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Electrochemical Investigation of Urea Oxidation on β $Ni(OH)_2$ and $Ni/Ni(OH)_2$

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Abstract

Urea oxidation is the key limiting reaction in energy conversion devices based on this molecule. Ni-based catalysts are widely used to catalyze this reaction via the intermediate formation of reactive NiOOH from nickel hydroxide. In this study, β $Ni(OH)_2$ urea oxidation activity is compared to $Ni/Ni(OH)_2$. Electrochemical active surface area, exchange current density, rate constants, and capacitance are estimated for these catalysts to mechanistically probe the reaction. A quantitative electrochemical analysis of urea oxidation on these catalyst surfaces yields important reaction parameters. The reaction orders of β $Ni(OH)_2$ with respect to KOH and $(NH_2)_2CO$ are 1.22 and 0.26, respectively, at a kinetically-controlled potential of 1.43 V vs. RHE. The reaction order with respect to KOH decreases gradually with potential and it is almost constant with urea. The similar trends in reaction order are observed with $Ni/Ni(OH)_2$. Electrochemical impedance measurements displayed lower charge-transfer resistance of β $Ni(OH)_2$ indicative of faster urea oxidation kinetics. It is observed that at the potential of 1.43 V, the charge transfer resistance of β $Ni(OH)_2$ (87.3 Ω cm_{ECSA}^2) lower by a factor of ~1.23 compared to $Ni/Ni(OH)_2$ (107.6 Ω cm_{ECSA}^2). The electrochemical surface area normalized heterogeneous rate constant of β $Ni(OH)_2$ is 2 times higher than that of $Ni/Ni(OH)_2$, in line their high intrinsic urea oxidation activity, capacitance and higher electrochemical phase stability. Moreover, the electrochemical chemical mechanism is observed on both catalysts in support with earlier report [1].

Keywords: Urea oxidation, β Ni hydroxide, rate constant, mechanism

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