Abstract ID : **100**

A Flow-Focused Droplet Train for Investigating Liquid Phase Processes with Ambient Pressure XPS

Content

We present a new droplet train experiment designed for measuring the chemical and physical properties of liquid solutions in pressures up to 30 mbar using ambient pressure XPS. Flow-focusing is used to create a positionally stable droplet train that is less prone to clogging than traditional methods. A decrease in gas pressure across an orifice is used to shape a liquid stream flowing through it. The liquid does not physically contact the orifice. We demonstrate flow-focusing with gas pressures below atmospheric pressure on the high-pressure side of the focusing orifice, a requirement for implementation into AP-XPS systems. Our droplet train generates thousands of uniform droplets a second, that are tunable in diameter between 100 to 500 microns. Results from commissioning experiments on aqueous solutions and colloidal systems will be presented. We will also discuss the time-resolved XPS capabilities of the droplet train. By changing the height of the droplet generation point above the spectroscopic analysis position and introducing a suitable time-zero trigger, different delay times can be measured. Depending on the speed of the droplets chosen, we can access delay times on the μs to ms timescales. Examples of possible systems to study include (but are not limited to) gas uptake at the liquid/vapor interface, photoinduced physical and chemical reactions in solution, and nucleation and growth of nanoparticles in solution.

The droplet train, to date, has been operated at a tender X-rays beamline, allowing measurements of liquids in 25 mbar (i.e. above the vapor pressure of water at room temperature) with reasonable data acquisition times. Tender X-rays make these measurements more bulk-sensitive than traditional soft X-ray AP-XPS measurements due to the higher kinetic energy of the photoemitted electrons. This opens a range of new possibilities for time-resolved XPS measurements of reactions and processes in “bulk” liquids, including the kinetics of photocatalytic reactions. Modularity of the droplet train experiment provides the opportunity for soft X-rays experiments as well, allowing for more traditional liquid-vapor interface sensitive measurements.

The droplet train module is a part of the SpAnTeX end station, which is equipped with a SPECS Phoibos 150 NAP 10 keV Analyzer capable of measuring up to 10 keV photoelectrons. The SpAnTeX end-station focuses on AP-XPS experiments in the tender X-ray regime (AP-HAXPES). The droplet train commissioning experiments were performed at the KMC-1 beamline at the BESSY II synchrotron facility, Berlin.

Primary author: Dr STARR, David (Helmholtz-Zentrum Berlin)

Co-authors: BERASATEGUI, Matias (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany); CLARK, Pip C. J. (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany); RALAIARISOA, Maryline (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany); SEAR, Michael J. (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany); FAVARO, Marco (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany); VAN DE KROL, Roel (Institute for Solar Fuels Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, D-14109 Berlin, Germany)

Presenter: Dr STARR, David (Helmholtz-Zentrum Berlin)

Track Classification: Technical developments