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ETHANOL ELECTRO-OXIDATION AT STAINLESS STEEL SURFACES

Resumo: Non-noble metals have been extensively used in electrocatalysis due to their affordability and high performance in different reactions. Nickel (Ni) in particular, is widely utilized as a catalyst for oxygen evolution reaction (OER) and ethanol oxidation reaction (EOR), primarily in the NiO_x state. Doping Ni with other elements, such as Fe^{3+}, assists in regulating the electronic structure of NiOOH, which is the most active specie for oxidation reactions.[1] In this study, our aim was to explore the potential of stainless steel (SS) compositions as a catalyst for EOR. We selected the SS310 alloy, which contains ~20% of nickel (with respect to Fe). Considering its high Fe content, this alloy has a potential to serve as a good catalyst for EOR. However, a significant challenge we encountered was the passivation of SS, necessitating a pre-treatment process. To overcome this, we subjected the alloy to a high-current treatment for few minutes, which promoted the conversion of elements to a high valence state. Subsequently, we rapidly immersed it in an acid solution of HCl and HNO_3 to remove the formed oxide layer.[2] Apart from identifying the activity for SS to oxidate 0.5 molar of ethanol, we also observed that the reaction is sensitivity to the cation nature, comparing 1 molar of LiOH, NaOH and KOH. Using KOH as electrolyte achieved the highest activity, while LiOH exhibited the lowest. We attributed this behavior to the intercalation of the cation in the Ni layers and its relationship with the hydrated radii of the cations. Surprisingly, during the oxidation process, electrochemical impedance spectroscopy (EIS) revealed the existence of Hopf bifurcation. This phenomenon manifests as a negative differential resistance (NDR) in the Nyquist plot, indicative of dynamic instabilities within the system. Indeed, potential oscillations were observed across all the electrolytes within 1.45 and 1.57 V_{RHE}, corresponding to the conversion of β-NiFeOOH and γ-NiFeOOH, in a stable pattern. However, Hopf bifurcation emerges from an adsorbate- adsorbate interaction, which was unexpected for this system, and further discussions on the underlying mechanism are ongoing.[3] Overall, this contribution presents a new perspective on the utilization of stainless steel in electrocatalysis as an effective catalyst for the oxidation of organic molecules. Stainless steel demonstrates potential as a relatively inexpensive catalyst with applications in renewable energy systems.

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