

Catalytic activity of palladium and platinum nanoparticles supported on metal fluorides

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Abstract

Palladium and platinum supported on metal fluorides were a subject of the investigation. The synthesized catalysts were tested in the reactions of *n*-pentane isomerization and chlorohydrocarbons hydrodechlorination.

In my studies aluminum and magnesium fluorides prepared by non-aqueous fluorolytic sol-gel method and characterized by high surface area were chosen as a support for the catalysts. An active metal phase (Pd, Pt) was deposited by adding precursors during a support synthesis or by an incipient wetness impregnation method. Post-fluorination and reduction steps were used for the activation of catalysts after synthesis. As a result, active palladium and platinum nanoparticles supported on metal fluorides were obtained.

Active catalysts were characterized by high surface (*HS*) area i.e. $>200 \text{ m}^2/\text{g}$, high acidity, in case of *HS*-AlF₃-supported catalysts, and high metal dispersion. The results from infrared spectroscopy-photoacoustic spectroscopy (FTIR-PAS) and temperature programmed desorption of ammonia (NH₃-TPD) showed the presence of Lewis and Brønsted acid sites. In addition, transmission electron microscopy (TEM) and X-ray Diffraction (XRD) confirmed the presence of small nanoparticles of palladium and platinum. The size of metal particles was determined as $<2 \text{ nm}$. A low metal dispersion indicated by hydrogen chemisorption, which is in a serious disagreement with the physical methods, can be explained by a low accessibility of a surface of metal nanoparticles. This problem was partially solved by initial pre-oxidation of catalysts.

Catalytic activity of the synthesized materials was investigated in two different types of reactions. Firstly, the efficiency of Pd-based catalysts was tested in the reaction of carbon tetrachloride and 1,2-dichloroethane hydrodechlorination. The catalysts exhibited high selectivity to hydrocarbons (C₁-C₄) formation, but the overall activity and stability were rather modest. *n*-Pentane isomerization was used as a second type of reaction. This process is very important in oil-refinery for production of high octane gasoline component. Pd/*HS*-AlF₃ and Pt/*HS*-AlF₃ catalysts showed an extremely high selectivity to the most desirable product - isopentane. Moreover, the materials demonstrated high level of substrate conversion for a long-term (7 days) experiment.

As a result, Pd and Pt supported on metal fluorides have many advantages and can be used for future investigation and preparation of new types of industrial catalysts.