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SOFT X-RAY SPECTROSCOPY - FIRST BEAMLINE AT POLISH SYNCHROTRON

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First beamline at Polish synchrotron should start in 2014. The concept of this line emerged since the beginning of the attempts to create in Poland a source of synchrotron radiation. Soft x-ray spectroscopy was present in all early projects.

The beamline is designed to perform possibly polarization dependent spectroscopic studies of solids using photons within a relatively large energy range, provided by an undulator and a grating monochromator.
The main technique is photoelectron spectroscopy, including angle resolved version. The layout of the beamline and endstation allows to use the light from the same source also for additional techniques - X-ray absorption (XAS) and x-ray emission spectroscopy (XES, RIXS) – in the next stage of beamline development. This solution enables complex analysis of the electronic structure of various materials including strongly correlated electron systems. Depending on the budget the project will be realized in one or two steps. First step – the basic photoelectron spectrometer, the second step: spin detector, x-ray emission spectrometer, MBE in the attached chamber.

Source:
circular (elliptical) polarization undulator,

- energy 30 – 1500 eV, variable polarization
- grating monochromator; resolving power $E/\Delta E \sim 10^4$
- beamsize at sample ~ 100×100 μm^2
- intensity ~ $10^{12} - 10^{13}$ phot/s/0.1%BW

Endstation

1. Photoelectron spectroscopy – resonant photoemission, spin resolved photoemission - hemispherical high resolution analyser, resolution ~ 1 meV, multichannel detector and micro-Mott detector for spin resolution (switchable),

- 6-axis manipulator with sample heating and cooling, temperature range at least 20-800 K,

2. Angle Resolved Photoemission – realised with the same analyser or with use of a spectrometer dedicated for angle resolved measurements,
3. X-ray Absorption Spectroscopy – sample current detector (TEY), fluorescence detector (TFY) – in the main chamber,
4. X-ray Emission Spectroscopy – Soft x-ray fluorescence spectrometer, (RIXS – Resonant Inelastic X-ray Scattering).

The available photon energy range includes the absorption edges of all elements important for new materials research. Both bulk materials and thin films can be studied with use of several techniques. Complex information about their electronic structure will be obtained in a large temperature range, using one main analysis chamber and due to in-situ sample preparation. Fast switching between the techniques will be an important advantage of this multitechnique solution.

Resonant photoemission gives information about localization of partial densities of states in valence band. In connection with the spin resolved photoemission, the beamline enables complex studies of materials designed for spintronics. Photon energies below 100 eV and an 6-axes manipulator enable angle resolved photoemission spectroscopy studies – the basic method used for electron band mapping of single crystalline bulk solids and thin films. Electron band structure of the new materials, including thin epitaxial films can be investigated. This knowledge is of great importance especially for materials with special electronic properties which are crucial for modern electronics. Strongly correlated electron systems are important in spintronics, magnetoelectronics and superconductivity.. One of the techniques which enables studies of electron correlations is Resonant Inelastic X-ray Scattering (RIXS). X-ray emission spectroscopy can give complementary information to x-ray absorption and photoemission.

Additionally, switchable circular polarization of x-ray which can be used for all techniques available at the endstation enables exploring the local magnetic moments and all electronic states sensitive to light polarization.

The beamline will be used to study:

- new materials for spintronics and magnetoelectronics,
- thin films and nanostructure multilayer systems, obtained in-situ (MBE is planned to be attached to the analysis chamber),
- surface of bulk compounds, cleaned and doped in-situ,
- surface magnetism,
- chemical reactions taking place at the surface.