

Some aspects of metal -support strong interactions in Rh/Al₂O₃ catalyst under oxidising and reducing conditions

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The aim of the paper is to elucidate the nature of the metal-support strong interactions in Rh/Al₂O₃ catalyst. The way of the investigations was unconventional; the mixed Rh-O-Al xerogel was used as a catalyst precursor and the catalyst was obtained by its annealing at 1113 K in air. Such thermal treatment yielded the catalyst in which Rh was either incorporated in the forming alumina crystallites or segregated on their surfaces. As-prepared catalyst was then oxidized at 773 K in oxygen and next reduced at 773 K in hydrogen or at 873 K in methane.

The changes in the rhodium content and in the oxidation degrees of Rh and Al in the surface nanolayers of 2 wt % Rh / Al₂O₃ catalyst during its oxidation and reduction were investigated by X-ray photoelectron spectroscopy (XPS). The powder X-ray diffraction (XRD) and high-resolution transmission electron microscopy (HRTEM) were used for phase identification in the catalysts. The results revealed the presence of a Rh⁴⁺/δ Al₂O₃ solid solution, Al-Rh bimetallic phase and Rh₂O₃ in the surface nanolayers of the freshly prepared catalyst. They also revealed that, during the catalyst interaction with hydrogen or methane, Rh₂O₃ and the Rh⁴⁺/δ Al₂O₃ solid solution undergo reduction to Rh and Rh-Al bimetallic phase, respectively. Aluminium was shown to segregate on the surface of Rh-Al nanocrystallites during the catalyst annealing in the reducing conditions. It was revealed that the next oxidation results in the formation of the alumina layers on Rh⁴⁺/δ Al₂O₃ solid solution nanocrystallites, making difficult their reduction at 773 K but not at 873 K.