Ruthenium deposition on CO_2-treated and untreated carbon black investigated by electron tomography

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Ruthenium nano-particles modified by selenium were investigated in the last decade as an alternative to platinum which is used as electro-catalyst in fuel cell cathodes. In order to achieve highly loaded Ru-Se catalysts in a well dispersed and active state, selected parameters of the preparation procedure were optimised, such as the morphology and surface chemistry of the carbon support, the active metal precursor compounds, the amount of the selenium promoter and the process parameters of the thermal treatment during catalyst formation [1]. These investigations revealed, that the characteristics of the carbon blacks used differ significantly and have a severe impact on the distribution and size of the ruthenium particles. The role of the carbon black pre-treatment by CO_2 on the ruthenium deposition properties is investigated in this contribution.

Commercial carbon black (Black Pearls by Cabot and Vulcan XC-72 by Cabot) was used as starting material, which was either used as-received or pre-treated in a CO_2 atmosphere at a temperature of 950 °C. Ruthenium loading was done by impregnation with $RuCl_4$ and a subsequent heat treatment at 250°C in a H_2/N_2 atmosphere. Finally, the carbon-supported ruthenium nanoparticles were modified with selenium by impregnation with $SeCl_4$ and a heat treatment at 850°C.

Differences in porosity of the carbon support and the distribution of $RuSe_x$ particles are investigated by TEM tomography in a Zeiss LIBRA 200 microscope. Reconstructed volume data sets are obtained using the IMOD [2-3] software for reconstruction of tilt series.

Figure 1 shows typical examples for the observed morphologies: Vulcan XC-72 carbon black has less porous parts on which large catalyst particles are deposited, whereas Black Pearl carbon black has a fine porosity with small and uniformly distributed Ru-particles.

1. G. Zehl, G. Schmithals, A. Hoell, S. Haas, C. Hartnig, I. Dorbandt, P. Bogdanoff, S. Fiechter, Angewandte Chemie / International Edition **46** (2007) p. 7311-7314
2. J. R. Kremer, D.N. Mastronarde, J.R. McIntosh, J. Struct. Biol. **116** (1996) p. 71-76.
3. D. N. Mastronarde, J. Struct. Biol. **120** (1997) p. 343-352.
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