

Electrochemical characterization of PtCu catalyst for methanol electrooxidation

Elektrohemijska karakterizacija PtCu katalizatora za elektrooksidaciju metanola

Sanja Stevanović*, Dragana Milošević, Dušan Tripković

¹ University of Belgrade, Institute of Chemistry, Technology and Metallurgy, National Institute of the Republic of Serbia, Njegoševa 12, 11000 Belgrade, Serbia

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*sanjas@ihtm.bg.ac.rs

Abstract

Direct methanol fuel cells (DMFCs) have ignited significant interest due to their straightforward design, efficient energy conversion, and eco-friendly emission characteristics. Creating efficient and long-lasting platinum-based catalysts is vital for advancing DMFCs. However, the most difficult concerns in the fuel cell sector are cost, efficiency, and lifetime. Because platinum is the most expensive component of DMFCs, it is most important to produce catalysts with higher activity and stability while reducing the content of expensive platinum. By integrating non-precious metals, such as copper, with platinum, we can significantly decrease reliance on costly platinum while enhancing catalytic efficiency, paving the way for a highly effective and versatile solution for a wide range of electrocatalytic applications. Recently, PtCu alloy catalysts have attracted particular attention because the formed bimetallic structures of Pt and Cu could enhance platinum activity and tolerance to CO poisoning, a common byproduct of the reaction. The synergistic effect between platinum and copper increases the overall catalytic activity, which lies in enhanced CO tolerance, bifunctional and electronic effects. Additionally, it is well-known that an optimized catalyst synthesis procedure could reduce the noble catalyst consumption and enhance its electrocatalytic performance. In this work, microwave-assisted polyol method was used to obtain PtCu/C catalyst for effective methanol oxidation reaction. The electrocatalytic activity of PtCu/C catalyst was examined in 0.5 M H₂SO₄ + 0.5 M CH₃OH solution. Catalyst stability was examined by long-term potential cycling. The results from cyclic voltammetry experiments indicate enhanced catalytic activities for methanol oxidation reaction and improved resistance ability to CO inhibition, after addition of Cu to Pt catalyst.

Keywords: fuel cells; platinum catalysts; PtCu alloy; methanol oxidation

Izvod

Direktne gorivne ćelije sa metanolom kao gorivom (DMFC) izazvale su značajno interesovanje zbog svog jednostavnog dizajna, efikasne konverzije energije i ekološki prihvatljivih karakteristika emisije. Stvaranje efikasnih i dugotrajnih katalizatora na bazi platine je od vitalnog značaja za unapređenje DMFC-a. Međutim, najteža pitanja u sektoru gorivnih ćelija su troškovi, efikasnost i vek trajanja. Pošto je platina najskuplja komponenta PEMFC-a, potrebno je proizvesti katalizatore sa većom aktivnošću i stabilnošću, uz smanjenje sadržaja skupe platine. Integracijom neplemenitih metala, kao što je bakar, sa platinom, možemo značajno smanjiti zavisnost od skupe platine, a istovremeno poboljšati katalitičku efikasnost, otvarajući put ka veoma efikasnom i svestranom rešenju za širok spektar elektrokatalitičkih primena. Nedavno su katalizatori u obliku PtCu legura privukli posebnu pažnju jer formirane bimetalne strukture Pt i Cu mogu poboljšati aktivnost platine i toleranciju na trovanje CO, koji je nepoželjni međuprodukt reakcije. Sinergijski efekat između platine i bakra dovodi do povećanja ukupne katalitičke aktivnosti, što leži u poboljšanoj toleranciji na CO,

bifunkcionalnim i elektronskim efektima. Pored toga, dobro je poznato da optimizovana procedura sinteze katalizatora može smanjiti potrošnju plemenitog katalizatora i poboljšati njegove elektrokatalitičke performanse. U ovom radu, korišćena je mikrotalasna poliolna metoda za dobijanje PtCu/C katalizatora za efikasnu reakciju oksidacije metanola. Elektrokatalitička aktivnost PtCu/C katalizatora ispitana je u rastvoru 0,5 M H₂SO₄ + 0,5 M CH₃OH. Stabilnost katalizatora ispitana je dugoročnim cikliranjem potencijala. Rezultati eksperimenata ciklične voltametrije ukazuju na poboljšanu katalitičku aktivnost za reakciju oksidacije metanola i poboljšanu otpornost na inhibiciju CO, nakon dodavanja Cu u Pt katalizator.

Ključne reči: gorivne ćelije; platinski katalizatori; PtCu legura; elektrooksidacija metanola

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