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Structural research of ternary nanoparticles for energy production

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Fuel cells fueled by ethanol became a very popular and interesting alternative as an energy source. This is related to the benefits of ethanol: less toxic compared to methanol, easier stored and transported than hydrogen and available from renewable resources[1,2]. However, the usage of ethanol as fuel, creates various challenges such as the difficulty to split the C–C bond [3]. Therefore the key challenge is to design and develop the appropriate type of catalysts. So far, the best catalysts for ethanol oxidation seem to be ternary PtRh / SnO_2 nanoparticles designed by the Adzic group [1,4,5]. Additionally to improve the SnO_2 electrocatalytic activity, F or Sb can be added [6].
Each of the three constituents has its own role in the oxidation pathway. The role of Rh is to cleave the C-C bond of ethanol, while SnO_2 provides OH species to oxidize intermediates and to free Pt and Rh sites for further ethanol oxidation [7].
The motivation for the present work is a better understanding of the synergistic effect between these three components in the nanocatalysts, develop the knowledge about electrocatalytic ethanol oxidation and try to replace rhodium in the ternary catalyst PtRh / SnO_2 by rhenium. In the present study three types of nanoparticles were synthesized: tin dioxide, platinum and rhenium nanoparticles. Subsequently, the Pt and Re nanoparticles were mixed together and deposited on the synthesized SnO_2 supports. The obtained PtRe / SnO_2 catalysts were deposited on carbon black (Vulcan XC-72R).
Global information about the nanoparticle size was obtained by Photon Correlation Spectroscopy (PCS). The structural and chemical analyzes of the nanocatalysts were carried out using transmission electron microscopy in the STEM mode using the HAADF detector. The structural analysis clearly showed that the all nanoparticles had a crystalline structure. The Pt and Re NPs had similar dimensions of around 3 nm and did not show a strong agglomeration compared to tin oxide NPs. This research is aimed to study surface properties of these nanocatalysts and determine their selectivity for the total oxidation of ethanol to CO_2.

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Primary author: Mrs DRZYMAŁA, Elżbieta (Institute of Nuclear Physics PAN)

Co-authors: Dr KOWAL, Andrzej (Institute of Nuclear Physics PAN); Mr GRUZEŁ, Grzegorz (Institute of Nuclear Physics PAN); Mrs PARLIŃSKA-WOJTAN, Magdalena (Institute of Nuclear Physics PAN)

Presenter: Mrs DRZYMAŁA, Elżbieta (Institute of Nuclear Physics PAN)

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