Preparation of PtM catalysts by electrodeposition for methanol oxidation

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Abstract

During the last decades fuel cells have attracted a great interest as an alternative form of energy production due to its high efficiency and low environmental impact [1]. A fuel cell is an electrochemical device that converts continuous and directly the chemical energy of a fuel source (hydrogen, alcohols…) and oxygen to electricity. These devices operate continuously while the electrodes are fed, unlike batteries, which have a limited capacity. They consist of two electrodes separated by a proton conductive membrane. At the anode occurs the oxidation of fuel and at the cathode the oxygen reduction. The direct methanol fuel cells (DMFC) are a type of polymer electrolyte membrane fuel cell (PEMFC) using aqueous solutions of liquid methanol (MeOH) as fuel. One of the advantages of the methanol compared to hydrogen is that MeOH is liquid, which allows easier handling, transportation and storage, and, moreover, it has a higher energy density and a lower price than hydrogen. The major drawback of these devices is the slow kinetics of methanol oxidation making necessary the use of catalysts. Platinum is the best metal that catalyzes the oxidation of methanol but it is easily poisoned by CO, a product resulting from the oxidation. Binary or ternary alloys of platinum such as ruthenium, cobalt or nickel decrease the poisoning and increase the catalytic activity toward complete methanol oxidation [2].

The main objective in this work was to obtain, by using electrodeposition techniques, a PtM nanoparticle series to catalyze the methanol oxidation reaction (MOR). Electrodeposition allows obtaining nanoparticles in a quick and easy way, although the deposits can only be performed on conductive material. In our case, this need turned what looks like a disadvantage into an advantage, since our intention was the direct preparation of nanoparticles on carbonaceous supports [3]. The composition of the prepared materials and the particle size were modulated by varying applied potential and deposition method. These materials have been morphologically characterized and evaluated as electrocatalysts for methanol oxidation in half-cell. SEM micrographs of these materials deposited on glassy carbon or carbon cloth showed homogeneous and well-distributed deposits (Figure 1). Moreover, their catalytic activity toward methanol oxidation in acidic media is a promising feature (Figure 2).

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References

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Figures

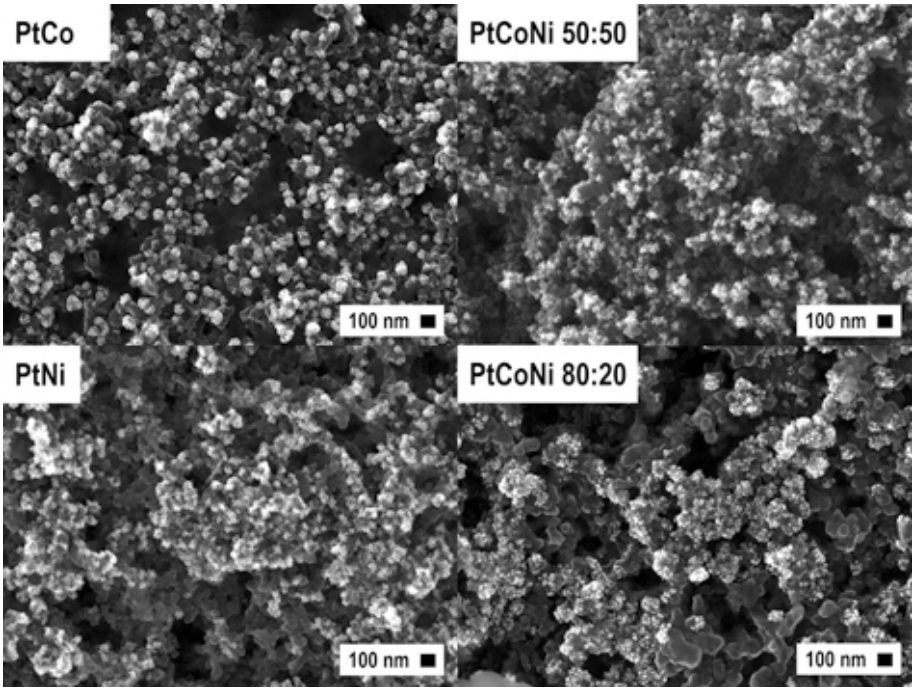

Figure 1.SEM micrographs of various deposits of PtM on microporous carbon cloth: PtCo; PtNi, and PtCoNi.

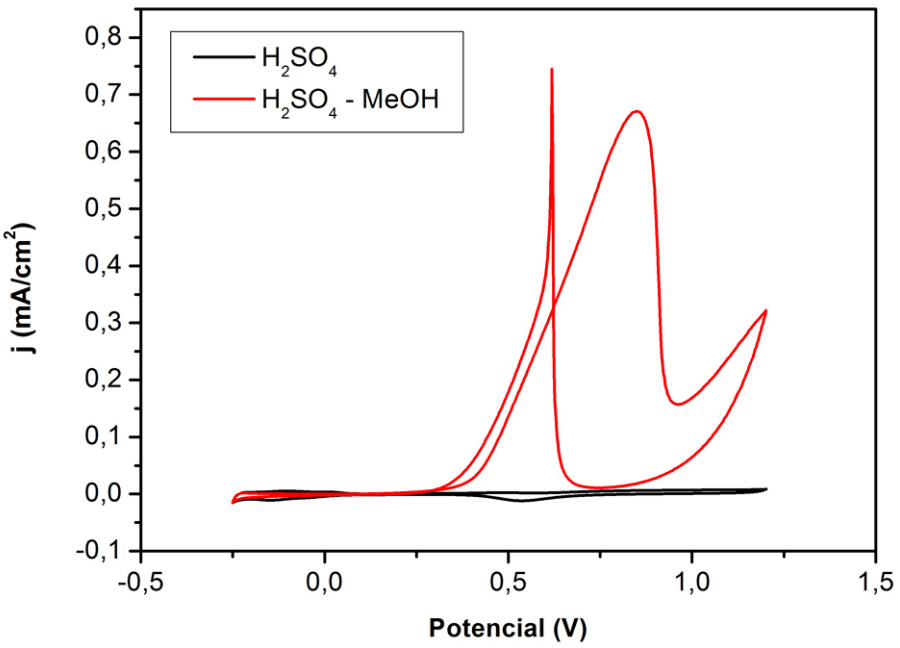

Figure 2. Cyclic voltammetric curve of a PtCo catalysts for MOR in 0.5 M H_2SO_4 + 1.0 M MeOH solution at a sweep rate of 10 mV s^{-1}.