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FinEstBeAMS: a beamline for atmospheric and materials sciences at MAX IV Laboratory

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Beamline

FinEstBeAMS [1] – Finnish-Estonian Beamline for Atmospheric and Materials Sciences – is located at the 1.5 GeV storage ring at MAX IV Laboratory in Lund, Sweden. It has mainly been financed by Finnish and Estonian research consortiums, but any researchers can apply for beamtime at the beamline. FinEstBeAMS receives synchrotron radiation from an elliptically polarizing undulator (EPU) and monocromatizes it with a plane grating monochromator using collimated light (cPGM). The operation range of the beamline is exceptionally large: it covers photon energies 4.5-1300 eV, thus extending from ultraviolet to soft X-rays. Another defining characteristic of FinEstBeAMS is that the EPU can deliver linearly polarized radiation in different directions (horizontal, vertical, inclined) as well as left- and right-circularly polarized radiation. Horizontal and vertical linear polarizations have been used in experiments. The development of other polarizations is under progress.

End stations

FinEstBeAMS has three dedicated end stations that are or can be installed at two branch lines: a gas-phase end station (GPES) [2], a photoluminescence end station (PLES) [3], and a solid-state end station (SSES) [4]. The GPES was designed for coincidence measurements between energy-resolved electrons and ions, but it can also be used for stand-alone electron spectroscopy and ion time-of-flight (TOF) spectroscopy. Different sources such as a cluster source and an aerosol sample delivery system (ASDS) can be coupled to the GPES. The PLES is used in optical spectroscopy to collect emission spectra in the wavelength range 200-1350 nm and excitation spectra in the operation range of the beamline, while allowing the temperature of samples to be varied from 10 K to 300 K. The GPES and PLES nowadays share one of the branches (Branch A). The SSES is a newer end station, which, due to its complexity, is permanently installed at the other branch (Branch B). It was designed as a high-throughput apparatus for X-ray photoelectron spectroscopy (XPS), angle-resolves photoemission spectroscopy (ARPES) and X-ray absorption spectroscopy (XAS).

Aerosol sample delivery system

We have recently developed the ASDS to study aerosol and free nanoparticles using X-ray photoelectron spectroscopy. Its main components are an aerodynamic lens and a source chamber, which is pumped by turbomolecular pumps. The source chamber is connected to the GPES via a skimmer, which has a conical shape and a small aperture (1.0-1.5 mm). The ASDS enables the delivery of a continuous flow of an aerosol from atmospheric pressure to vacuum in the shape of a narrow beam of free flying particles (Figure 1). It facilitates XPS studies of aerosol particles in-flight without prior deposition. In the commissioning stage, the ASDS was used to study sea salt aerosol particles, which are composed of complex mixtures of organic and inorganic compounds, as well as engineered nanoparticles ablated from Sn, Cu, Pd and Zn electrodes. The ASDS was made available to general users in autumn 2023. The first two user experiments focused on model atmospheric organic-salt aerosol particle mixtures and on the role of alkali metals in soot formation.
References

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