



Contents lists available at ScienceDirect

Journal of Power Sources

journal homepage: www.elsevier.com/locate/jpowsour

Autothermal recirculating reactor (ARR) with Cu-BN composite as a stable reactor material for sustainable hydrogen release from ammonia

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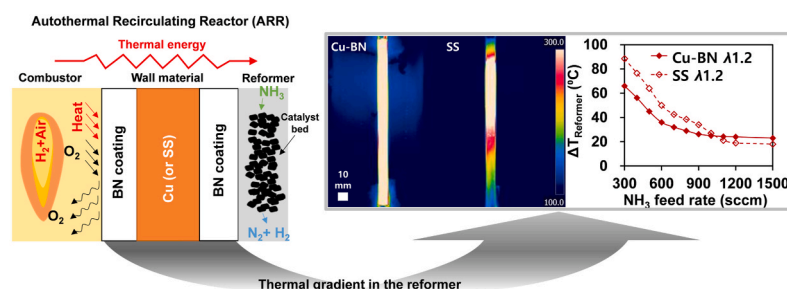
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HIGHLIGHTS

- Combustion of reformat H₂ was used as a heat source for NH₃ decomposition.
- Reforming efficiency of 70.95% was achieved with a lab-scale autothermal reformer.
- Fuel cell equivalent power of 84 W was obtained with CO_x-free operation.
- Cu-BN was proposed as a viable reactor material for temperature-sensitive reactions.
- Autothermal NH₃ decomposition can be envisaged for onboard power generation.

GRAPHICAL ABSTRACT



ARTICLE INFO

Keywords:

Ammonia decomposition
Hydrogen combustion
Copper
Boron nitride
Autothermal reactor design
Fuel cell

ABSTRACT

Ammonia (NH₃) has been proposed as a viable hydrogen (H₂) carrier, but high reaction temperature and endothermic nature of NH₃ decomposition require an efficient reaction system to maximize useable energy from NH₃. Adoption of carbon-free heat sources and efficient heat transfer to the reaction bed are crucial for sustainable H₂ release. Herein, the autothermal recirculating reactor (ARR) concept with the fractional utilization of the reformat H₂ as a clean combustion fuel is proposed and experimentally investigated. Additionally, BN-coated Cu as a composite reactor material is developed for heat transfer enhancement of high-temperature H₂ release reaction in a thermally-coupled NH₃ decomposition and H₂ combustion system. Coating performance against chemical degradation of Cu has been tested and confirmed. High NH₃ conversion of >99.6% and reforming efficiency of 70.95%, even with high fraction of heat loss owing to small scale validation, show feasibility of the as-proposed reformer. Operation of the suggested system is envisaged with self-sustained heat

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