Advanced Structural Analysis of Pt-Sn-based Nanoparticles with TXRF and Complementary Methods

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Pt is one of the most important catalyst materials e.g. for fuel cells. One major drawback are its high costs. The use of nanoparticulate Pt is common practice to increase the mass specific catalytic activity and, thus, save material costs. The addition of other elements allows a) to further increase the Pt mass specific activity and b) to alter its activity and selectivity by geometric and electronic effects. Wet-chemical synthesis allows an outstanding high degree of control over the phase, size and shape of nanoparticles.

Here, we present a synthesis that yielded Pt-Sn-based nanoparticles with a controllable phase. We produced nanoparticles with a crystalline PtSn, $PtSn_2$ or $PtSn_4$ core with a diameter in the range of 5 to 10 nm depending on the synthesis parameters. The samples were studied with various methods allowing a detailed analysis of the nanoparticles' structure [1].

The crystalline phase was studied via Powder X-Ray Diffraction. The size distribution was determined via Transmission Electron Microscopy. High-Resolution Transmission Electron Microscopy allowed a phase analysis of single particles and an analysis of the distribution of different crystalline domains within nanoparticles. Energy Dispersive X-Ray Analysis yielded information about the elemental composition. The stochiometry and the elements' oxidation state of the nanoparticles' surface could be studied with X-Ray Photoelectron Spectroscopy. Total Reflection X-Ray Fluorescence Analysis provided further information about the stoichiometry over the nanoparticles' whole volume. It allows the fast and facile preparation, measurement and analysis of samples needing only some ng of material, which is advantageous for laboratory-based syntheses yielding only small amounts of sample material. Additionally, Gracing Incidence X-Ray Fluorescence Analysis is presented.

[1] A. Erdt, C. Gutsche, U. E. A. Fittschen, H. Borchert, J. Parisi, J. Kolny-Olesiak, Control of Crystallographic Phases and Surface Characterization of Intermetallic Platinum Tin Nanoparticles (under preparation).