Katedra fyziky kondenzovaných látek
Department of Condensed Matter Physics

Praha, 15th October 2014

Dear Madam/Sir,

The Department of Condensed Matter Physics (Structure Analysis) of Charles University (Praha) is dedicated to the research of structure of crystalline materials using conventional x-ray diffraction techniques, neutron scattering and synchrotron radiation. The main research direction is focused on the structure analysis of thin films, multilayers, surfaces and nanocrystalline materials in order to find relationships between structure and properties of substances. The research program has gradually evolved with the choice of new materials (thin films and ferroelectric hard materials, semiconductors, magnetics, magnetic and semiconductor multilayers, quantum dots, liquid crystals, fullerenes, clay materials…

The study of defects in microcrystals and nanorods is also a field that is highly interesting that could be developed in the future experimental beamline dedicated to surface x-ray diffraction at the Alba synchrotron. Since our group, headed by Dr. Vaclav Holy, is also interested in the study on the influence of defects in the structural properties of small dimension crystals, synchrotron x-ray diffraction is thoroughly used in order to investigate the local composition and structure in such defective materials.

In our group, another of the on-going projects is to apply the coherent diffraction imaging method to study the interrelation between stress and defects with the structure and properties of nano-structures, i.e. nanowires…

For these reasons, it would be valuable to us as future users of the beamline dedicated to surface x-ray diffraction at the Alba synchrotron the possibiity this beamline considers coherent diffraction imaging as a priority activity to probe non-destructively the local structure, shape and strain of structures at the micro/nanometer scale.

Yours faithfully,

Dr. Vaclav Holy

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EUROPEAN SYNCHROTRON RADIATION FACILITY
INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

Dear Madam/Sir,

I am head of the Structure Materials Groups and Scientist in charge of the ID03 beamline at the European Synchrotron Radiation Facility (ESRF). My research activity is focused in the study of low dimensional systems under very different condition environments with a surface diffraction dedicated beamline able to operate with different in-house/collaborative developed tools to adapt the beamline to the technical requirements needed to perform a requested experiment. A huge diversity of supported environments is available, from UHV conditions to HP/HT catalysis experiments, electrochemistry, coherence and even photoemission using an AFM tip as photo-electron collector.

Since X-rays are weakly absorbed by matter, surface X-ray diffraction is not limited to free surfaces under UHV conditions but can be applied with success to buried solid interfaces, solid/liquid interfaces and high pressure gas/solid interfaces. This is of particular importance in the case of heterogeneous catalytic reaction where the role of the catalyst can be studied under real working conditions.

In addition to crystallographic studies, surface diffraction is also suited for dynamical studies such as epitaxial growth, ion patterning, surface kinetics and phase transitions. In particular, ion erosion with ion beams in combination with grazing-incidence small-angle scattering has been employed to study the dynamical evolution of medium range correlations during nanopatterning.

Moreover, the possibility of tuning the photon wavelength allows to carry out experiments at resonance energies of particular elements. This is important to investigate surface magnetism in order to determine the depth distribution and magnetization of the resonant atoms. Resonance can also be used to determine the involvement and role of a particular atomic species in the surface/interface structure.

I strongly support the project of the surface diffraction beamline proposed for ALBA. This beamline will be complement the ESRF-ID03 beamline, which is strongly oversubscribed, since will add the possibility to control the polarization of the incident beam and the ulterior analysis of the polarized scattered beam. Moreover, the synergies between both beamlines, i.e. detectors and software analysis requirements, could encourage collaboration in fields of mutual interest and will help in widening the use of x-ray diffraction for the understanding of material surface/interface properties and of chemical reactions

Yours faithfully,

Grenoble, October 15th, 2014

Dr. Roberto Felici

Société Civile
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Istituto Officina dei Materiali
Trieste, Cagliari, Grenoble, Perugia

Trieste, 15th October 2014

Dear Madam/Sir,

Dr. Maddalena Pedio is Senior Scientist at the TASC-INFM national laboratory in Trieste. She is scientific coordinator of the laboratory Inverse Photoemission and electron Spectroscopies at CNR-IOM TASC. The Dr. M. Pedio research activity is focused on fundamental aspects of condensed matter, as well as on the use of photon and electron spectroscopies on materials and surface science performed both in laboratory apparata and synchrotron radiation facilities: She participated to the "Luce di Sincrotrone" project at the LNF-INFN ADONE facility and she have taken part to commissioning of several beamlines at ADONE, ELETTRA and ESRF. She was responsible of the VUV beamline and the local responsible of the BEAR-INFM beamline at the ELETTRA synchrotron. At present (current position) she is applying Time resolved spectroscopies (new radiation sources FEL) to nanostructured materials. Her scientific activity is divided into research lines including New Instrumentation, Surfaces and interfaces, optical properties of materials, microscopic modeling of the functionalization of surfaces, nano-dimensional materials, films, interfaces. She has being responsible of several national and international projects. She organized various national and international events. On the above topics, Dr. Pedio has about 110 original publications in JCR journals and over 80 presentations at International Conferences.

Long range and local structure determination correlation with electronic properties of low dimensional systems are the dominant themes in much of her research. These topics focus on nanostructured materials: clean surfaces (elemental and III-V semiconductors, metals) interface formation, interaction or chemisorptions of low Z elements, bi and poly atomic and large molecules (fullerenes, acenes, porphyrinoids) with ordered surfaces, development of surface treatment/growth processes of materials, growth of SiC thin film by fullerenes precursors carburization, graphene, nanotubes. She performed research by high resolution photoemission core level shift analysis (ARUPS and surface photoelectron diffraction) and inverse photoemission in surface and interface characterization, and Surface X-ray diffraction experiments. She is being deep involved in the X-ray optical absorption theoretical modeling and data analysis of X-Ray Diffraction and absorption spectroscopies (XAFS and Multiple Scattering NEXAFS analysis, even Time Resolved) with synchrotron radiation.

For these reasons, it would be valuable to us as future users of the beamline dedicated to surface x-ray diffraction at the Alba synchrotron to have the possibility to perform structural studies in molecular systems adsorbed on metal, oxides or semiconductors, as well as to perform in situ growth process using grazing incidence small angle diffraction techniques to get morphological information on the self-assembling of structures at nanometer scale.

Yours faithfully,

Dr. Maddalena Pedio

UNIVERSITÀ DEGLI STUDI FIRENZE

Firenze, 15th October 2014

Dear Madam/Sir,

Dr. Massimo Innocenti, Professor at the Department of Chemistry "Ugo Schiff" of the University of Florence is developing a research activity mainly focused on nanomaterials obtained by electrochemical procedures and usable in Electrocatalysis, Energetics and Sensoristic. In recent years very care has been taken over the preparation of substrates for electrodeposition of practical interest in the field of fuel cells and solar cells. The activities in the field of surface analysis techniques combined with an emphasis on how the Electrochemical Microscopy-Atomic Force Microscopy in solution and also under the control of the potential are to be highlighted. The possibility to study non-conductive surfaces too, directly in work environment, has allowed to obtain significant results both in medical and technological field in different areas from the applied electrochemistry.

My research interests converge with two techniques that usually are complementary between them and that could be of high interest to me and my group the possibility to combine diffraction and electrochemistry techniques to follow in situ structural and morphological evolution of electrodes under reaction conditions.

For these reasons, it would be valuable to us a beamline considering these techniques to have the possibility to become members of the user community of ALBA facility.

Yours faithfully,

Dr. Massimo Innocenti

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UNIVERSITÀ DEGLI STUDI FIRENZE

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Geneva, October 25, 2014

Dear Madam/Sir,

I write to you to express my strong interest in the set-up and development of a structural beamline at the ALBA facility for the advancement of the research of my community.

I am a member of the Jean-Marc Triscone's Group at the Physics Department of Condensed Matter of the University of Geneva. Our research group works on the realization and study of artificial oxide heterostructures. Of particular interest are the behaviour of correlated oxide systems and the study of interface induced phenomena. As member of this Group, I am mainly interested in research activities related to structural and electronic properties of oxide heterostructures.

In our current research, one of the major goals is to unravel mechanisms that lead to high-temperature superconductivity, mimicking some of the electronic and structural features in artificial heterostructures. One approach we are pursuing is to sandwich a thin superconducting film between dielectric layers to screen fluctuations. Our group is internationally renowned for its ability to build and control such layers. We will also investigate methods to both induce and stabilise superconductivity by shining laser light on ad-hoc engineered oxide structures.

These aims require the use of novel experimental techniques such as thin film deposition and synchrotron diffraction techniques, combined with advanced computer simulations. On the theoretical side, we are currently collaborating with different groups that calculate *ab-initio* band structures and some electronic properties.

On the experimental side, we have in-house growth facilities to prepare oxide films and multi-layer systems. Structural study of oxide surfaces and interfaces benefit from collaboration with transmission electron microscopy groups but most importantly, grazing incidence diffraction is one of the most useful and versatile techniques we use to accomplish this investigation.

For these reasons, it is extremely valuable to our community a beamline featuring these surface characterization techniques. We hope that the ALBA facility will host one such beamline and that we can participate as members of the user community.

Yours faithfully,

Stefano Gariglio

Marseille, 15th October 2014

Dear Madam/Sir,

At IM2NP-CNRS, the Stress research group headed by Pr. Olivier Thomas is highly interested to become a user of the future experimental beamline dedicated to surface x-ray diffraction at the Alba synchrotron. Our group is focused on the study of the structural and mechanical properties of materials with small dimensions. Synchrotron x-ray diffraction is thoroughly used in order to investigate local strain and composition fields as well as texture. The group has a strong international recognition within the field of stresses in small dimensions. Pr. Olivier Thomas is presently Director of the International Research Network MECANO (Mechanics of Nano-objects).

The analytical methods for studying the microstructure down to the atomic scale are constantly being improved. It is, however, still challenging to study nano-objects without averaging over non-identical objects and level inhomogeneities, and to avoid destructive sample preparation. In recent years, X-ray lens-less microscopy such as coherent X-ray diffraction imaging (CDI) is gaining interest with the publication of successful studies showing an increase in spatial resolution down to 10 nm. When the coherence length of the incident beam is larger than the diffracting object, the three-dimensional diffraction patterns can be regarded as the conversion of the object to reciprocal space. In Bragg condition, information on the object in terms of the *local* density and lattice strains can be extracted.

At IM2NP-CNRS, one of our on-going projects is to apply the CDI method to study the interrelation between stress and diffusion inside nanostructures. Recently, within a collaboration between MPI Stuttgart, CEA-Grenoble and ID03/ESRF, we have demonstrated that anomalous coherent X-ray diffraction imaging is a promising and attractive method to map the shape, concentration and deformation fields simultaneously inside coherent and coherently diffracting nanostructures [S. T. Haag, M.-I. Richard, S. Labat, M. Gailhanou, U. Welzel, E. J. Mittemeijer, and O. Thomas, Phys. Rev. B **87**, 035408 (2013)]. The technique even permits *in situ* experiments owing to its non-destructive nature. During an *in situ* annealing experiment we have demonstrated that core-shell morphology was preserved in Ag/Au nanowire at temperatures that are reported to lead to significant intermixing by volume diffusion in bulk material [S. T. Haag, M.-I. Richard, U. Welzel, V. Favre-Nicolin, O. Balmes, G. Richter, E. J. Mittemeijer, and O. Thomas, Nano Lett. **13**, 1883 (2013)].

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We want to pursue our efforts and look inside nanostructures *in situ* and *in operando* during reaction (mostly thermal annealing and catalysis) to probe the structure at ultimate dimensions and to reveal surface and interface effects. Mastering the control of surfaces and interfaces at small dimensions (typically several nm) is a real challenge, which calls for a fundamental understanding of the interplay between shape, size, strain, faceting, composition, defects and ordering at the nanoscale and the use of advanced *in situ* characterization methods like coherent x-ray diffraction imaging and advanced ptychography. Coherent x-ray ptychography, which aims to solve the diffraction-pattern phase problem by interfering adjacent Bragg reflections coherently and thereby determine their relative phase, circumvents the problems of non-ideal beams by retrieving both the illumination function and the density and phase of the sample. In the case of reconstruction/retrieval of coherent scattering patterns, the resolution depends on the data quality, which is determined by the coherence flux and is ultimately limited by the wavelength.

For these reasons, it would be valuable to us as future users of the beamline dedicated to surface x-ray diffraction at the Alba synchrotron that this beamline considers coherent diffraction imaging as a priority activity to probe non-destructively the local structure, shape and strain of structures at the nanometer scale possibly *in situ* and *in operando*.

Yours faithfully,

Dr. Marie-Ingrid Richard
Pr. Olivier Thomas

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UNIVERSITY

Div. Of Synchrotron Radiation Research
Johan Gustafson

Lund, November 5 2014

To whom it may concern,

I hereby express my support for the suggested multipurpose X-ray diffraction beamline, SIRENA, at ALBA.

My research focuses on atomic-scale understanding of structures and processes on surfaces, mainly with the aim of reaching a fundamental understanding of catalytic reactions. For this we use a combination of several, mainly synchrotron radiation based, techniques in order to establish the relation between surface structure of model catalysts and their catalytic activity.

For the interaction between single gases and model catalysts, one can most often prepare the structures of interest under realistic conditions, quench them by cooling and study them under ultra-high vacuum with the whole range of available surface science techniques, such as low-energy electron diffraction, scanning tunneling microscopy (STM) and X-ray photoelectron spectroscopy (XPS). In contrast, it is most often not possible to quench a phase formed in a mixture of gases, especially during a catalytic reaction. Consequently, these structures have to be investigated in situ (or in operando).

Most surface science techniques, however, make use of the strong interaction between electrons and matter in order to gain surface sensitivity. This in general limits their use to ultra-high (or at least high) vacuum conditions, and the range of tools available for in situ studies under realistic catalysis conditions is very limited. By employing differential pumping and electronic lenses, high-pressure XPS can be performed in pressures up to about 10 mbar. STM in principle does not require vacuum, but the atomic resolution is usually lost under realistic reaction conditions. Hence, one of the few methods available for atomic surface structure determination under realistic reaction conditions is grazing incidence X-ray diffraction (GIXRD). Similarly, grazing incidence small angle X-ray scattering (GISAXS) is very useful for in situ investigation of shape, size, strain, faceting, defects and ordering of nanostructures.

My group has a strong international recognition within the field of catalysis and surface oxidation using the approach outlined above. As a member of the Division of Synchrotron Radiation Research at Lund University, and with our close connection to the MAX IV laboratory, I know the big technological efforts required to develop new knowledge about material properties and their relation to

atomic scale structure. For this reason I support this project of a multipurpose X-ray diffraction beamline at ALBA.

This project will offer new and more accessible resources of high standard for the Spanish user community, and has the potential to strengthen their expertise in important areas such surface and nanostructure characterization and catalysis. It will also be of great value for the European, as well as global, user community, as there is a general shortage of this kind of experimental stations.

Yours Sincerely,

Dr Johan Gustafson
Associate Senior University Lecturer