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LiXEdrom: High Energy Resolution RIXS Station dedicated to Liquid Investigation at BESSY II

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Abstract: LiXEdrom is an experimental station dedicated to high resolution RIXS measurements on liquid samples. It is equipped with two VLS gratings and advanced photon detector (MCP/phosphorous screen/CCD), covering soft X-ray range of 200 – 1200 eV. The efficient differential pumping and cooling systems ensure successful executions of X-ray spectroscopy on liquid samples in vacuum. Liquid samples are introduced into the vacuum chamber by micro-jet or flow-cell techniques.

1 Introduction

LiXEdrom experimental station is equipped with high energy resolution X-ray spectrometer and dedicated to investigation of functional materials in solution and at surfaces and interfaces, with X-ray absorption (XAS) and resonant inelastic X-ray scattering (RIXS) techniques.
The X-ray spectrometer includes two variable-line-spacing (VLS) spherical gratings and an advanced X-ray photon detector (microchannel plate (MCP)/phosphorous screen/CCD camera assembly). The two gratings, one with 1200 l/mm line density covering energy range of 200 – 500 eV and the other with 2400 l/mm covering 400 – 1200 eV, are mounted on a motorized stage with 10 nm positioning

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accuracy. The resolving power $E/\Delta E$ is around 4000 for the high energy grating at 800 eV, while 5000 for the low energy grating at C K-edge, when a 10 μm X-ray spot size on sample is achieved. Switching grating is swift (within one second), thanks to the compact design of grating holder and motor. The vacuum of graing/detector chamber and beamline (<5 x10^{-9} mbar) is well protected by pinholes, efficient differential pumping and cooling systems installed between the sample chamber and grating chamber and between the sample chamber and beamline. The sample chamber is usually kept at 10^{-4} – 10^{-5} mbar with running liquid-jet inside, or $\sim 10^{-7}$ mbar with liquid flow-cell. The liquid-jet and flow-cell are the two applied techniques for the introduction of liquid samples into vacuum chamber.

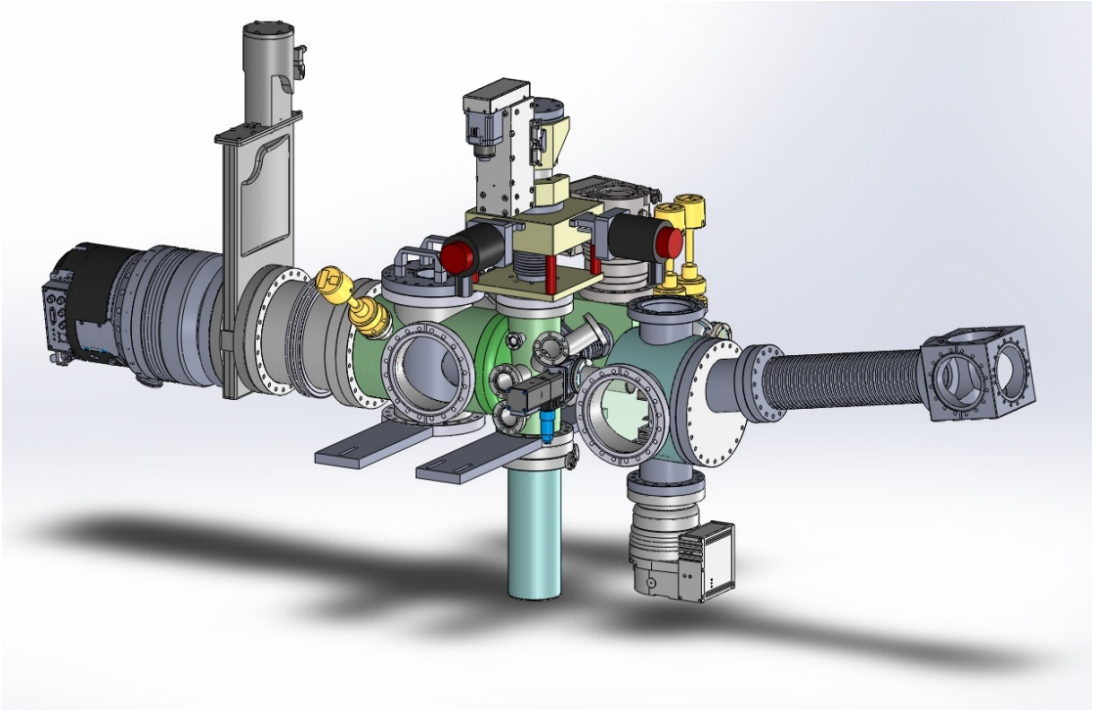

Figure 1: Schematic view of the LiXEdrom endstation.

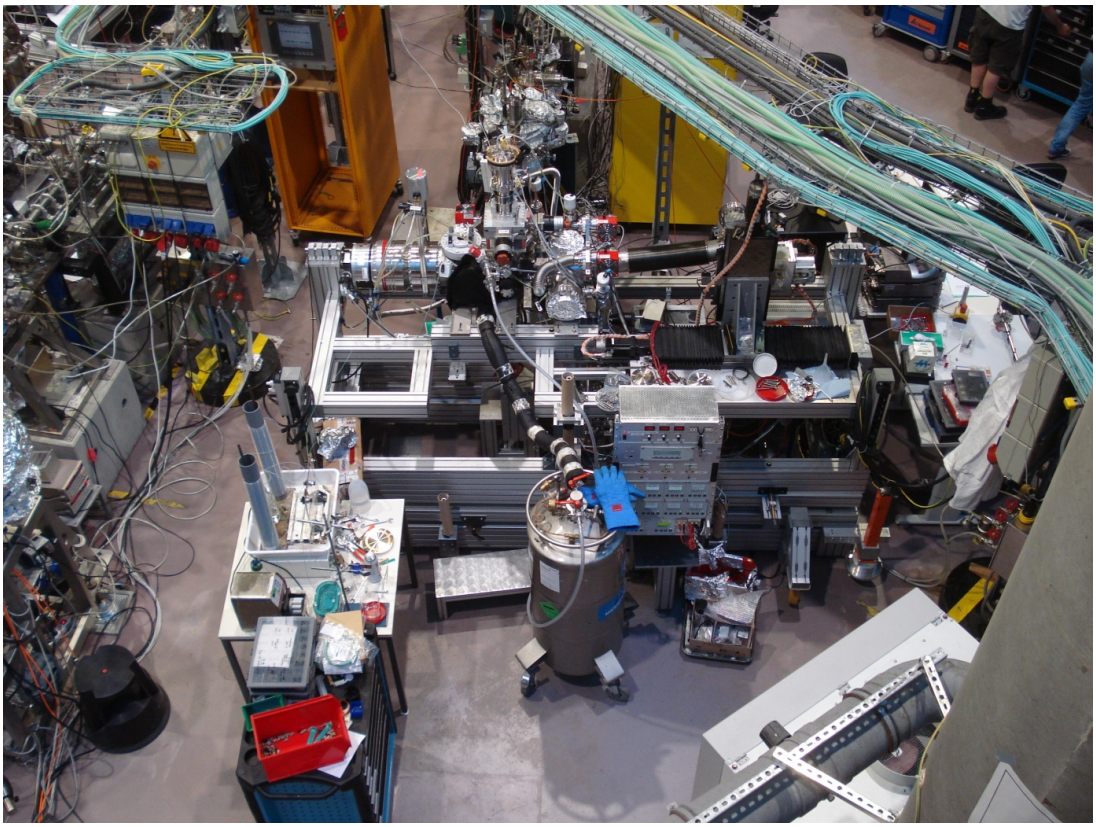

Figure 2: Top view of the LiXEdrom endstation.

2 Instrument applications

- Investigation of Hydrogen-bond network and Hofmeister effects in aqueous solutions
- Determination of interfacial electronic properties (electron delocalization) at the solute-solvent interface
- Exploring the strength of charge-donation and back-donation at the metal-ligand bond in organometallic and porphyrin complexes
- Observation of electronic structure changes of catalysts in solution and electrolytes along the reaction path
- Investigating the surface chemistry of nanoparticles in solution activated by different surfactants

3 Technical Data

Monochromator	Two VLS spherical gratings: radius 9.75 m / line density 1200 l/mm and radius 13 m / line density 2400 l/mm
Experiment in vacuum	Yes, grating/detector chamber < 5 x 10^{-9} mbar, sample chamber 10^{-4} – 10^{-5} mbar with liquid-jet or $\sim 10^{-7}$ mbar with flow-cell
Scattering geometry	Horizontal, 90° angle with respect to beamline
Energy range	200 – 1200 eV
Resolving power $E/\Delta E$	$\sim$ 4000 for VLS2400 grating $\sim$ 5000 for VLS1200 grating
Detector	Microchannel plate (MCP)/phosphorous screen/CCD camera assembly
Sample	Liquids (micro-jet and flow-cell) and solids
Sample manipulator	Motorized XYZ sample manipulator with micrometer precision
Temperature	Room temperature

Table 1: Technical parameters of the LiXEdrom endstation.

References

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