HiPP-2
Electron Spectrometer

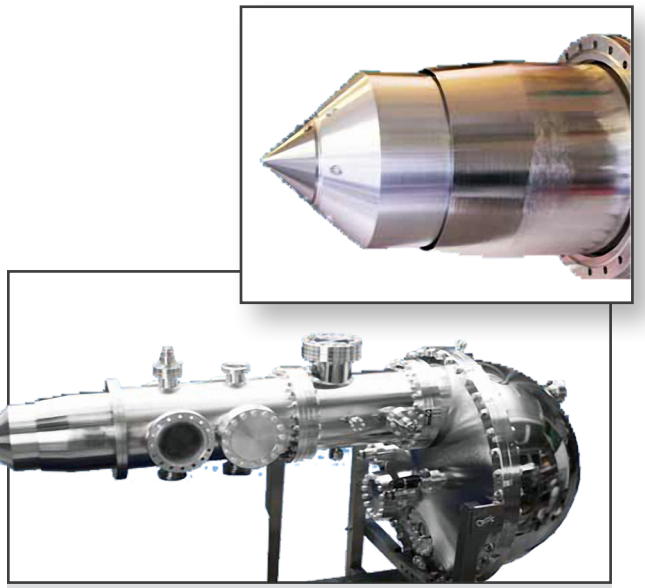

Figure 1: The Scienta Omicron R4000 HiPP-2.
Figure 2 (insert): Standard front cone of the R4000 HiPP-2 pre-lens.

The Scienta Omicron HiPP-2 analyser is developed for high pressure photoelectron spectroscopy (HiPP or APPES) as well as hard x-ray photoelectron spectroscopy (HAXPES). This state-of–the-art analysis tool enables angle-resolved photoemission at ambient pressures up to 50 mbar and electron kinetic energies up to 10 keV, as well as the combination of the two.

The HiPP-2 analyser is based on the Scienta Omicron 10 keV analyser and developed to allow for high pressures at the sample position. This is achieved by the addition of a pre-lens that combines efficient differential pumping with electron optics, that refocuses the electron paths through the pre-lens. The resulting transmission is at least an order of magnitude better than conventional differential pumping setups. The complete setup is shown in Fig. 1.

The pre-lens is equipped with a front cone with a small aperture that permits electrons to enter the analyser while providing efficient differential pumping, see Fig. 2. The front cone angle is 45 degrees, which allows easy access for photon sources, other equipment, and sample handling. The front cone can be interchanged in order to increase or decrease the aperture and thereby optimise the transmission vs. maximum pressure of the experiment. Truncated front cones are available, to allow for increased working distance when performing UHV experiments. The front cone can furthermore be customised to allow for user-specific designs, e.g. gas cells.

The analyser contains four differential pumping zones to enable efficient pumping, see Fig. 3. In spite of this, the novel refocusing design of the pre-lens enables an angular resolved range of 22 degrees, as well as a maximum angular acceptance of 26 degrees. The angular mode enables not only band structure investigations, but also XPS depth profiling and x-ray photoelectron diffraction (XPD). The extended angular range of the analyser is enabled by the use of a novel mesh-based design of the pre-lens.

New directions of Science

While photoemission traditionally have been limited to ultra-high vacuum (UHV) conditions, the possibility to perform experiments under ambient pressure conditions opens up for completely new directions of science. Research topics that become possible include studies of liquids, gaseous samples and aerosols, as well as studies of catalysis under near-working conditions. Furthermore, the combination of ambient pressure and HAXPES enables studies of buried interface and bulk properties of complex samples including fuel cells. The long electron inelastic mean free path characteristic of the HAXPES regime enables detailed studies of liquid/solid and liquid/liquid interfaces, including chemical information.

This capability makes HiPP-HAXPES a unique tool for investigations of these systems. The HiPP-2 instrument introduces photoemission as an attractive tool for a wide range of research areas, including wet chemistry, atmospheric physics/chemistry and biology.

Technical Highlights:

- 50 mbar N_2 / 20 mbar H_2O pressure at sample position
- Energy range up to 10 000 eV with full angular acceptance
- Refocusing pre-lens with efficient differential pumping
- Angular acceptance: 26°
- Angular resolved range: 22°

Experimental Results

The performance of the analyser has been verified in factory tests. The transmission mode of the instrument was tested using a Scienta Omicron VUV5000 He lamp and a GC50 gas cell using Xe gas as a test sample. Fig. 4 shows that the instrumental resolution is 10.6 meV at 20 eV pass energy. The angular mode was tested using an angular device and an electron gun for a kinetic energy of 1020 eV and a pass energy of 100 eV. The angular pattern displays 9 lines with an interval of 2.5 degrees, showing that the analyzer is capable of measuring an angular resolving interval of 22 degrees (Fig. 5).

Pressure tests have been performed by leaking gas into the test sample chamber. The tests were performed with lens voltages corresponding to 9 keV electron kinetic energy. Using a 300 mm front cone opening 50 mbar N_2 or 20 mbar H_2O can be achieved at the sample position without any discharges, and with pump powers well below critical values.

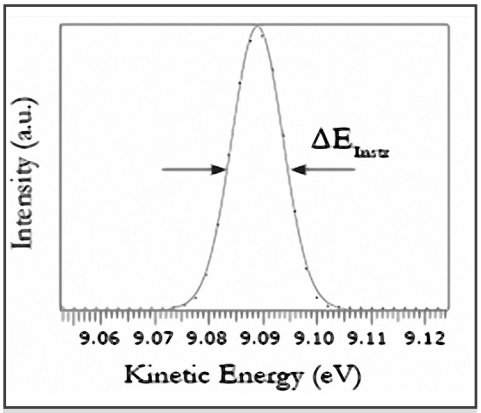

Figure 4: Transmission mode measurement of Xe $5p_{3/2}$ using 20 eV pass energy, showing a resolution of 10.6 meV.

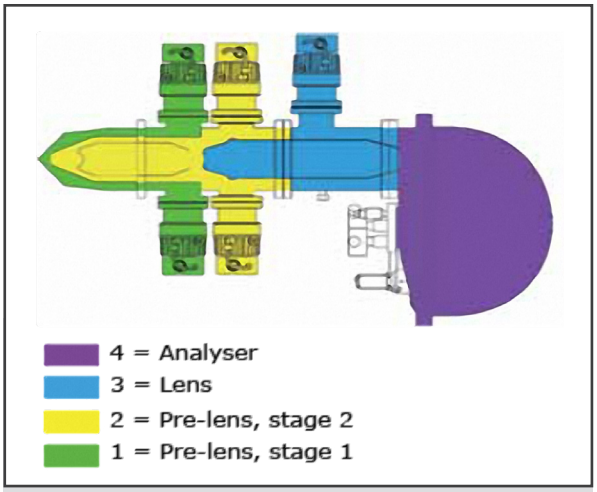

Figure 3: Schematic illustration of the four differential pumping stages of the Scienta Omicron R4000 HiPP-2.

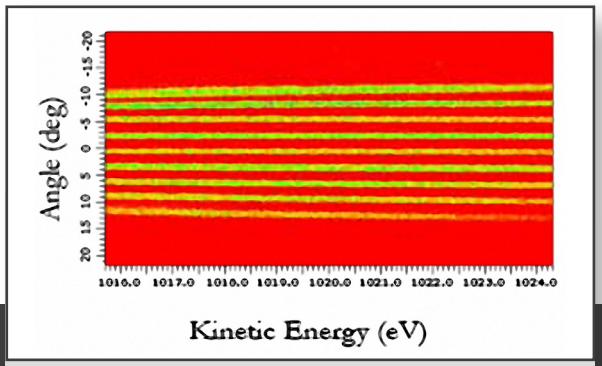

Figure 5: Angular mode measurement showing an angular resolved range of 22 degrees.

Technical Data

Technology Overview

Property	Specification
Energy resolving power	>1750 (0.2 mm slit)
Max., theoretical energy resolving power	4000 (0.01 mm slit)
Energy resolution	15 meV at 500 eV Ek 40 meV at 5 000 eV Ek 70 meV at 10 000 eV Ek
Lens acceptance angle	26°
Angular resolved range	22°
Kinetic energy range	
Transmission mode	5-10 000 eV
Angular mode	10-10 000 eV
Pass Energy	5-500 eV
Working distance	~1 mm (depending on front cone)
Vacuum tank	Stainless steel
Magnetic shielding	Double µ-metal shield
Pressure	better then 2×10-10 mbar (UHV) up to 50 mbar (HiPP), verified for N_2
Baking temperature	120 °C
Analyser radius	200 mm
Mounting flange	NW 200 CF, fixed
Slits	9

Detector type	MCP/CCD camera
Detector interface	Ø 40 mm MCP
Energy channels	>500 simultaneous
Angular channels	> 400 simultaneous
Scanned mode	Yes
Quick mode	Yes
Intensity deflectors	Yes (x, y)
ISS	Option
Analyzer pump port	Yes

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