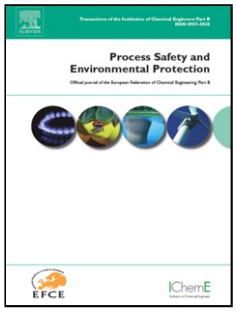

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Authors: Soraya Hosseini, Soorathep kheawhom, Salman Masoudi Soltani, Mohamed Kheireddine Aroua, Houyar Moghaddas, Rozita Yusoff

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Improvement of Product Selectivity in Bicarbonate Reduction into Formic Acid on a Tin-based Catalyst by Integrating Nano-diamond Particles

Soraya Hosseini[a,*], Soorathep kheawhom[a], Salman Masoudi Soltani[b], Mohamed Kheireddine Aroua[c], Houyar Moghaddas[d],Rozita Yusoff[e]

[a]Computational Process Engineering Research Laboratory, Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok 10330, Thailand

[b]Department of Mechanical, Aerospace & Civil Engineering, College of Engineering, Design and Physical Sciences, Brunel University London, London UB8 3PH, United Kingdom

[c]Research Centre for Nano-Materials and Energy Technology (RCNMET), School of Science and Technology, Sunway University, Bandar Sunway, 47500, Petaling Jaya, Malaysia

[d]Departments of Immunology and Physiology, Faculty of Arts and Science, University of Toronto, Ontario, Canada

[e]Department of Chemical Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia

*Corresponding author's Tel: +60387344414
*Corresponding author's e-mail: soraya20h@gmail.com

Abstract

In this study, the efficiency of electrochemical reduction of bicarbonate into formic acid was improved by using a composite electrode made up of tin (Sn), nanodiamond (ND) and carbon nanotube (CNT). In the absence of ND, a compositional ratio of 10/90 (Sn/CNT) demonstrated the highest current density. However, by adding ND in a compositional ratio of 10/90/100 (Sn/CNT/ND) the highest efficiency towards formate/formic acid was achieved. It was observed that the presence of ND enhanced the selectivity of product for formic acid. The effects of bicarbonate concentration and scan rate have also been studied to understand the reduction mechanism. The peak potential shifted towards larger negative values of applied potential with an increase in the scan rate from 0.01 to 0.1 V/s, confirming the irreversible nature of the reduction process. The linear relationship between the current and the square root of the scan rate (with a slope value of 0.519) suggested that the reaction process is fully diffusion-controlled. Formic acid was produced using both electrodes; however, the electrode containing nano-diamond successfully improved the process yield for formic acid. Electrochemical impedance study revealed a significant difference between Warburg coefficient for oxidation and reduction processes with values of 29.63×10^{12} and