P-01

UARPES -Angle Resolved Photoelectron Spectroscopy beamline at National Synchrotron Radiation Centre SOLARIS

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Keywords: angle resolved photoelectron spectroscopy, synchrotron radiation, synchrotron facilities

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The Angle Resolved Photoelectron Spectroscopy (ARPES) allows for measurements of fundamental quantities describing the electron state in space, i.e. the energy (E) and the momentum (k). Additionally, if the spin selector is used, a complete set of quantum numbers for electron in space may be obtained. Within a so called sudden approximation the electron energy, momentum and spin measured over the sample surface may be related, to binding energy, quasimomentum, and spin, that the electron had in the solid before the photoelectric event took place. Thus a complete image of the electronic band structure of the studied solid is obtained experimentally. Beside this simple picture ARPES gives also detailed insights into complex electron – electron and electron – lattice interactions in the solid.

Nowadays there are hopes that advanced techologies, conserving natural resources (e.g. for energy production and supply) may be developed based on new materials and devices. The key for advances here will be likely found in the knowledge about the electronic structure of complex systems. This point of view is well illustrated by recent developments of knowledge with reference to collossal magnetoresistance, high temperature superconductivity, topological insulators as well as to many other interesting phenomena [1-13]. A lot of these developments have been enabled by ARPES studies.

The importance of ARPES technique for contemporary science and technology is widely recognized. Dedicated ARPES beamlines exist at almost all synchrotron radiation centers worldwide. Typically, for these beamlines, the demanded beamtime many times surpasses the offered one. Based on these considerations it is predicted that the high demand for ARPES studies will continue in future.

To meet this expected demand a beamline dedicated for Angle Resolved Photoelectron Spectroscopy will be constructed as one of the first at SOLARIS synchrotron facility. We have proposed the acronym UARPES (Ultra ARPES) as the name for this research installation.

The UARPES beamline is being designed to have the following performance:
energy range of 8-100 eV,
resolving power ≥ 20 000 over the full energy range,
ph. flux on the sample≥5x10^{11} *photons/s @20000 RP,*
available polarizations: linear: vertical, horizontal, inclined; circular; elliptical,
higher harmonics at the sample position < 1%,
excited spot size on the sample < 500 x 500 μm^2

Elliptically polarizing, APPLE-II type undulator is chosen as a light source. The undulator will have quasi-periodic geometry for suppression of unwanted harmonics in its radiation spectrum. It will be capable of both parallel and antiparallel modes of operation ensuring the full control over the light polarization.

The monochromator will be combining normal (NIM) and grazing incidence (PGM) optics, similarly to recent implementation at SLS [14]. The NIM mode is helpful for additional harmonics rejection, where they are particularly abundant, i.e. at the lowest photon energies. Thus the NIM mode will be used in the energy range 8 – 30 eV while the PGM mode will be used in the energy range 25 – 100 eV.

The experimental endstation will be composed of several ultrahigh vacuum chambers designed for sample processing and analysis, as well as for storage and transfer. Cryogenic, 5-axes manipulator will be capable of stabilizing the sample temperature in the range 10 – 500 K, as well as of precise positioning of the sample surface for experiments. State-of-the-art electron energy spectrometer, having energetic resolution down to 1 meV, will be capable of massively parallell recording of angle-resolved data. Advanced automation will make possible remote ARPES experimentation. Low energy electron diffractometer, with MCP image amplifier, will be available for surface structure studies. Sample processing devices will allow for typical in situ preparation techniques such as sputter cleaning, thermal annealing, thin film growth, sample cleaving, surface reactions in the gas phase.

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