo) in two different deposition modes — multilayer deposition and co-deposition [1]. The changes associated to the reaction with surrounding transition metal (monitored via Reflection High Energy Electron Diffraction and X-ray Photoemission Spectroscopy) lead to valency transition of europium $Eu^{2+} \leftrightarrow Eu^{3+}$. Ferromagnetic behavior of the Eu-Fe films up to the highest available temperature of 400 K and strong thermomagnetic effects, were observed via SQUID. The XPEEM images (X-ray Photoemission Electron Microscopy) indicate segregation of the divalent europium for selected films. Additionally observed anomalies in temperature dependence of electrical resistivity, obtained from 4-point probe measurements, may indicate frustration in magnetic ordering.

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P-03

Structural properties of $Ca_9R(VO_4)_7$ (R = La, Nd, Gd) single crystals: An X-ray diffraction study

A. Behrooz[1], W. Paszkowicz*[1], P. Romanowski[1], B. Nazarenko[2], and A. Shekhovtsov[2]

[1]Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, PL-02668 Warsaw, Poland,
[2]Institute for Single Crystals, NAS of Ukraine, Lenin Ave. 60, 61001, Kharkov, Ukraine

Keywords: calcium rare earth vanadate, structure refinement
*) email@paszk@ifpan.edu.pl

Whitlockite-related materials form an extended family of compounds. Those of the $Ca_9R(VO_4)_7$ formula (R = a rare earth) are considered for applications in optoelectronics, e.g., in white-light emitting diodes, as discussed in Refs. [1, 2]. In the $Ca_9R(VO_4)_7$ structure (space group *R*3*c*) the R atoms partially occupy the Ca sites, as has been shown in [3, 4]. In the present work, structural characterization of $Ca_9R(VO_4)_7$ (R = La, Nd, Gd) single crystals is performed using the powder diffraction and high-resolution diffraction.

$Ca_9R(VO_4)_7$ single crystals were grown by the Czochralski method. X-ray rocking curves and as reciprocal space maps were obtained using a laboratory high-resolution diffractometer. The rocking curves as well as the reciprocal space maps of symmetrical 0 0 30 and asymmetrical 1 0 16 reflection show that all three crystals are of high-quality, without any blocks or grains. An analysis of the X-ray diffuse scattering indicates on the presence of the point defects, in the form of vacancies. The crystals were verified to conserve the [001] orientation of the applied seed. The powder diffraction data for polycrystalline samples prepared from the single crystals were collected using a laboratory X'PERT diffractometer equipped with a Ge monochromator and a strip detector. Phase analysis has shown that the crystals are pure $Ca_9R(VO_4)_7$ phases. The results of Rietveld refinements show a general consistency with literature data for polycrystalline samples prepared by solid state reaction [3, 4]. A small off-stoichiometry indicated by structure refinement correlates with the trends indicated by elemental analysis.

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P-04

Structure of magnetron sputtered $SmNiO_3$ thin films

K. Bilewska[1,3*], M. Wojtyniak[1], K. Balin[1], J. Szade[1], and P. Ruello[2]

[1]*A. Chełkowski Institute of Physics, University of Silesia, Uniwersytecka 4, 40-007 Katowice, Poland*
[2] *Laboratoire de Physique de l'Etat Condense, Universite du Maine, 72085 Le Mans, France*
[3]*Institute of Non-Ferrous Metals, Sowińskiego 5, 40-100 Gliwice, Poland*

Keywords: $RNiO_3$, thin films, magnetron sputtering

*e-mail: kbilewska@us.edu.pl

Perovskite oxides from $RNiO_3$ family (R – rare earth ion) are of great interest due to the metal-insulator transition they exhibit [1,2]. For possible applications it is vital to study the material of a thin film structure. Therefore within this work a $SmNiO_3$ thin film deposited by radio frequency magnetron sputtering on Si(100) have been studied. The influence of the deposition conditions as well as annealing on the structure and electronic properties was investigated. We found out that the standard deposition atmosphere, which is a mixture of argon and oxygen gases, facilitates columnar growth along a certain crystallographic direction, while deposition in pure argon results in polycrystallinity of the films. Several techniques were used in order to characterize obtained samples, including x-ray diffraction, x-ray fluorescence spectroscopy, x-ray photoelectron spectroscopy, secondary ion mass spectroscopy and atomic force microscopy with a conducting tip. What is more in order to get insight into local composition XPEEM microscopy was used.

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P-05

Electrochemical synthesis and structural studies of zinc complexes with benzofuran derivatives

A. Drzewiecka[1*], A. Wolska[1], M.T. Klepka[1], Z. Komosa[2], A.E. Koziol[2], and M. Struga[3]

[1]*Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, 02-668 Warsaw, Poland*
[2]*Faculty of Chemistry, Maria Curie-Sklodowska University, pl. Marii Curie-Skłodowskiej 3, 20-031 Lublin, Poland*
[3]*Faculty of Medicine I, Medical University of Warsaw, ul. Oczki 3, 02-007 Warsaw, Poland*

Keywords: synchrotron radiation, XAFS, zinc complexes

*e-mail: adrzew@ifpan.edu.pl

Zinc plays structural and catalytic role in a number of enzymes [1]. Therefore, a detailed understanding of its functions requires information on how the chemistry of zinc is modulated by its coordination environment.

In our laboratory, several zinc(II) complexes with benzo[b]furancarboxylic acids were electrochemically synthesized [2]. The compounds were obtained as microcrystalline powders and structurally investigated by IR spectroscopy, elemental and thermal analyses as well as XAFS spectroscopy. In parallel, the powdered complexes were dissolved in a number of solvents and subjected to the process of crystallization. The slow evaporation of solvents allowed to receive the crystals, suitable for the X-ray diffraction studies, for one complex only.
The structural studies indicated that the carboxylate group of ligand can bind in the monodentate and bidentate modes to the Zn cation.

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P-06

Phase transitions in double metal cyanide catalysts

E. Dynowska[1*], A. Chrusciel[2], K. Lawniczak-Jablonska[1], I.N. Demchenko[1], J. Janik[2], and B. Sacher-Majewska[3]

[1]*Institute of Physics, Polish Academy of Sciences, al. Lotników 32/46, PL-02668 Warszawa, Poland*
[3] *Scientific Consortium ADVANCE DMC, MEXEO Kędzierzyn-Koźle, Poland*
[3] *Opole University, Dept. of Chemistry, Poland*

Keywords: catalysts, x-ray diffraction, thermogravimetry, differential scanning calorimetry
*e-mail: dynow@ifpan.edu.pl

Double metal cyanide (DMC) catalysts, obtained on the basis of zinc hexacyanocobaltate (III) ($Zn_3[Co(CN)_6]_2 \cdot nH_2O$), are used in industrial processes of polyaddition of oxiranes. These catalysts are obtained by introduction non-stoichiometric quantities of selected ligands into the $Zn_3[Co(CN)_6]_2 \cdot nH_2O$ structure.

Depending on the type of ligands and their connection procedure the catalysts exhibit different levels of activity.

The key problem is to find a mechanism justifying the catalytic properties of this group of catalysts.

For this purpose the X-ray diffraction (XRD) measurements in combination with thermo-analytical studies: thermogravimetry (TG) and differential scanning calorimetry (DSC) were undertaken.

The thermoanalytical studies allowed the observation of the effects associated with the water evaporation and the effects characteristic for dissociation of ligands bonding in the catalyst, occurring for temperatures significantly above the boiling point of these ligands.

A series of XRD measurements for the samples of hydrated zinc hexacyanocobaltate (III) and catalysts were carried out after their annealing in the characteristic temperatures indicated by thermoanalytical studies.

The results confirmed the relationship between the mass loss and the structural transformation. In the hydrated zinc hexacyanocobaltate (III) the mass loss is mostly attributed to the evaporation of water, in particular the removal of water molecules from the cubic structure of $Zn_3[Co(CN)_6]_2 \cdot nH_2O$, resulting in the appearance of rhombohedral phase of $Zn_3[Co(CN)_6]_2$.

In the catalysts, after different annealing processes, the unidentified transition phases have been observed. Annealing at the sufficiently high temperatures (above 280°C) led to transformation into the rhombohedral phase.

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P-07

Magnetic behavior of non-interacting iron oxide nanoparticles in physiological solution

S. Haracz[1], J. Rybka[1], M. Hilgendorff[2], and M. Giersig[2]

[1]*Faculty of Chemistry, Adam Mickiewicz University, Umultowska 89 B, 61-614 Poznań, Poland*
[2]*Fachbereich Physik, FreieUniversität Berlin, Arnimalle 14, 14195 Berlin, Germany*

Keywords: magnetic nanoparticles, Raman spectroscopy

*e-mail: sylwiahr@amu.edu.pl

Magnetic proerties of nanoparticles depends on various parameters, such as size, shape, condition of synthesis or organic ligands on the surface. Here we present magnetic characteristics of non-interacting, highly crystalline iron oxide nanoparticles coated with modified polyacrylic acid [1-4]. The analysis comprised both static and dynamic magnetic behavior of magnetic nanoparticles in physiological solution.

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P-08

Difference in structure and conformational dynamics of DPPC and DPPC/DNA systems with selected gemini surfactants with different spacer

Wojciech Kida[1*] and Maciej Kozak[1]

[1]*Dept. of Macromolecular Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland*

Keywords: phospholipids, gemini surfactant, dicationic surfactant, DNA, DNA-phospholipids interaction, DNA-surfactant interaction

*e-mail: wk57@wp.pl

Cationic gemini surfactants (consisting of 2 cationic head groups and 2 hydrophobic tails linked by a spacer group) have proven to be effective synthetic vectors for gene delivery (transfection) [1-2].

The aim of this work was to investigate the influence of surfactants with different chain lenght on structure and conformation of DPPC and DPPC/DNA systems.

Complexes of gemini surfactant/DPPC and gemini surfactant/DPPC/DNA have been investigated using differential scanning calorimetry (DSC), small angle scattering of synchrotron radiation (SAXS) and Fourier transformed infrared spectroscopy (FTIR). Compounds with DNA have been also investigated using complementary techniques: agarose gel electrophoresis and circular dichroism (CD).

The studied surfactants have strong influence on structural and thermodynamic properties of measured complexes like disappearance of pretransition, the changes of the main phase transition temperature as well as changes the organisation of lipid bilayers in the multilayer lamellar phase.

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P-09

Complexes between DNA and selected gemini surfactants – circular dichroism and AFM studies

Żaneta Kołodziejska[1], Zuzanna Pietralik[1], and M. Kozak[1*]

[1]*Faculty of Physics, Adam Mickiewicz University, ul. Umultowska 85, 61-614 Poznań, Poland*

Keywords: circular dichroism, gemini surfactants

*e-mail: mkozak@amu.edu.pl

The efficacy of gene therapy depends on the transfection stage of genetic material into cells. The best transfection properties provide a lipid-like molecules similar to components of biological membranes. These particles should have high affinity to genetic material and efficiently combine with him. Such molecules can be cationic gemini surfactants which, due to their physicochemical properties (positive electric charge, low critical micelle concentration CMC) are promising delivery systems for genetic material in gene therapy.

The aim of this study was to investigate the process of complex formation between gemini cationic surfactants and DNA. Dicationic surfactants studied had a different length of the hydrophobic chains (different number of carbon atoms in the chain).

Based on the data obtained by circular dichroism and electrophoresis can be concluded that the gemini surfactants with long side chains effectively combined with DNA at low concentrations in the solution.

AFM images confirmed the formation of vesicular structures – complexes between DNA and surfactants.

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P-10

Electronic band structure of $La_{2/3}Pb_{1/3}Mn_{2/3}(Co,Fe,Ni)_{1/3}O_3$

M. Kowalik,[1,2*] W. Tokarz[2],
R. Zalecki[2], and A. Kołodziejczyk[2]

[1] *Rzeszów University of Technology, Dept. of Physics, 6, Powstańców Warszawy Str. 35959 Rzeszow, Poland*

[2] *AGH University of Science and Technology, Dept, of Solid State Physics, 30, Mickiewicza Str, 30-059 Krakow*

Keywords: electronic structure, manganese perovskite, DFT

*e-mail: mkowalik@prz.edu.pl

We have investigated the theoretical valence band structure of half-metallic $La_{2/3}Pb_{1/3}Mn_{2/3}(Co,Fe,Ni)_{1/3}O_3$ Colossal magnetoresistance (CMR) manganites. The calculations were done based on first-principles Density Functional Theory (DFT) with General Gradient Approximation GGA+U using Wien2K package [1]. Density of state (DOS) was calculated using the modified tetrahedron method.

The calculated photoemission spectra for all three substitutions are similar in shape. The main effect of the substitution of an Mn atom by a transition metal such as Fe, Co or Ni, is a progressive decrease of width of an insulating gap. This effect should be seen in the UPS or XPS valence band spectra.

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P-11

The influence of NP's with Fe_3O_4 core on biomembrane modelsystems - the ATR-FTIR studies

M. Kręcisz[1], S. Haracz[1], J. Rybka[1],
M. Giersig[1,2], and M. Kozak[3]

[1]*Faculty of Chemistry, Adam Mickiewicz University, Umultowska 89 B, 61-614 Poznań, Poland*
[2]*Fachbereich Physik, FreieUniversität Berlin, Arnimalle 14, 14195 Berlin, Germany*
[3] *Dept. of Macromolecular Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland*

Keywords: nanoparticles, phospholipids, DMPC, ATF-FTIR spectroscopy

*e-mail: kreciszmonika@gmail.com

Studies were performed to investigate the influence of nanoparticles with magnetic core - Fe_3O_4 on biomembrane model systems, based on DMPC. NP's were synthetized using standard methods [1,2] and characterized by TEM, magnetic (SQUID) and Raman spectroscopies. Samples with 10% DMPC and different concentrations of NP's were examined by ATF-FTIR to establish the impact of NP's on phase behavior of model phospholipids systems. NP's with magnetic core have attractive properties which can be used in biomedical application (for example MRI), so also were done measurements to define the nanotoxicity on model systems at physiological temperature of human body.

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P-12

Synchrotron-based X-ray diffraction studies of carbonate hydroxylpyromorphite $Pb_{10}(PO_4)_6(OH)_2$

M. Kwaśniak-Kominek,[1*] M. Manecki,[1] and O.Borkiewicz[2]

[1] *AGH – University of Science and Technology, al. Mickiewicza 30, 30-065 Kraków, Poland*
[2] *Argonne National Laboratory, 9700 South Cass Avenue, 433 Argonne, IL 60439-4858, US*

Keywords: Rietveld refinement, hydroxylpyromorphite, carbonate substitution

*e-mail: kwasniak@geol.agh.edu.pl

The formula of apatites is represented as $M_{10}[XO_4]_6Y_2$, where M is occupied Ca and Pb, position Y by anions including OH, Cl, F, and position $[XO_4]$ accommodates ionic complexes such as $[PO_4]$, $[VO_4]$ and $[AsO_4]$. In calcium hydroxylapatites, $Ca_{10}(PO_4)_6(OH)_2$, substitutions of carbonate ion are common. Carbonates can be accommodated within the structure in two distinct crystallographic positions: type A, where CO_3^{2-} is located in the structural channel (substitution for OH) and type B substitution for PO_4^{3-} tetrahedron. Location of the carbonate ion in lead hydroxylapatite structure however, is still unknown.

In order to determine the nature of carbonate substitutions in hydroxylpyromorphite, $Pb_{10}(PO_4)_6(OH)_2$, two synthetic analogues were prepared via solution growth route - (1) carbonate-free (HPY-P) and (2) with the maximum theoretical substitution of CO_3^{2-} (HPY-CO_3). High-resolution X-ray diffraction measurements were carried out at the beamline 11-BM of the Advanced Photon Source, Argonne National Laboratory. Subsequent Rietveld refinement analyses were based on the structural model of carbonate-substituted calcium hydroxylapatite by Fleet et al. [1].

The results indicate that CO_3^{2-} in HPY is present in both structural positions. The calculated formula of the carbonated sample is $Pb_{10}(PO_4)_{5.85}[(CO_3)_{0.58}(OH)_{1.3}]$. The refined unit cell parameters for HPY-P and HPY-CO3 are a=9.8789 Å, c=7.4301 Å and a=9.8784 Å, c=7.7364 Å, respectively.

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P-13

Photoelectron spectroscopy studies of double metal cyanide catalysts

K. Lawniczak-Jablonska[1*], W. Lisowski[2], J.W.Sobczak[2], I.N. Demchenko[1], A. Chruściel[3], and J. Janik[3,2],

[1] *Institute of Physics, Polish Academy of Sciences, Lotnikow Str 32/46, 02 668 Warsaw, Poland*
[2] *Institute of Physical Chemistry, Polish Academy of Sciences, Kasprzaka Str 44/52, 01 224 Warsaw, Poland*
[3] *Scientific Consortium ADVANCE DMC, MEXEO, 47 225 Kędzierzyn-Koźle, Energetykow Str 9, Poland*

Keywords: catalysts, chemical bonding, XPS
*e-mail: jablo@ifpan.edu.pl

Double metal cyanide (DMC) catalysts, based on zinc hexacyanocobaltate (III) ($Zn_3[Co(CN)_6]_2{\cdot}nH_2O$), are widely used for epoxide polymerization. Active catalysts could be prepared in the presence of a low molecular weight complexing agents as organic coordination ligands [1]. By adding various complex ligands the catalytic activity of the DMC catalyst can be improved [2,3]. However, despite of wide application in chemical industry, the mechanism of their catalytic activity is still discussing. Generally the Zn atoms are assumed to be the active centers in the DMC catalyst structure. It is still open question related to stability of the DMC catalysts at various experimental conditions. In order to get more experimental data in this point we used the X-ray photoelectron spectroscopy (XPS) technique to study the DMC catalyst before and after argon ion beam etching. The composition and chemical nature of elements within the surface region of both the reference zinc hexacyanocobaltate and catalyst samples were analysed. The samples prior to Ar^+ ion sputtering revealed the coexistence of native oxides of Co and Zn in addition to the main Zn-Co-CN compounds. Argon ion sputtering of both samples led to their partial destruction and formation of oxide states of Co and Zn. The contribution of Co-O states at the surface area of the argon sputtered catalyst is evidently larger than at the reference material. Character of Zn bonds is dominated by Zn-CN even after sputtering with 2 keV Ar^+ ions. The contribution of Zn-O states was found to be relatively small.

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P-14

Optimizing of thin film superconducting lead photocathodes at NCBJ in Świerk

J. Lorkiewicz*, R. Nietubyć, M. Barlak, R. Mirowski, and J. Witkowski

National Centre for Nuclear Research (NCBJ), ul. A.Soltana 7, Pl 05-400 Otwock-Świerk, Poland

Keywords: photocathode, thin film, lead

*e-mail: jerzy.lorkiewicz@ncbj.gov.pl

Photocathodes deposited as thin lead films on a wall of a niobium RF cavity were accepted as a way to construct superconducting RF e^- injectors [1-2]. Ultra High Vacuum cathodic arc was implemented and developed at NCBJ to deposit thin Pb films which can be used as superconducting photocathodes in electron guns of superconducting radio-frequency linear accelerators [3]. The main drawback of this method is the presence of lead droplets within the films. In electromagnetic field the micrometer-sized droplets cause such effects as dark current or field emission. To cope with this problem filtering of metal plasma flux is applied inside deposition devices that typically reduces the film deposition rate by orders of magnitude which in turn leads to thinner layers with degraded purity.

Therefore, to reach sufficiently smooth and thick lead photocathodes we decided to deposit lead using unfiltered plasma deposition and next recrystallize the obtained films. We report on our current works aimed at establishing such post-deposition heat treatment.

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P-15

Temperature evolution of structural properties of hexagonal NiAs-type MnTe

Roman Minikayev[1*], Wojciech Szuszkiewicz[1], Elżbieta Dynowska[1], Barbara Witkowska,[1] and Tony M.T. Bell[2]

[1] Institue of Physics, PAS, al. Lotników 32/46, 02-668 Warszawa, Poland
[2] Hasylab, DESY, Notkestr. 85, D-22607 Hamburg, Germany

Keywords: MnTe, lattice parameters, thermal expansion

email: minik@Ifpan.edu.pl

NiAs-type MnTe exhibiting antiferromagnetic properties is particularly interesting due to the possibility of its applications in spin electronic devices. The successful growth of such MnTe thin layers by MBE [1] opened a possibility of its potential applications in multilayer structures. The expansion coefficients of materials constituting given structure belong to important parameters required for correct interpretation of the physical properties of considered multilayer. Previous MnTe literature data were limited to narrow temperature range (170 - 350 K) [2, 3] and demonstrated a sharp decrease of the *c* parameter value with decreasing temperature below Néel temperature (T_N) unaccompanied by any significant change in the *a* parameter temperature dependence.

The high quality single MnTe crystals were grown in the Institute of Physics PAS and investigated by the XRD methods using synchrotron radiation in Hasylab at the temperature range from 15 K to 1100 K. The linear expansion coefficients for *a* and *c* parameters were determined. A partial transformation of MnTe into $MnTe_2$ at high temperatures was observed. At T_N value the *a* parameter exhibit a kink in its temperature dependence.

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P-16

Structure characterization of large ZnO crystals from Oława Foundry

Roman Minikayev[1], Jarosław Z. Domagała[1], Elżbieta Dynowska[1], Katarzyna Gas[1], Elżbieta Łusakowska[1], Wojciech Szuszkiewicz[1]*, Józef Cebulski[2], Jakub Grandysa[2], Patrick Baroni[3], and Anthony M.T. Bell[4]

[1] Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, Warszawa 02-668, Poland
[2] Microelectronics and Nanotechnology Center, University of Rzeszów, Rejtana 16a, 35-959 Rzeszów, Poland
[3] Laboratoire Leon Brillouin, CEA-CNRS, CE Saclay, Gif-sur-Yvette 91191, France
[4] HASYLAB at DESY, Notkestr. 85, Hamburg 22607, Germany

Keywords: ZnO, X-ray diffraction, thermal expansion

e-mail: szusz@ifpan.edu.pl

ZnO is a wide band-gap semiconductor with unique physicochemical properties but development of ZnO-based electronics is strongly limited by the lack of large crystals of high quality suitable for industry as substrates for the homoepitaxy.

The goal of this work is to determine structure properties of unique ZnO crystals obtained as by-product of zinc white production in Oława Foundry. These crystals are about 1 cm wide and about 12 cm long rods with a hexagonal basis. The powder X-ray diffraction measurements confirmed a hexagonal wurtzite structure of the samples (the crystal axis coincides with the wurtzite *c*-axis) and a lack of additional peaks resulting from possible precipitates. Studies with the use of SIMS technique evidenced a presence of Mn and Mg at an impurity level. The analysis of the Bragg peak intensity distribution maps in the reciprocal space showed very homogeneous distribution of defects and small scattering of the mosaic block orientation. The linear expansion coefficients for the *a* and *c* lattice parameters were determined with the use of synchrotron radiation in the temperature range from 15 K to 1100 K at Hasylab.

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P-17

Structure of HCC oligomers – SAXS and MD studies

Magdalena Murawska[1], Anders Grubb[2], Martyna Maszota[3], Sylwia Rodziewicz-Motowidło[3], and Maciej Kozak[1*]

[1]Department of Macromolecular Physics, Faculty of Physics, Adam Mickiewicz University Poznań, Poland
[2]Department of Clinical Chemistry, Lund University, Sweden.
[3] Department of Chemistry, University of Gdańsk, Poland

Keywords: human cystatin C, SAXS, molecular dynamics simulations

*e-mail: mkozak@amu.edu.pl

Human cystatin C (HCC) is a small protein (the inhibitor of cysteine proteases) with amyloidogenic properties. Dimerization process of HCC occurs through the three-dimensional exchange of structural domains called as "domain swapping". HCC forms also different oligomeric forms (trimers, tetramers, decamers and other oligomers of higher molecular weights [1-3].

The study presented was aimed at developing low-resolution structure of trimeric form of human cystatin C in solution (stabilized by covalent bonds) and comparing this structure with the structure of HCC trimers calculated by molecular dynamics simulations.

The molecular dynamics simulations were performed using AMBER program package and several structural models of HCC trimers were created. The X-ray scattering data were obtained using synchrotron radiation and SAXS camera (EMBL beam line X33, DORIS storage ring, DESY, Hamburg, Germany; λ= 0.15 nm). Structural models of the human cystatin C trimers in solution were restored by a *ab initio* simulations in program DAMMIN [4]. Low-resolution structure of HCC trimer exhibits the 3-fold axis of symmetry.

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P-18

Evaluation of the undulator capabilities for POLFEL

R. Nietubyć[1,2]

[1]National Centre for Nuclear Research Świerk, Sołtana 7, 05-400 Otwock, Poland
[2]National Synchrotron Radiation Centre Solaris, Jagiellonian University, Gołębia 7/P.1.6, 30-387 Kraków

Keywords: FEL, undulator

*e-mail: r.nietubyc@ncbj.gov.pl

The construction approach proposed for POLFEL is split onto two phases differing in achievable electron energy range. In the first stage the maximal energy of 50 MeV capacitates the wavelength in Terahertz and infrared range, while the completed accelerator will provide the electrons of 1 GeV and enables XUV radiation. For the THz-IR source two interchangeably operating planar undulators are foreseen. They will be of fixed gap at 12 mm and 5 mm, respectively, and provide radiation in the wavelength ranges 1000 μm - 100 μm and 100 μm - 6 μm, respectively, with the average power in the range 10 W and average peak power of 0.3 MW. Elliptical undulator will be installed in the second phase of construction.

Available wavelengths, pulse duration, peak and average power ranges have been evaluated dependently on electron beam parameters: energy, energy spread, emittance, bunch charge, and repetition rate. Obtained results lay the ground for accelerator optimization in terms of experimental requirements and for constitution of scientific case for the laboratory.

P-19

Performance of superconducting thin film lead photocatode

R. Nietubyć[1,2], R. Barday[3], W. Grabowski[1], T. Kamps[3], P Kneisel[4], O. Kugeler[3], J. Lorkiewicz[1], A. Neuman[3], J. Sekutowicz[4,], J. Smedley[5], and T. Wasiewicz[1]

[1]National Centre for Nuclear Research Świerk, Sołtana 7, 05-400 Otwock, Poland
[2]National Synchrotron Radiation Centre Solaris, Jagiellonian University, Gołębia 7/P.1.6, 30-387 Kraków
[3]Helmholtz Zentrum Berlin für Materialen and Energie, Hanh-Meitner Platz 1 14109 Berlin, Germany
[4]Tthomas Jefferson National Accelerator Facility, Newport News, Virginia 23606
[5]Deutches Elektronen Synchrotron, Notkestrasse 85, 22607 Hamburg, Germany
[6]Brookhaven National Laboratory, Upton, New York 11974, USA

Keywords: SRF accelerators, thin films.

*e-mail: r.nietubyc@ncbj.gov.pl

Thin lead film photocathodes have been recognised as an advantageous solution for superconducting electron injectors [1, 2]. In comparison to commonly used Cs_2Te cathodes, it allows to expel normal conducting materials from the resonant cavity together with a complicated transfer mechanism. Electron guns furnished with 1 μm thick lead layer have been built and tested in at Hobicat injector in terms of RF performance, quantum efficiency and beam diagnostics and showed a resonant quality in the range of $2 \cdot 10^{10}$ up to accelerating gradient of 30 MVm^{-1} and quantum efficency of $9 \cdot 10^{-5}$ when excited with 258 nm wavelength laser [3-5].

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P-20

Synchrotron radiation for study Fano type photoemission resonances in rare earth atoms

B.A. Orlowski*, B.J. Kowalski, E. Guziewicz, I. Kowalik, M. Pietrzyk, and A. Reszka

Institute of Physics, PAS,
al. Lotnikow 32/46, 02-668 Warsaw, Poland

Keywords: photoemission, Fano resonance, rare earth

e-mail: orbro@ifpan.edu.pl

The synchrotron radiation is a strong intensity source of continuous radiation in the wide range of energy starting from infrared, visible range, vacuum ultraviolet, soft X-ray and hart X-ray up to several hundreds thousands of eV. It gives possibility to study effects in chosen range as a function of continuous scale of energy. The paper presents application of the radiation in the range from 100 to 200 eV obtained duo to monochromator Flipper II with 6 diffraction grids mirrors. In the range of energy the optical transition edges occur for rare earth metal atoms $4d^{10} – 4f^{n}$. It gave as a chance to measure photoemission spectra containing 4f electrons and to obtain corresponding to it Fano resonance. Results permit to determine parameters of Fano type resonant curve. Remarkable maximum in resonant energy highly increases sensitivity to recognize small amount of measured 4f electrons contribution to the spectra. As the resonant energy is different for different valences of ions (high correlation effects for highly localized f orbitals) the experiment helps to distinguish between the valences of the rare earth metal in the sample. The results will be concern to Gd, Eu and Sm [1] atoms.

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P-21

High energy photoemission spectra of crystals with local structure - application of synchrotron radiation

B.A. Orlowski*, B. J. Kowalski, M. Pietrzyk, and A. Reszka

Institute of Physics, PAS,
al. Lotnikow 32/46, 02-668 Warsaw, Poland

keywords: photoemission, PbCdTe

*(e-mail:orbro@ifpan.edu.pl

The synchrotron radiation was used to measure Tunable High Energy Photoemission Spectra (THE-XPS) at a wiggler beam line station BW2 (DORIS, HASYLAB, DESY, Hamburg) with energy range from 2.4 to 10 keV, monochromatic photon flux $5x10^{12}$ photons/s and energy resolution of 0.5 eV. The set of ternary crystal $Pb_{1-x}Cd_xTe$ spectra contain valence band and core level electrons: Cd 4*d*, Pb 5*d*, Te 4*d*, Pb 4*f*, Pb 4*d*, Cd 3*d* and Te 3*d* electrons.

The introduction of Cd ion on a sit of Pb ion in PbTe rock salt crystal leads to the creation of ternary crystal e.g. $Pb_{0.94}Cd_{0.06}Te$ [1] still with the rock salt structure. As the Cd ion radius is smaller than Pb ion radius it can lead to the increase of Cd – Te and Pb – Te distance in these region of crystalline local structure created around Cd ion. These crystalline local structure leads to the appearance of electronic local structure at these region. The spectra of samples indicate existence of the local electronic structure in the ternary crystal.

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P-22

Influence of the length and type of spacer group of gemini surfactants on their ability to form stable complexes with nucleic acids in a presence of helper lipid

Z. Pietralik[1*] and M. Kozak[1]

[1]*Dept. of Macromolecular Physics, Faculty of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland*

Keywords: gene therapy, gemini surfactant, small angle X-ray scattering

*e-mail: zuzannap@amu.edu.pl

A promising alternative to virus-based vectors, currently used in gene therapy appear to be amphiphilic compounds, especially gemini surfactants which have been tested for possible applications in this field [1,2].

This work was performed on alcoxyderivatives of bis-imidazolium quaternary salts with three different spacer groups. Additionally, to enhance the biocompatibility of the tested lipoplexes, a helper phospholipid – DMPC was used.

The SAXS data were collected at the Beam Line I911-4 at the MAXII storage ring (Lund, Sweden) and BM29 BioSAXS line in ESRF Grenoble (France) using the MarCCD 165 mm and PILATUS 1M detector, correspondingly. Synchrotron radiation wavelength was 0.091 nm and 0.15 nm, respectively. The scattering vector range was $0.1< s <4$ nm^{-1}. All data were analyzed using program PRIMUS [3].

SAXS data have indicated that the addition of surfactants cause a gradual perturbation of the lamellar phase typical for DMPC and eventually, the formation of different structural phases.

The longer spacer group of surfactant has stronger influence on the structural behaviour of the system. Moreover for certain values of charge ratio, the studied systems form stable complexes with DNA of low molecular weight..

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P-23

Modifications of structures formed by phosphatidylcholine by gemini surfactants with cyclic side chains as a key to successful DNA transportation

Z. Pietralik[1*] and M. Kozak[1]

[1]*Dept. of Macromolecular Physics, Faculty of Physics, Adam Mickiewicz University Umultowska 85, 61-614 Poznań, Poland*

Keywords: gene therapy, gemini surfactant, small angle X-ray scattering

*e-mail: zuzannap@amu.edu.pl

Extremely important in gene therapy is a delivery system (also known as a vector), which improves the delivery of the therapeutic DNA into cells and protects genetic material from damage. Especially desirable are nonviral delivery systems, for example systems based on amphiphilic compounds [1].

All studied gemini surfactants possess aliphatic side chains with the same length but differ in the type (linear or cyclic). This study comprises of characterization of three types of mixed systems: phoshpolipid/surfactant, surfactant/DNA and phospholipid/surfactant/DNA. These systems were thoroughly characterised by small angle scattering of synchrotron radiation (SAXS), differential scanning calorimetry (DSC), Fourier transform infrared spectroscopy (FTIR), circular dichroism spectroscopy (CD) and agarose gel electrophoresis.

The series of the SAXS data sets were collected at the Beam Line I911-4 at the MAXII storage ring (Lund, Sweden) and BM29 BioSAXS line in ESRF Grenoble (France) using the MarCCD 165 mm and PILATUS 1M detector, respectively. The scattering vector range was $0.1<s<4$ nm^{-1}. All data were analyzed using the program PRIMUS [2].

Studied surfactants show strong influence on conformational and structural behaviour and thermodynamic parameters of formed systems. Obtained results therefore enabled us to choose the most suitable candidates for DNA transportation.

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P-24

Crystallographic and thermographic analysis of phase transition of zirconium dioxide induced by dental processing

A. Piosik[1], K. Żurowski[2], W. Hędzelek[1], and M. Kozak[3*]

[1]Department of Prosthodontics, Poznań University of Medical Sciences, Bukowska 70, 60-812 Poznań, Poland.
[2]Industrial Institute of Agricultural Engineering, Starołęcka 31, 60-963 Poznań, Poland.
[3]Department of Macromolecular Physics, Faculty of Physics, Adam Mickiewicz University Umultowska 85, 61-614 Poznań, Poland.

Keywords: zirconium dioxide, dental processing, X-ray diffraction

*e-mail: mkozak@amu.edu.pl

Zirconium dioxide is now the material widely used in the dental prosthetics. However, the improper mechanical treatment can induce changes in the microstructure of zirconium oxide. From the viewpoint of mechanical properties and performance the phase transitions of ZrO_2 from the tetragonal to the monoclinic, induced during mechanical processing, are particularly undesirable [1].

The aim of this study was to evaluate the phase transitions of dental zirconium dioxide induced by mechanical treatment by the use of scanning electron microscopy and powder diffraction. For mechanical working of material were used various types of of drills used presently in dentistry. At the same time the surface temperature was monitored during milling using a thermal imaging camera.

Diffraction analysis allowed to determine the effect of temperature and mechanical processing methods on the scale of induced changes. The observed phase transition (to the monoclinic phase) were correlated with methods of mechanical processing.

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P-25

The influence of Mn_4Si_7 inclusions dimension on silicon matrix strain state in Si:Mn

P. Romanowski[1], J. Bak-Misiuk[1*], K. Sobczak[1], R. Jakiela[1], and A. Misiuk[2]

[1]Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, PL-02668 Warsaw, Poland
[2] Institute of Electron Technology, al. Lotnikow 32/46, PL-02668 Warsaw, Poland

Keywords: Si:Mn, nanoinclusions, Mn_4Si_7, X-ray diffraction, SIMS, TEM, strain state

*e-mail: bakmi@ifpan.edu.pl

Czochralski and Floating-zone 001-oriented silicon single crystals were implanted with 160 keV Mn^+ ions to a dose of 1×10^{16} cm^{-2} and next annealed for 1 h at temperatures up to 800 °C. As it has been reported earlier Mn_4Si_7 nanoinclusions are created during the temperature processing. Using TEM method as well as by analysis of X-ray diffuse scattering it has been found that the sizes of the inclusions increase with annealing temperature, whereas their concentration decreases [1].

The aim of the present work is to determine the influence of the Mn_4Si_7 inclusions on the silicon matrix strain state. Unsymmetrical shape of 004 X-ray diffraction peaks shows that there is a distribution of the matrix lattice parameter. This effect disappears after 800 °C processing. A strong correlation between the sizes of nanoinclusions and the matrix strain state has been found. When the sizes are below of 15 nm, the tensile strain occurs but when the particle sizes exceed 20 nm, they become incoherent in respect to the silicon matrix.

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P-26

XAS study of carbon coated Co-Fe nanoparticles

K. Schneider[1,2], D.A. Zając[1], D. Rybicki[1], J. Żukrowski[1], J. Przewoźnik[1], M. Sikora[1], T. Strączek[1], W. Prendota[1], Cz. Kapusta[1*], C.I. Marquina,[3] and M.R.Ibarra[4]

[1]*Department of Solid State Physics, Faculty of Physics and Applied Computer Science, AGH University of Science & Technology, 30-059 Krakow, Poland*
[2]*Department of Electronics, Faculty of Computer Science, Electronics and Telecommunications, AGH University of Science & Technology, 30-059 Krakow, Poland*
[3]*Instituto de Ciencia de Materiales de Aragón (ICMA) & Dpto. de Física de la Materia Condensada, CSIC-Universidad de Zaragoza, 50009 Zaragoza, Spain*
[4]*Instituto de Nanociencia de Aragón, Universidad de Zaragoza, 50009 Zaragoza, Spain*

Keywords: magnetic nanoparticles, XANES, EXAFS

*e-mail: kapusta@agh.edu.pl

Results of a combined magnetic, XAS, NMR and Mössbauer spectroscopy study of new magnetic nanoparticle materials for biomedical applications are presented. The samples have been obtained by arc melting of graphite electrodes filled with metallic Co, $Co_{0.2}Fe_{0.8}$, Fe or magnetite. In order to determine the local structure, the metal valence state and the magnetic properties of the synthesised materials, X-ray Absorption Spectroscopy in the XANES and EXAFS range, Nuclear Magnetic Resonance spectroscopy, Mössbauer spectroscopy as well as Vibrating Sample Magnetometry were used as characterisation techniques.

^{59}Co NMR spectra of cobalt based nanoparticles measured at room temperature, 77 K and 4.2 K are characteristic for the fcc-Co phase. Also, the Fourier transforms of the Co;K-edge EXAFS spectra reveal the dominant fcc-Co phase. The $Co_{0.2}Fe_{0.8}$ EXAFS at the Fe;K-edge and Co;K-edge show the major bcc-Fe structure.

Mössbauer spectra of Fe and Fe_3O_4 derived nanoparticles show dominant bcc-Fe and Fe_3C sextets and a singlet arising from the smallest, paramagnetic particles. Materials derived from Fe_3O_4 do not differ significantly from those obtained by melting the Fe metal electrode. They exhibit a moderate magnetic hardness due to the nanometric size of the particles and the presence of magnetically hard cementite. The Fe:K absorption edge shape and energy as well as the EXAFS chi(R) functions show that the Fe oxidation degree and local environments are similar to those of metallic iron.

P-27

Application of interface distribution function and correlation function methods for studying the lamellar structures of polymers using small-angle X-ray scattering

Cz. Ślusarczyk[1*]

[1]*Institute of Textile Engineering and Polymer Materials, University of Bielsko-Biała, 2, Willowa Str. 43-309 Bielsko-Biała, Poland*

Keywords: SAXS, crystallization, lamellar structure

*e-mail: cslusarczyk@ath.bielsko.pl

Crystallizing polymers exhibit complex morphology involving coexistence of crystalline and amorphous regions. During crystallization of polymers from quiescent melt usually thin lamellar crystals are formed. These lamellae are arranged in stacks, with layers of amorphous material being inserted between the crystalline lamellae. Because amorphous and crystalline layers in lamellar stacks exhibit different electron densities, the small-angle X-ray scattering (SAXS) method is frequently used to evaluation of parameters describing this type of superstructure. In such case the SAXS curve exhibits a maximum which angular position corresponds to an average repeating distance of the lamellar structure. This distance called *the long period* can be estimated directly from the SAXS curve using Bragg law. Detailed analysis of the distribution of SAXS intensity requires determination of the correlation function and/or the interface distribution function (IDF). These functions allowed for determination the values of the long period (L_P), the crystalline and amorphous layer thicknesses (l_C and l_A respectively) and the local volume fraction crystallinity (Φ_L).

Application of these functions requires however substraction of contribution due to electron density fluctuation and performing a number of corrections of measured intensity. The present paper shows all steps necessary in the obtaining of these functions. In the application part of the study both correlation and interface distribution functions are used to describe the structural changes in poly(ethylene oxide) during cooling at a rate 10 ^{o}C/min. from the melt to room temperature and during subsequent heating at the same rate from room temperature to melting temperature.

P-28

XAS study of selenium enriched shiitake mycelium

T. Strączek[1*], D. Zając[1], K. Schneider[1,2], M. Sikora[1], Cz. Kapusta[1], and J.Turło[3]

[1] *Department of Solid State Physics, Faculty of Physics and Applied Computer Science, AGH University of Science & Technology, 30-059 Krakow, Poland*

[2] *Department of Electronics, Faculty of Computer Science, Electronics and Telecommunications, AGH University of Science & Technology, 30-059 Krakow, Poland*

[3] *Department of Drug Technology and Pharmaceutical Biotechnology, Medical University of Warsaw, 1 Banacha St, 02-097 Warsaw, Poland*

Keywords: Selenium, bioactivity, XANES, EXAFS

**e-mail: Tomasz.Straczek@fis.agh.edu.pl*

Shiitake mushrooms are well known as a common component of eastern cuisine as well as an important element in Asian medicine. Recently, some efforts on producing bio-active specimens based upon selenium enriched Shiitake mycelium have been undertaken. A crucial problem for understanding its biomedical activity is determination of the form of Selenium in them, as well as its location in the molecular structures of individual species. Among useful tools for solving these problems the X-ray Absorption Spectroscopy (XAS) is the most suitable one. Therefore, in the present work XAS in the near-edge region (XANES) and in the extended range (EXAFS) of the K-absorption edge of Selenium was used.

The mycelium samples studied have been obtained from the mushrooms grown on substrates enriched in selenium. Four samples have been selected for the study: a lyophilised mycelium and three isolated polysaccharide fractions with different protein content. Additionally, four reference samples of known Selenium form have been studied. Measurements have been carried out at the X-Beamline of the synchrotron laboratory HASYLAB/DESY in Hamburg. The spectra have been measured at the temperatures of 77 K and 10 K.

XANES spectra show that the Selenium form varies between the samples from elemental form in the polysaccharide fraction with the highest Se content to Se(IV) in the sample with its lowest content. The lyophilised shows predominant content of Se(II). The Fourier transformed EXAFS spectra have been compared to the spectra simulated for the possible Selenium containing species and provided the information as to which one is the most populated in the particular sample.

P-29

Dimerisation of *Pseudomonas syringae* efector protein HopQ1 (S51A) in solution without DTT

M. Taube[1*], F. Giska[2], M. Krzymowska[2], J. Hennig[2], and M. Kozak[1]

[1] *Faculty of Physics, Dept. of Macromolecular Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland*

[2] *Laboratory of Plant Pathogenesis, Institute of Biochemistry and Biophysics, Polish Academy of Science, Pawinskiego 5a, 02-106 Warsaw, Poland*

Keywords: small angle X-ray scattering, HopQ1 protein, low resolution structure

*e-mail: mtaube@amu.edu.pl

Plant pathogenic bacteria use type III secrection system (TTSS) to inject proteins to the plant cell apoplasts in order to evade plant immune response and help in colonization. Many of this proteins, called effectors, are recognized by the plant immune system that triggers programed cell death to stop further pathogen colonization.

HopQ1 is an effector protein injected to the plant cell by the bacteria *Pseudomonas syringae*. Bacteria cells, producing HopQ1 protein, are able to colonize bean plants but are recognized by the tobacco plants immune system [1]. HopQ1 molecule consist of two domains: N-terminal unstructurized domain and C-terminal domain with homology to the nucleoside hydrolases. HopQ1 protein interact with the plant 14-3-3 protein [2]. Phosphorylation of serine 51 of HopQ1 is necessary for the interaction. Mutation of serine 51 to alanine leads to the changes in cellular localization from nuclear to the cytoplasmic.

In solution HopQ1 (S51A) protein exists as a monomer with elongated and unstructurized N-terminal domain. In conditions without reduction agents like dithiothreitol HopQ1 mutant (S51A) forms dimers with maximum particle dimater (D_{max}) equal to 12.8 nm. Low resolution *ab-initio* model obtained using DAMMIN program [3] is elliptical and clearly distinct from the model of monomeric HopQ1 which is bottle shaped.

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P-30

Ionic strength and temperature dependent conformational changes of the wheat Hsp90 protein

M. Taube[1*], A. Jarmołowski[2], and M. Kozak [1]

[1]*Faculty of Physics, Dept. of Macromolecular Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland*
[2] *Faculty of Biology, Dept, of Gene Expression, Adam Mickiewicz University, Umultowska 89, 61-614 Poznan, Poland*

Keywords: small angle X-Ray scattering, Hsp90, conformational changes
*e-mail: mtaube@amu.edu.pl

Heat Shock Protein 90 kDa (Hsp90) is ubiquitous chaperone protein that plays important role in protein folding and maintaining proper folds and conformation of many cellular factors like kinases and transcription factors [1].

Hsp90 forms dimers in solution. Each monomer consists of three domains: N-terminal ATPase domain, middle domain, that plays role in substrate protein binding process and C-terminal dimerization domain. Hsp90 protein in solution exists in equilibrium between two conformations: open and closed. In closed conformation besides C-terminal dimerization also N-terminal domains of two monomers interacts with each other. Equilibrium is species dependent and other factors like pH and presence of small molecule osmolites can cause changes in it [2].

In this study we investigated the effect of the ionic strength on the conformation of *Triticum aestivum* Hsp90 protein (TaHsp90) in apo, ADP and AMPPNP bound states. We also examined effect of temperature on Hsp90 protein without bound nucleotides. In the low ionic strength conditions Hsp90 protein exists in rather compact conformation characterized by the maximum particle size (D_{max}) equal to 22 nm in both nucleotide bound and apo states. Ionic strength cause shift to the more open, expanded conformation characterized by the D_{max} equal to 30 nm. Higher temperatures also changes equilibrium to the more extended conformation. Detailed analysis revealed that TaHsp90 can exist in three different conformation in solution and equilibrium between those states is ionic strength and temperature dependent.

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P-31

Electron beam dynamics calculations for POLFEL linear accelerator

T. Wasiewicz[1], W. Grabowski[1], K. Kosiński[1], R. Nietubyć[1,2], J. Sekutowicz[3], and M. Staszczak[1]

[1]*National Centre for Nuclear Research Świerk, Sołtana 7, 05-400 Otwock, Poland*
[2]*National Synchrotron Radiation Centre Solaris, Jagiellonian University, Gołebia 7/P.1.6, 30-387 Kraków*
[3]*Deutches Elektronen Synchrotron, Notkestrasse 85, 22607 Hamburg, Germany*

Keywords: FEL, Tesla, cavity, beam dynamics.
*e-mail: tomasz.wasiewicz@ncbj.gov.pl

The poster presents beam properties calculation for the superconducting linac of free electron laser POLFEL [7] Normalized slice emittance and bunch size are tracked for the 1.6-cell superconducting injector with solenoid followed by 2-structure cryomodules [4] of HZDR-type.

Main results are taken from ASTRA [2] 2D calculations. First the cavity and solenoid were tested in order to find the most suitable parameters to meet the expected values. It was optimized for the slice emittance. After that stage the cryomodules were added and now the beam size was honed due to its great focusing and reaching values near zero.

In the meantime 3D calculations are performed for the model using tools such as CUBIT [3], ACE3P [1], Para View [6], Microwave Studio [5]. At the moment we are trying to add couplers to the cavity, which make the model very complex. As soon as we deal with that we wish to calculate emittance for the 3D model of the cavity with solenoid and cryomodules.

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P-32

SXMCD study of magnetic adatoms on Bi_2Se_3 and Bi_2Te_3 single crystals

M. Waśniowska[1], M. Dobrzański[2], M. Sikora*[2], T. Eelbo[1], I. Miotkowski[3], R. Wiesendanger[1], and A. Kozłowski[2]

[1] *Institute of Applied Physics, University of Hamburg, Germany*
[2] *Faculty of Physics and Applied Computer Science, AGH - University of Science and Technology, Kraków, Poland*
[3] *Dept, of Physics, Purdue University, West Lafayette, USA*

Keywords: SXMCD, magnetic adatoms, topological insulators

*e-mail: marcin.sikora@agh.edu.pl

The topologically protected electronic surface states were extensively studied in Bi_2Se_3 and Bi_2Te_3 by means of ARPES. Similarly to graphene, these materials were predicted to exhibit a single Dirac cone, that is protected by time reversal symmetry. This symmetry can be broken by introducing magnetic elements with a net out-of-plane magnetic moment [1,2]. Magnetic impurities not only change the electronic properties of the parent material but also introduce magnetic order to the system, for instance Bi_2Te_3 doped with Mn shows ferromagnetic order below 12 K depending on the Mn concentration [3].

In this contribution we present SXMCD studies of magnetic properties of adatoms (and dopants) on (in) single crystals of Bi_2Se_3 and Bi_2Te_3. At first, we discuss the methodology of the measurements, that allows to detect high quality spectra at low levels of doping. A detailed analysis of XAS shape suggests that adatoms usually exhibit an atomic electronic configuration equal to that of the free atom. Element specific magnetization profiles of adatoms were fitted using a thermodynamical model including Zeeman splitting and magnetic anisotropy. Depending on the adatom/substrate combination, different types of anisotropy – either uniaxial out-of plane or basal ion-plane easy axis – is revealed. However, the magnetic moments of bulk magnetic dopants exhibit nearly isotropic magnetic properties.

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P-33

Investigation of defect structure in undoped calcium molybdate single crystals ($CaMoO_4$) by means of X-ray diffraction methods

E. Wierzbicka[1*], A. Malinowska[1], K. Wieteska[2], W. Wierzchowski[1], M. Lefeld-Sosnowska[3], M. Świrkowicz[1], T. Łukasiewicz[1], K. Mazur,[1] and C. Paulmann[4]

[1] *Institute of Electronic Materials Technology, Wólczyńska 133, 01-919 Warsaw, Poland*
[2] *Institute of Atomic Energy POLATOM, 05-400 Otwock-Świerk, Poland*
[3] *Institute of Experimental Physics, University of Warsaw, ul. Hoża 69, 00-681 Warsaw, Poland*
[4] *HASYLAB at DESY, Notkestr. 85, 22-603 Hamburg, Germany*

Keywords: X-ray synchrotron radiation, calcium molybdate, topography

*e-mail: edyta.wierzbicka@itme.edu.pl

The aim of the present study was the characterisation of crystal lattice defects of calcium molybdate $CaMoO_4$ crystals, which are suitable materials for many applications in acoustic-electronics, acoustic-optics, nonlinear optics, as laser hosts and scintillators, solid state lasers, different kinds of substrates and active elements of ionizing radiation detectors. For all these applications the large-sized single crystals of high structural quality are required.

The samples were investigated by means of synchrotron white beam topography, monochromatic beam topography and conventional X-ray Lang projection topography. The high resolution rocking curves were also taken using synchrotron and conventional arrangements.

The topographs of $CaMoO_4$ indicated a considerably good crystallographic perfection of the crystals. In particular they did not reveal any segregation fringes proving high homogeneity of chemical composition. Relatively high densities ($< 10^4$ cm^{-2}) of weak point like contrasts, which can be most probably interpreted as dislocation outcrops, were observed.

The visible imperfection of the investigated crystals was variously developed block structure. The evaluation of lattice misorientation was realised by means of superimposed projection and section white beam synchrotron radiation topographs. The evaluated misorientation between various blocks was in the range of several arc minutes.

The block structure is generally caused by cracks during the cooling process. It can be connected with thermal stresses.

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Ghost segregation pattern and other defects in mixed strontium-calcium-barium niobates

W. Wierzchowski[1], K. Wieteska[2], A. Malinowska[1*], E. Wierzbicka[1], M. Romaniec[1], M. Lefeld-Sosnowska[3], M. Świrkowicz[1], T. Łukasiewicz,[1] and C. Paulmann[4]

[1]*Institute of Electronic Materials Technology, Wólczyńska 133, 01-919 Warsaw, Poland*
[2]*National Centre for Nuclear Research, Sołtana 7, 05-400 Otwock, Poland*
[3]*Institute of Experimental Physics University of Warsaw, Hoża 69, 00-681 Warsaw, Poland*
[4]*HASYLAB at DESY, Notkestr. 85, 22603 Hamburg,*

Keywords: strontium barium niobate; calcium barium niobate; crystal lattice defect structure; diffraction topography

*e-mail: agnieszka.malinowska@itme.edu.pl

We present recent results of the defect structure investigations of selected ferroelectric niobates such as $Sr_xBa_{1-x}Nb_2O_6$ (SBN), $Ca_xBa_{1-x}Nb_2O_6$ (CBN) and mixed $(Ca_{0.28}Ba_{0.72})_y(Sr_{0.61}Ba_{0.39})_{1-y}Nb_2O_6$ (CSBN) single crystals grown by the Czochralski method. The studies were performed by means of synchrotron and conventional diffraction topography and scanning electron microscopy.

The investigations indicated a new very characteristic phenomenon in CSBN crystals, consisting in the presence of two different systems of segregation fringes forming the crossing pattern. First of them is the normal one, connected with the subsequent position of the growth surface and hence is coaxial with the core and the boundaries of the crystal. The second one, crossing the previous, is probably related to the kind of ghost pattern reproducing some chemical composition changes in the new growing part of the crystal. Some rod-like inclusions were also revealed around the core in the central part of samples cut out from various crystals. Contrary to previously studied SBN and CBN crystals, any glide bands in the CSBN were observed.

The scanning electron microscopic studies of selectively chemical etched samples revealed the domain structure in SBN and CBN crystals. The domains (probably ferroelectric domains) were located along [001] directions. They are not directly observed in the diffraction topography, but they probably contribute to the enhanced intensity in some reflections.

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Local inhomogeneities of strontium titanate thin films doped with iron

M. Wojtyniak[1*], J. Szade[1], R. Wrzalik[1], and K. Szot[1,2]

[1]*Institute of Physics, Univ. of Silesia, 40-007 Katowice, Poland*
[2]*Peter Grünberg Institut, Forschungszentrum Jülich, 52425 Jülich, Germany*

Keywords: $SrTiO_3$, thin film, resistive switching, xpeem
*e-mail: mwojtyniak@us.edu.pl

The resistive switching phenomenon attracted a lot of attention in recent years thanks to its possible applications. The ability to change the resistivity of the material by applying external field only seems ideal for a new type of non-volatile memory – the Resistive Random Access Memory. Among many materials exhibiting resistive switching phenomena, the strontium titanate is quite suitable for basic investigations since it can be considered a model material due to its simple structure, good quality single crystals availability and substantial literature on its various properties.

Although it was already shown that the changes of the resistivity switching originates form the local oxygen modification by the external field [1], the work is far from complete. For example doping with transition metals should influence the electrical properties of the material and thus has to be investigated.

Therefore in our work we focus iron doped $SrTiO_3$ in a most suitable for applications thin film form. The thin films obtained by pulsed laser deposition method on Nb doped $SrTiO_3$ substrates were doped with 1, 2 and 5% Fe. Several techniques were used to study the thin film properties, such as: X-ray Photoelectron Spectroscopy and Local Conductivity Atomic Force Microscopy along with the magnetic measurements. Results showed that the electric behavior in nanoscale is very inhomogeneous and well conducting spots of various sizes (from several nm up to 100 nm) are found. Moreover some of the results made us curious about the iron dopant distribution in the matrix, therefore we turned to X-ray photoemission microscopy measurements. We found a small iron inhomogeneities in case of 20 nm thick film and quite interesting structure in the case of 100nm thick film.

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P-36

XANES as a tool for determining a 3-D arrangement around the metal ions in the bioactive complexes

A. Wolska[1*], A. Drzewiecka[1],
M.T. Klepka[1], and W. Ferenc[2]

[1] *Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, 02-668 Warsaw, Poland*
[2] *Faculty of Chemistry, Maria Curie-Sklodowska University, pl. Marii Curie-Skłodowskiej 2, 23-031 Lublin, Poland*

Keywords: synchrotron radiation, XANES, FEFF calculations, metal complexes

*e-mail: Anna.Wolska@ifpan.edu.pl

The metal–organic ligand complexes came into close attention while it was discovered that through the complexation process one can obtain the metal-organic compounds with improved properties in respect to the parent ligand [1]. Since the properties of a compound depend on its structure, it is important to determine the geometry of the complex.

The shape of a spectrum in the XANES region strongly depends on the angles between the neighboring atoms. Therefore, XANES analysis can be used as a tool for determining the 3-D arrangement around the absorbing atoms. As an example the search of the neighborhood of the metal ions in Co(II) and Cu(II) complexes of cinnamic acid is shown.

The analysis is carried out as follows: (*i*) the EXAFS analysis is performed; (*ii*) from the structural database several models are selected with parameters being in agreement with the EXAFS results; (*iii*) for these models the XANES spectra are calculated with FEFF 9.5 code [2] and the best models are selected for the next step; (*iv*) the ligands in the models are rotated; (*v*) the best results are selected and checked again with the EXAFS results.

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Kalendarium aktywności Instytutu Fizyki i władz Uniwersytetu Jagiellońskiego w staraniach o dostęp i o wykorzystywanie źródeł promieniowania synchrotronowego w pracach badawczych

Andrzej Kisiel

Instytut Fizyki, Uniwersytet Jagielloński

Kalendarium jest przeglądem starań Instytutu Fizyki i administracji Uniwersytetu Jagiellońskiego o uzyskiwanie dostępu pracowników naukowych do europejskich źródeł promieniowania synchrotronowego i o wykorzystywanie tego promieniowania w badaniach naukowych. Chronologiczny opis zdarzeń poprzedza syntetyczne wprowadzenie umożliwiające łatwiejsze zrozumienie istotnych motywów podejmowanych starań i okoliczności towarzyszących podejmowanym zabiegom. Szczególne miejsce w Kalendarium zajmuje bardzo aktywna, trwająca blisko 40 lat ścisła współpraca polsko-włoska, której głównym organizatorem i animatorem był wielki przyjaciel Polski, nieżyjący już Franco Bassani profesor Instytutu Fizyki Uniwersytetu Rzymskiego I La Sapienza a następnie Scuola Normale Superiore di Pisa. Aktywna współpraca była bardzo efektywnie kontynuowana przez szereg polskich i włoskich współpracowników aż do roku 2008.

A Calendar of the Institute of Physics and Jagiellonian University authorities activity in the efforts to ascertain an access of scientific workers to synchrotron radiation sources and and to ensure application of this radiation in the research studies. The present Calendar is a short review of the Institute of Physics and Jagiellonian University Authorities efforts to an access of scientific workers to the European synchrotron radiation sources, and to ensure application of this radiation in the research studies. A chronological description of the events is preceded by short Introduction. This description allows for better understanding of the successive efforts and accompanying circumstances. A particular atttention is paid in the Calendar to almost 40-year close Polish-Italian cooperation. This collaboration inaugurated in Spring 1971 by a great friend of Poland Franco Bassani, a professor Institute of Physics of the Rome University I La Sapienza and latter Scuola Normale Superiore in Pisa. The effective collaboration by many Polish and Italian collaborators has been carried out up to year 2008.

1. Wprowadzenie

Odkryte w roku 1947 promieniowanie synchrotronowe, jako promieniowanie pasożytnicze w synchrotronach elektronowych [1,2], zostało bardzo szybko wykorzystane w badaniach naukowych i zastosowaniach technicznych ze względu na miliony razy większe natężenie (jasność) od natężenia promieniowania elektromagnetycznego pochodzącego ze źródeł konwencjonalnych, niezwykle małą rozwartość wiązki promieniowania (wysoka kolimacja) oraz ciągły rozkład energetyczny widma w bardzo szerokim zakresie energii od dalekiej podczerwieni do twardego promieniowania rentgenowskiego. Oprócz wymienionych bardzo ważnych cech dla rozwoju spektroskopowych badań eksperymentalnych, promieniowanie synchrotronowe jest spolaryzowane liniowo lub eliptycznie w zależności od położenia detektora względem osi podłużnej wiązki promieniowania [3]. Te cenne własności promieniowania synchrotronowego sprawiły, że liczba eksperymentów z użyciem tego promieniowania zaczęła rosnąć intensywnie już w latach siedemdziesiątych ubiegłego wieku, a obecnie roczne wykorzystanie promieniowania synchrotronowego sięga milionów godzin pracy eksperymentalnych linii pomiarowych, zainstalowanych przy synchrotronach elektronowych i pierścieniach kumulujących, pracujących w wielu krajach świata wyłącznie dla potrzeb badawczych nauk przyrodniczych i różnorodnych zastosowań technicznych.

Zapoczątkowane w połowie lat pięćdziesiątych ubiegłego wieku systematyczne badania eksperymentalne struktury elektronowej pasm walencyjnego i przewodnictwa ciał stałych metodami spektroskopii optycznej [4,5], wymagały stosowania w eksperymentach źródeł światła w obszarze dalekiego nadfioletu i miękkiego promieniowania rentgenowskiego. Do spełnienia tych wymagań doświadczalnych, konieczne było wówczas budowanie kilku różnych źródeł promieniowania elektromagnetycznego, które by pokrywały cały obszar energetyczny promieniowania stosowany w eksperymencie. W połowie lat sześćdziesiątych ubiegłego stulecia badania struktury elektronowej ciał stałych, były bardzo młodą i nadzwyczaj aktualną i obiecującą dziedziną zainteresowania w spektroskopii optycznej ciała stałego. Z tych powodów w roku 1965 w Zakładzie Fizyki Doświadczalnej, kierowanym wówczas przez prof. Henryka Niewodniczańskiego i równocześnie dyrektora Instytutu Fizyki Uniwersytetu Jagiellońskiego, zostały rozpoczęte badania spektroskopowe struktury elektronowej półprzewodników z użyciem konwencjonalnych źródeł światła. Konieczne do badań bardzo wysokiej jakości monokrystaliczne materiały półprzewodnikowe były dostarczane przez aktywnie współpracujący z Zakładem Fizyki Doświadczalnej Instytut Fizyki Polskiej Akademii Nauk w Warszawie. Pierwsza wspólna publikacja dotycząca analizy struktury elektronowej związków półprzewodnikowych CdHgTe ukazała się już w roku 1969 [6]. Prężnie rozwijające się badania struktury elektronowej półprzewodników były motorem do sformułowania w październiku 1969 roku wniosku Instytutu Fizyki UJ o włączenie badań optycznych ciała stałego w zakresie próżniowego nadfioletu 6 – 10 eV do Centralnego Planu 5-letniego badań naukowych i rozwoju technicznego na lata 1971 – 1975. Badania miały być realizowane w oparciu o posiadaną bazę aparaturową (fluorytowy spektrograf próżniowy) i bardzo uciążliwe w eksploatacji konwencjonalne źródła promieniowania elektromagnetycznego w nadfiolecie próżniowym. Pojawienie się możliwości zastosowania w badaniach spektroskopowych promieniowania synchrotronowego, pokrywającego cały obszar energii stosowany w spektroskopii optycznej próżniowego nadfioletu, eliminowało niebagatelny problem złożonej budowy kilku różnych źródeł oraz właściwej dla nich kalibracji natężenia promieniowania. W roku 1971 autorowi Kalendarium w czasie pięciomiesięcznego stypendium w Instytucie Fizyki Uniwersytetu Rzymskiego La Sapienza, została złożona, przez opiekuna naukowego prof. Franco Bassani'ego, bardzo korzystna propozycja dotycząca podjęcia wspólnych włosko-polskich badań optycznych dla związków półprzewodnikowych w zakresie energii promieniowania od 10 – 100 eV przy użyciu promieniowania synchrotronowego z 1,1 Ge synchrotronu elektronowego usytuowanego w Frascati. Proponowane wspólne badania rozszerzały znacznie rozpoczęte wcześniej w Zakładzie Fizyki Doświadczalnej IF UJ badania optyczne półprzewodników w zakresie energii światła 0,5 – 10 eV. Propozycja włączenia się do wspólnych badań z użyciem promieniowania synchrotronowego w sposób istotny zmodyfikowała na wiele lat programy badawcze Pracowni Spektroskopii Optycznej Półprzewodników, utworzonej w roku 1965 w ramach Zakładu Fizyki Doświadczalnej, a następnie od roku 1973 przynależącej do Zakładu Fizyki Ogólnej. Bardziej szczegółowy opis bardzo pomyślnie rozwijającej się i trwającej wiele lat współpracy włosko-polskiej został przedstawiony w dwu artykułach wcześniej zamieszczonych w Biuletynie PTPS [7,8]. Wysoki stopień zaangażowania się w tej współpracy uwidacznia szereg haseł Kalendarium. Rytmiczna współpraca polsko-włoska wiązała się jednak istotnie z możliwościami uzyskiwania stałej zgody Ministerstwa Szkolnictwa Wyższego i Techniki oraz scentralizowanych i bardzo podejrzliwych władz paszportowych, niechętnie zatwierdzających częste i systematyczne wyjazdy naukowe z Instytutu Fizyki UJ kilku tych samych osób, bezpośrednio zaangażowanych we współpracę. Drugim nie mniej istotnym problemem do rozwiązania było uzyskiwanie pomocy finansowej na krótkoterminowe wyjazdy do włoskich źródeł promieniowania synchrotronowego w celu przeprowadzania serii pomiarowych. Z początkiem lat siedemdziesiątych ubiegłego stulecia wszystkie wymienione kwestie związane z systematyczną i owocną współpracą polsko-włoską były w praktyce bardzo trudne do rozwiązania. Trzeba zdawać sobie sprawę, że podejmowane starania przypadły na okres rosnącego otwarcia politycznego w kierunku Europy Zachodniej i USA. Należało więc umiejętnie wykorzystywać tą sprzyjającą koniunkturę i wprowadzane stopniowe ułatwienia w opresyjnej polityce paszportowej. Przedstawione Kalendarium jest, opartą na dokumentach, syntetyczną historią rozwoju starań podejmowanych przez dyrekcję i pracowników Instytutu Fizyki oraz kolejnych rektorów i Biuro Współpracy z Zagranicą UJ o uzyskanie systematycznego dostępu najpierw do włoskich źródeł promieniowania synchrotronowego, a następnie również do innych europejskich źródeł promieniowania synchrotronowego. Systemowe trudności w prowadzeniu nie zaburzonej współpracy przedstawicieli krajów obozu socjalistycznego z naukowcami krajów Europy Zachodniej, odczytał bezbłędnie nasz przyjaciel i główny organizator współpracy włosko-polskiej nieżyjący już Franco Bassani, profesor Uniwersytetu Rzymskiego I La Sapienza, wybitny i uznany w świecie teoretyk w zakresie fizyki ciała stałego. Bez jego umiejętności przekonywania władz polskich i użycia przez niego posiadanych znacznych wpływów we włoskich gremiach decyzyjnych w Narodowym Centrum Badań (Centro Nazionale delle Ricerche - (CNR)) i Narodowym Instytucie Energii Jądrowej (Istituto Nazionale di Fisica Nucleare (INFN)), zawieranie umów o współpracy bezpośredniej pomiędzy Uniwersytetem Jagiellońskim i Uniwersytetem Rzymskim La Sapienza nie przebiegałoby tak sprawnie. Wprowadzona w Polsce w drugiej połowie lat siedemdziesiątych formuła umów o współpracy bezpośredniej cedowała na rektorów uczelni współpracujących, obowiązki związane z właściwą realizacją programów naukowych i dysponowaniem częstotliwością podróży służbowych niezbędnych do realizacji umów. Taka formuła umów o współpracy bezpośredniej uwalniała współpracę międzynarodową od dotychczas krępujących restrykcyjnych przepisów paszportowych. W różnych okresach współpracy bezpośredniej, trwającej faktycznie 37 lat od roku 1971 do roku 2008, zasłużyli się polsko-włoskiej współpracy oprócz prof. Franco Bassaniego zatrudnionego najpierw w Instytucie Fizyki Uniwersytetu Rzymskiego I La Sapienza a następnie w Scuola Normale Superiore w Pizie, bardzo zaprzyjaźnieni z nami profesorowie: Gianfranco Chiarotti i Mario Piacentini z Uniwersytetu Rzymskiego I La Sapienza, Adalberto Balzarotti i Umberto Grassano z Uniwersytetu Rzymskiego II Tor Vergata, Giuseppe Dalba z Uniwersytetu w Trento oraz Settimio Mobilio i Emilio Burattini z Narodowego Laboratorium w Frascati (LFN).

Po odzyskaniu przez Polskę pełnej niepodległości w roku 1989 dotychczas występujące trudności zmieniły swój charakter. Wprawdzie ustąpiła uciążliwa i opresyjna kontrola państwa dotycząca wyjazdów zagranicznych, jednakże problem uzyskiwania finansowej pomocy od ubogiego państwa polskiego na systematyczne badania naukowe zagranicą, pozostał dalej problemem kluczowym. Hasła Kalendarium są wymownym świadectwem zrozumienia i aktywności władz Uniwersytetu Jagiellońskiego, zmierzającej do pozyskania dostępu do najnowocześniejszych technik badawczych przed rokiem 1989 jak również po transformacji Państwa Polskiego w roku 1989.

Warte podkreślenia jest włączanie się Instytutu Fizyki i władz Uniwersytetu Jagiellońskiego w bardzo aktywne popieranie działalności powstałego w roku 1991 Polskiego Towarzystwa Promieniowania Synchrotronowego, które od powstania koordynowało wielokierunkowe starania o uzyskanie dostępu do źródeł promieniowania synchrotronowego oraz prowadziło i prowadzi nadal bardzo owocną działalność edukacyjną. W roku 1998 kilku profesorów Instytutów Fizyki UJ i AGH wystąpiło do KBN z projektem budowy na terenie kampusu Uniwersytetu Jagiellońskiego polskiego synchrotronu jako narodowego źródła promieniowania synchrotronowego. Po dwunastoletnich staraniach podjęta przez nich inicjatywa stała się faktem. W kwietniu 2010 roku została podpisana umowa Uniwersytetu Jagiellońskiego z Ministerstwem Szkolnictwa Wyższego i Nauki na realizację projektu „Narodowe Centrum Promieniowania Elektromagnetycznego dla Celów Badawczych”. Projekt dotyczył budowy i uruchomienia pierwszego polskiego synchrotronu elektronowego. Umowa o budowie pierwszego polskiego synchrotronu elektronowego jako narodowego źródła promieniowania synchrotronowego kończyła sukcesem starania, rozpoczęte przez krakowskie środowisko naukowe w roku 1998. Ukończenie budowy synchrotronu SOLARIS jest przewidywane w roku 2014. Wraz z uruchomieniem tego synchrotronu otworzą się wreszcie zupełnie nowe bardzo atrakcyjne możliwości badawcze przed polskimi użytkownikami promieniowania synchrotronowego.

2. Kalendarium działań Instytutu Fizyki i władz Uniwersytetu Jagiellońskiego w latach 1969 – 2012

10.10.1969 r. – Wniosek Instytutu Fizyki UJ o finansowanie z Centralnego Planu 5-letniego badań naukowych i rozwoju technicznego na lata 1971 – 1975, badań optycznych ciała stałego w zakresie próżniowego nadfioletu 6 – 10 eV w oparciu o posiadaną bazę aparaturową (fluorytowy spektrograf próżniowy i budowane źródła światła).

Wiosna 1971 r. – Propozycja Prof. Franco Bassani’ego i Adalberto Balzarotti’ego, członków nieformalnej Grupy Solidi Roma, utworzonej z pracowników Instytutu Fizyki Uniwersytetu Rzymskiego La Sapienza oraz Narodowego Laboratorium w Frascati (Laboratori Nazionali di Frascati (LNF) należącego do Narodowego Instytutu Fizyki Jądrowej (INFN), dotycząca podjęcia, z dr Andrzejem Kisielem z Instytutu Fizyki UJ, wspólnych badań optycznych związków półprzewodnikowych w zakresie 10 – 100 eV przy użyciu promieniowania synchrotronowego. Propozycja stanowiła interesujące rozszerzenie projektowanych w IF UJ w roku 1969 badań optycznych struktury elektronowej półprzewodników w zakresie energii światła 0,5 – 10 eV.

Jesień 1973 r. – Opracowanie szczegółowego programu wspólnych badań Pracowni Spektroskopii Optycznej Półprzewodników przynależącej do Zakładu Fizyki Ogólnej IF UJ z grupą Solidi Roma, utworzonej z pracowników Instytutu Fizyki Uniwersytetu Rzymskiego La Sapienza oraz Narodowego Laboratorium w Frascati (Włochy) (Laboratori Nazionali di Frascati (LNF)), na temat własności optycznych półprzewodników w zakresie energii światła 10 – 300 eV przy użyciu promieniowania synchrotronowego z 1,1 GeV synchrotronu elektronowego usytuowanego w Frascati.

22.12.1973 r. – Skierowanie przez Prof. Adama Strzałkowskiego, dyrektora Instytutu Fizyki UJ, do Departamentu Współpracy z Zagranicą Ministerstwa Nauki, Szkolnictwa Wyższego i Techniki (MNSzWiT) wniosku w sprawie zapewnienia IF UJ niezbędnych środków finansowych do prowadzenia współpracy dwustronnej z grupą Solidi Roma w zakresie badań własności optycznych półprzewodników w próżniowym nadfiolecie z użyciem promieniowania synchrotronowego.

20.12.1974 r. – Rozpoczęcie w Narodowym Laboratorium w Frascati (LNF) cyklu wspólnych włosko-polskich badań optycznych w próżniowym nadfiolecie w zakresie energii światła 10 – 100 eV dla cienkich warstw palladu z użyciem promieniowania synchrotronowego z 1,1 GeV synchrotronu elektronowego.

7–13.12.1975 r. – Wizyta w Instytucie Fizyki UJ Franco. Bassani’ego prof. Uniwersytetu Rzymskiego La Sapienza i dyrektora włoskiego programu PULS (Programma per l’Utilizzatione della Luce di Sincrotrone). Wizyta została zakończona spotkaniem z Rektorem UJ prof. Mieczysławem Karasiem w sprawie nawiązania trwałej współpracy IF UJ z programem PULS, w zakresie stosowania do badań optycznych w próżniowym nadfiolecie i analizy struktury elektronowej związków półprzewodnikowych promieniowania synchrotronowego z pierścienia akumulującego ADONE.

16.12.1975 r. – Wystosowanie przez Rektora UJ prof. Mieczysława Karasia listów intencyjnych do Prezydenta Narodowego Centrum Badań - CNR (Centro Nazionale della Ricerche) i Prezydenta Narodowego Instytutu Fizyki Jądrowej - INFN (Istituto Nazionale di Energia Nucleare), zwierzchnika Laboratori Nazionali di Frascati, w sprawie nawiązania trwałej współpracy Instytutu Fizyki Uniwersytetu Jagiellońskiego z programem PULS w zakresie wspólnego wykorzystywania promieniowania synchrotronowego w badaniach optycznych półprzewodników. Rozesłanie listów intencyjnych było rezultatem przeprowadzonej rozmowy z prof. F. Bassanim.

16.04.1976 r. – Pismo MNSzWiT do Rektora UJ z załączonym włoskim projektem programu wspólnych badan włosko-polskich w zakresie teoretycznej i eksperymentalnej fizyki ciała stałego w obszarze próżniowego nadfioletu i promieniowania rentgenowskiego z użyciem promieniowania synchrotronowego z pierścienia akumulującego ADONE. Propozycja współpracy kierowana do Instytutów Fizyki Uniwersytetu Warszawskiego i Uniwersytetu Jagiellońskiego miała być realizowana w ramach włosko-polskiej międzyrządowej Umowy o Współpracy Naukowej i Technicznej.

11.05.1976 r. – Odpowiedź Instytutu Fizyki UJ na pismo MNSzWiT potwierdzająca chęć rozszerzenia podjętej wcześniej włosko-polskiej współpracy w programie PULS w zakresie badań z wykorzystaniem promieniowania synchrotronowego w dziedzinie spektroskopii optycznej w próżniowym nadfiolecie i spektroskopii rentgenowskiej materiałów półprzewodnikowych.

1977 r. – Pierwsza publikacja autora afiliowanego w IF UJ wspólnie z członkami grupy Solidi Roma na temat przygotowania i diagnostyki cienkich warstw palladu przeznaczonych do badań spektroskopii optycznej w próżniowym nadfiolecie z użyciem promieniowania synchrotronowego z 1.1 GeV synchrotronu elektronowego [9].

1977 r. – Pierwszy polskojęzyczny artykuł przeglądowy na temat własności i zastosowania promieniowania synchrotronowego w spektroskopii optycznej półprzewodników [10].

Lata 1977 – 1979 – Podjęcie współpracy przez Instytut Fizyki UJ z włoskim programem PULS poprzez Polską Akademię Nauk ze strony polskiej i CNR (włoski odpowiednik PAN) ze strony włoskiej. Współpraca ta dotyczyła głównie krótkoterminowej wymiany osobowej (szereg obustronnych wizyt). W trakcie tych wizyt zostały podjęte intensywne negocjacje dotyczące zawarcia Umowy o Współpracy Bezpośredniej pomiędzy Uniwersytetem Jagiellońskim i Uniwersytetem Rzymskim La Sapienza w zakresie wykorzystywania promieniowania synchrotronowego z pierścienia akumulującego ADONE (Frascati) w badaniach optycznych i rentgenowskich półprzewodników. W negocjacjach i przygotowaniu Umowy uczestniczył z ramienia UJ nieżyjący już Prorektor prof. Alojzy Gołębiewski.

24.10.1979 r. – Podpisanie Umowy o Współpracy Bezpośredniej w zakresie prowadzenia prac badawczych między Uniwersytetem Jagiellońskim i Uniwersytetem Rzymskim La Sapienza. Umowa została podpisana przez Rektora UJ prof. Mieczysława Hessa i Rektora UR La Sapienza prof. Antonio Ruberti'ego. Dołączony do Umowy program wspólnych badań dotyczył jedynie współpracy Instytutu Fizyki Uniwersytetu Jagiellońskiego z Instytutem Fizyki Uniwersytetu Rzymskiego, uczestniczącym w programie PULS w zakresie wykorzystywania w badaniach optycznych półprzewodników promieniowania synchrotronowego z pierścienia akumulującego ADONE w Frascati. Podpisana Umowa była pierwszym porozumieniem w skali Polski, przewidującym wykorzystanie promieniowania synchrotronowego do badań i aplikacji w fizyce ciała stałego. Umowa była czynnie wykorzystywana przez członków Zakładu Fizyki Ogólnej IF UJ aż do momentu zamknięcia i demontażu pierścienia akumulującego ADONE w roku 1994. Porozumienie było następnie jeszcze wielokrotnie prolongowane i czynnie wykorzystywane do organizowania wspólnych polsko-włoskich prac badawczych ze spektroskopii optycznej i rentgenowskiej ciała stałego z użyciem promieniowania synchrotronowego z pierścienia akumulującego ELETTRA w Trieście oraz kolaidera DAΦNE w Frascati (do roku 2008).

1982 r. – Pierwsza publikacja naukowa pracowników IF UJ w ramach programu PULS na temat rentgenowskiej analizy EXAFS (Extended X-ray Absorption Fine Structure) potrójnych związków mieszanych $Cd_{1-x}Mn_xTe$ [11]. Publikacja ta zapoczątkowała obszerny cykl badań struktury lokalnej kryształów związków potrójnych. Kilkanaście artykułów z tego cyklu zostało nagrodzonych w roku 1986 II Nagrodą Ministra Nauki i Szkolnictwa Wyższego, a następnie w roku 1989 Nagrodą Sekretarza Naukowego PAN. W kolejnych latach wspólne badania polsko-włoskie zostały rozszerzone na badania struktury elektronowej półprzewodników przy pomocy analizy rentgenowskich krawędzi absorpcji znanej w literaturze jako analiza XANES (X-ray Absorption Near Edge Structure). W ramach współpracy IF UJ z programem ADONE, w dziedzinie rentgenowskiej spektroskopii absorpcyjnej (XAS), zostało opublikowanych łącznie ponad 60 artykułów naukowych w czasopismach o zasięgu międzynarodowym.

1986 r. – Pierwsza publikacja naukowa pracowników IF UJ przy użyciu promieniowania synchrotronowego z synchrotronu w Daresbury (Wielka Brytania) na temat procesów fotojonizacji molekuł [12]. Publikacja ta zapoczątkowała w Polsce obszerny cykl badań procesów fotojonizacyjnych w molekułach prowadzonych najpierw przy użyciu promieniowania synchrotronowego z synchrotronu w Daresbury, a następnie z synchrotronów MAX II i MAX III w Szwecji.

1986 r. – Pierwsza publikacja naukowa autora z Polski, wychowanka IF UJ, pracownika Instytutu Fizyki Jądrowej w Krakowie, na temat analizy pierwiastków śladowych w tkankach biologicznych przy użyciu promieniowania synchrotronowego z synchrotronu elektronowego w Brookhaven National Laboratory (USA) [13]. Publikacja ta zapoczątkowała w Polsce obszerny cykl badań tkanek biologicznych metodami spektroskopii rentgenowskiej i spektroskopii podczerwonej przy użyciu promieniowania synchrotronowego pochodzącego z różnych europejskich synchrotronów elektronowych i pierścieni kumulujących. W badaniach tych brali i biorą nadal udział profesorowie fizyki Instytutu Fizyki Jądrowej PAN w Krakowie, Instytutu

Fizyki i Collegium Medicum Uniwersytetu Jagiellońskiego oraz AGH.

1986 r. – Pierwsza publikacja naukowa pracowników IF UJ w programie PULS w zakresie spektroskopii optycznej w próżniowym nadfiolecie przy użyciu promieniowania synchrotronowego z pierścienia akumulującego ADONE [14]. W ramach tego programu współpracy opublikowano łącznie ponad 30 publikacji naukowych.

Wiosna 1989 r. – Podpisanie Umowy o współpracy bezpośredniej pomiędzy Uniwersytetem Jagiellońskim i Uniwersytetem w Trento (Włochy), dotyczącej prowadzenia wspólnych prac badawczych z użyciem promieniowania synchrotronowego. Szczegółowy program przewidywał prowadzenie badań Instytutu Fizyki UJ i Zakładu Fizyki Uniwersytetu w Trento w zakresie optycznej i rentgenowskiej analizy struktury elektronowej i struktury lokalnej związków półprzewodnikowych przy użyciu promieniowania synchrotronowego z pierścienia akumulacyjnego ADONE w Frascati.

17–18.02.1991 r. - Zorganizowanie w Krakowie przez Instytut Fizyki UJ (w pałacyku Szyszko-Bohusza) Pierwszego Krajowego Sympozjum Użytkowników Promieniowania Synchrotronowego (1. KSUPS). Inicjatorami tego sympozjum byli nieżyjący już prof. Juliana Auleytner z Instytutu Fizyki PAN w Warszawie, który od połowy lat siedemdziesiątych śledził z uwagą rozwój badań w fizyce ciała stałego z użyciem promieniowania synchrotronowego [15] oraz autor Kalendarium zaangażowany od szeregu lat w badania ze spektroskopii optycznej i rentgenowskiej z użyciem promieniowania synchrotronowego. Celem Sympozjum był przegląd potencjału naukowego polskich grup użytkowników promieniowania synchrotronowego. W celu skonsolidowania tego środowiska w trakcie Sympozjum podjęto inicjatywę utworzenia Polskiego Towarzystwa Promieniowania Synchrotronowego (PTPS).

5.05.1991 r. – Oficjalna rejestracja sądowa Polskiego Towarzystwa Promieniowania Synchrotronowego (PTPS) z siedzibą w IF UJ. Celem działalności Towarzystwa były starania o łatwiejszy dostęp polskich użytkowników promieniowania synchrotronowego do źródeł promieniowania w Europie. Również istotnym celem działalności było podnoszenie kwalifikacji naukowych członków Towarzystwa.

07.1991 r. – Wystosowanie Memoriału Polskiego Towarzystwa Promieniowania Synchrotronowego, z gorącym poparciem Rektora UJ prof. Andrzeja Pelczara, do Komitetu Badań Naukowych w sprawie przystąpienia Polski, w charakterze członka, do Europejskiego Centrum Promieniowania Synchrotronowego (European Synchrotron Radiation Facility – (ESRF)) w Grenoble. Celem Memoriału było uzyskanie przez całe polskie środowisko naukowe stałego dostępu do promieniowania synchrotronowego w ESRF.

1992 r. – Pierwsza publikacja naukowa, opublikowana przez pracowników Środowiskowego Laboratorium Analiz Fizyko-Chemicznych i Strukturalnych UJ, na temat rentgenowskiego rezonansowego rozproszenia atomów przy użyciu promieniowania synchrotronowego z synchrotronu Laboratorium DESY-HASYLAB w Hamburgu [16]. Publikacja ta zapoczątkowała obszerny cykl prac dotyczących dyfrakcji promieniowania rentgenowskiego w ciele stałym przy użyciu promieniowania synchrotronowego.

Lata 1992 – 1995. – Rozmowy przedstawicieli Instytutów Fizyki UJ i AGH oraz Polskiego Towarzystwa Promieniowania Synchrotronowego z Dyrekcją synchrotronu elektronowego ELETTRA w Trieście, w sprawie zainstalowania na wiązce promieniowania synchrotronowego z tego synchrotronu, polskiej linii rentgenowskiej spektroskopii absorpcyjnej (X-ray Absorption Spectroscopy line (XAS)). Niestety, pomimo nadzwyczajnej przychylności prof. Georgio Margaritondo, Przewodniczącego Komitetu Programowego, oraz prof. Renzo Rosei, Dyrektora Naukowego synchrotronu „ELETTRA", rozmowy nie przyniosły pożądanych rezultatów. Komitet Badań Naukowych nie był w stanie wyasygnować kwoty około 1 miliona dolarów na budowę oraz eksploatację planowanej polskiej linii pomiarowej XAS przy synchrotronie ELETTRA w Trieście.

23.07.1993 r. – Podpisanie Umowy o wspólnym prowadzeniu prac badawczych między Uniwersytetem Jagiellońskim i Uniwersytetem Rzymskim II „Tor Vergata" Umowa podpisana z ramienia UJ przez Prorektora prof. Krystynę Dyrek dotyczyła współpracy Instytutów Fizyki Uniwersytetu Jagiellońskiego i Uniwersytetu Rzymskiego II w zakresie badań fizyki ciała stałego. Umowa dawała również możliwość prowadzenia badań z użyciem promieniowania synchrotronowego z pierścieni akumulujących ADONE w Frascati i ELETTRA w Trieście.

25–26.10.1993 r – Zorganizowanie 2. Krajowego Sympozjum Użytkowników Promieniowania Synchrotronowego Mogilany 93 (2.KSUPS). Sympozjum zostało zorganizowane w Domu Pracy Twórczej w Mogilanach przez Instytut Fizyki i Regionalne Laboratorium Analiz Fizyko-Chemicznych i Badań Strukturalnych Uniwersytetu Jagiellońskiego oraz Polskie Towarzystwo Promieniowania Synchrotronowego. W czasie Sympozjum odbyła się dyskusja „okrągłego stołu" w sprawie potrzeby budowy i zainstalowania na wiązce promieniowania synchrotronowego ELETTRA w Trieście, polskiej linii rentgenowskiej spektroskopii absorpcyjnej (XAS) a także planowanych programów naukowych związanych eksploatacją tej linii. Zarząd PTPS uzyskał pełne poparcie członków Towarzystwa dla inicjatywy rozmów w sprawie zainstalowania polskiej rentgenowskiej linii pomiarowej przy synchrotronie ELETTRA w Trieście.

18-19.6.1997 r. – Zorganizowanie 4. Krajowego Sympozjum Użytkowników Promieniowania Synchrotronowego (4.KSUPS). Sympozjum zostało zorganizowane w Polonijnym Instytucie Uniwersytetu Jagiellońskiego przez Instytut Fizyki i Regionalne Laboratorium Analiz Fizyko-Chemicznych i Badań Strukturalnych Uniwersytetu Jagiellońskiego oraz Polskie Towarzystwo Promieniowania Synchrotronowego. W czasie Sympozjum przypomniano 50 rocznicę odkrycia promieniowania synchrotronowego

4–5.11.1997 r. – Spotkanie CENTRALSYNC-1 w Budapeszcie przedstawicieli Austrii, Czech, Węgier i Polski, reprezentowanej przez prof. Andrzeja Kisiela z Instytutu Fizyki UJ i ówczesnego prezesa PTPS. Na spotkaniu uczestnicy podpisali list intencyjny, który wyrażał gotowość podjęcia wspólnych starań o utworzenie międzynarodowego konsorcjum reprezentującego wymienione państwa przed Europejskim Centrum Promieniowania Synchrotronowego (ESRF) w Grenoble oraz intencję doprowadzenia do podpisania umowy o współpracy badawczej z ESRF w charakterze międzynarodowej Współpracującej Grupy Naukowej (Research Collaborating Group).

8.07.1998 r. – Złożenie Wniosku na ręce Ministra, prof. Andrzeja Wiszniewskiego, Przewodniczącego Komitetu Badań Naukowych przez grupę profesorów fizyki z Instytutów Fizyki UJ i AGH, w sprawie utworzenia Narodowego Centrum Promieniowania Synchrotronowego oraz budowy w ramach tego Centrum, pierwszego polskiego synchrotronu elektronowego jako narodowego źródła promieniowania synchrotronowego przeznaczonego do badań w fizyce, chemii, biologii, medycynie i naukach technicznych. Przedłożony Wniosek przygotowany przez profesorów Krzysztofa Tomalę, Józefa Spałka i Krzysztofa Królasa z Instytutu Fizyki Uniwersytetu Jagiellońskiego oraz profesorów Andrzeja Kołodziejczyka i Karola Kropa z Instytutu Fizyki Akademii Górniczo-Hutniczej podpisało 22 sygnatariuszy reprezentujących różne dziedziny nauki.

3.10.1998 r. – Spotkanie CENTRALSYNC-2 przedstawicieli Austrii, Czech, Węgier i Polski zorganizowane w Krakowie w Collegium Novum przez Instytut Fizyki UJ i Polskie Towarzystwo Promieniowania Synchrotronowego. Celem spotkania było podsumowanie postępu starań dotyczących podpisania przez sygnatariuszy umów cząstkowych z ESRF oraz potwierdzenie intencji utworzenia międzynarodowego konsorcjum.

05.1999 r. – Wprowadzenie pod obrady Prezydium Komitetu Badań Naukowych przez Ministra Nauki, Przewodniczącego Komitetu Badań Naukowych prof. Andrzeja Wiszniewskiego, sprawy przystąpienia Polski do Europejskiego Centrum Promieniowania Synchrotronowego w Grenoble na zasadach międzynarodowej Współpracującej Grupy Naukowej. Wniosek dotyczący starań o przystąpienie Polski do ESRF, przedstawił na tym posiedzeniu Andrzej Kisiel prof. Uniwersytetu Jagiellońskiego i przewodniczący PTPS. Po wyczerpującej merytorycznej dyskusji, wspieranej przekonywującymi argumentami V-przewodniczącego KBN prof. Andrzeja Kajetana Wróblewskiego, wniosek uzyskał jednogłośne poparcie Prezydium KBN. Decyzję tę należy uznać za ważny sukces środowiska nauk przyrodniczych, użytkującego promieniowanie synchrotronowe do badań naukowych. Na tym posiedzeniu po raz pierwszy zostało potwierdzone przez Prezydium KBN, że użytkowanie promieniowania synchrotronowego leży w interesie Nauki Polskiej, w podobnym stopniu jak użytkowanie reaktorów neutronowych, cyklotronów oraz podobnie jak członkowstwo w CERN i w innych organizacjach naukowych. To stanowisko Prezydium KBN uzasadniło celowość przyznania środków finansowania na członkostwo Polski w ESRF w Grenoble.

6.11.1999 r. – Spotkanie CENTRALSYNC–3 w Pradze dla przedstawicieli Austrii, Czech, Węgier i Polski reprezentowanej przez prof. Andrzeja Kisiela z IF UJ i vice-prezesa PTPS w celu ostatecznego podsumowania stanu starań o utworzenie międzynarodowego konsorcjum oraz przedyskutowanie ramowego statutu tworzonego konsorcjum.

20.01.2000 r. – Przyznanie z rezerwy celowej Ministerstwa Finansów środków finansowych niezbędnych do zawarcia umowy przez Polskę z ESRF. Decyzja ta uprawniała PTPS do wszczęcia oficjalnych negocjacji z władzami ESRF. Przebiegające bardzo pomyślnie negocjacje zostały niestety wstrzymane ze względu na pojawienie się trudności formalno-prawnych wynikających z nieposiadania osobowości prawnej przez PTPS. W celu usunięcia tych przeszkód, były prowadzone rozmowy z prorektorem UJ do spraw współpracy międzynarodowej prof. Marią Nowakowską w kwestii podpisania i administrowania środkami finansowymi przyznanymi na obsługę Umowy zawieranej przez Polskę z ESRF w Grenoble. Uniwersytet Jagielloński obawiał się konsekwencji finansowych i nie podjął się tego zadania. Gwałtowne zamrożenie środków jesienią 2000 roku, spowodowane wzrostem deficytu budżetowego Państwa (dziura Bauca) wstrzymały zawarcie Umowy na okres czterech lat. Od roku 2002 ostatnią fazę negocjacji w imieniu PTPS prowadziła v-prezes PTPS prof. Krystyna Ławniczak-Jabłońska, będąca pracownikiem IF PAN w Warszawie. 16 kwietnia 2004 r**.** została zawarta Umowa z Europejskim Centrum Promieniowania Synchrotronowego w Grenoble dotycząca uczestniczenia Polski w charakterze międzynarodowej Współpracującej Grupy Naukowej (Research Collaborating Group). W imieniu Polski Umowę podpisał dyrektor Instytutu Fizyki PAN w Warszawie prof. Jacek Kossut. Tak więc ostatecznie po 13 latach starań Polskiego Towarzystwa Promieniowania

Synchrotronowego, polskie środowisko nauk przyrodniczych otrzymało stały dostęp w Europejskim Centrum Promieniowania Synchrotronowego do najbardziej nowoczesnych w Europie linii pomiarowych, wykorzystujących jako źródło światła promieniowanie synchrotronowe.

12-17.06.2006 r. – 8th International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS-8) w Zakopanem, zorganizowana przez Centrum Badawcze Nanostruktur i Materiałów Zaawansowanych (NANOSAM), Wydział Fizyki, Astronomii i Informatyki Stosowanej Uniwersytetu Jagiellońskiego i Polskie Towarzystwo Promieniowania Synchrotronowego. Program i streszczenia wygłoszonych referatów ukazały się w *Synchrotron Radiation in Natural Science, Bulletin of the Polish Synchrotron Radiation Society*, Vol. **5,** 1-2, 2006, a wybrane artykuły w Vol. **5,** 3, 2006,

26.09.2007 r. – I Krajowa Konferencja Polski Synchrotron – Linie Eksperymentalne zorganizowana przez Uniwersytet Jagielloński, Centrum Promieniowania Synchrotronowego, Polskie Towarzystwo Promieniowania Synchrotronowego i Uniwersytet Adama Mickiewicza. Program konferencji ukazał się w Biuletynie PTPS *Synchrotron Radiation in Natural Science* Vol. **6,** 1-2 (2007).

20–21.06.2008 r. – II Krajowa Konferencja Polski Synchrotron – Linie Eksperymentalne zorganizowana przez Uniwersytet Jagielloński, Centrum Promieniowania Synchrotronowego, Polskie Towarzystwo Promieniowania Synchrotronowego i Instytut Fizyki PAN w Warszawie. Program konferencji i streszczenia komunikatów ukazały się w *Biuletynie PTPS Synchrotron Radiation in Natural Science* Vol. **7,** 1-2 (2008).

9.04.2010 r. – Podpisanie Umowy na realizację projektu „Narodowe Centrum Promieniowania Elektromagnetycznego dla Celów Badawczych", który dotyczył budowy i uruchomienia pierwszego polskiego synchrotronu elektronowego usytuowanego na terenie kampusu Uniwersytetu Jagiellońskiego w Pychowicach.. Umowę podpisali w imieniu MSWiN Minister Barbara Kudrycka i Rektor UJ prof. Karol Musioł. Umowa o budowie pierwszego polskiego synchrotronu elektronowego jako narodowego źródła promieniowania synchrotronowego kończyła sukcesem dwunastoletnie starania, rozpoczęte przez krakowskie środowisko naukowe w roku 1998.

16.05.2012 r. – Wmurowanie kamienia węgielnego w fundamentach budynku synchrotronu elektronowego budowanego na kampusie Uniwersytetu Jagiellońskiego w Pychowicach. Aktu wmurowania kamienia węgielnego dokonał Rektor UJ prof. Karol Musioł w obecności Podsekretarza stanu Ministerstwa Nauki i Szkolnictwa Wyższego prof. Jacka Gulińskiego, Przewodniczącego Rady Narodowego Centrum Promieniowania Synchrotronowego UJ prof. Krzysztofa Królasa, Dyrektora Narodowego Centrum Promieniowania Synchrotronowego UJ prof. Marka Stankiewicza, i Prezesa Polskiego Towarzystwa Promieniowania Synchrotronowego dr hab. Macieja Kozaka oraz zaproszonych gości.

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Kalendarium starań Polskiego Towarzystwa Promieniowania Synchrotronowego w latach 1991 – 2002 o dostęp do europejskich źródeł promieniowania synchrotronowego

Keywords: synchrotron radiation, beamline, electron.

Kalendarium jest skondensowanym opisem działań Polskiego Towarzystwa Promieniowania Synchrotronowego mających na celu ułatwienie dostępu dla polskich badaczy do linii pomiarowych użytkujących promieniowanie synchrotronowe w Europejskim Centrum Promieniowania Synchrotronowego w (ESRF) w Grenoble i synchrotronie ELETTRA w Trieście. Kalendarium zawiera również krótkie Wprowadzenie prezentujące uzasadnienie podejmowanych starań.

A calendar of the Polish Synchrotron Radiation Society efforts in the years 1991-2002 aiming for access to European synchrotron radiation sources. The Calendar is a condensed description of the Polish Synchrotron Radiation Society efforts aiming for facilitation of access of the Polish researches to synchrotron beamlines in the European Synchrotron Radiation Facility in Grenoble and in synchrotron ELETTRA situated in Trieste. The Calendar contains also a short introduction presenting the motivation of the efforts.

1. Wprowadzenie

Gwałtownie rosnące w latach osiemdziesiątych ubiegłego stulecia światowe zapotrzebowanie na badania naukowe fazy skondensowanej z użyciem promieniowania synchrotronowego, spowodowało wzrost globalnej liczby użytkowników promieniowania synchrotronowego, w tym również znaczący wzrost liczby badaczy pochodzących z Polski. Dobrze przygotowani merytorycznie pracownicy naukowi polskich Uniwersytetów i Instytutów PAN byli bardzo chętnie przyjmowani do współpracy w ośrodkach synchrotronowych Europy, USA i Japonii. Pierwsze prace naukowe z użyciem promieniowania synchrotronowego wykonane z udziałem badaczy z Polski pojawiły się na przełomie lat siedemdziesiątych i osiemdziesiątych ubiegłego wieku w zakresie spektroskopii optycznej i rentgenowskiej [1,2]. Wówczas Instytut Fizyki Uniwersytetu Jagiellońskiego zaczął wypracowywać mechanizmy współpracy włosko-polskiej w użytkowaniu promieniowania synchrotronowego z 1,1 GeV synchrotronu usytuowanego w Frascati, a następnie z 2,5 GeV pierścienia kumulującego ADONE i synchrotronu ELETTRA w Trieście. Bardziej szczegółowy przebieg tych starań został przedstawiony w kilku artykułach [3,4,5] a pierwsze opublikowane rezultaty badań prezentują publikacje [6,7]. W połowie lat osiemdziesiątych IF UJ podjął efektywną współpracę naukowa z ośrodkami synchrotronowymi w Daresbury (Wielka Brytania), Brookhaven National Laboratory (USA) MAX I i II w Szwecji oraz w Niemczech z HASYLAB w Hamburgu i BESSY I i II w Berlinie. Efektami tej współpracy były wspólne publikacje pracowników i wychowanków Instytutu z zespołami badawczymi tych ośrodków [8,9,10].

W tym okresie nieżyjący obecnie prof. Julian Auleytner z Instytutu Fizyki PAN w Warszawie śledził uważnie rozwój zainteresowania użytkowaniem promieniowania synchrotronowego w fizyce ciała stałego [11]. Wspierał swoim autorytetem rozwój badań synchrotronowych w ośrodku warszawskim a także zachęcał do badań z użyciem promieniowania synchrotronowego pracowników naukowych Instytutu Fizyki UJ. We wrześniu 1989 w Mądralinie k. Warszawy zorganizował Międzynarodowe Seminarium Spektroskopii Rentgenowskiej i Elektronowej (2nd International Seminar on X-Ray and Elektron Spectroscopy), na którym S. Bergwall z Uniwersytetu Lulea w Szwecji wygłosił referat plenarny na temat „*Synchrotron Radiation in Soft X-ray and Elektron Spectroscopy*", a P.O. Nielsen z Uniwersytetu w Göteborgu przedstawiał wyniki badań spektroskopii elektronowej uzyskane z użyciem promieniowania synchrotronowego. Na tym Seminarium również grupa polsko-włoska z Instytutu Fizyki Uniwersytetu Jagiellońskiego i Zakładu Fizyki Uniwersytetu w Trento zaprezentowała badania XANES dla CdMnTe i MnTe z użyciem promieniowania synchrotronowego z pierścienia akumulującego ADONE w Frascati. Seminarium w Mądralinie było stymulującą zachętą do prowadzenia badań naukowych z użytkowaniem promieniowania synchrotronowego.

W celu zacieśniania kontaktów naukowych i ochrony interesów użytkowników powstało w roku 1988 Europejskie Towarzystwo Promieniowania Synchrotronowego. Podobne tendencje pojawiły się również w jeszcze bardzo niewielkim, polskim środowisku użytkowników promieniowania synchrotronowego, które korzystało z różnych synchrotronów w Europie i USA. W lutym 1991 r. z inicjatywy prof. Juliana Auleytnera z Instytutu Fizyki PAN w Warszawie oraz autora tego Kalendarium, fizycy i chemicy oraz współpracujący z nimi lekarze i biologowie, spotkali się w Krakowie w pałacyku Szyszko-Bogusza na zorganizowanym przez Instytut Fizyki Uniwersytetu Jagiellońskiego Pierwszym Krajowym Sympozjum Użytkowników Promieniowania Synchrotronowego (1. KSUPS). Podstawowym celem Sympozjum było dokonanie przeglądu potencjału naukowego polskich użytkowników promieniowania synchrotronowego. Uczestnicy Sympozjum zaprezentowali ponad 20 komunikatów naukowych i zadeklarowali chęć utworzenia Polskiego Towarzystwa Promieniowania Synchrotronowego (PTPS). Wśród 28 członków założycieli, było 11osób z Instytutu Fizyki i Chemii UJ oraz Instytutu Fizyki Jądrowej w Krakowie, w tym osiem osób z Zakładu Fizyki Ogólnej IF UJ. Pozostali założyciele reprezentowali głównie Instytuty Fizyki PAN w Warszawie i Uniwersytetu

Warszawskiego. Zarejestrowane w maju 1991 roku Polskie Towarzystwo Promieniowania Synchrotronowego rozpoczęło trwającą do dzisiaj aktywną działalność.

Hasła Kalendarium są świadectwem podejmowania szeregu ważnych inicjatyw przez PTPS w zakresie ułatwienia polskim użytkownikom dostępu do źródeł promieniowania synchrotronowego. Niestety, skuteczność tych starań była bardzo ograniczona przede wszystkim przez szczupłość środków finansowych przeznaczanych na wyspecjalizowane badania naukowe w ubogim Państwie Polskim, borykającym się w latach dziewięćdziesiątych ubiegłego stulecia z podstawowymi trudnościami ekonomicznymi. Jedynym wymiernym rezultatem istotnie poprawiającym możliwości badawcze z użyciem promieniowania synchrotronowego w naukach przyrodniczych było zawarcie po 13 latach starań w roku 2004 umowy z Europejskim Centrum Promieniowania Synchrotronowego (ESRF) w Grenoble. Wieloletnie, nawet nieskuteczne, negocjacje na różnych szczeblach Komitetu Badań Naukowych i Państwowej Agencji Atomowej ugruntowały przekonanie, że użytkowanie promieniowania synchrotronowego leży w żywotnym interesie Nauki Polskiej, w podobnym stopniu jak użytkowanie reaktorów neutronowych, cyklotronów i jak członkowstwo Polski w CERN-ie. Zatem można sądzić, że obecna bardzo przyjazna atmosfera dla rozwoju badań w Polsce z użyciem promieniowania synchrotronowego ma swoje korzenie również w pierwszym dziesięcioleciu działalności Polskiego Towarzystwa Promieniowania Synchrotronowego.

2. Kalendarium

4-7.09.1989 r. – Zorganizowanie przez prof. Juliana Auleytnera z Instytutu Fizyki PAN w Warszawie 2nd International Seminar on X-Ray and Elektron Spectroscopy w Mądralinie k. Warszawy. Część referatów na Seminarium była poświęcona badaniom z użyciem promieniowania synchrotronowego.

17-18.02.1991 r.- Pierwsze Krajowe Sympozjum Użytkowników Promieniowania Synchrotronowego (1. KSUPS) zorganizowane przez Instytut Fizyki Uniwersytetu Jagiellońskiego w Krakowie w pałacyku Szyszko-Bohusza, z inicjatywy prof. Juliana Auleytnera z Instytutu Fizyki PAN w Warszawie i prof. Andrzeja Kisiela z Instytutu Fizyki Uniwersytetu Jagiellońskiego. Założeniem Sympozjum był przegląd potencjału naukowego polskich użytkowników promieniowania synchrotronowego. W celu skonsolidowania tego środowiska w trakcie Sympozjum podjęto spontaniczną inicjatywę utworzenia Polskiego Towarzystwa Promieniowania Synchrotronowego (PTPS).

5.05.1991 r. – Oficjalna rejestracja sądowa Polskiego Towarzystwa Promieniowania Synchrotronowego z siedzibą w Krakowie w IF UJ przy ul Reymonta 4. Statutowymi celami działalności Towarzystwa było podjęcie starań o łatwiejszy dostęp polskich użytkowników promieniowania synchrotronowego do źródeł promieniowania w Europie oraz podnoszenie kwalifikacji naukowych członków Towarzystwa. Pierwszym Prezesem PTPS został prof. Andrzej Kisiel z UJ, a vice-prezesem - prof. Julian Auleytner z IF PAN w Warszawie. Prof. Kisiel pełnił obowiązki prezesa do 1999 roku a ponadto do 2002 r. jako vice-prezes, był odpowiedzialny za prowadzenie rozmów i pertraktacji w sprawie uzyskania dostępu polskich naukowców do źródeł promieniowania synchrotronowego. Pełniejszy opis działalności PTPS można znaleźć w artykule [12].

07.1991 r. – Przedstawienie w Komitecie Badań Naukowych Memoriału nowopowstałego Polskiego Towarzystwa Promieniowania Synchrotronowego (PTPS) w sprawie przystąpienia, w charakterze członka, do European Synchrotron Radiation Facility – (ESRF)) w Grenoble w celu uzyskania stałego dostępu polskiego środowiska naukowego do badań z użyciem promieniowania synchrotronowego. Memoriał został poparty przez Rektora UJ prof. Andrzeja Pelczara.

13–21.05.1992 r. – I. International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS)) w Jaszowcu, zorganizowana przez Polskie Towarzystwo Promieniowania Synchrotronowego. Przewodniczącymi Szkoły i Sympozjum byli profesorowie Julian Auleytner i Andrzej Kisiel. Materiały Szkoły i Sympozjum ukazały się drukiem w Acta Physica Polonica vol. 82, zeszyt 1 i 2 (1992) jako *Proceedings of the International School and Sympodium on Synchrotron Radiation in Natural Science* pod redakcją Krystyny Ławniczak-Jabłońskiej i Grzegorza Kowalskiego. Pierwsza ISSRNS zapoczątkowała organizację kolejnych, powtarzających się regularnie co dwa lata, międzynarodowych szkól i sympozjów. Służyły one ambitnie potraktowanej edukacji środowiska polskich użytkowników promieniowania synchrotronowego. Na tym polu PTPS osiągnęło nadzwyczaj pozytywne rezultaty. Międzynarodowe Szkoły od I do X ISSRNS w roku 2010 oraz zorganizowane sympozja krajowe (KSUPS) zostały opisane w artykule [13].

1992 – 1995 – Rozmowy pomiędzy Dyrekcją synchrotronu ELETTRA w Trieście a przedstawicielami Instytutów Fizyki UJ i AGH oraz Polskim Towarzystwem Promieniowania Synchrotronowego w sprawie zainstalowania na wiązce promieniowania synchrotronowego z synchrotronu ELETTRA polskiej linii rentgenowskiej spektroskopii absorpcyjnej (X-ray Absorption Spectroscopy line (XAS)). Niestety, mimo nadzwyczajnej przychylności strony włoskiej, rozmowy nie przyniosły pożądanych rezultatów. Komitet Badań Naukowych nie przyznał wówczas odpowiednich środków finansowych na budowę oraz na eksploatację planowanej polskiej linii pomiarowej XAS w Trieście.

4-5.11.1997 r. – Spotkanie CENTRALSYNC-1 w Budapeszcie i podpisanie listu intencyjnego przez przedstawicieli Austrii, Czech, Węgier oraz Polskę, reprezentowaną przez prof. Andrzeja Kisiela z IF UJ, ówczesnego prezesa PTPS. List intencyjny wyrażał gotowość podjęcia wspólnych starań o utworzenie konsorcjum i podpisanie umowy o współpracy badawczej z European Synchrotron Radiation Facility (ESRF) w Grenoble w charakterze międzynarodowej Współpracującej Grupy Naukowej (Research Collaborating Group).

12.1997 r. - Przekazanie drugiego Memoriału PTPS Ministrowi prof. Andrzejowi Wiszniewskiemu, Przewodniczącemu KBN, w sprawie przystąpienia Polski do ESRF w Grenoble na nowych korzystnych warunkach finansowych, wspólnie z innymi krajami Europy Środkowej, w charakterze międzynarodowej Współpracującej Grupy Naukowej (Research Collaborating Group). Propozycja PTPS spotkała się z dużą przychylnością w KBN co umożliwiło podjęcie poważnych negocjacji.

6.07.1998 r. – Złożenie Wniosku grupy profesorów uczelni krakowskich na ręce Ministra, prof. A. Wiszniewskiego, Przewodniczącego Komitetu Badań Naukowych, w sprawie utworzenia Narodowego Centrum Promieniowania Synchrotronowego i budowy, w ramach tego Centrum, synchrotronu elektronowego jako źródła promieniowania synchrotronowego przeznaczonego do badań w fizyce, chemii, biologii, medycynie i naukach technicznych. Przedłożony Wniosek przygotowany przez profesorów Krzysztofa Tomalę, Krzysztofa Królasa i Józefa Spałka z Instytutu Fizyki Uniwersytetu Jagiellońskiego oraz Andrzeja Kołodziejczyka i Karola Kropa z Zakładu Fizyki Ciała Stałego Akademii Górniczo-Hutniczej podpisało 22 sygnatariuszy reprezentujących różne dziedziny nauki.

3.10.1998 r. – Spotkanie CENTRALSYNC-2 zorganizowanie w Krakowie przez IF UJ i PTPS dla przedstawicieli Austrii, Czech, Węgier i Polski. Celem spotkania było podsumowanie w wymienionych krajach postępu starań o utworzenie konsorcjum i podpisania umowy z ESRF.

05.1999 r. –Wprowadzenie pod obrady Prezydium Komitetu Badań Naukowych przez Ministra Nauki, Przewodniczącego Komitetu Badań Naukowych prof. Andrzeja Wiszniewskiego, sprawy przystąpienia Polski do Europejskiego Centrum Promieniowania Synchrotronowego (ESRF) w Grenoble na zasadach międzynarodowej Współpracującej Grupy Naukowej. Wniosek dotyczący starań o przystąpienie Polski do ESRF, przedstawił na tym posiedzeniu Andrzej Kisiel prof. Uniwersytetu Jagiellońskiego i przewodniczący PTPS. Po wyczerpującej merytorycznej dyskusji, wspieranej przekonywującymi argumentami V-przewodniczącego KBN prof. Andrzeja Kajetana Wróblewskiego, wniosek uzyskał jednogłośne poparcie Prezydium KBN. Decyzję tę należy uznać za ważny sukces środowiska nauk przyrodniczych, użytkującego promieniowanie synchrotronowe do badań naukowych. Na tym posiedzeniu po raz pierwszy zostało potwierdzone przez Prezydium KBN, że użytkowanie promieniowania synchrotronowego leży w interesie Nauki Polskiej, w podobnym stopniu jak użytkowanie reaktorów neutronowych, cyklotronów oraz podobnie jak członkowstwo w CERN i w innych organizacjach naukowych. To stanowisko Prezydium uzasadniło celowość przyznania środków finansowania na członkostwo Polski w ESRF w Grenoble.

31.05–1.06.1999 r. – 5. Krajowe Sympozjum Użytkowników Promieniowania Synchrotronowego (5. KSUPS) w Warszawie zorganizowane przez prof. Marię Lefeld-Sosnowską z Instytutu Fizyki Doświadczalnej Uniwersytetu Warszawskiego. Walne Zebranie PTPS wybrało nowe władze Towarzystwa. Prezesem został prof. Bronisław Orłowski z IF PAN w Warszawie, a vice-prezesem – prof. Andrzej Kisiel z IF UJ, który nadal pozostał odpowiedzialny za starania o dostęp do źródeł promieniowania synchrotronowego.

6.11.1999 r. – Spotkanie CENTRALSYNC–3 w Pradze przedstawicieli Austrii, Czech, Węgier i Polski reprezentowanej przez prof. Andrzeja Kisiela z IF UJ i vice-prezesa PTPS w celu ostatecznego podsumowania stanu starań o utworzenie międzynarodowego konsorcjum oraz przedyskutowanie ramowego statutu tworzonego konsorcjum.

20.01.2000 r. – Przyznanie z rezerwy celowej Ministerstwa Finansów środków finansowych niezbędnych do zawarcia umowy przez Polskę z ESRF. Decyzja ta uprawniała PTPS do wszczęcia oficjalnych negocjacji z władzami ESRF. Przebiegające bardzo pomyślnie negocjacje zostały niestety wstrzymane ze względu na pojawienie się trudności formalno-prawnych wynikających z nieposiadania osobowości prawnej przez PTPS. W celu usunięcia tych przeszkód, były prowadzone rozmowy z prorektorem UJ do spraw współpracy międzynarodowej prof. Marią Nowakowską w kwestii podpisania i administrowania środkami finansowymi przyznanymi na obsługę Umowy zawieranej przez Polskę z ESRF w Grenoble. Uniwersytet Jagielloński obawiał się konsekwencji finansowych i nie podjął się tego zadania. Gwałtowne zamrożenie środków jesienią 2000 roku, spowodowane wzrostem deficytu budżetowego Państwa (dziura Bauca) wstrzymały zawarcie Umowy na okres czterech lat.

12–17.06.2000 r. V International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS-5) w Ustroniu - Jaszowcu, zorganizowana przez Polskie Towarzystwo Promieniowania Synchrotronowego . Materiały Szkoły i Sympozjum ukazały się drukiem w J. of Alloys and Compounds vol. 328, (2001) jako Proc. the 5th International School and Symposium on Synchrotron Radiation in Natural Science, pod redakcją Czesława Kapusty, Wojciecha Kwiatka, Jerzego Koniora I Marka Stankiewicza.

Czerwiec 2001 r. - Ukazanie się pierwszego zeszytu Biuletynu Polskiego Towarzystwa Promieniowania Synchrotronowego pt. Synchrotron Radiation in Natural Science, Bulletin of the Polish Synchrotron Radiation Society (Vol.1 Number 1). Biuletyn powstał z inicjatywy dr. Wojciecha Paszkowicza z IF PAN w Warszawie. Został on pierwszym redaktorem pisma.

17–22.06. 2002 r. – VI. International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS-6) w Ustroniu - Jaszowcu, zorganizowana przez Polskie Towarzystwo Promieniowania Synchrotronowego i Instytut Fizyki PAN w Warszawie. Komitetowi Organizacyjnemu przewodniczyli Bronisław Orłowski i Krystyna Jabłońska. Walne Zebranie powtórnie powierzyło fotel prezesa prof. Bronisławowi Orłowskiemu z IF PAN. Vice-prezesem została doc. Krystyna Jabłońska z IF PAN, która przejęła, od ustępującego prof. Andrzeja Kisiela, odpowiedzialność za starania o uzyskanie dostępu do źródeł promieniowania synchrotronowego.

Działalność PTPS w następnych latach zostanie opisana przez kolejnych Prezesów Towarzystwa w przyszłych numerach Biuletynu PTPS.

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Prof. dr hab. Andrzej Kisiel
Prezes PTPS w latach 1991-1999
i vice-prezes w kadencji 1999-2002.

11^{th} International Symposium and School 2012 in Kraków - the very successful and remarkable event

The 11^{th} ISSRNS was organized by the Polish Synchrotron Radiation Society in cooperation with the Henryk Niewodniczański Institute of Nuclear Physics at the Polish Academy of Sciences, Kraków and under the honorary patronage of the Mayor of the Royal City of Kraków, Prof. Jacek Majchrowski, General Director of the Institute of Nuclear Physics PAN, Prof. Marek Jeżabek, and Rector of the Jagiellonian University in Kraków, Prof. Karol Musioł.

The Board of Polish Synchrotron Radiation Society decided to organize the meeting in Kraków because the National Synchrotron Radiation Centre SOLARIS is located there; the corner stone ceremony for it also took place at the synchrotron site in the new University campus in May, 2012. The conference venue was very close to the place where SOLARIS is being built.

The Royal City of Kraków is [one of] the major center of education in Poland. Ten university or academy-level institutions educate 170,000 students here, and next eleven institutions of academic education. Kraków is now a city of culture and science with numerous theatres, cinemas, museums, galleries, music centers and cabarets. In 1978, Kraków was included on the UNESCO list of world cultural heritage. The town is located 219 m above sea level, on the Vistula River, 100 km from the Tatra Mountains and 300 km from Warsaw, the capital of Poland. The historic centre of Kraków, the former (untill the 17th century) capital of Poland, is situated at the foot of the Royal Wawel Castle. The 13^{th}-century merchants' town has Europe's largest market square and numerous historical houses, palaces and churches with their magnificent interiors. Further evidence of the town fascinating history is provided by the remnants of the XIV^{th}-century fortifications and by the medieval site of Kazimierz with its ancient synagogues in the southern part of town, historical buildings of the Jagiellonian University in the center of the Old Town, and - on the Wawel hill - the gothic cathedral where many kings of Poland were buried.

Figure 1. The session in City Hall.

Photo by. J. Pełka

Figure 2. The excursion along the Vistula river.

Photo by W. Przybyłowicz

The very successful and remarkable event which was the ISSRNS 2012 that could combine scientific purpose with possible rest. Both was possible due to all lecturers, contributors and participants form fourteen countries such as: Austria, Canada, Czech Republic, France, Germany, Italy, Japan, Poland, South Africa, Singapore, Spain, Switzerland, United States of America, and The Netherlands. I would like to thank all them for wonderful atmosphere they have created. In the programme, there was a special session held in the City Hall (Fig. 1). The lectures of this session presented current status of the SOLARIS project among other important Polish activities on large scale facilities such as the National Center for Hadron Therapy and PolFEL project. We had also opportunities to have informal meetings and discussions. Any place was good for those, on boat (Fig. 2), during the walk through the city or in the Niepołomice Royal Castle.

The scientific topics discussed at the ISSRNS 2012 meeting included are listed below.

- Synchrotron radiation in nanoscience
- X-ray absorption, fluorescence and photoelectron spectroscopies
- X-ray magnetic dichroism
- X-ray diffraction: methods and applications
- Macromolecular crystallography
- Synchrotron radiation in life sciences
- Applications of free electron lasers
- Synchrotron and alternative radiation sources - instrumentation.

The conference programme included 23 plenary and section lectures, 21 oral communications as well as 64 posters (the activities during the poster session are illustrated in Fig. 3). A measurable result of conference is the volume of Radiation Physics and Chemistry edited by W.M. Kwiatek, M. Kozak, and W. Paszkowicz. This volume contains selected 31 papers on the research work presented at the ISSRNS 2012 conference. The papers cover a wide range of research topics connected with the synchrotron radiation ranging from construction of free electron lasers or synchrotron optics, to the structural biology or applications of synchrotron radiation for cultural heritage protection.

The financial support from the Polish Ministry of Science and Higher Education, and our industrial sponsors such as Hamamatsu, Bruker Poland, Bruker-Optics, Panalytical, Netzsch, and Spectro-Lab is highly acknowledged.

Needless to say, the success of the ISSRNS 2012 would not be possible without hard work of International Advisory Board, Scientific Committee, and Local Organizing Committee to whom should be given the special warm thankfulness.

Welcome for the next ISSRNS meeting to be held in the proximity of Warsaw in June 2014.

Wojciech M. Kwiatek
/Conference Chairman/

Figure 3. Poster session.

Photo by S. Bożek

12th International School and Symposium on Synchrotron Radiation in Natural Science

The 12th International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS 2014) will be held on 15-20 June 2014 in a conference center located in Mazovia, the historical province in the central part of Poland surrounding Warsaw. The exact venue will be specified in autumn 2013.

The ISSRNS 2014 is the next one in a series of biennial meetings organized in Poland since 1992.

This time, it is organized by the Polish Synchrotron Radiation Society together with two institutes: Institute of Physics, Polish Academy of Sciences in Warsaw and National Centre for Nuclear Research in Świerk, with a substantial support within the EU Grant EAgLE/REGPOT. The ISSRNS meetings have traditionally been devoted to recent advances and new techniques employing synchrotron radiation (SR) in physics, chemistry, materials science, crystallography, biology and medicine as well as in the fields of archaeometry, environmental protection, geology, quality control, etc. The aim of this interdisciplinary meeting is also to bring together scientists working with synchrotron radiation and those who would like to learn more about the sources and specific experimental techniques. The meeting has a format of advanced workshop covering recent developments of synchrotrons and short-wavelength free electron lasers and providing a forum for reporting the most recent achievements in fundamental and applied research. Several introductory and tutorial lectures addressed to young researchers (M.Sc. and Ph.D. level), as well as to new potential users of the synchrotron radiation are foreseen.

The year 2014 has been declared by the United Nations as the International Year of Crystallography, the discipline, whose progress is strictly related to the development of modern SR sources - synchrotrons and short-wavelength FELs. In Poland, the first national synchrotron SOLARIS in Krakow is under construction, to be operational in late 2014. A concept of POLFEL, the Polish free electron laser proposed to be constructed in Świerk also reaches its maturity. These facts will pronouncedly influence the programme of the incoming meeting beyond its traditional topics to cover interests of the SR community of users, designers and constructors of the new synchrotron sources.

The program of the meeting will include:

- X-ray diffraction: methods and applications,
- Macromolecular crystallography,
- Structure solution in nano- and micro-scales
- Elastic scattering of X-rays,
- Synchrotron radiation in nanoscience,
- Imaging, holography, spectroscopic mapping,
- X-ray absorption, fluorescence and photoelectron spectroscopies,
- X-ray magnetic dichroism,
- Synchrotron radiation at long wavelengths (THz, IR and VUV),
- Synchrotron radiation in life sciences and medicine,
- Novel applications of Free Electron Lasers,
- Synchrotron and alternative radiation sources – new developments and instrumentation,
- Advanced optics, irradiation damage and metrology of intense beams,
- And many other…

The abstracts of all contributions presented at ISSRNS will be published in a volume of Synchrotron Radiation in Natural Science, and the proceedings in a reputable international journal.

The official language of the Meeting is English.

The Organizers cordially invite all contributors interested in the synchrotron radiation and its application to participate in ISSRNS 2014.

Address of the ISSRNS 2014 Office
ISSRNS 2014
Institute of Physics, Polish Academy of Sciences
Al. Lotników 32/46
PL-02-668 Warsaw
POLAND
e-mail: issrns2014@ifpan.edu.pl
website: http://issrns2014.ncbj.gov.pl

AUTHORS' INDEX