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Driving the Pathway of CO_2RR by Controlling Water Concentration in Ionic Liquids

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CO_2, a major greenhouse gas linked to global warming, can serve as a reagent for producing valuable molecules[1]. Electrocatalysis is a promising approach for CO_2 reduction under ambient conditions, using water to hydrogenate molecules[2]. However, this field faces the challenge that water also contributes to energy losses via the Hydrogen Evolution Reaction (HER)[3]. Ionic Liquids (ILs), molten salts at room temperature, have shown the ability to expand the Electrochemical Stability Window (ESW), enabling the possibility to work at more negative potentials[4]. This study demonstrates that by controlling water concentration in ILs, it is possible to mitigate the HER and to control CO_2RR pathways. For instance, it was possible to apply -1.6 V vs Fc/Fc^+ with 20 mmol L^{-1} of water and achieve approximately 13% of faradaic efficiency (FE) for H_2. Also, comparing the products distribution, when applying -0.9 and -1.0 V vs Fc/Fc^+ with 80 mmol L^{-1} of water, as shown at Figure 1B, it is possible to drive the CO_2RR toward methanol and methane production. In contrast, with 20 mmol L^{-1}, represented by Figure 1A, at the same potentials, these two products practically disappear, indicating that the intermediate *CHO is less favorable in this situation.

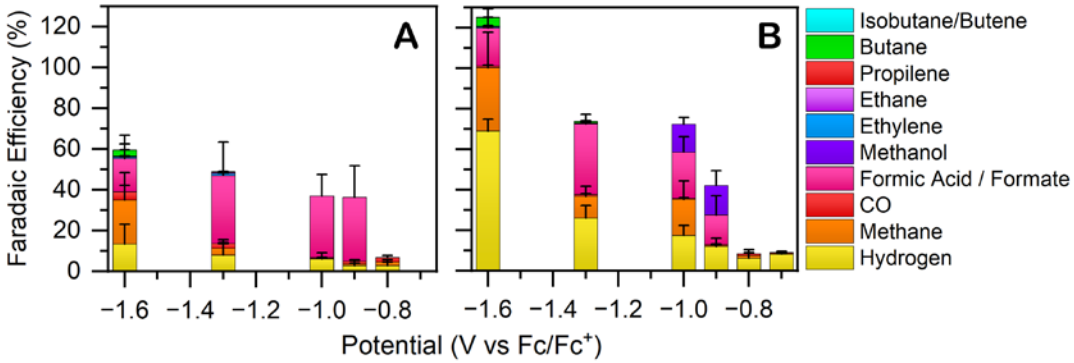

Figure 1: *Faradaic efficiencies for different products from -0.7 to -1.6 V vs Fc/Fc^+ with (A) 20 mmol L^{-1} and (B) 80 mmol L^{-1} of water. The selected potentials were applied for 3 hours, and the products were determined by NMR-H and GC-FID/TCD for liquid and gaseous molecules, respectively.*

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