

LowDosePES: the low-dose photoelectron spectroscopy end-station at the PM4 beamline at BESSY II

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Abstract: A brief description of the main equipment at the Low Dose PhotoElectron Spectroscopy end-station is given, and a few possible applications highlighted.

1 Instrument description

The new LowDose PES end-station is installed at the BESSY II PM-4 beamline. The end-station is equipped with a SES100 hemispherical analyzer, as well as with a novel angle-resolved time-of-flight (ArTOF) spectrometer. Distinctive features of the latter are an extremely high transmission and the possibility to collect electrons over a very broad angular range in parallel (Ovsyannikov et al., 2013). As the ArTOF calls for a pulsed source with repetition rate of few MHz maximum, a fast mechanical chopper is installed at the intermediate focus of the beamline enabling permanent access to 1.25 MHz - spaced X-ray bunches, not only with the single-bunch filling pattern of the storage ring, but also during the more common hybrid operation mode (Förster et al., 2015). In spring 2016, an ultra-fast (300 fs) high-average power (30 W) high-repetition rate (up to 2MHz) infrared (1030 nm) laser will be incoupled to the LowDose PES, thus allowing time-resolved pump-probe photoemission measurements.

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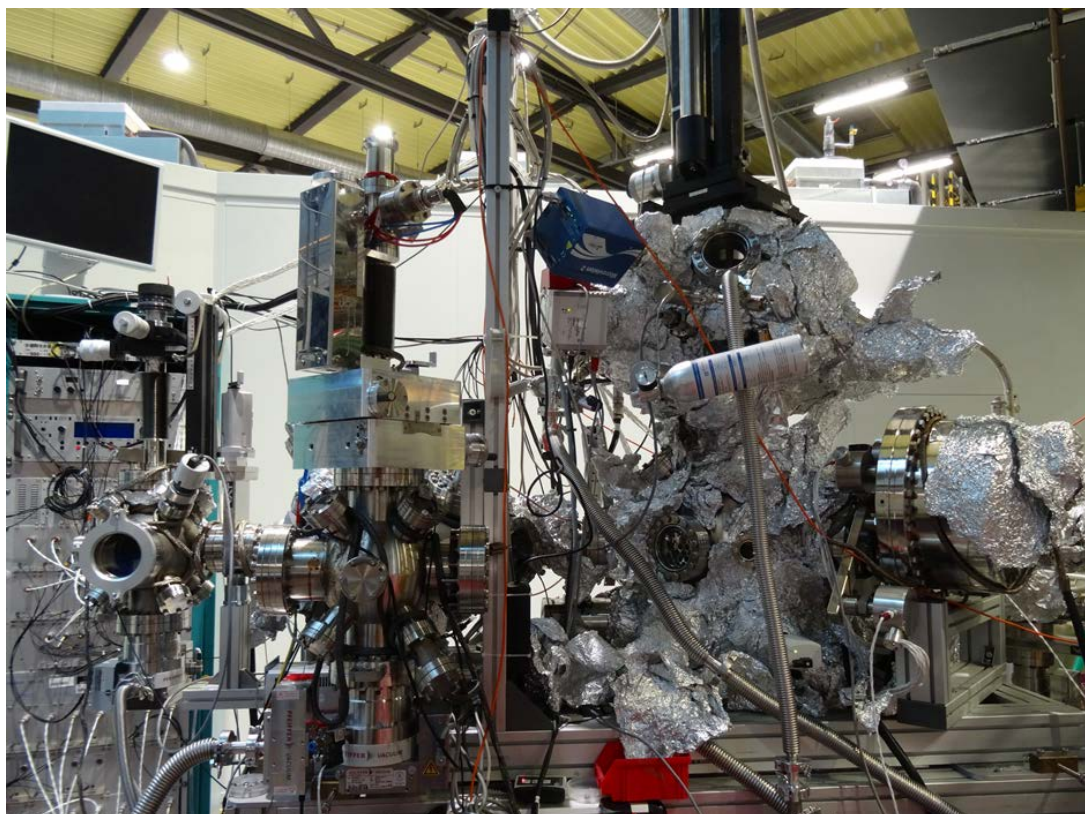


Figure 1: View of the LowDose PES end-station.

2 Instrument application

Thanks to the high transmission of the ArTOF, roughly 1000 times faster acquisition times and equally reduced dose rates can be achieved with respect to the more conventional hemispherical analyzers. This will open the door to PES investigations of a wide class of materials that usually suffer from radiation damage, including - in particular - technologically relevant photoactive organic crystals (Vollmer et al., 2012).

When further considering its full cone detection capabilities, the ArTOF turns out to be particularly suitable to track changes in the sample electronic structure as a function of parameters such as gas exposure, temperature or delay after excitation from an optical pump.

Among possible applications for the instrument, we like to mention: ARPES studies of radiation-sensitive organic single crystals or heterostructures, molecular orbital tomography, combined retrieval of structural and chemical information via X-ray photoelectron diffraction.

3 Technical information

The following experimental methods are accessible at the LowDose PES end-station:

- angle-resolved photoelectron spectroscopy (ArPES),
- ultraviolet photoelectron spectroscopy (UPS),
- X-ray photoelectron spectroscopy (XPS),
- X-ray photoelectron diffraction (XPD),
- electron yield near edge X-ray absorption fine structure (EY-NEXAFS).

The reader is addressed to the table below for further information regarding the beamline and existing

possibilities for sample preparation and conditioning.

Monochromator	PGM; energy range: 18 - 1800 eV
Experiment in vacuum	Yes ($\sim 10^{-10}$ mbar)
Temperature range	10 - 500 K
Detectors	Scienta ArTOF-2 electron energy analyzer Scienta SES100 electron energy analyzer
Manipulators	VG x,y,z, θ stage with Janis cryostat
Sample	10 mm x 10 mm maximum size, thickness up to 3 mm
Top preparation chamber	clean sample preparation, ports for up to 3 replaceable evaporators, MCP LEED, mass spectrometer
First ("clean") preparation chamber	preparation chamber for non-organic samples, several ports for replaceable evaporators etc, gas inlet, quartz microbalance, sputter gun, resistive heating up to 900 K, storage place for 6 samples (2 heatable, 4 not-heatable)
Second ("organics") preparation chamber	preparation chamber for organic samples, several ports for replaceable evaporators etc, mass spectrometer, resistive heating up to 900 K, storage place for 2 samples (1 heatable, 1 not-heatable)

Table 1: Technical parameters of the LowDose PES end station.

References

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