Developing an eco-friendly ammonia catalyst
19 October 2022

Schematic illustration of the strategies involved in the electroconversion of air pollutant NO to NH\textsubscript{3} via electrolyzer powered by renewable electricity. The produced NH\textsubscript{3} can be used as the feedstock of fertilizers, chemical supply, and energy carriers. Credit: Advanced Science (2022). DOI: 10.1002/advs.202201410

A DGIST research team led by Professor Sangaraju Shanmugam, Department of Energy Engineering, developed a catalyst that converts nitric oxide (NO) to ammonia (NH\textsubscript{3}). This electrochemical technology offers high Faradaic efficiency and low overpotential and produces NH\textsubscript{3} in an eco-friendly manner.

NH\textsubscript{3} is an important chemical raw material in the fertilizer, textile, and pharmaceutical industries, and it is considered a carbon-free hydrogen carrier with a high energy density. Typically, NH\textsubscript{3} is produced using the Haber–Bosch process; however, this process is responsible for approximately 1–2% of global CO\textsubscript{2} emissions.

The electrochemical conversion of NO to NH\textsubscript{3}, an alternative to the Haber–Bosch process, has received considerable attention. This eco-friendly method consumes the air pollutant NO gas to produce NH\textsubscript{3}. Therefore, this promising approach can replace conventional methods without affecting the environment or emitting CO\textsubscript{2}.

However, owing to the corrosive nature of NO gas, the morphology of the metal-nanoparticle electrocatalyst degrades during electrosynthesis. Therefore, it is necessary to obtain a catalyst material with high stability that facilitates long-term electrochemical NH\textsubscript{3} synthesis.

Professor Shanmugam's research team developed a core-shell nickel nanoparticle coated with nitrogen-doped carbon nanostructured electrocatalysts via a simple co-precipitation method for stable NH\textsubscript{3} production. This catalyst is stable and efficient and offers a high Faradaic efficiency of 72.3% at a low overpotential (550 mV) in a 100% NO-saturated electrolyte.

Additionally, a solar-to-NH\textsubscript{3} efficiency of 1.7% and Faradaic efficiency of more than 50% were achieved using a solar-energy-assisted full-cell PV-NORR electrolyzer.

Professor Shanmugam says that "this research has developed an energy-efficient and eco-friendly technology to synthesize NH\textsubscript{3} with zero carbon footprint, and we hope to commercialize this technology to contribute to environmental conservation and sustainability."

The findings of this research were published in Advanced Science.


Provided by Daegu Gyeongbuk Institute of