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Ammonia from Air: Electrochemical synthesis from water and nitrogen.

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ABSTRACT

A major technological advancement will be the generation of ammonia directly from air, as this will enable fertilizers and hydrogen fuels to be generated on-site, rather than through conventional large Haber-Bosch reactors and then transported long distances. This paper presents how green ammonia can be synthesis directly from air through nitrogen electrofixation under ambient pressure and temperature conditions. This approach utilises a novel electrochemical cell assembly, that incorporates water droplets within humidified air, that upon a working electrode with an applied potential of at least 1 V produces ammonium. The research focuses on enhancing ammonia selectivity and yield while mitigating side reactions, particularly reducing the hydrogen evolution reaction (HER). This is achieved through the catalyst/binder combination, which is focused on promoting nitrogen sorption. A key focus is on a novel catalyst-binder configurations that maximises ammonia yield and Faradaic efficiency (FE). This is further enhanced through limiting water sorption. As the process efficiency is strongly mass transfer limited, due to the diffusion of nitrogen and ammonia through their respective gas boundary layers, pulsed potential electrochemical nitrogen reduction (P-eNRR) is applied to improve the performance. This technique applies a pulsed potential, so that the working electrode potential fluctuations on the order of milliseconds, which restricts the competing HER. The outcome is improved ammonia production from humidified nitrogen and air, with valuable insights into catalyst-binder design and pulsed potential application for green ammonia synthesis, contributing to the development of sustainable fuel and agricultural solutions.

KEY WORDS

Ammonia; Hydrogen; Electrochemistry

BIOGRAPHY

Colin A. Scholes CChem FRACI CEng MIChemE is a Professor in the Department of Chemical Engineering at the University of Melbourne. He is an expert in clean energy processing and membrane science, particularly developing strategies to assist the transition to a low carbon future as well as the generation and transportation of clean hydrogen carrier fuels.

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