Techniques in CERIC

Information has been extracted from some surveys sent scientists of all CERIC PF

## **Elettra Sincrotrone Trieste** (Italy)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **High pressure x-ray diffraction** | X-ray diffraction measurements as a function of pressure at ambient temperature |  |
| **X-ray Photoemission Electron Microscopy** | full-field imaging combined with photoelectron spectroscopy |  |
| **Photoelectron emission (XPS)** | Spatially resolved XPS (SPEM = Scanning PhotoEmission Microscopy) |  |
| **Diffraction (i.e. X-Ray Diffraction (XRD))** | Structural characterization of crystalline materials |  |
| **Photoelectron emission** | Synchrotron light-excited XPS and UPS |  |
| **X-ray absorption near edge structure (XANES)** | Secondary-electron-yield (SEY) and Auger-electron-yield (AEY) modes |  |
| **Near edge X-ray absorption fine structure (NEXAFS)** | Secondary-electron-yield (SEY) and Auger-electron-yield (AEY) modes |  |
| **X-ray absorption spectroscopy (XAS)** | Secondary-electron-yield (SEY) and Auger-electron-yield (AEY) modes |  |
| **Diffraction** | Structural characterization of crystalline materials |  |
| **Emission or Reflection** | X-ray fluorescence (XRF) |  |
| **Angular Resolved PES** |  |  |
| **Ultraviolet photoelectron spectroscopy (UPS)** |  |  |
| **Angular Resolved PES** |  |  |
| **X-ray photoelectron spectroscopy (XPS)** |  |  |
| **Small angle scattering** | Taking time resolved scattering patterns during change of T,p chemical potential etc. |  |
| **FTIR Absorption Spectroscopy** | FTIR spectroscopy (FTIR) is an analytical methodology where the infrared light is absorbed at specific frequencies related to the vibrational bond energies of the functional groups present in the molecule. A characteristic pattern of bands is formed, which is the vibrational spectrum of the molecule. |  |
| **FTIR absorption microscopy** | FTIR microscopy is an analytical methodology where the infrared light is absorbed at specific frequencies related to the vibrational bond energies of the functional groups present in the molecule. A characteristic pattern of bands is formed, which is the vibrational spectrum of the molecule. The information can be spatially resolved both using a mapping approach (single point detector) or an imaging approach (bidimensional IR detector) |  |

## **National Institute of Chemistry** (Slovenia)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **Nuclear magnetic resonance (NMR) spectroscopy** | nD NMR spectra provide information about structure, properties, purity of samles/materials |  |
| **Solid state nuclear magnetic resonance spectroscopy** | Solid-state NMR spectroscopy exploits atomic nuclei with magnetic dipole and electric quadrupole moments to inspect local magnetic and electric fields within solids. It enables element-specific insight into local structure and dynamics. |  |

## **Graz University of Technology** (Austria - Italy)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **Small angle scattering (SAS)** | Elastic small angle scattering of hard X-rays to resolve structural features between 1 and 100 nm. The scope of the technique is time resolved experiments on solids, liquids, gases and interfaces. Many sample environments are available. Various measurement protocols have been implemented. |  |
| **Small angle scattering (SAS)** | Small angle scattering of hard X-rays to resolve structural features between 1 and 200 nm. measure the diffuse elastic scattering vs the scattering vector q. The samples are liquids, solids, and interfaces. |  |
| **Dynamic light scattering (DLS)** | Dynamic light scattering on liquids at fixed or variable angle |  |
| **Static light scattering (SLS)** | Static light scattering of laser radiation in the visible regime to reveal structures from 100 nm- several micrometers. The intensity is measured versus the scattering vector q. The sample form is liquid or paste like. |  |

## **National Institute of Material Physics** (Romania)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **Analytical Transmission Electron Microscopy** | An accelerated electron beam is used for microstructural and analytical characterization of materials using imaging, diffraction, X-ray and electron spectroscopy |  |
| **Transmission Electron Microscopy (TEM)** | microscopy technique - the image is magnified and focused onto an imaging device, such as a fluorescent screen, onto a layer of photographic film or detected by a sensor such as a CCD - imaging at a significantly higher resolution than light microscopes - nanotechnology and nanomaterials to metallic alloys, ceramics and semiconductor research |  |
| **Electron Energy Loss Spectroscopy (EELS)** |  |  |
| **Energy-Dispersive X-ray Spectroscopy (EDS)** |  |  |
| **Electron Paramagnetic Resonance aka Electron Spin Resonance (ESR) spectroscopy** | Resonant absorption of microwave photons - sample submitted to a static magnetic field - to study chemical species with unpaired electrons |  |

## **Charles University Prague** (Czech Republic - Italy)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **X-ray photoelectron spectroscopy (XPS)** | photoelectron emission - laboratory X-ray source 1254 or 1487 eV - high vacuum - get information about chemical composition and electronic structure |  |
| **Synchrotron radiation XPS (SR-XPS)** | photoelectron emission - synchrotron source - get information about chemical composition and electronic structure |  |
| **Ultraviolet photoelectron spectroscopy (UPS)** | photoelectron emission - He lamp 21.2 or 4.82 eV - get information about chemical composition and electronic structure |  |
| **Resonant photoemission spectroscopy (RPES)** | photoelectron emission - scanning photon energy - measuring core level or valence band spectrum - scope is the spectrum shape - get information about chemical composition and electronic structure |  |
| **Angle-resolved photoemission spectroscopy (ARPES)** | photoelectron emission - measure angle resolved version - get information about chemical composition and electronic structure |  |
| **X-ray absorption spectroscopy (XAS)** | scanning photon energy - measuring secondary electrons in case of SEY mode or Auger line in case of AEY mode - analyzer axis: kinetic energy - the scope is the total intensity |  |
| **Near edge X-ray absorption fine structure (NEXAFS)** | scanning photon energy - measuring secondary electrons in case of SEY mode or Auger line in case of AEY mode - analyzer axis: kinetic energy - the scope is the total intensity |  |
| **X-ray absorption near edge structure (XANES)** | scanning photon energy - measuring secondary electrons in case of SEY mode or Auger line in case of AEY mode - analyzer axis: kinetic energy - the scope is the total intensity |  |
| **Low-energy electron diffraction (LEED)** | Analysis of the surface crystallinity |  |
| **Near Ambient Pressure XPS (NAP-XPS)** | photoelectron emission - it is possible to combine up to three different gases with total pressure up to 10 mbar and heat the sample up to 500 °C - get info about electronic and structural properties of small organics |  |
| **Near Ambient Pressure UPS (NAP-UPS)** | photoelectron emission - it is possible to combine up to three different gases with total pressure up to 10 mbar and heat the sample up to 500 °C - get info about electronic and structural properties of small organics |  |
| **In-situ electrochemistry** | Sample preparation - Ultra high vacuum  conditions |  |
| **Field Emission Scanning Electron Microscopy (FESEM)** | Study the sample morphology and composition - detection of secondary electron (SE) and back-scattering electron (BSE) - high vacuum (HV) operation allowing high-resolution (1nm) / high-current / low-noise imaging - get info about tructure uniformity determination and small contamination feature geometry and elemental composition measurement |  |
| **Energy-dispersive X-ray spectroscopy (EDX)** | Chemical element mapping of surfaces with sub-micron resolution |  |
| **Ion scattering spectroscopy (ISS)** | Used for the topmost chemical composition |  |
| **X-ray Photoelectron Diffraction (XPD)** | photoelectron emission - angular scans - analyzer axis: kinetic energy - get info about morphology, electronic structure and chemical composition |  |

## **Hungarian Academy of Sciences –Centre for Energy Research** (Hungary)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **Prompt gamma activation analysis (PGAA)** | neutron-source - emission of gamma photons - used for non-destructive elemental analysis of samples - a pulsed beam can also be used - The BGO annulus and catchers around the HPGe detect most of the scattered gamma photons. If the events from the HPGe and the BGO are collected in anticoincidence mode, Compton-suppressed spectra can be acquired |  |
| **Prompt-Gamma Activation Imaging (PGAI)** | position-resolved element analysis |  |
| **Neutron-induced prompt-gamma spectrometry (NIPS)** | neutron-source - designed mostly for large-sample - gamma measurement - the gamma detector systems are regularly calibrated for counting efficiency and non-linearity |  |
| **Neutron Activation Analysis (NAA)** | method for quantitative composition analysis of chemical elements - based on converting the stable nuclei of the sample to radioactive nuclei by nuclear reactions, followed by the quantitation of the reaction products via their gamma radiations - non-destructive - gamma-rays emitted from the sample are counted in a low-level gamma-spectroscopic counting - detect and collect the gamma spectra - short-term or long-term irradiation - |  |
| **Static/dynamic neutron and X-ray imaging (RAD)** | Neutron and X-ray imaging - inner structure of even a bulky object can be characterized in a non-destructive way - the interactions between the beam particles and the matter result in the attenuation of the transmitted neutron or X-ray beam so giving contrast on a sensitive screen -2D and 3D imaging - static imaging, dynamic radiography |  |
| **Static/dynamic cold neutron imaging (NORMA)** | Neutron imaging - to obtain visual information on the structure and/or inner processes of a given object - inner structure of even a bulky object can be characterized in a non-destructive way - cold regime provides higher contrast compared to that for the thermal neutrons - 2D and 3D imaging - static imaging, dynamic radiography |  |
| **Total scattering neutron powder diffraction ()** | covers the range of medium-resolution powder, liquid and amorphous total diffraction - tailor the beam for the required Q-range - record the total scattering powder diffraction pattern from 4.5 to 142.6 degrees in 2Theta - |  |

## **Polish Ministry of Science and Higher Education** (Poland)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
| **Photoemission electron microscopy (PEEM)** | used in material sciences, physics, chemistry, geosciences and biosciences |  |
| **X-ray absorption spectroscopy (XAS)** | photon energy range (200–2000 eV) - to study chemical and electronic, structural - covers the absorption K edges for light elements, from carbon to silicon, L edges of elements with Z between 20 and 40, including 3d elements, and also M edges of many heavier atoms, including 4f elements. |  |
| **X-ray natural linear dichroism (XNLD)** | photon energy range (200–2000 eV) - to study chemical and electronic, structural |  |
| **X-ray magnetic circular dichroism (XMCD)** | photon energy range (200–2000 eV) - to study magnetic properties |  |
| **X-ray magnetic linear dichroism (XMLD)** | photon energy range (200–2000 eV) - to study magnetic properties |  |

## **Ruđer Bošković Institute** (Croatia)

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| **Technique** | **Key-concepts**  **(extracted from scientist description)** | **PaNOSC & ExPaNds Classes** |
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