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Synergistic Effects of Bismuth Adatoms on Electrocatalytic Properties of Electrodeposited Nanostructured Platinum Electrodes

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An innovative simple procedure for preparation of platinum nanostructured electrode deposited on a tantalum substrate by application of a square wave potential regime has been established. The potential regime comprises a square wave between two limits, the lower limit allows spontaneous deposition of platinum while the upper limit does not. The dependence of the produced particles in terms of size and uniformity of distribution was explored. The optimal conditions for preparation of the nanostructured platinum deposits were 100 Hz frequency, -0.4 V and 0.00 V lower and higher limits of the square wave respectively with an amplitude of 0.4 V . The optimal concentration of $PtCl_4^-$ was $1.0x10^{-3}$ M. The prepared surfaces were allowed to contact 0.5 M H_2SO_4 + $1x10^{-3}$ M Bi^{3+} solution were Bi atoms were irreversibly adsorbed at the platinum nanostructured surfaces to form $Pt_{nano}Bi_{ad}$ surfaces (a notation for platinum nanostructured surface with irreversibly adsorbed Bi atoms). The electrocatalytic properties of $Pt_{nano}Bi_{ad}$ catalytic surfaces were tested for electrooxidation of methanol and formic acid. $Pt_{nano}Bi_{ad}$ electrode showed higher electrocatalytic properties than the plain Pt_{nano} electrode. This proves the notion of the synergistic effects of Bi adatoms and nanostructured surfaces in imparting higher electrocatalytic properties to platinum electrodes.

Keywords: platinum nanostructured electrodes, adatom electrodes, synergistic catalytic effects, electroxidation of methanol, electroxidation of formic acid.

FULL TEXT