L-13 **Thu. 03. 09., 16^{00}-16^{40}**

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

J. J. Kolodziej[1,2]*, K. Szamota-Leandersson[2]

[1]*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, Kraków, Poland*
[2]*National Synchrotron Radiation Centre SOLARIS, Krakow, Poland*

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

*e-mail: jj.kolodziej@uj.edu.pl

Angle Resolved Photoelectron Spectroscopy (ARPES) allows for measurements of fundamental quantities describing a photoelectron state in space, i.e. the energy (E) and the momentum (k). If a spin selector is used additionally, a complete set of quantum numbers for the electron may be obtained. Than, 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 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.

Many recent advances in materials science have been enabled by better understanding of the electronic structure of complex systems, gained due to ARPES studies. Examples include advances in fields such as high temperature superconductivity, topological insulators, graphene physics [1-15].

The importance of the 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, demanded beamtime many times surpasses the offered one. To meet the predicted demands a beamline dedicated for Angle Resolved Photoelectron Spectroscopy is constructed at SOLARIS synchrotron facility. It has been given an acronym UARPES (after Ultra ARPES).

The UARPES beamline has been designed to have the following performance: energy range of 8-100 eV; resolving power $\geq$ *20 000 over the full energy range; photon flux on the sample* $\geq 5x10^{11}$ *photons/s@20000 RP; available polarizations: vertical, horizontal, inclined, circular, elliptical; higher harmonics at the sample <1%; spot size on the sample 300 x 30* μm^2.

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

The beamline monochromator is combining normal (NIM) and grazing incidence (PGM) optics, similarly to recent implementation at SLS [12]. The NIM mode is indispensable for additional harmonics rejection, where they are particularly abundant, i.e. at the lowest photon energies. The NIM mode is designed to be used in the energy range 8 – 30 eV while the PGM mode in the energy range 25 – 100 eV.

The experimental endstation is composed of several ultrahigh vacuum chambers designed for sample processing and analysis, as well as devices for the sample storage and transfer. Cryogenic, 5-axes manipulator is 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, is capable of massively parallell recording of angle-resolved data spectroscopic data. Low energy electron diffractometer (LEED), with MCP image amplifier, is available for the sample positioning and surface structure studies. Processing devices allow for typical *in situ* sample surfrace preparation techniques such as sputter cleaning, thermal annealing, thin film growth, sample cleaving, surface reactions in the gas phase. Sample surface composition and crystallographic order may be monitored during preparation processess using combined LEED/AES device.

---

[1] A. Damascelli *et al., Rev. Mod. Phys.* **75** (2003) 473.
[2] J. C. Campuzano *et al., Phys. of Supercond.* **2** (2003)167.
[3] M. A. Hossain *et al., Nature* **425** (2008) 527.
[4] V. B. Zabolotnyy *et al., Phys. Rev*. B **76** (2007) 064519.
[5] Y. Kamihara *et al., J. Am. Chem. Soc*. **130** (2008) 3296.
[6] F. Bisti *et al., Phys. Rev*. B **91** (2015) 245411.
[7] K. Schulte *et al., Appl. Surf. Sci*. **267** (2013) 74.
[8] J. Maletz *et al., Phys. Rev*. B **89** (2014) 220506.
[9] S. Ideta *et al., Phys. Rev*. **89** (2014) 195138.
[10] A. A. Kordyuk, *Low Temp. Phys*. **40** (2014) 286.
[11] D. Ootsuki *et al.,* J. Phys. Soc. Jap. **83** (2014).033704.
[12] Y-J. Chang *et al., Phys. Rev. Lett.* **111** (2013) 126401.
[13] H. M. Benia *et al., Phys. Rev*. B **91** (2015) 161406.
[14] N. Xu *et al., Phys., Rev*. B **90** (2014) 085148.
[15] M. Hashimoto *et al., Nature Physics* **10** (2014) 483.