EuroNanoForum 2015

Latvian Presidency of the Council of the European Union

EU2015.LV

Advanced analytical scanning electron microscopy for the characterization of nanoparticles

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The accurate and quick characterization of nanoparticles is more and more demanded in academia and industry research, as well as for consumer protection purposes. Electron microscopy is one of the few techniques capable of imaging individual nanoparticles and can consequently determine their size and shape. Modern scanning electron microscopes (SEM) are capable of resolving nanoparticles with diameters well below 10 nm. The optional use of the SEM in transmission mode (T-SEM), using transmitted electrons for imaging while having the sample prepared on conventional TEM grids as substrate, leads to a different contrast, which can be exploited to determine the boundary of nanoparticles very accurately. Hence, traceable nanoparticle sizes can be measured [1].

Energy dispersive X-ray spectroscopy (EDX) is the usual way of adding element sensitivity to an SEM when analyzing structures in the micrometer range. Improving the spatial resolution of EDX to the nanometer range would be very helpful for the analysis of nanoparticle mixtures, as may be the case in consumer products. This goal can be achieved by the use of thin, electron transparent substrates, which drastically reduce the excitation volume for the X-ray generation. Consequently, the signal-to-noise ratio of the X-rays emitted from the nanoparticles is enhanced. The resulting weak signal can conveniently be measured with highly sensitive, modern, large-area silicon drift detectors (SDD).

Scanning Auger electron microscopy (SAM) can be used to analyze the surface structure of nanoparticles. The high surface sensitivity in the nano-range as well as element specificity of the Auger electrons enable to study the shell of core-shell nanoparticles with high lateral resolution.

In this contribution, various examples (based on suitable reference materials) will be presented, demonstrating the capabilities of all discussed varieties of analytical SEM.

References

1. E Buhr et al., Meas. Sci. Technol. 20 (2009) 084025