NEGATIVE-ION–POSITIVE-ION COINCIDENCE SPECTROSCOPY IS USED TO STUDY MOLECULAR FRAGMENTATION FOLLOWING CORE EXCITATION AND CORE IONIZATION

A. Kivimäki,[1,2] C. Stråhlman,[3] R. Richter[4] and R. Sankari[2]

[1]Nano and Molecular Systems Research Unit, University of Oulu, P.O. Box 3000, 90014 Oulu, Finland
[2]MAX IV Laboratory, Lund University, P.O. Box 118, 22100 Lund, Sweden
[3]Institute Methods and Instrumentation for Synchrotron Radiation Research, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin, Germany
[4]Elettra – Sincrotrone Trieste, Area Science Park, 34149 Trieste, Italy

email: antti.kivimaki@maxiv.lu.se

Molecules composed of low-Z elements usually break into parts after the absorption of an X-ray photon. This dissociation mostly produces positive and neutral fragments owing to the positive charge of the molecular ion after normal and resonant Auger decay, which are the predominant decay channels of core-ionized and core-excited states, respectively. However, negative ions (or anions) have also been observed at the core edges of several small molecules such as CO_2, H_2O and SF_6.

We have recently constructed an experimental set-up to study molecular fragmentation processes involving both negative and positive ions [1]. The set-up is composed of two ion time-of-flight (TOF) spectrometers facing each other: one of them is for negative ions, the other for positive ions. Most unwanted electrons can be deflected with the aid of a weak magnetic field. In the measurements, negative particles (anions + some remaining electrons) and positive ions are recorded continuously for a chosen time using constant potentials in the common interaction region of the two TOF spectrometers. Coincidences between negative ions and positive ions are searched for in post-measurement data analysis: if particles arrived within a certain time interval (for instance, 10 μs) from each other, they are considered to originate from the dissociation of the same molecule. The analysis also allows us to find coincidences between one negative ion and several positive ions.

This tandem TOF set-up has been used to measure the intensities of negative-ion/positive-ion and negative-ion/positive-ion/positive-ion coincidences as a function of photon energy across the O 1s edge of water [2]. Here we also report similar results obtained from the methanol and formic acid molecules.

[1] C. Stråhlman, R. Sankari, A. Kivimäki, R. Richter, M. Coreno and R. Nyholm, Rev. Sci. Instrum. 87 (2016) 013109.
[2] C. Stråhlman, A. Kivimäki, R. Richter and R. Sankari, J. Phys. Chem. A 120 (2016) 6389.