Physico-Chemical nanomaterials

Functionalized silicasorbents containing platinum metals for efficient nanomaterials based catalysts

O. Yu. Boldyrieva[1], A. M. Bondar[1], O. B. Volovenko[1], O. A. Zaporozhets[1], A. V. Yatsymyrskiy[1], D. A. Stratiychuk[2], V. V. Lisnyak[1]

[1] Taras Shevchenko Kyiv National University, 60 Volodymyrska str., Kyiv-1601, Ukraine.E-mail:lisnyak@univ.kiev.ua

[2] V. N. Bakul Institute of Superhard Materials, NAS of Ukraine, 2 Avtozavodska str., Kyiv-04074, Ukraine.

Nowadays, hydrogen (H_2) is considered as a potential fuel for numerous power engines and generators. The progress in H_2 adaptation causes an increase of the attention of researchers to the reaction of $2H_2 + O_2 = 2H_2O$, which can be used to solve some of the negative effects of H_2 fuels utilization, when H_2 is mixed with the atmospheric oxygen. The latter can be preventing by H_2 recombination. Recombiners can treat even non-flammable mixtures, but they slowly eliminate H_2 from O_2 rich gas mixtures. Therefore, for the effective recombination one needs for development of high efficient H_2 oxidation catalysts, as nano-materials. One of the important steps in the development of the high-active catalysts includes a search for support of the most active oxidation catalysts being the nano-sized platinum-group metals (PGM). In this work, the nano-materials based oxidation catalysts were prepared by adsorption/impregnation of PGM ions on silochrom and silica gels functionalized with different organics such as AcAc, primary alkylic amines, as -Pr-NH_2, thiourea, malonic acid and quaternary ammonium salts. The hydrogen oxidation catalysts containing nano-particles of PGM were formed by using red/ox routs applied to the surface complexes of platinum metals with 0.1–0.5 mass% of PGM. The optimal range of the reduction temperature to form nanosized particles was chosen within 120–230 ºC. The higher temperature, according to the TG-H_2 reduction data, is an optimal for a mild reduction of PGM and the partial destruction of the surface complexes. The catalytic activity of the prepared nanocatalysts was examined in the H_2 oxidation with O_2 under GC control of H_2 conversion versus temperature and time. The results of catalytic test show that the H_2 conversion versus the temperature has a hysteretic character for up to 25 cycle of heating-cooling. The latter could be assigned to the reaction passing via heterogeneous-homogeneous mechanism, besides all the nanocatalysts show high catalytic activity at –10–50 °C. The temperature at the total conversion for the prepared catalysts is achieved at 20–120 °C lower than for the commercial KP-0.1-0.5 and some of the BASF catalysts.