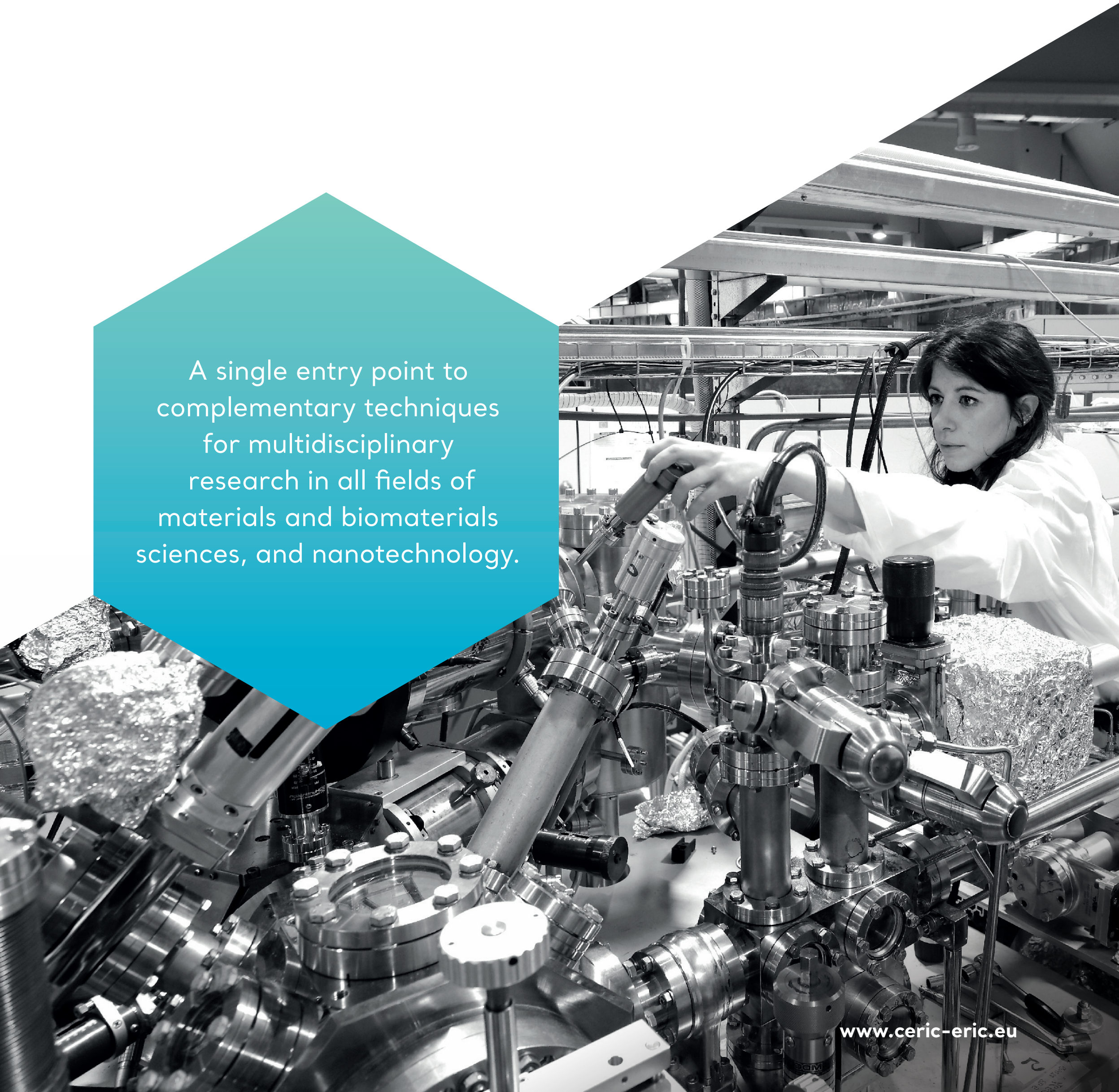
CERIC

Central European
Research Infrastructure
Consortium

# Open for Scientific Users



A single entry point to complementary techniques for multidisciplinary research in all fields of materials and biomaterials sciences, and nanotechnology.

www.ceric-eric.eu

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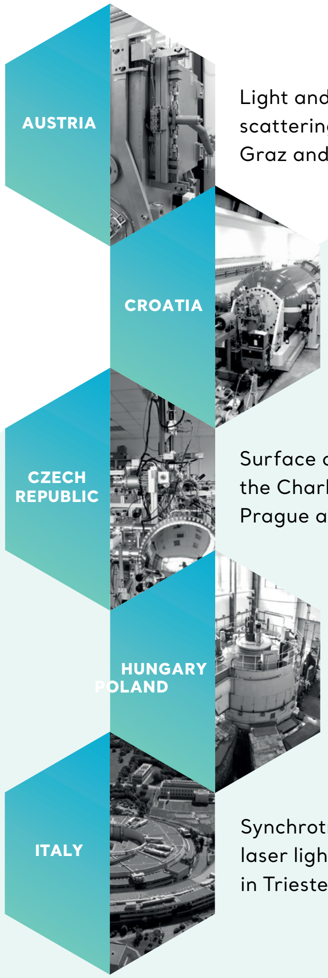
# Open for Science

CERIC-ERIC* is a distributed multidisciplinary research infrastructure for basic and applied research in all fields of materials and biomaterials sciences, and nanotechnology.

Located in 9 countries of Central and South-Eastern Europe (Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Romania, Serbia and Slovenia), it is open to researchers from all over the world through one single open access point. A peer review evaluation system guarantees a competitive free access to nearly 50 multi-probe techniques based on the use of electrons, ions, neutrons, photons and protons.

CERIC offers a combination of methods spanning NMR, X-ray electron spectroscopy and light scattering, ion beam analysis, high resolution electron microscopy, X-ray electron spectroscopy, materials analysis using synchrotron radiation and neutron beams. Researchers can access the integrated facilities by applying to the open calls, with single- or multi-technique proposals in a wide variety of fields such as health, micro and nano-technologies, energy, food, cultural heritage, informatics and many more.




Light and X-rays scattering at the TU Graz and in Trieste

Ion beams at the Ruđer Bošković Institute in Zagreb

Surface analysis at the Charles University Prague and Elettra

Neutrons at the Budapest Neutron Centre

Synchrotron and laser light at Elettra in Trieste


Synchrotron light at Solaris in Krakow

Electron microscopy and EPR at the National Institute of Material Physics in Magurele

Ion and proton beams at theVinča Insitute of Nuclear Sciences in Belgrade

NMR at the National Institute of Chemistry in Lubiana

# Open Access

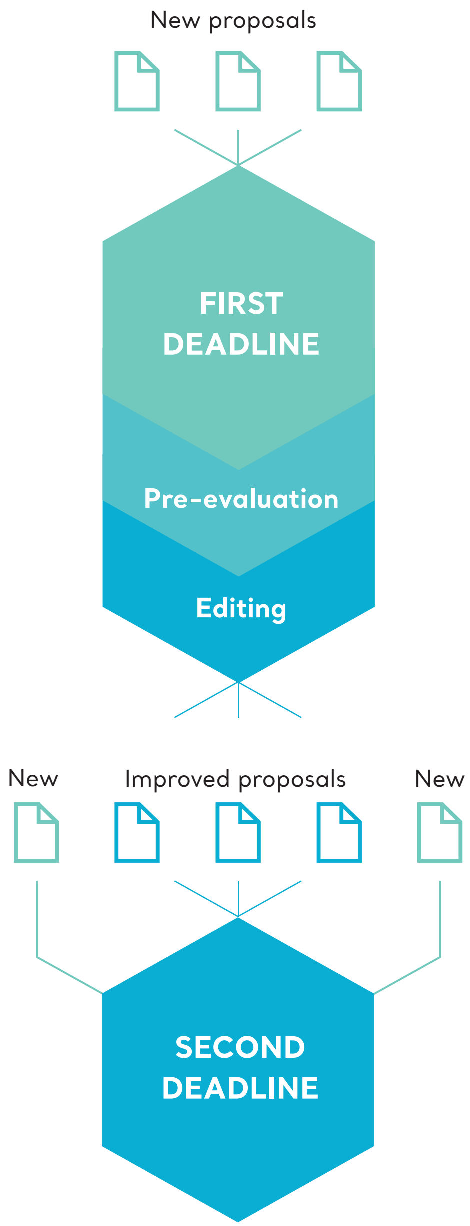

Access to CERIC is open to researchers from all over the world through two Calls for Proposals per year. It is free of charge for academic and non-proprietary research requiring access to one or more techniques.

The condition for free access is the publication of the results of the experiments, with the appropriate references to the facilities and to the local contacts involved. Proposals shall be submitted online through the specific online platform (VUO - Virtual Unified Office). The best ones will be selected by peer review through an independent and international panel of experts whose choice is based solely on excellence.

## How to apply?

CERIC facilitates the application process by offering a two-steps deadline option. The first deadline is meant for having a pre- evaluation of the proposal and to submit an improved version within the second deadline. Expert users may decide to submit their proposals directly on the second deadline. The evaluation takes into account both the technical feasibility and the scientific quality of the proposals.

### Two-step dedline option

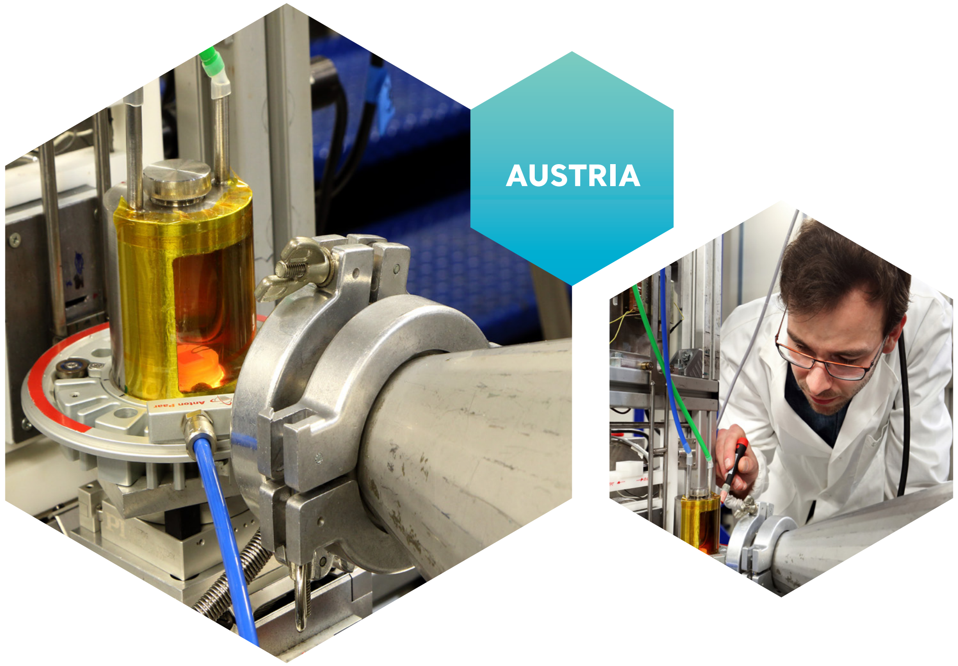



Submit your proposal online at:
**https://vuo.elettra.trieste.it**




**Technical University Graz**

# Institute of Inorganic Chemistry

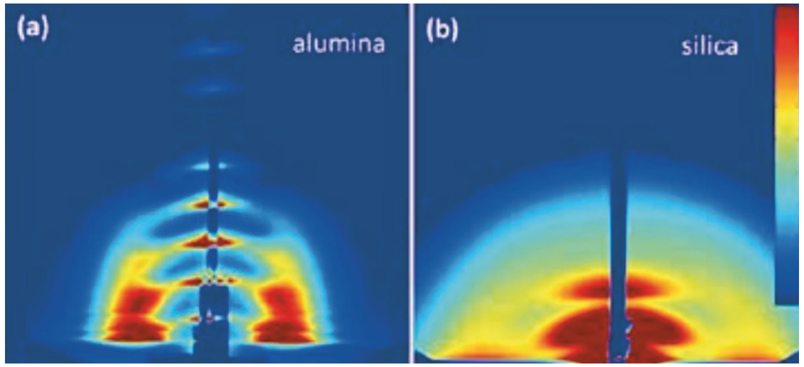



The Institute of Inorganic Chemistry of the Technical University Graz is dedicated to the structural characterization of nanosystems with scattering techniques.

It is covering topics such as **advanced materials, (bio-)polymers, nanoparticles and proteins in solids, surfaces, liquids, and in the gas phase.** It provides access to its light and X-ray scattering laboratories, as well as to the Austrian SAXS beamline and the Deep X-ray Lithography beamline at Elettra. The facility has an excellent record in terms of scientific output and international recognition from biology to materials sciences.

## Research fields and applications


The research at the Institute of Inorganic Chemistry is mainly focused on fundamental and applied aspects of organometallic chemistry towards functional materials. The scientists and technicians of the available scattering laboratories which compose the Austrian facility, have profound experience in the structural investigation of (bio-) nano-materials, therefore bridging the gap between nanoscale materials and biology. Besides basic research, an intense activity of **design and development of instrumentation and sample environment** is also carried out.




Experiments can be conducted in fields as diverse as **physics, chemistry, material sciences, pharmaceutics and biology.** Consequently, applications cover the respective technological fields, from **energy, nano-technology and electronics, to nanomaterials, health and nutrition.** The production of 3D micro-structures made out of a large variety of metals, alloys or ceramics, opens a wide variety of potential applications in the fields ceramics, opens a wide variety of potential applications in the fields.





## Research techniques and methods

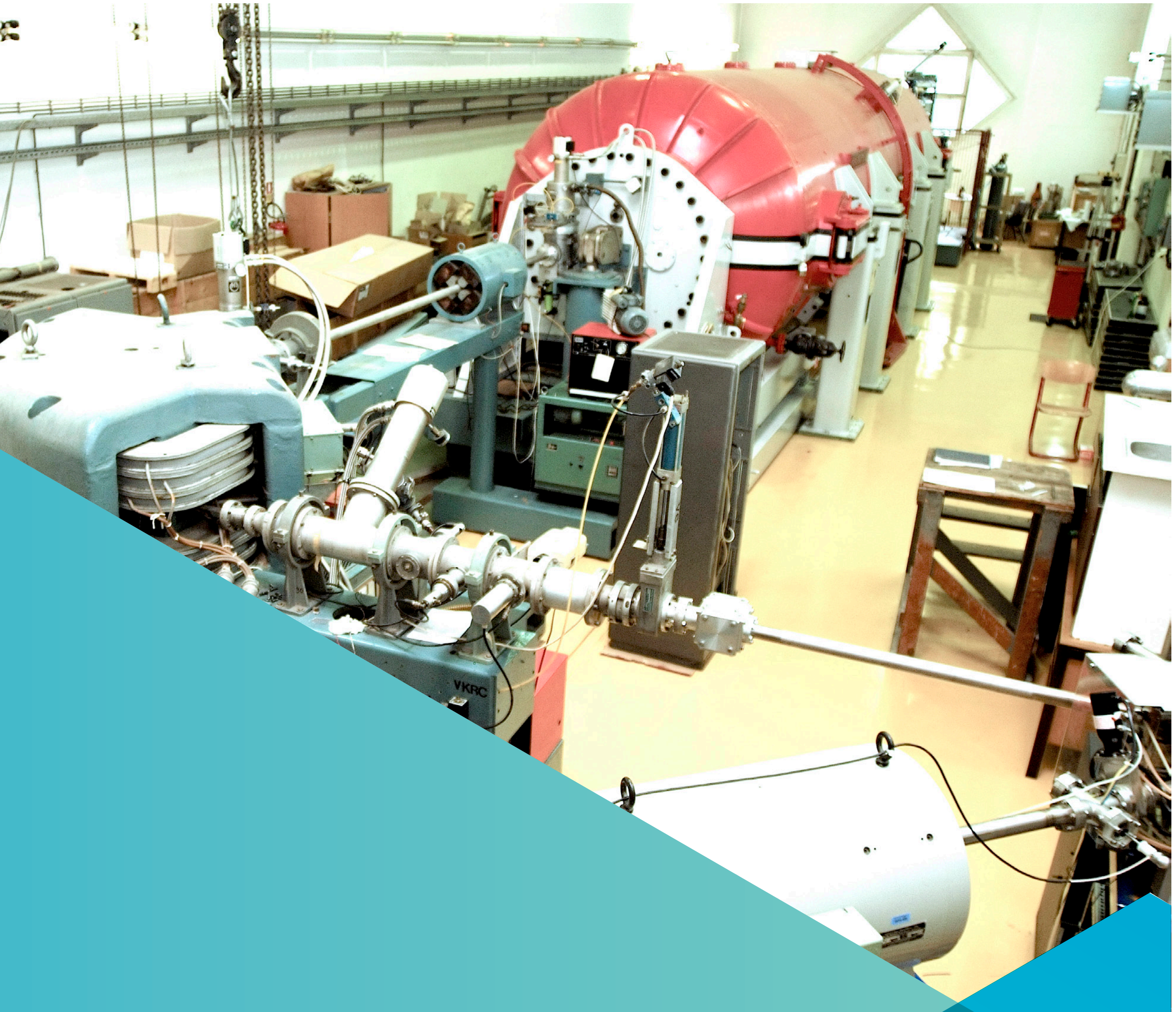
- Structural characterization and study of the kinetics and dynamics of self-assembly processes and chemical reactions.
- Development of photonics, energy and sensors applications.
- Preparation and synthesis of biomembranes and mesoporous materials, drug delivery systems based on biomembranes.
- Mapping of the local structure of complex materials.
- Time resolved studies of fast structural transitions in the sub-millisecond time region of liquids, surface and gas phase.
- Test and implementation of microfluidics systems.
- Production of high aspect ratio three dimensional structures in materials with quasi perfect side-wall verticality, optical quality roughness and a resolution of about 0.5 µm.
- Hard X-ray radiation assisted material synthesis and processing.

SAXS beamline in Trieste

## Instruments and techniques available in CERIC

The Austrian facility offers access to the **SAXS** - Small Angle X-ray Scattering and to the **DXRL** - Deep X-ray Lithography synchrotron radiation beamlines at Elettra (Italy), as well as to the Static **(SLS)** and the Dynamic **(DLS)** light scattering and to the various SAXS instruments and related laboratories in Graz.

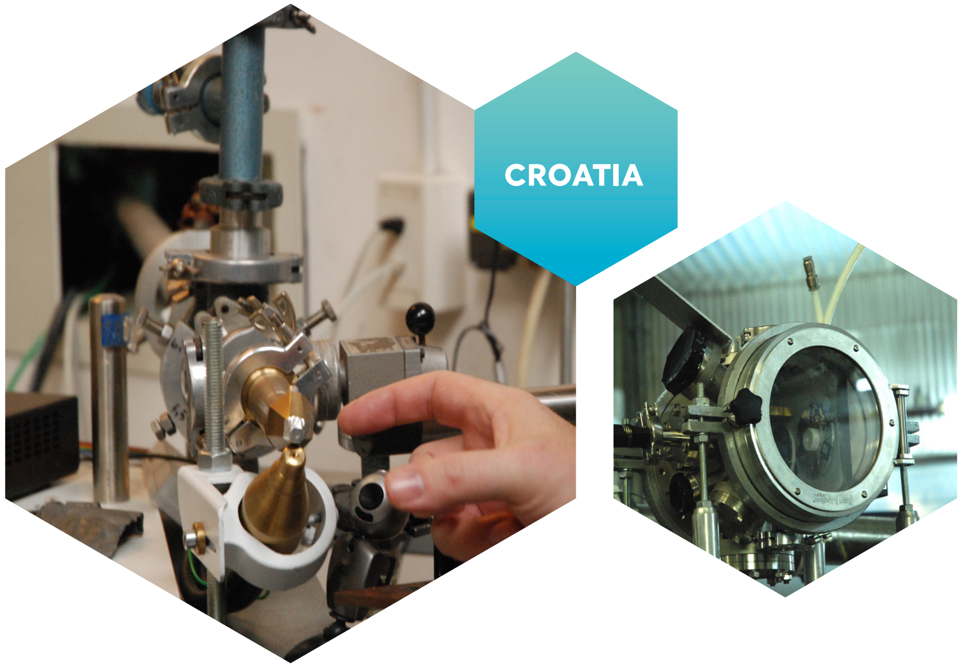
IfAC Institut für Anorganische Chemie





**Ruđer Bošković Institute**

# RBI Accelerator Laboratory




The accelerator laboratory of the Ruđer Bošković Institute (RBI) offers two electrostatic tandem accelerators and 8 beam lines equipped with a variety of ion beam techniques.

The RBI is regarded as the Croatian leading research institute in natural and biomedical sciences, as well as in marine and environmental research. It acts as the Croatian entry point to CERIC, through its Division of Experimental Physics that is in charge of the operation of the tandem accelerator facility.

# Research fields and applications


The tandem accelerator facility at the RBI offers a wide range of state-of-the-art techniques for the synthesis and analysis of materials, based on the processes that occur during ion beam passage through matter. The scientific efforts of the RBI group have a strong focus on material science, with MeV energy ion beam irradiation having a twofold role: either as a sample preparation
step, where ion beam irradiation modifies the exposed material, or as sample analysis technique using various ion beam analysis (IBA) techniques.

6.0 MV EN Tandem Van de Graaff.

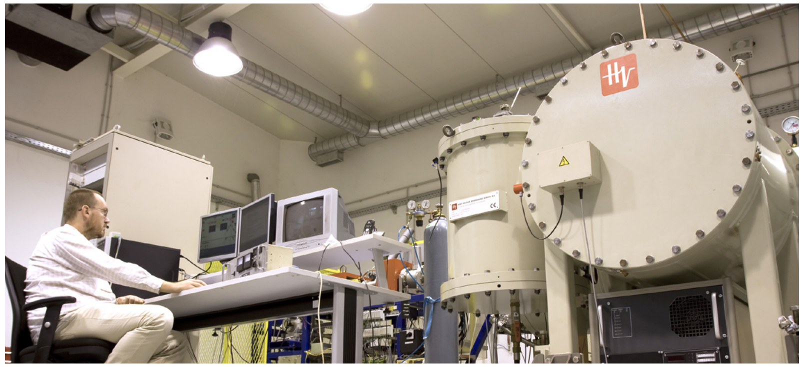
Applications in other fields have also been recently intensified. These include **cultural heritage** (non-destructive analysis of unique objects), **biomedicine** (microanalysis of tissues and biomaterials, irradiation of living cells, induction of mutations in seeds, etc.) and **environment monitoring** (air particulate matter analysis, bio-monitors of pollution, etc.).





# Research techniques and methods

- IBIC (Ion Beam Induced Charge) tests of novel detector structures (e.g. wideband gap semiconductors, novel diamond radiation detector configurations) and charge transport properties in photovoltaics.
- Investigations of complex radiation detector systems (e.g. pixel detectors from CERN, strip detectors for nuclear physics).
- Microprobe ion beam irradiation (e.g production of graphitic lines in diamond, direct writing lithography, single ion implantation).
- Near surface elemental depth profiling and development of SIMS (Secondary Ion Mass Spectrometry) using MeV energy ions.
- In situ studies of radiation resistance of crystalline materials (including those of interest for fusion related research).
- Analysis of large number of samples, especially for environmental studies (e.g. air particulate matter filters).



1.0 MV Tandetron.

# Instruments and techniques available in CERIC

The RBI is dedicated to the development and applications of ion beam techniques for materials' modification and characterization, such as **PIXE** and **RBS** (Particle Induced X-ray Emission and Rutherford Backscattering), **heavy ion microprobe** (microanalysis, imaging, irradiation and detector testing), **dual beam irradiation chamber with RBS channelling** (radiation damage studies), and **TOF ERDA** spectrometer (Time-of-Flight Elastic Recoil Detection Analysis) for high resolution depth profiling.



### Charles University Prague

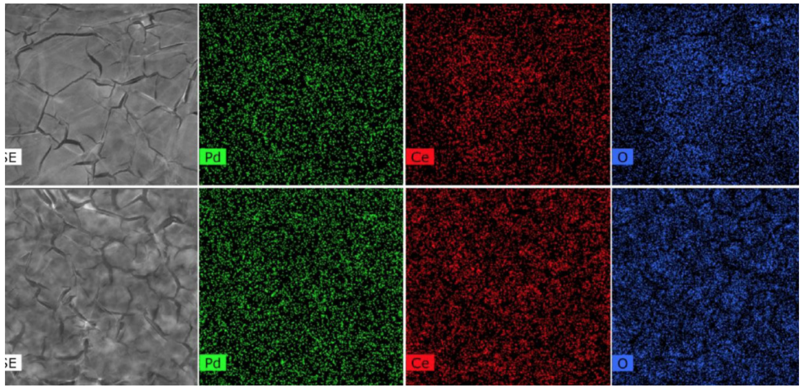
# Surface Physics Laboratory


The Czech facility encompasses the Surface Physics Laboratory (SPL) in Prague (CUP) and the Materials Science Beamline (MSB) in Trieste.

The SPL and MSB team has a veritable track record in the fields of physics and chemistry of surfaces of solids and addresses the daily challenges in materials research.

# Research fields and applications


The SPL research group has expertise in structural and physico-chemical surface analysis, thin film and nanostructure growth and studies of reaction mechanism on catalyst surfaces and biosensors. The SPL is equipped with five complete systems for preparation, characterization and imaging of materials surfaces. It also operates the MSB facility, which is a versatile photoemission beamline suitable for experiments in materials science, surface physics, catalysis and organic molecules on various surfaces.




20 m viewfield SEM images and EDS mapping of Pd, Ce and O signals of fresh Pd@ CeO2/graphite (top row) and Pd@CeO2/P-graphite samples (bottom row).

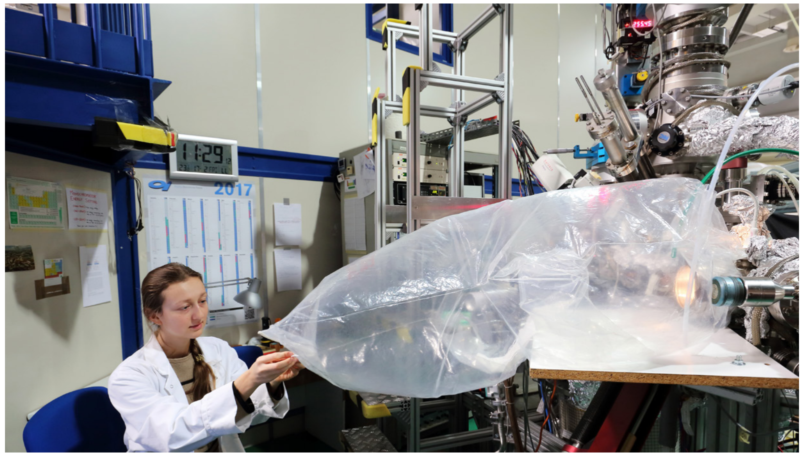
Fundamental knowledge drives applied research in **catalysts, gas sensing and biosensing**. Advances in the catalyst research made leaps and bounds towards affordable and durable hydrogen fuel cells, one of the next-gen elements of **energy production, energy storage and carbon-free mobility**. In the field of sensing, sensors of gasses for chemical and vacuum monitoring applications have been designed and prototyped. Foundations of knowledge-based development of hybrid (organic-inorganic) devices for biomolecular and medical sensing have also been laid for future possible applications in **biomolecular and biomedical analytical tools and point-of-care diagnostics**.





# Research techniques and methods

- Photoemission spectroscopies (XPS, XPD, UPS and ARKUPS), ion scattering spectroscopy (ISS, LEIS) and electron diffraction (LEED).
- Surface chemical analysis.
- Preliminary specimen characterization and surface control recipe refinement for synchrotron experiments.
- Sample heating and cooling (100-1500 K), Ar+ beam cleaning and MBE thin film deposition for in situ surface preparation.
- Calculation of the surface electronic structure.
- Mapping of the sensory and catalytic properties of materials with structural changes that may occur in the surfaces during their chemical function.



Material Science Beamline in Trieste.

# Instruments and techniques available in CERIC

The Czech facility offers X-ray Photoelectron Spectroscopy and Diffraction **(XPS-XPD), FESEM** - Field Emission Gun Scanning Electron Microscope, **NAP XPS** - Near Ambient Pressure X-ray Photoelectron Spectroscopy, and access to the **Materials Science Beamline** at Elettra, dedicated to soft X-ray photoelectron spectroscopy.



### Hungarian Academy of Sciences - Centre for Energy Research

# Budapest Neutron Centre

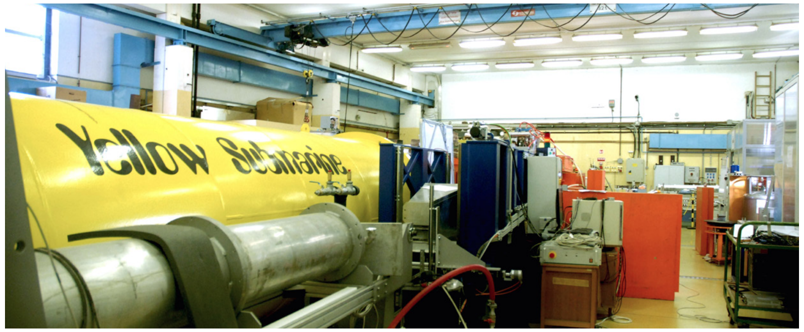

The Budapest Neutron Centre (BNC) is a consortium of two research centres (Centre for Energy Research and Wigner Research Centre for Physics) located at the KFKI Campus of the Hungarian Academy of Sciences in Budapest.

The Budapest Research Reactor (BRR) and a number of neutron research facilities and beamlines are operated by the BNC to perform R&D in nuclear science and technology, and material sciences.

## Research fields and applications

HUNGARY

The research at BNC mainly focuses on the study of the **interaction of radiation with matter,** as well as on **isotope and nuclear chemistry, radiography and radiation chemistry, surface chemistry and catalysis**. The neutron scattering instruments allow the investigation of the microscopic properties of solids, liquids, soft materials, biological objects and condensed matter, allowing to perform the macro- and microstructural characterization of materials and in operando studies of devices by imaging and element analysis. Radiation damage studies and medical isotope production can also be carried out.




SANS diffractometer Yellow Submarine.

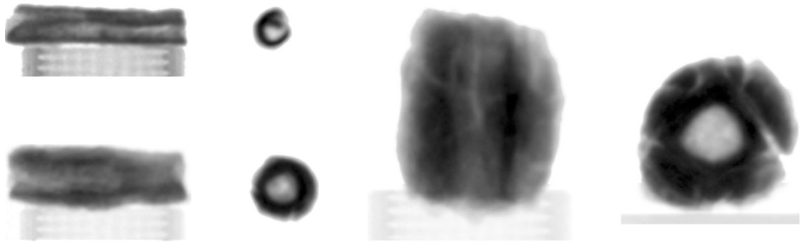
The BNC provides the experimental basis for materials testing, irradiation damage biological irradiation, dosimetric and **nuclear safety investigations**, with a main focus on **nuclear and renewable energy research**, with activities performed in fuel analysis and thermal hydraulics. Thanks to its non-destructive techniques, it also allows exploring the composition and the **manufacturing techniques of archaeological artefacts**, as well as conducting **investigations of biological objects**. Furthermore, neutron radiography helps to solve industrial problems and radioisotope production is mainly used for **medical purposes**.





## Research techniques and methods

- Non-destructive multi-elemental/ isotopic analysis of various samples, including archaeological objects, rock samples, catalysts, samples of inactive tracing, fissionable materials.
- Study of cold neutron captures, determination of the nuclear structure of the target nuclei and measurement of the decay-properties of fissionable materials.
- Measurement of density, composition and magnetization fluctuations of materials.
- Atomic structural investigations of amorphous solids and molecular liquids.
- Specular and off-specular scattering to study depth profiles and in-plane structures. High-resolution diffractometry, strain analysis, quasielastic and inelastic scattering, thermal beam irradiation and transmission tests.
- Structural and magnetic properties of thin films, multilayers, interfaces and membranes.



Neutron images of the three iron beads made from hammered meteoritic iron, in side view and perpendicular.

## Instruments and techniques available in CERIC

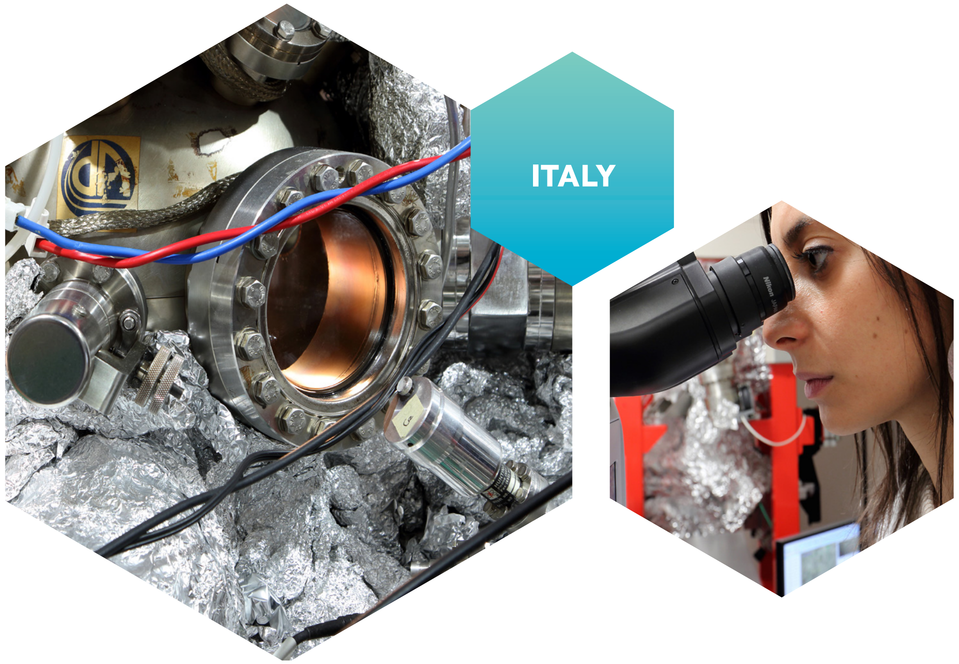
BNC experimental stations cover a wide variety of measuring techniques: **BIO** - Biological Irradiation facility, **TOF** - Time-of-Flight diffractometer, **MTEST** - Material Test diffractometer, **PGAA** - Prompt Gamma Activation Analysis, **PSD** - neutron diffractometer with a Position Sensitive Detector system, **SANS** - Small Angle Neutron Scattering diffractometer, **RNAA** k0- Neutron Activation Analysis, **GINA** - neutron reflectometer with polarisation option, **TAST** - thermal neutron three-axis spectrometer and neutron holographic instrument, **RAD** - thermal radiography station, also equipped with dynamic radiography capability.

BNC
BUDAPEST NEUTRON CENTRE



### Elettra Sincrotrone Trieste

# Synchrotron Light



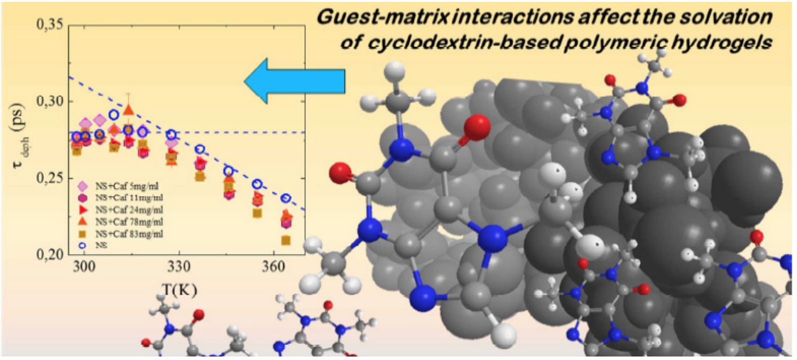

Elettra Sincrotrone Trieste offers a third-generation synchrotron light source specialized in the fine analysis of matter.

The synchrotron light, generated by the acceleration of the electrons in the storage ring, is collected and conveyed to the experimental stations, where the advanced materials' samples are placed to be characterized and analyzed in their structure. Laboratories specialized in chemistry, microscopy, materials science, electronics and information technology support all the research activities.

Elettra Sincrotrone Trieste

# Research fields and applications


The beamlines at Elettra cover a wide variety of experimental techniques and scientific fields, including photoemission and spectromicroscopy, crystallography, small-angle scattering, dichroic absorption spectroscopy, x-ray imaging, etc. The investigated research fields span materials science, surface science, solid-state chemistry, atomic and molecular physics, as well as biology and medicine. The possibility to observe the materials at the nanometer scale is fundamental to shed light on several open problems in the physics of liquids, solids and glasses, phononic and photonic crystals, and hydrogen- bond based systems ranging from simple water to proteins.

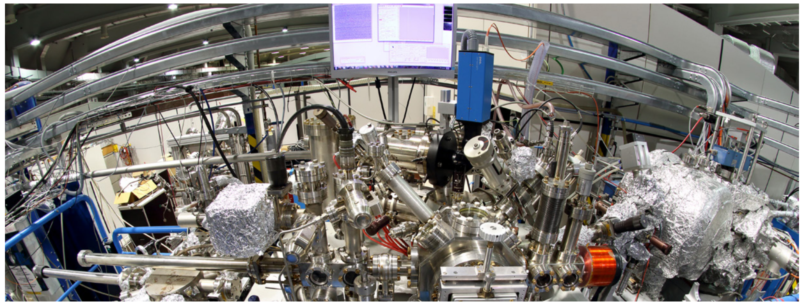



Effect of guest-matrix interactions on the solvation of cyclodextrin-based polymeric hydrogels is studied by UV Raman experiments

Synchrotron light makes it possible to see the details of the structure and behaviour of atoms and molecules, helping to solve the most disparate problems in fields encompassing **electronics, environmental science, pharmacology, diagnostics, engineering, nanotechnology and cultural heritage.**
Elettra Sincrotrone Trieste also develops products and prototypes for the international market: instruments for **environmental quality control, fine-particle analyzers, anti-counterfeit sensors and devices, light source and accelerator components, amplifiers and sensors.**

# Research techniques and methods

- Study of the electronic structure and many-body effects in solid materials. Study of inelastic scattering with ultraviolet radiation.
- Spectroscopy, micro- and nanospectroscopy and imaging.
- Medical diagnostic radiology.
- Investigation on the chemical, magnetic, electronic and structural
- properties of samples spanning single crystals, thin films and new nanostructures.
- Grazing angle diffraction and reflectivity, residual stress and texture analysis, phase identification, structural and kinetic studies.
- Protein crystallography, powder diffraction, high pressure and solid-state physics.
- Spectroscopy and study of the dynamics of atomic and molecular processes like inner-shell and
- multiple excitations and ionization.



Nanospectroscopy beamline.

# Instruments and techniques available in CERIC

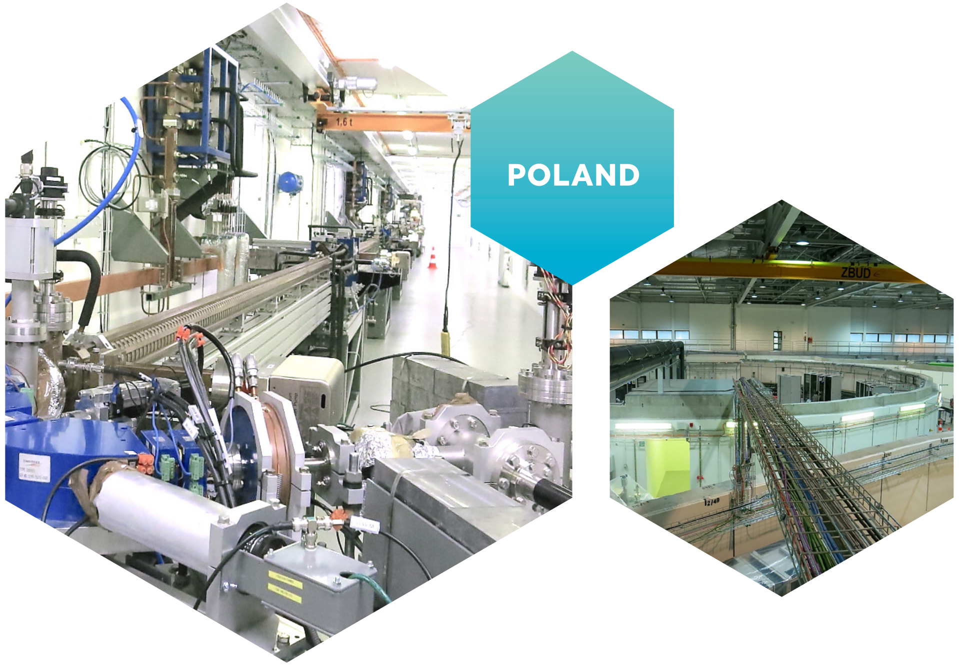
Elettra Sincrotrone Trieste contributes to CERIC a wide variety of instruments and techniques. Among others, the following beamlines are accessible by the users: **BaDElPh** - Band Dispersion and Electron-Phonon coupling, **IUVS** - Inelastic scattering with Ultraviolet radiation, **MCX** - Materials Characterisation by X-ray diffraction, **Nanospectroscopy**, **Esca Microscopy**, **SISSI** - Synchrotron Infrared Source for Spectroscopy and Imaging, **SYRMEP** - SYnchrotron Radiation for MEdical Physics, **XRD1** - X-ray Diffraction Spectromicroscopy, **XAFS** - X-ray absorption spectroscopy, **SuperESCA** - High resolution core-level photoemission spectroscopy, **TwinMic** - Soft X-ray Transmission and Emission Microscope.

Elettra Sincrotrone Trieste




**Jagiellonian University**

# National Synchrotron Radiation Centre SOLARIS




The National Synchrotron Radiation Centre SOLARIS, founded in 2009, operates as an independent unit of the Jagiellonian University in Krakow.

It is the first large scale research infrastructure in Poland for multidisciplinary research in **physics, chemistry, medicine and geology, bio- and nanotechnology, archaeology and art history**. The Centre was built between 2010 and 2015. The investment was co-financed by the European Union with funds from the European Regional Development Fund, as part of the Innovative Economy Operational Programme.

SOLARIS
NATIONAL SYNCHROTRON
RADIATION CENTRE

# Research fields and applications


Synchrotron light covers a wide spectrum of electromagnetic waves, from infrared to X-rays. Thanks to its unique properties, it allows scientists to obtain a 3D, exceptionally precise image of objects by using synchrotron tomography. Additionally, radiations of this type can be used for the electron and magnetic analysis of the structure of materials and for the study of particle interactions.
The Polish facility helps unravelling the mysteries of very complicated systems, such as proteins or viruses.

Experimental hall at Solaris.

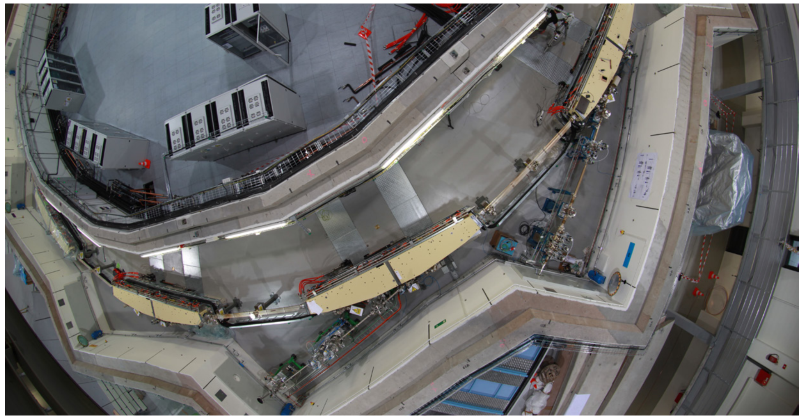
At SOLARIS, scientists can study and create micro- and nano-electronic elements. This opens up new doors for progress when it comes to **processors, memory and integrated circuits**. New technologies are also arising which can be used for the production of **new photovoltaic materials**. Much of the research conducted in the Polish facility may be applied to industry. This is the case of the research on **pharmaceuticals, crystals, powders, fibres, metals and their alloys, semiconductors and ceramic materials**, analysis of wear patterns, corrosion or adhesion, and studies of the stability of solutions, emulsions, and colloidal solutions.





# Research techniques and methods

- Absorption experiments providing information about the internal energetic structure of materials.
- Measurement of three fundamental electron properties such as energy,
- momentum, and spin to describe the electronic structure of materials.
- Creation and interpretation of light spectrums arising from the action of radiation on the material studied.
- Diffraction, used for the dispersion of electromagnetic radiation. Spectroscopy based on the polarization of electromagnetic radiation. Microscopy and imaging (representation and recreation) using X-rays.



Solaris synchrotron.

# Instruments and techniques available in CERIC

At SOLARIS, two beamlines are offered at the moment. The **PEEM/XAS bending magnet beamline** (200-2000 eV photon energy range) is equipped with two end stations: PEEM (Photoemission Electron Microscopy) and XAS, devoted to spectroscopic studies by absorption of soft X-rays. The **UARPES variable polarization undulator beamline** (8-100 eV photon energy range) is equipped with the ARPES end station, allowing precise studies on the structure of the energy bands of solids and their surfaces.

SOLARIS NATIONAL SYNCHROTRON RADIATION CENTRE



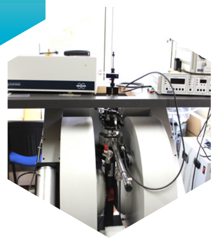
**National Institute of Materials Physics**

# Laboratory of Atomic Structures and Defects in Advanced Materials

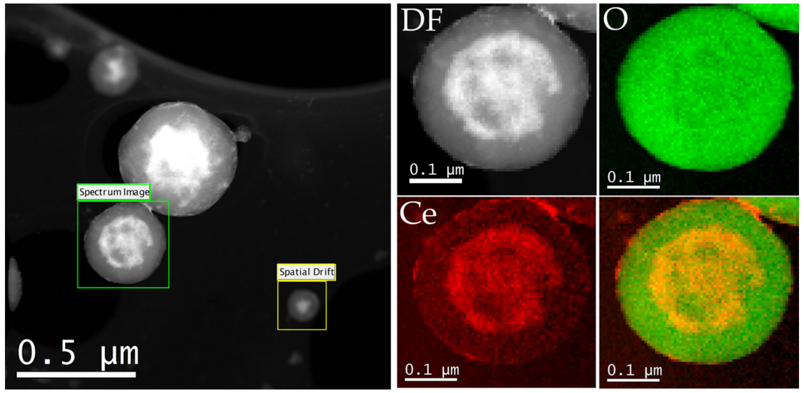

The Laboratory of Atomic Structures and Defects in Advanced Materials (LASDAM), at the National Institute of Materials Physics (INFM) in Magurele - Romania, offers instruments and expertise for research in solid state physics and materials science, including the synthesis and characterization of advanced materials for applications in microelectronics, catalysis, energy and ICT.

# Research fields and applications

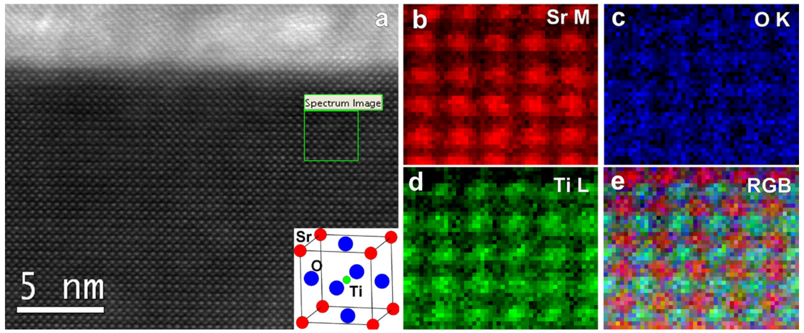
ROMANIA



The overall research activity is mainly focused on advanced multifunctional materials and nanostructures, with potential applications in high-tech industries. The research at LASDAM concerns the investigation of the physical properties - mainly of the structure - of advanced materials, resulting either in size effects (nanostructures, thin films) or defect engineering. The research activity is mainly directed towards the discovery, investigation and manipulation of physical properties at nanometric and atomic scale for the **characterisation and development of new materials** (dielectrics, semiconductors, alloys, ceramics) to be used in various applications, such as **semiconductor technology, gas sensing, radiation detectors, telecommunications**.




STEM EELS Spectrum Imaging from SiO2 - CeO2 core-shell structures.



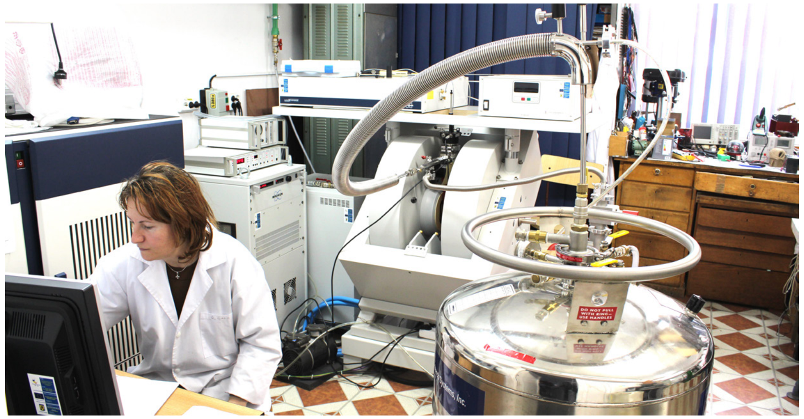

HAADF STEM image at the STO-SRO interface along the STO [010] zone axis (STO unit cell inserted).





# Research techniques and methods

- Investigations down to the atomic scale by microstructural (HRTEM), spectroscopic (EPR) and optical methods of native and induced defects in bulk and nanostructured solid materials. Investigations of materials' properties by using paramagnetic point defects as atomic probes. Investigations of the changes induced by defects in ordered and partially disordered solids. Synthesis of oxide semiconducting or magnetic nanostructures for applications in gas sensing, catalysis and photocatalysis.
- Hyperfine interactions in solids.
- Modelling of order-disorder transformations in crystalline media and transient phenomena in condensed matter.



Electron Paramagnetic Resonance (EPR).

# Instruments and techniques available in CERIC

Investigation techniques and state-of-the-art equipments for materials synthesis, processing and characterization are made available to CERIC. They include structural methods: Analytical High-Resolution Transmission Electron Microscopy (**HRTEM**), and Spectroscopic Methods: Electron Paramagnetic Resonance (**EPR**).

### National Institute of Chemistry

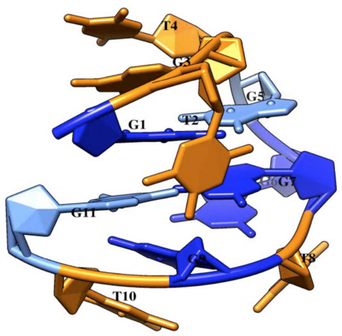
# Slovenian NMR


The Slovenian NMR Centre at the National Institute of Chemistry was established by the Slovenian Ministry of Science and Technology in 1992 as a national research infrastructure.

Its participation in CERIC has fulfilled the ambition to become a facility of international standards that offers access to users from Central Europe and elsewhere. The research results are published in around 40 papers annually in well respected international scientific journals.

# Research fields and applications


The Slovenian NMR Centre offers expertise and access to users **studying the relationships between the structure of materials, the sequence and recognition of biomolecules and their dynamics**, to gain deeper insights into the biological functions, chemical structures and interactions in solution or solid phase, as well as into the nature of the fundamental biological processes and properties of chemicals and materials. The Slovenian NMR centre also offers support to the development and production processes in the **pharmaceutical, chemical, petrochemical, agrochemical and food industry.**




Structure of a stable G.

**NMR spectroscopy** is indispensable in chemical analysis and identification, determination of 3D structures and study of dynamics of small and larger biomacromolecules. It allows the study of chemical reactions and polycrystallinity, analytical and bioanalytical procedures, as well as the identification of metabolites and various amorphous forms. The expertise of the NMR Centre is widely used in the **production of coatings, paints and plastics**, as well as for the **analysis of inorganic and organic materials**. It is also used for **environmental protection purposes** and in establishing the **provenance and quality of food products.**





# Research techniques and methods

- Structural studies of biological macromolecules and their dynamics in solution state. Studies for the understanding of the molecular basis of diseases.
- Structure characterization and interaction of novel biologically active compounds with protein targets and design of active compounds.
- Structure and interactions in the solid state, polycrystallinity and polymorphism.
- Characterization of recombinant proteins in solution.
- Structure and analysis of synthesised lower molecular weight compounds in solution and solid state.
- Study of complex mixtures of compounds in solution profile of impurities in drugs, degradation products, quality and quantitative analysis of organic compounds with the use of hyphenated techniques.


# Instruments and techniques available in CERIC

current instrumentation offered by the Slovenian NMR Centre through CERIC in a peer-reviewed open access mode includes an **800 MHz (David), two 600 MHz (Magic and Lara)** and two **300 MHz (Odie and Ajax) NMR spectrometers** with a broad selection of probes including cryo -probes.

# Contacts

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