Fed. funding:	$2,5M
Length	42 mo.

High Rate Ammonia Synthesis by Intermediate Temperature Solid-state Alkaline Electrolyzer

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Subcontractors: Iowa State University and Penn State University
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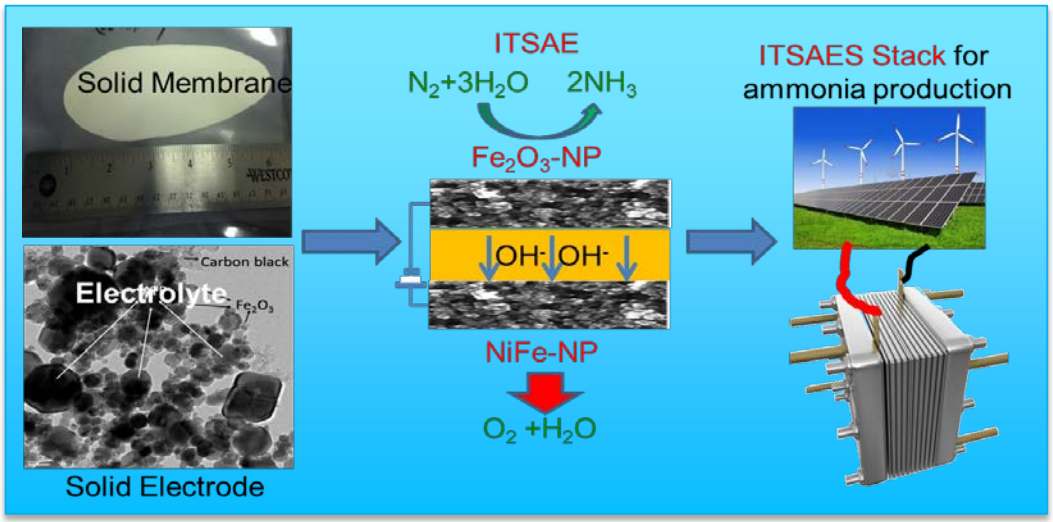
Project Vision

We are developing an intermediate temperature (100-300°C) solid-state alkaline electrolyzer for high-rate ammonia production from air and steam electrolysis.

Project Impact

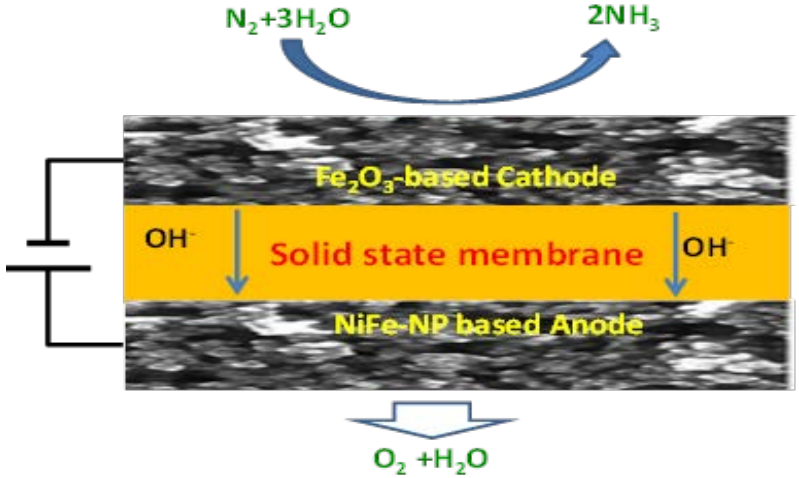
Enable efficient conversion of renewable energy into energy-dense CNLF and enable a new nitrogen fertilizer industry.



Innovation and Objectives

Innovation

The ITSAE integrates highly OH^- conducting solid membrane, novel cost-effective nanostructured Fe_2O_3-based nitrogen reduction reaction (NRR) cathode catalyst, and amorphous noble metal free NiFeOx nanoparticle (2-4 nm) oxygen evolution reaction (OER) anode catalyst.



Task outline, technical objectives

1.0 Develop large thin intermediate temperature solid-state alkaline membrane with ASR ≤ 0.125 Ωcm^2 (**STI Q1~Q11**)

2.0 Develop highly active Fe_2O_3-based mixed oxide NRR catalysts (**ISU Q1~Q12**)

3.0 Use DFT modeling to elucidate elementary NRR reaction mechanisms and guide catalyst design (**PSU Q1~Q10**)

4.0 Fabricate and test ITSAEs stacks (**STI&ISU Q11~Q14**)

Tech-to-Market strategy

1.0 Technologies development including catalysts for NRR and ITSAE. Generation of patents.

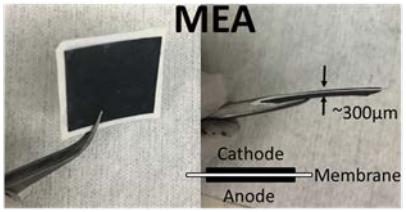
2.0 Market analysis and engagement of partners for ammonia production.

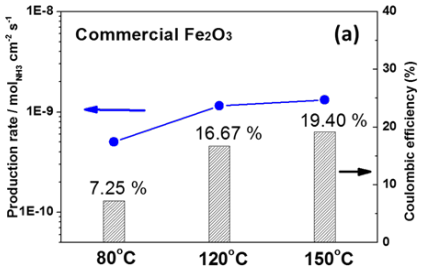
3.0 Pilot plant demonstration and technologies licensing.

Innovation and Objectives

Project history

A high CE and production rate were achieved in alkaline molten-salts based electrolyzer at 200°C (Science, 2014. 345). It is desired to utilize solid membrane at the same operation temperature range and alkaline environment.





Proposed targets

Metric	State of the Art	Proposed
Alkaline electrolyte	Solid: ≤85°C Liquid: 200~400°C	Solid: 100~300°C
Production rate	$<10^{-8}$ mol/cm^{2}s^1	~10^{-6} mol/cm^{2}s
CE	< 1.0%	>90%
Energy input	>487 kJ/mol NH_3	<380 kJ/mol NH_3

Anticipated challenges

Major Challenges	Approaches
Ammonia selectivity	Fe based bimetallic oxide catalyst
Long-term stability	Optimize electrode structure and MEA

Desirable partnerships

- Industrial catalysts production company
- Large scale ammonia production companies
- Wind/Solar farms
- Distributed ammonia production