Oscillatory Ethanol Electro-oxidation on Platinum-Niobium Electrodes

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The electro-oxidation of ethanol has emerged as a promising route for sustainable hydrogen production and energy conversion in electrochemical devices. [1,2] This study investigated the dynamics of ethanol electro-oxidation under oscillatory conditions using platinum–niobium (PtNb/C) catalysts with two distinct metal ratios (3:1 and 1:1). The carbon-supported catalysts were synthesized by chemical reduction with sodium borohydride and evaluated for their electrocatalytic performance under oscillatory conditions in acidic medium. The investigation focused particularly on the role of surface-free regions on the electrode and the presence of short-lived intermediate species adsorbed during the oscillatory regime. PtNb/C electrodes exhibited distinct oscillatory behaviors. The 1:1 Pt:Nb catalyst showed lower current consumption and shorter oscillation periods, indicating higher efficiency and a less poisoned surface. Niobium played a key role in mitigating poisoning intermediates, enhancing ethanol electro-oxidation with reduced Pt content. XRD and EDS confirmed niobium incorporation in both 3:1 and 1:1 formulation. While the 3:1 behaved similarly to commercial Pt/C, the 1:1 showed higher current, lower frequencies, and greater dynamic stability. These findings reinforce niobium's potential as a promoter, combining reduced cost, improved activity, and sustainability.

Acknowledgments:

RCGI – Research Centre for Greenhouse Gas Innovation, hosted by USP and sponsored by FAPESP (#2020/15230-5) and Shell Brasil, and ANP (Brazil's National Oil, Natural Gas and Biofuels Agency) through the R&D levy regulation. HV (FAPESP, #2019/22183-6) and CNPq (##311419/2023-2); NVB (CNPq, #350422/2023-0); HSA (PUB-USP).

References:

[1] O. Faye, J. Szpunar, e U. Eduok., Int J Hydrogen Energy, 47, 13771–13802, (2022).

[2] L. Jiang, A. Hsu, D. Chu, e R. Chen. Int J Hydrogen Energy, 35, 365–372, (2010).