Anomalous SAXS and WAXS for the Structure of Pt/Ru Catalyst Nanoparticles

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With the high flux (3×10^{11} photons/s) and wide photon spectrum (5-35 keV) provided by the newly constructed superconducting wavelength shifter at the National Synchrotron Radiation Research Center, Taiwan, we study the structure of Pt and Pt/Ru nanoparticles embedded in carbon grains for fuel cell applications, using anomalous small angle X-ray scattering (ASAXS) and wide angle X-ray scattering. Using photon energies near 11.5 and 22.1 keV for the L and K absorption edges of Pt and Ru, respectively, in ASAXS, we have extracted the structural information for the Pt nanoparticles, including a mean dia. of 2.3 nm and a polydisperisty of 25%. Whereas the ASAXS result for the Pt/Ru nanoparticles indicates clearly a core-shell structure with Pt taking the core position. On the other hand, at a temperature above 450 °C WAXS reveals a sign of core-shall structural inversion for the Pt/Ru nanoparticles of an average dia of 3.3 nm. The structural inversion results in a significant growth in particle size, from a diameter of 3.3 nm to 5.0 nm, due to the reorganization and fusion of the nanoparticles. The coordinating numbers of Pt and Ru extracted from EXAFS data for the nanoparticles support the core-shell structure revealed by ASAXS and WAXS.

Keywords: anomalous scattering, small-angle x-ray scattering, nanoparticles