Sustainable electrochemical green ammonia synthesis via vanadium-based catalyst-coated membrane

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Abstract:

Green ammonia is the most promising fuel to pave the way toward a sustainable world. The fast-growing CO_2 gas emission could be suppressed properly using a carbon-free fuel like green ammonia while neither CO_2 is emitted during fuel synthesis nor combustion.Importantly, ammonia will play a crucial role to ease the shortage of food and depletion of natural resources by improving agricultural productivity. In this study, a highly active electroconductive catalyst was synthesised by depositing a vanadium-based catalyst on a graphene sheet. Vanadium atoms are linked to the graphene surface through an organic conjugated ligand during hydrothermal treatment and doped after performing pyrolysis. Meta-stable graphene supported star-like shape catalyst were then loaded onto Nafion membranes to assemble a proton/electron conductive cathodic membrane. In this research, green ammonia was synthesised through the assembled cathodic membrane in an electrochemical cell from water and nitrogen at ambient temperature and pressure. Results show a highly active and stable catalyst with high vanadium quantity towards ammonia formation. In addition to evaluating the effect of graphene loading against ammonia crossover through the Nafion membrane, the impact of applied overpotential, electrolyte condition (type, concentration, pH) and also rection condition (cell's temperature and pressure) are investigated by measuring the ammonia formation rate, Faradic efficiency and current density.

Keywords: Electrochemical, Cathodic membrane, Nitrogen reduction reaction, Electrocatalysis.