THE RIGHT TOOLS FOR THE RIGHT JOB: SOFT X-RAY PHOTOELECTRON SPECTROSCOPY OF FREE-STANDING NANOMATTER

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The advantageous use of nanomaterials stem from their unique, size-scalable properties, and their ability to provide enormously more surface area for chemical reactions to occur compared to bulk materials. It is indeed the surface that matters: Whether it is a nanomedicine application or naturally occurring chemical reactions involving atmospheric particles, it is the electronic structure of the surface of these particles which essentially affect their reactivity and physical chemistry. Therefore, the studies of the first monolayers of nanomaterials are of utmost importance, and when it comes to surface sensitive techniques probing the electronic structure of matter, there is no other like *soft x-ray photoelectron spectroscopy*. Naturally occurring nano-sized matter is often in *gas-phase*, like soot from forest fires, atmospheric sea-salt particles, and sulfate particulate matter of volcanic and biogenic origin [1]. Thus, it is important to study them in their natural environment as free-standing isolated species, since deposition on substrates may changed their properties and induce other undesired effects like charging. In general, this requires special experimental techniques where a focused beam of nanoparticles compatible with high vacuum conditions is created. Compared to photoelectron spectroscopy of deposited samples, orders of magnitude signal loss from isolated nanoparticles is expected only by considering much lower sample density, and furthermore, the creation, alignment, and focusing of nanoparticle beams is not trivial. However, soft X-ray photoelectron spectroscopy of free-standing nanomatter is a technique with crucial benefits, which makes the efforts to exploit this technique worth it. Here, the strengths of the technique are discussed and some important parameters that can be extracted from the experimental data are presented. Especially highlighted is the extreme surface sensitivity of this technique, enabling structural, chemical, and dynamical characterisation of nanoparticle surfaces [2, 3, 4].

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