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# Investigation of graphene supported platinum, platinum-nickel and platinum-nickel-titania nanoparticles as electrocatalysts for fuel cells

L. Tamašauskaitė-Tamašiūnaitė[1], J. Jablonskienė[1], M. Semaško[2], A. Balčiūnaitė[1], A. Zabielaitė[1], J. Vaičiūnienė[1], R. Kondrotas[1], R. Juškėnas[1], E. Norkus[1]
[1]Center for Physical Sciences and Technology, A. Goštauto 9, LT-01108 Vilnius, Lithuania
[2]Vilnius University, Naugarduko 24, LT-03225 Vilnius, Lithuania

The demand for clean and sustainable energy sources has become a strong driving force in continuing economic development, as well as in the improvement of human living conditions. Proton exchange membrane (PEM) fuel cells, as clean energy-converting devices, have drawn a great deal of attention in recent years due to their high efficiency, high energy density, and low or zero emissions. PEM fuel cells have several important application areas, including transportation, stationary and portable power, and micro-power (1-4). Since methanol, ethanol and borohydride is used as fuel, a great deal of effort has been put into the exploration of cost-effective, active, and stable catalysts with high activity towards the oxidation of methanol, ethanol and borohydride.

In the present study a rapid microwave heating method was used to prepare graphene supported platinum, platinum-nickel and platinum-nickel-titania nanoparticles electrocatalysts (denoted as Pt/GR, Pt-Ni/GR and Pt-Ni-$TiO_2$/GR). The transmission electron microscopy was employed to characterize the catalysts. Inductively coupled plasma optical emission spectrometry was used for estimation of Pt and Ni metal loadings. The electrocatalytic activity of the synthesized catalysts towards the oxidation of methanol, ethanol and borohydride was investigated by means of cyclic voltammetry and chronoamperometry. The electroactive surface areas of the prepared catalysts were determined from the cyclic voltammograms of Pt/GR, Pt-Ni/GR and Pt-Ni-$TiO_2$/GR catalysts recorded in a deaerated 0.5 M $H_2SO_4$ solution at a sweep rate of 50 mV $s^{-1}$.

The Pt/GR, Pt-Ni/GR and Pt-Ni-$TiO_2$/GR catalysts synthesized by means of the microwave heating irradiation with different platinum and nickel loadings were prepared and their properties were compared. It was found that the prepared catalysts exhibited a high catalytic efficiency towards the oxidation of methanol, ethanol and borohydride comparing with that of pure Pt electrode.

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