Electrocatalytic oxidation of ethanol on Ni electrode

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Introduction

Direct alcohol fuel cells (DAFCs) were attracting increasing interest as a compact power sources for portable applications, mainly due to the relatively simple handling, storage, and transportation of the fuel. However, the question of the toxicity of methanol remains crucial. Methanol is considered since a long time as a toxic product (mainly neurotoxic). It is to use other alcohols presenting negligible or very low chemical toxicity, which is essential, at least for some applications. Ethanol appears to be an interesting alternative fuel for a wide utilization [1]. Its low toxicity added to its availability (from biomass products) is an important positive point for its use as an alternative fuel to methanol even if its reactivity is slightly lower.

Despite its attractive properties, finding a catalyst that allows a complete ethanol oxidation to produce 12 electrons per molecule still remains a great challenge [2].

The purpose of the present work is to study the electrochemical oxidation of ethanol on a nickel electrode aiming at the elucidation of the mechanism, derivation of the kinetic parameters of the process and the usefulness of the electrocatalytic process.

Keywords: Electrocatalytic, Ethanol, Fuel cell, Nickel.

Experimental

Sodium hydroxide and ethanol used in this work were Merck products of analytical grade and were used without further purifications. Electrochemical studies were carried out in a conventional three electrode cell powered by an electrochemical system comprising of EG & G model 273 potentiostat/galvanostat. The system is run by a PC through M270 commercial softwares via a GPIB interface.

Fig. 1 shows cyclic voltammogram of Ni electrode in 1M NaOH solution in the presence of 0.3 M ethanol and at a potential sweep rate of 10mVs⁻¹. At Ni electrode, oxidation of ethanol appeared as a typical electrocatalytic response. The anodic charge increased with respect to that observed for the modified surface in the absence of
ethanol and it was followed by decreasing the cathodic charge in presence of ethanol in solution.

The anodic current in the positive sweep was proportional to the bulk concentration of ethanol and any increase in the concentration of ethanol caused an almost proportional linear enhancement of the anodic current.

Result and discussion

Redox transition of nickel species present in the film is:

\[ \text{Ni(II)} \leftrightarrow \text{Ni(III)} + e^- \]

and ethanol is oxidized on the modified surface via the following reaction:

\[ \text{Ni(III)} + \text{ethanol} \xrightarrow{k_2} \text{intermediate} + \text{Ni(II)} \]

\[ \text{Ni(III)} + \text{intermediate} \xrightarrow{k_3} \text{products} + \text{Ni(II)} \]

References: