MONASH University

MONASH INNOVATION

HIGH EFFICIENCY AMMONIA PRODUCTION

A highly efficient and selective ammonia production process based on electrolysis at ambient temperature and pressure. Novel electrocatalysts combined with a novel electrolyte offer high efficiency with opportunities for recycling and/or on-demand production.

- **High efficiency electrochemical process**
- **Novel electrocatalysts**
- **Novel electrolyte**
- **Possible application in fuel cells**

THE CHALLENGE

Ammonia (NH_3) is one of the most widely produced chemicals worldwide. Fertilising of agricultural crops is the main application, but others include explosives, plastics, fibres and other industrial applications.

Current technology involves reaction of hydrogen gas with nitrogen at high pressure in the presence of a catalyst. The process requires a large amount of energy and more than 1% of global energy consumption is used for ammonia production.

More sustainable ammonia production is possible based on electrolysis of water to generate the hydrogen required, using renewal energy sources. However the process remains inefficient and is not widely used.

Ammonia-based fuel cells also are an important area of development, particularly in the area of renewable energy.

THE TECHNOLOGY

We have developed a very high-efficiency electrochemical process for generating ammonia, either as a gas or in solution.

We have identified a novel family of nanostructured electrocatalysts, which, combined with a novel electrolyte, together provide a very significantly increased efficiency of reaction.

Our new electro-catalysts selectively and efficiently catalyse reduction of nitrogen (N_2) to ammonia (NH_3). These new catalysts overcome the problems associated with previous electrocatalysts that do not have high enough efficiency, catalytic activity and stability for an economically feasible N_2 reduction process.

In addition, our patented electrolyte medium offers the advantage of elevated solubility for N_2 gas, increasing the concentration of nitrogen at the electrolyte / electrode interface, contributing to increased efficiency at ambient temperature and pressure.

The system makes use of atmospheric nitrogen or potentially could use nitrogen generated as a product from ammonia fuel cells.

The combination of increased efficiency and solubility makes our technology an ideal partner for ammonia fuel cells. The ammonia solution may be stored and used when required for energy production. In addition, nitrogen generated as a product from ammonia fuel cells could be used as the source of nitrogen for the ammonia generation process.

A variant of the process allows for direct production of ammonium sulphate in solution, which is commonly used as a fertiliser.

Intellectual property: Three Australian provisional patents filed in 2015/16.

THE OPPORTUNITY.

This technology presents a number of exciting options for development. We seek a partner to take the technology to the next step towards a commercial process.

Our team of researchers are experts in developing novel catalysts and electrolyte media for energy storage / production research.

The Monash research team is led by Prof Doug MacFarlane (Australian Research Council Laurate Fellow; ARC Centre for Electro materials Science – Energy Program Leader).

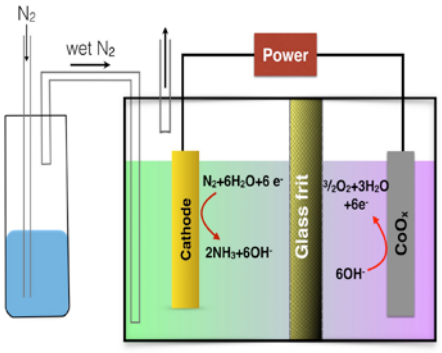

Figure 1: Schematic of a typical electrochemical cell for N_2 reduction.

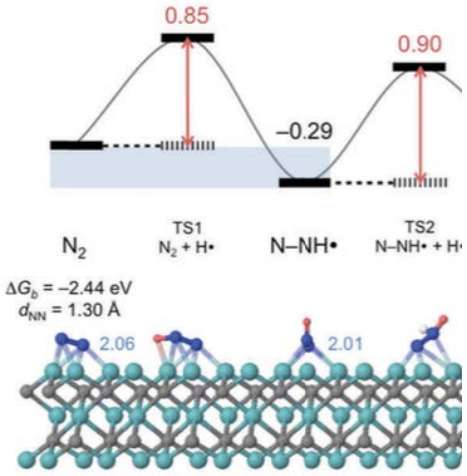

Figure 2: Calculation of low energy pathway on N_2 reducing catalysts.

KEY CONTACT

Angeline Bartholomeusz
Business Development Manager
Monash Science
T: +61 3 9905 4613
E: angeline.bartholomeusz@monash.edu

GROUP OF EIGHT AUSTRALIA

CRICOS provider: Monash University 00008C
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