

**SYNTHESIS, CHARACTERIZATION, AND CATALYTIC PROPERTIES OF METAL
POLYMER COMPLEXES BASED ON COPOLYMERS OF
POLYETHYLENE (PROPYLENE) GLYCOL MALEATES WITH ACRYLIC ACID**

T.O.Khamitova*, S.Zh.Davrenbekov, A.T.Kazhuratova, S.K.Topaeva,
A.A.Taiken, A.M.Adeshova

*Buketov State University, Karaganda, Kazakhstan, *e-mail: khamitova.t@inbox.ru*

One of specific features of metal–polymer composites is that active components in the form of nano- and microcrystals are distributed in the bulk of the polymer matrix, which stabilizes them, preserving the high activity of metal particles and remaining a highly elastic support. The metal/polymer composites combining unique properties of the polymer and metals acquire some new properties that the materials taken separately do not have. These materials of a new class are used as electrode materials for making high-sensitivity selective electrodes, chemical sensors, and various detectors giving response to ions and molecules of dissolved substances being analyzed in monitoring of various natural objects. Metal/polymer composites are efficient as catalysts and electrocatalysts [1, 2].

New mono- and bimetallic polymer complexes p-EGM: AA/Ag, p-EGM:AA/Ni, p-EGM: AA/Ag–Ni, p-PGM:AA/Ag, p-PGM:AA/Ni, and p-PGM:AA/Ag–Ni, exhibiting catalytic activity in hydrogenation, were prepared by immobilization of metal particles in supports of p-EGM(PGM) : AA copolymers. The reaction can be performed under mild conditions with high yield using the p-EGM : AA/Ag–Ni catalyst containing 0.9% Me.

The structure of all the mono- and bimetallic polymer complexes synthesized was confirmed by IR spectroscopy. According to the SEM data, the metal nanoparticle size depended on the pore size in the initial polymer matrices, p-EGM:AA and p-PGM:AA. For MPC-1,2 samples prepared from p-EGM:AA (14.8/85.2 wt %), the particle size was 80 ± 10 nm, which corresponds to the denser structure of the support. For MPC based on p-PGM:AA (15.1/84.9 wt %), the particle size was 85 ± 5 nm, in agreement with the TEM estimation of the pore size. The EDX data show that the distribution of Ni⁰ and Ag⁰ over the polymer cross section is relatively uniform. The mean number of metal particles per 25 μm^2 is $\sim 1800 \pm 100$ for Ag and $\sim 1200 \pm 100$ for Ni.

The reaction rate in the presence of bimetallic systems increases by a factor of ~ 5 – 6 compared to monometallic nickel and by a factor of ~ 10 – 11 compared to the system without catalyst; correspondingly, the selectivity to piperidine increases by a factor of ~ 3 – 4 .

Our results show that the optimum conditions for electrocatalytic hydrogenation of pyridine are as follows: 1.5 A, 35°C, bimetallic catalyst p-EGM:AA/Ag–Ni (0.9% Me), on which the reaction rate and selectivity with respect to piperidine are the highest.

Its reuse leads to only a minor loss of the activity. It should be noted that the systems obtained can be readily separated from the reaction products and repeatedly used without activity loss.

References

1. Lee J. H., Kamada K., Enomoto N., Hojo J. // J. Colloid Interface Sci. 2007. V. 316. P. 887.
2. Burkeev M. Zh., Khamitova T.O., Havlicek D., Bakibaev A.A., Tazhbaev E.M., Davrenbekov S.Zh., Kozhabekova G.E.. Synthesis and Catalytic Properties of Polymer-Immobilized Nanoparticles of Cobalt and Nickel. Catalysis in Industry. – 2018. - Vol. 10, №4. P. 270–278.