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

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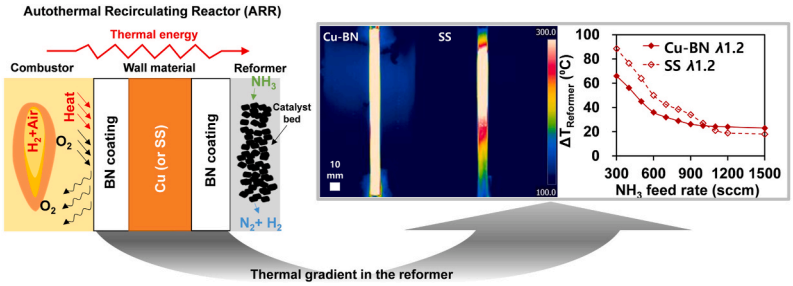
HIGHLIGHTS

- Combustion of reformate H_2 was used as a heat source for NH_3 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 NH_3 decomposition can be envisaged for onboard power generation.

GRAPHICAL ABSTRACT



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ABSTRACT

Ammonia (NH_3) has been proposed as a viable hydrogen (H_2) carrier, but high reaction temperature and endothermic nature of NH_3 decomposition require an efficient reaction system to maximize useable energy from NH_3. Adoption of carbon-free heat sources and efficient heat transfer to the reaction bed are crucial for sustainable H_2 release. Herein, the autothermal recirculating reactor (ARR) concept with the fractional utilization of the reformate H_2 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 H_2 release reaction in a thermally-coupled NH_3 decomposition and H_2 combustion system. Coating performance against chemical degradation of Cu has been tested and confirmed. High NH_3 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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