Surface Characterisation of Nanoparticles: Different Surface Analytical Techniques Compared

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Nanoparticles are by definition ultrafine particles with lengths in two or three dimensions larger than 0.001 micrometer (1 nanometer) and smaller than 0.1 micrometer (100 nanometers) and which may or may not exhibit a size-related intensive property [1]. Most of these properties, such as enhanced chemical reactivity, catalytic activity and optical properties depend on their high surface to volume ratio.

Nanoparticles play an emerging role in science and economy. E.g. it is expected that in 2015 a turnover of 1000 billion € is generated by nanotechnology [2]. Nevertheless, beside these economic chances the ecological and toxicological risks are currently difficult to judge. Therefore, the characterization of the specific surfaces interactions between nanoparticles and biological cells will play a crucial role in the toxicology of nanoparticles.

Interestingly to date characterization of nanoparticles is often performed in terms of their physical properties only (e.g. size and topography). Systematic studies on the chemical properties of nanoparticles and their surface interactions are rarely found. An analytical portfolio of techniques therefore needs to be developed which allows both the characterization of the elemental as well as the molecular composition of the particles. In order to also address core-shell structures the information depth of the techniques applied needs to be variable.

We have applied Low Energy Ion Scattering (LEIS), Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS), X-Ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM/EDX) and Inductive Coupled Plasma (ICP)-MS to the characterization of nanoparticles of both homogeneous composition and core-shell structures. The different information depths of the techniques allow a detailed investigation of the chemical composition. Results will be compared with respect to qualitative and quantitative aspects of the analyses. Prospects for the characterization of nanoparticles in cellular matrices will be discussed.

[1] ASTM: Standard Terminology Relating to Nanotechnology. URL: [http://www.astm.org/Standards/E2456.htm], 14.4.2011
[2] BMBF: Milliarden-Markt mit Nanotechnologie. URL: [http://www.bmbf.de/press/2075.php], 14.4.2011