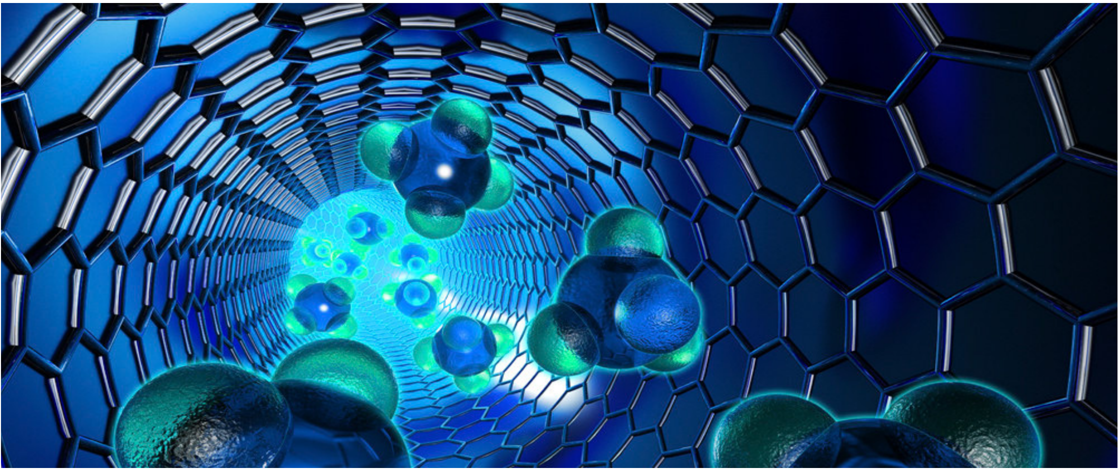
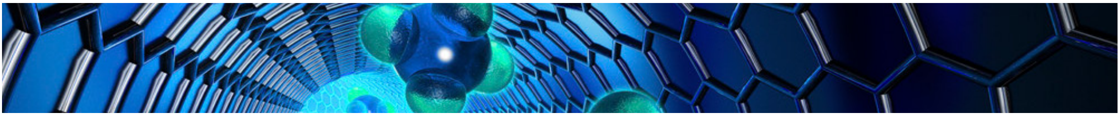
"Nanotechnology: From Materials to Science"

15-16 February 2018 | Charles University, Prague



How much do you know about the industrial applications of nanotechnology ?

ACCELERATE is funded by the European Union Framework Programme for Research and Innovation Horizon 2020, under grant agreement 731112



PROGRAMME

Day 1 - 15 February 2018

12.00 Lunch and registration

13.00 Welcome to the event

13.10 CERIC-ERIC overview and introduction to the ACCELERATE project
Angela Zennaro, CERIC-ERIC

13.30 Nanofabrication facilities offered by the recently opened Research Innovation and Technology Center for New Materials: Ionut Enculescu, National Institute of Materials Physic, Romania.

14.00 ERP Characterisation of doped wide-bandgap semiconductors.
Mariana Stefan,National Institute of Materials Physics, Romania.

14.30 The emerging field of correlative Probe and Electron Microscopy: Jan Neuman, Nenovision.

15.00 Questions on the topics

15.15 Coffee and Networking

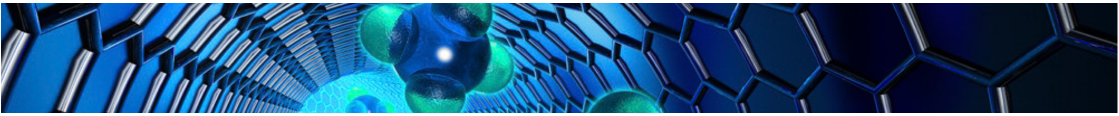
15.45 Analytical HRTEM characterisation of thin films and nanostructural materials: Corneliu Ghica, National Institute of Materials Physic, Romania.

16.15 Making the Invisible Visible - Synchrotron Nano-characterisation techniques for Materials and Life Science: Christina Krywka, HZG, Germany.

16.45 Nanoparticle drugs: Diego Ettore Liberati, National Research Council of Italy.

17.15 Questions on the topics

17.30 Networking and reception drink



PROGRAMME

Day 2 - 16 February 2018

08.30 Coffee and Networking
09.00 Welcome to day-2 of the event

Parallel Session 1

09.05 Nanomaterial benefits.
Jan Prochazka, Advanced Materials-JTJ – Czech Republic
09.35 Operando characterization of batteries and fuel cells using x-ray absorption spectroscopy: capabilities of the beamline XAFS at ELETTRA
Giuliana Aquilanti, Elettra Sincrotrone Trieste, Italy.
10.05 XPS techniques applied to study electrochemical systems and semiconductor behaviour under nanoscale in operative conditions:
Matteo Amati, Elettra Sincrotrone Trieste, Italy.
10.35 Questions on the topics

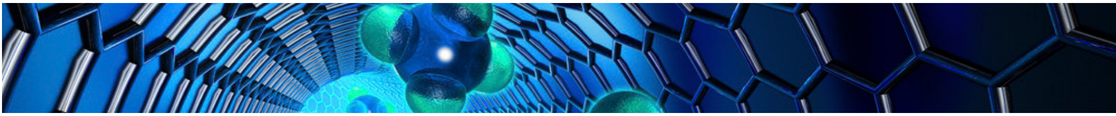
Parallel Session 2

09.05 Ultra-fast radiotherapy device.
Gabriele Grittani, Eli Beamlines, Czech Republic.
09.35 Infrared Nano-antennas – Synthesis and characterization of metallic nanowires for molecule sensing.
Ina Schubert, GSI, Germany
10.05 Nano-analytics in Pharmaceutics.
Aden Hodzic, CERIC-ERIC

10.35 Questions on the topics
10.50 Coffee and Networking

11.20 Investigation of Nanocrystal Dynamics in a continuous-flow device through combination of Optical Spectroscopy and Synchrotron-based X-ray techniques: Robert Seher, University of Hamburg – Germany
11.50 Production and analysis of nanostructures using ion beams of the MeV energy range.
Milko Jakšić, Institute Ruđer Bošković - Croatia.
12.20 Renewables: gRaphENE for WAter in Life Sciences.
Lisa Vaccari, Elettra Sincrotrone Trieste - Italy

12.40 Questions on the topics.
12.55 Lunch, networking and closing session



CERIC-ERIC overview
Introduction to the ACCELERATE project

Angela Zennaro, Industrial Liaison Officer, CERIC-ERIC

About CERIC-ERIC

CERIC-ERIC* (Central European Research Infrastructure Consortium) is an integrated multidisciplinary research infrastrure for basic and applied research in the field of materials, biomaterials and nanotechnology.

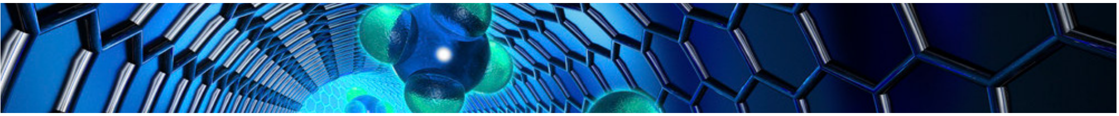
With excellent facilities in 9 countries in Central and Eastern Europe (Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia), CERIC supports proprietary research through a problem-solving approach, using some of the best scientific facilities and expertise in Central and Eastern Europe. Confidentiality is ensured through specific agreements guaranteeing the customer ownership of results.

About the ACCELERATE project

ACCELERATE is a Horizon 2020 project, supporting the long-term sustainability of large scale research infrastructures (RIs) through the development of policies and legal and administrative tools for a more effective management and operation of RIs, with a special focus on ERICs and CERIC in particular.

To help secure RIs' sustainability, relevance and effectiveness, the project develops frameworks to improve the offer of tailored services to private and public entities, ensuring outreach to new scientific and industrial communities worldwide and defining common protocols for monitoring and assessing RIs' socio-economic impact. Finally, a major focus on capacity building will develop current and future RIs' staff competences.

***ERIC**: A European Research Infrastructure Consortium is a full legal entity under EU law, with the goal to establish and operate, through its Members, a Research Infrastructure of European importance on a non-economic basis.

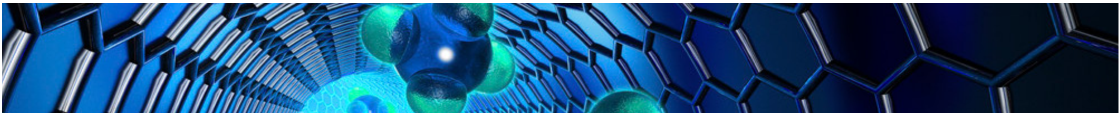


Research Innovation and Technology Center for New Materials (RITecC)

Ionut Enculescu, National Institute of Materials Physics - Romania

The National Institute of Materials Physics, located just outside Bucharest, in Magurele - Romania, is one of the leading R&D institutions of the country. With more than half of a century tradition in fundamental and applied research, we aim at becoming a leader in technology development and transfer. Extensive collaboration with all the main actors on the R&D scene including Universities, private business, government agencies and a strong infrastructure development are key elements in this process.

The new Research Innovation and Technology Center for New Materials represents an important step on this path of becoming a regional beacon of excellent research. The facility containing both characterization and fabrication equipment is continuously growing in an internationally recognized excellence center.

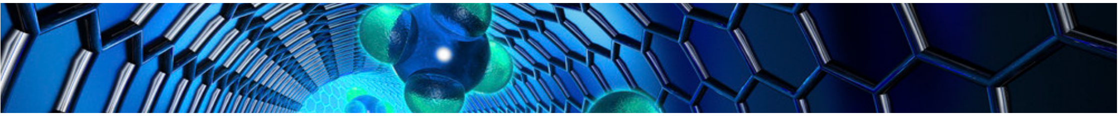


EPR characterization of doped wide-bandgap semiconductors

Mariana Stefan, National Institute of Materials Physics, Romania

Electron paramagnetic resonance (EPR) spectroscopy is one of the key methods used in the investigation of point defects in semiconductors, as it can detect with high sensitivity the presence of paramagnetic defects and determine their chemical identity, electronic and microscopic structure, formation and recombination mechanisms. Due to its sensitivity to the defect environment EPR is often used to probe the local structure modifications induced by irradiation or thermochemical treatments.

The EPR investigations conducted in the past few years in our group on nanostructured semiconductors doped with transition metal ions have covered both these aspects, providing valuable information for the synthesis of semiconductor nanostructures with controlled doping level and dopant distribution for specific technological applications. We will present some of the most relevant results concerning the incorporation level of dopants in ultra- small semiconductor nanocrystals, the distribution of dopant ions in the nanocrystals core, at grain boundaries or in the intergrain region, the evaluation of the segregation process in nanostructured thin films, the formation of secondary phases and their composition, localization and thermal stability and the origin of the magnetic properties in nanocrystalline semiconductors.

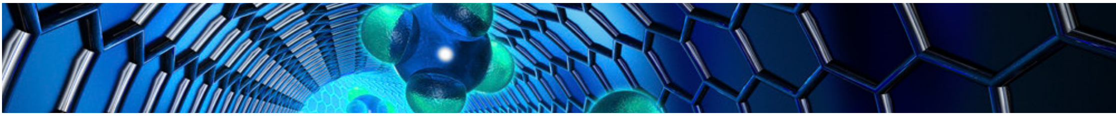


The emerging field of correlative Probe and Electron Microscopy

Jan Neuma, Nenovision, Czech Republic

The development of scientific instrumentation and analytical methods was in the last decade significantly influenced by the integration of different techniques into the compact instrumentation. Scanning Electron Microscopy (SEM) and Scanning Probe Microscopy (SPM) are commonly used imaging techniques in Material Sciences, Nanotechnology and Life Sciences. Integration of LiteScope SPM produced by NenoVision into the SEM extend the instrument capabilities and offers several benefits, such as 3D characterization, measurements of electrical and magnetic properties and more. New measurement techniques for the true correlative imaging, which enable direct comparison of the images from SEM and SPM will be presented. The unique measurement technique, Correlative Probe and Electron Microscopy (CPEM) for correlative imaging has been developed by the SPM manufacturer NenoVision and tested in the SEM instruments for various applications.

Correlative Probe and Electron Microscopy (CPEM) is based on a different principle than the traditional approach of correlative microscopy of SEM and SPM techniques. In the past both techniques were already integrated but used separately. Therefore, the comparison of obtained images was very difficult and misleading due to different scanning systems, image distortions, resolutions etc. Using CPEM technology electron beam is focused close (100 nm) to the SPM tip, where scanning is made by piezo scanner with the sample. During the measurements distance between the tip and electron beam is constant. Simultaneous collection of SPM and SEM signals enables simultaneous imaging of the slightly shifted areas by SEM and SPM. The shift is simply eliminated during the post-processing. Obtained images can be correlated very easily due to their identical scanning system and coordinates. Images can be directly correlated without any further data processing, where each pixel is represented by the X, Y, Z coordinates given by SPM and color (mask) corresponding to the one or more signal from SEM detectors. CPEM can accommodate several more signals from different detectors or related techniques like EBIC or CL. Each signal is then represented by the unique mask and can be used for the further image analyses.

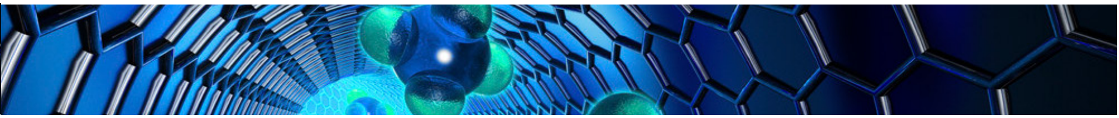


Analytical HRTEM characterisation of thin films and nanostructural materials

Corneliu Ghica, National Institute of Materials Physics, Romania

In the era of nanotechnology, transmission electron microscopy (TEM) is one of the most required and meaningful techniques in materials science. Recent progress in reducing or eliminating the electron optical aberrations have determined significant instrumental improvements in terms of spatial resolution and analytical sensitivity, turning TEMs into instruments capable of providing morphological, microstructural and chemical information at nanometric and even atomic scale. Processes occurring at nanometric scale, like crystal growth, formation of interfaces and microstructural defects, atomic diffusion have a crucial impact on materials behaviour at macroscopic level. The microstructural information provided by advanced TEM investigations is needed to understand the functionality of the investigated systems, allowing for further improvement of their functional parameters.

By presenting various examples of studies developed in our laboratory on different classes of materials (nanomaterials, thin films) we will illustrate the practical potential of the advanced microstructural investigations performed in our laboratory for future collaborations with industrial partners within common projects.



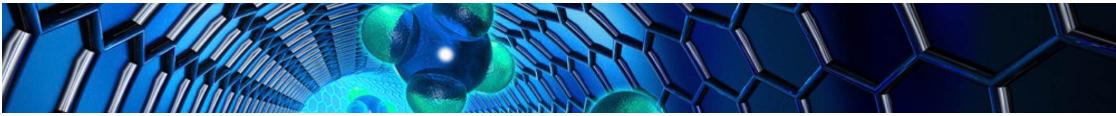
Making the Invisible Visible - Synchrotron Nano-characterisation techniques for Materials and Life Science

Christina Krywka, HZG, Germany

The structure and the structure-function-relationships of complex synthetic and biological materials is often accessible only through high resolution X-ray imaging techniques. The use of synchrotron radiation for X-ray imaging allows generating data in a quality and resolution not attainable at conventional laboratory sources. Moreover, it facilitates the implementation of the so called “in situ techniques”, where external parameters can be modified while X- ray data is being recorded. In this way, in corrosion processes, the response of materials to mechanical load or high temperatures are monitored in real time.

We provide such techniques at our beamlines at the world’s largest synchrotron radiation source PETRA III in Hamburg, Germany. We have developed and implemented a number of X-ray imaging techniques, specifically adapted to the demand of materials science related research: X-ray Microtomography, X-ray Nanotomography and Scanning X-ray Nanodiffraction. Using these techniques, we can visualize 3D microscopic structures, as well as “invisible” structures such as maps of residual stress profiles, all with resolutions down to below 1 µm.

This presentation will provide an overview of synchrotron techniques, an outline on how to gain access to these facilities and few examples of the possible applications.



Nanoparticle Drugs

Diego Liberati, National Research Council of Italy

A dream for chemical therapy would be to be able to carry just the exact quantity of the very molecule needed precisely only to the target organ or tissue or part of it, in due time for due period.

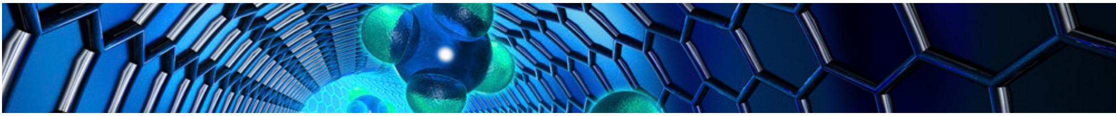
Nanotechnology promises to allow to embed such an active principe in a carrier, possibly inactive out of the target, then migrating for instance in blood or radio-directed and finally dissoluting at the target site, and thus releasing the desired course of therapy.

Best practice and examples of success as well as difficulties will be discussed, hopefully taking also into account some of the other issues treated within the summit.

Operando characterization of batteries and fuel cells using x-ray absorption spectroscopy: capabilities of the beamline XAFS at ELETTRA

Giuliana Aquilanti, Elettra Sincrotrone Trieste, Italy

In a world with a growing population, demand for energy is growing. In parallel, the present fossil fuels have supplied most of humanity's energy. The environmental costs, such as the effects of climate change, can only be thwarted in a low-carbon society. In this respect, the role of batteries and fuel cells in everyday life is undeniable, and tremendous efforts are made to optimize their performances. The knowledge of the relationship between the electrochemical processes and the chemical and morphological changes is a necessary step for such optimization.
In batteries, the dynamic processes and the complexities governing electrochemical energy storage are most ideally studied under simulated operating conditions. In fuel cells, operando experiments are very useful to study the structure and oxidation state of electrode materials, for both electrodes and electrolytes. In fact, in operando experiments, there is an implicit expectation that data provide an accurate representation of the reaction behavior found under normal operating conditions. Operando measurements allow to prevent several drawbacks due to the sample transfer needed for typical ex-situ measurements. Alteration of air or moisture sensitive species is avoided, as well as the occurrence of relaxation reactions which might show up when the electrical circuit is open, inducing a transformation of the initial cycled material. The whole study can be performed on a single test cell suppressing the effects of uncontrolled differences in a set of cells which are needed for a stepwise ex-situ study of the electrochemical mechanism.
X-ray absorption spectroscopy is the synchrotron radiation based technique that is able to provide information on both local structure and electronic properties in a chemically selective manner. It can be used to characterize the dynamic processes that govern the electrochemical processes, and to shed light on the redox chemistry and changes in the structure, to design cathode materials with improved properties. The XAFS beamline at Elettra is dedicated to x-ray absorption spectroscopy and can operate in a large energy range from 2.4 to 25 keV. Although conceived to be general purpose, recently a lot of research has concerned the operando study of advanced batteries.
In this presentation, I will describe the beamline XAFS at synchrotron Elettra and the different improvements recently implemented to perform operando measurements in batteries showing some achievements in this field. The first results related to the CERIC internal project "CEROP", which aims at deciphering single-atom catalysis in Pt/ceria systems via operando methods, will be highlighted.



XPS technique applied to study electrochemical systems and semiconductors behaviour at submicron scale in operative conditions

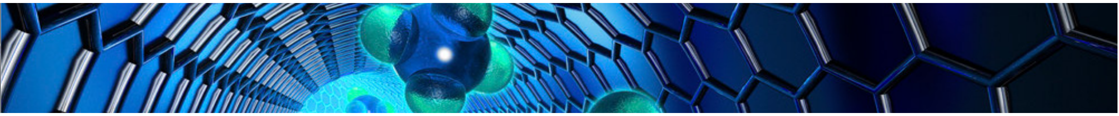
Matteo Amati, Elettra Sincrotrone Trieste, Italy

One of the key aspect of modern technology is the dimension of the active components in devices. For example in electronic, where the typical dimensions are at the nanoscale, or in electrochemical system where the active components, i.e. particles, are often in the submicron scale. Due to the small size it is difficult to study the system's behaviour with characterization techniques different from electron microscopies. Therefore, a detailed chemical characterization at the relevant scale is missing.

The Scanning PhotoEmission Microscope (SPEM) hosted at the ESCAmicroscopy beamline at the Elettra synchrotron, uses a direct approach to characterize chemically surfaces and interfaces at the submicron scale i.e. the use of a small focused X-ray photon probe to illuminate the sample. The focusing of the x-ray beam is performed by using a Zone Plate (ZP), which is a Fresnel type lens. The SPEM can operate in two modes: imaging and spectroscopy. In the first mode the sample surface is mapped by synchronized–scanning the sample with respect to the focused photon beam and collecting photoelectrons with a selected energy. The second mode is X-ray Photoelectron Spectroscopy (XPS) from a micro- spot. The X-ray beam can be downsized to a diameter of 120 nm, which allows imaging resolution of less than 50 nm. The overall energy resolution is better than 200 meV [1].

Recent achievements in the chemical and electronic characterization of components relevant for semiconductor technology, for example nano-wires, and electrochemical systems, for example Solid Oxide Fuel Cell, will be presented, providing an overview of the capabilities and flexibility of this powerful technique. In particular the possibility to operate at temperature, bias and pressure close to the typical operando condition for the real device will be discussed.

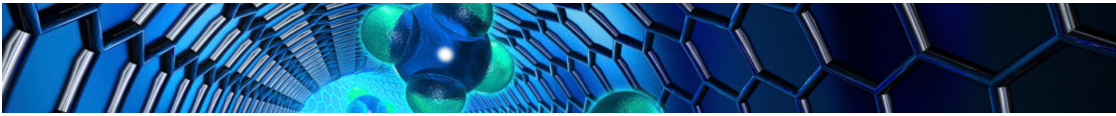
[1] https://www.elettra.eu/elettra-beamlines/escamicroscopy.html



Ultra-fast radiotherapy device

Gabriele Maria Grittani, ELI-Beamlines, Czech Republic

On-line monitoring of the target volume during the dose delivery is currently a key aspect of radiotherapy. We propose a device capable of delivering high dose rates (>200 mGy/s) with on- line imaging of the target volume. The device consists of a pulsed radiation source synchronized with an imaging system. In a preferred configuration, the pulsed radiation source is a multi-arm laser plasma electron accelerator delivering 50-250 MeV electron beams at 10 Hz. Each pulse is shorter can deliver more than 20 mGy at dmax. In a preferred configuration, the imaging system is based on x-ray or MRI.
The technical design of the prototype has been developed according to the guidelines received by meetings with radiation oncologists from 3 different institutions in the Czech Republic. Status of the project and roadmap will be presented.

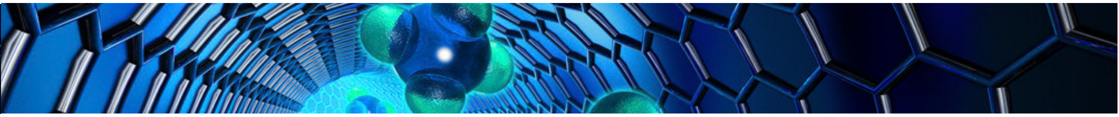


Infrared Nanoantennas – Synthesis and characterization of metallic nanowires for molecule sensing

Ina Schubert, GSI, Germany

Due to their small dimensions, metallic nanowires can serve as infrared nanoantennas with interesting applications e.g. in solar cells, as waveguides, and for sensing. The near- and far- field antenna properties are based on the excitation of standing electronic waves on the nanowires, called localized surface plasmons. One very promising application of the antennas is to sense molecules already at low concentrations. At the antenna resonance frequency, very high near-fields are generated, that allow enhancing strongly the vibrational signal of molecules that are located in the proximity of the nanowire. By tuning different nanowire parameters, such as e.g. length, diameter and composition, electric field enhancement factors of up to 105 have been obtained.[1]
We synthesize nanowires by electrodeposition in ion-track etched polymer templates.[2]
Therefore, polymer foils are irradiated with swift heavy ions at the linear accelerator UNILAC at GSI. Each ion creates a damage track in the foil that can be transferred into a nanochannel by chemical etching. The polymer foils with nanochannels serve as template for the subsequent electrochemical deposition of nanowires. The method allows us to control almost all important nanowire's parameters, such as nanowire dimensions, morphology, crystallinity, shape, and composition. With the aim to create nanoantennas with high sensing efficiencies, we have prepared a variety of different gold and silver nanostructures, such as smooth and porous nanowires, nanowires separated by small gaps, and networks out of interconnected nanowires.[3] The plasmonic properties of single metallic nanostructures dependent on the different nanowire parameters were characterized using infrared microscopy, and electron energy-loss spectroscopy in a transmission electron microscope.[4-7]
The presentation will provide an overview over the nanostructures that we create with our technique. In addition, the plasmonic characterization of these structures with respect to their application for molecule sensing will be presented.

1 F. Neubrech et al. Phys. Rev. Lett. 101 157402 (2008).
2 M. E. Toimil-Molares, Beilstein J. Nanotechnol.
3, 860, 2012. 3 I. Schubert et al. Beilstein J. Nanotechnol. 6, 1272 (2015). 4 I. Alber et al. ACS Nano 5, 9845 (2011).
5 I. Alber et al. ACS Nano 6, 9711 (2012).
6 I. Schubert et al. Nanoscale 7, 4935 (2015).
7 I. Schubert et al. Adv. Opt. Mater. 4, 1838 (2016).



Nano-Analytics in Pharmaceutics

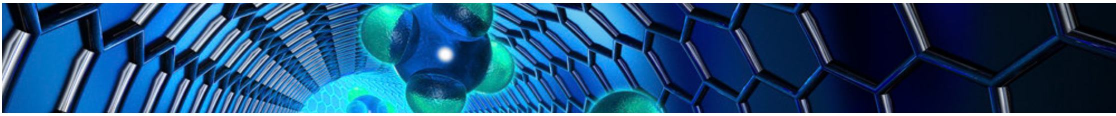
Aden Hodzic, CERIC-ERIC

The increasing importance of Nano analytics for pharmaceutical technology opens a new field of applications for drug research and quality control by using, applying and developing novel tools. The upcoming (European, national and international) laws and regulations for ensuring quality of products will bring more rigorous rules especially in the pharmaceutical and food industries. Hence, the development/application of new methods that allow useful results in the more sensible Nano-range, may respond to the new requirements and lead to a better quality of development and production as well as to shorter production-times, while avoiding drug side effects and bringing a financial benefit.

CERIC-ERIC offers services based on Nano-analytical and multi-technique methodologies, which can be applied to meet requirements imposed on modern pharmaceutical products as well as to satisfy new restrictive quality rules. We will use Nano-analytical multi- techniques for the development of drug formulations and release in solid (i.e. calcium stearate/ibuprofen), liquid-crystal (lipid nanoparticles formulation) and liquid state (oral dosage form formulation). The examples are systems enclosed with active pharmaceutical ingredients (APIs). Drug release and quantification of the samples is very time-consuming and cost- intensive. Therefore, we apply a methodology based on Nano analytics, which may overcome this problem by serving and predicting dissolution and structural properties in the time range of minutes. The research will impact the therapeutic performance of Nano- systems once administered.

So far, only a small number of analytical tools are available. Hence, we focus on application and development of new Nano- methodologies for developing drugs of tomorrow.

Project website: http://www.ceric-eric.eu/index.php?n=Research.NanoAnalytics



Investigation of Nanocrystal Dynamics in a Continuous-Flow Device through Combination of Optical Spectroscopy and Synchrotron-based X-ray techniques

Robert Seher, University of Hamburg,Germany

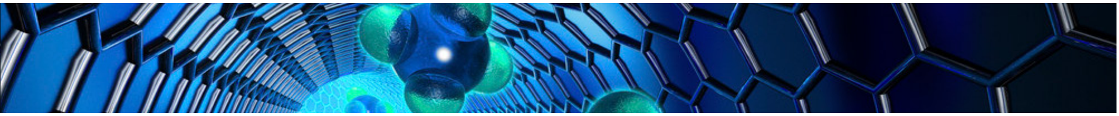
Semiconductor nanocrystals (NCs), so-called quantum dots (QDs), have been a hot topic in academic research for more than 30 years, culminating in their recent commercial application in mass-market consumer electronics. Nevertheless, relatively little is known about their exact formation mechanism.

The knowledge of this mechanism would allow the development of tailor-made synthesis protocols for new material systems, supplanting previous trial-and-error approaches and in consequence saving precious resources.

An ideal tool for the time-resolved investigation of this mechanism is the continuous-flow device (CFD) developed within our group at the University of Hamburg. Its capabilities comprise well-defined time resolution, as well as precise control over reaction conditions.

The application of this device to the investigation of the formation of NCs will be presented, highlighting the results leading to the postulation of a magic-sized-cluster- mediated growth mechanism during the formation of CdSe NCs.

Based on this, as well as on recent results regarding the dynamics of cation-exchange reactions in NCs, it will be shows, how synchrotron-based X-ray scattering and spectroscopy techniques can complement ordinary laboratory-based characterization techniques in nanoparticle research.

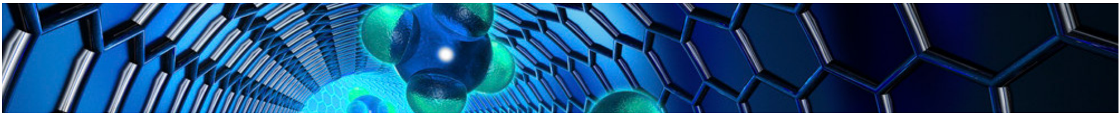


Production and analysis of nanostructures using ion beams of the MeV energy range

Milko Jakšić, Institute Ruđer Bošković - Croatia

A variety of interaction processes that take place during the passage of fast (MeV energy range) ions through matter, form a basis of the ‘ion beam analyses’, a pool of sensitive non- destructive analytical techniques. Some of these techniques, such as ERDA (Elastic Recoil Detection Analysis) and RBS (Rutherford backscattering) for example, could be used to characterize thicknesses as well as elemental composition of layers with depth resolution down to the 1 nm range. Examples of RBS and ERDA applications as well as the review of all other IBA techniques will be presented.

In addition to analysis, ion energy loss in material can be also a basis of nano-structuring technology. Examples of applications of techniques based on single ion implantation, formation of latent ion tracks by swift heavy ions, ordering of nanostructures by ion beam and ion microbeam lithography will be presented.



RENEWALS: gRaphENE for WAter in Life Sciences

Lisa Vaccari, Elettra Sincrotrone Trieste, Italy

The understanding of cellular behavior cannot be fully achieved by dissecting the cellular milieu: complexity at cellular level goes beyond the structure and function of its constituents and needs to be addressed by a more holistic in-cell approach. To this aim, the analysis of biological specimens in their physiological environments by a multi-probe synergic approach is a crucial requirement. However, while studies in liquid environment are nowadays possible for techniques such as AFM and Raman micro- spectroscopy, for other techniques physiological conditions remain a severe constraint: water is a strong IR absorber and limits experiments in soft X-rays regime, SEM and TEM analysis, which require vacuum conditions.

To overcome these limitations, RENEWALS, a CERIC-ERIC internal project, proposes a graphene-based environmental liquid cell that takes advantage from graphene properties: transparency to photons and electrons, chemical inertness, impermeability, electrical conductivity, and capability to sustain ambient to UHV pressure differentials. Our goal is to set up reproducible and easy methods for graphene liquid cell production, that go beyond the proof-of-principle experiments reported in literature, aiming attention at additional aspect such as biocompatibility, basically neglected up to in this kind of experiments.

In this presentation, the results of the first year of the RENEWALS project will be presented, focusing on the specific topic of the cytotoxicity of Aluminium nanoparticles (NPs) for human lung cells, and highlighting how an in-cell multi-probe analysis can help on shedding new light on aspects such as interaction, uptake and localization on NPs, not yet fully clarified.