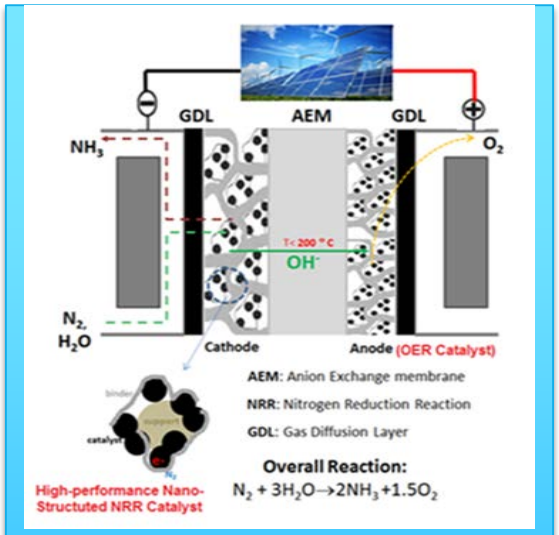
Fed. funding:	$ 1.5M
Length	24 mo.

High-Efficiency Ammonia Production from Water and Nitrogen

PI: Hui Xu, Giner, Inc.
Co-PI(s):
Gang Wu, SUNY-Buffalo (SUNY)
Yushan Yan, University of Delaware (UD)
Mary Biddy, National Renewable Energy Laboratory (NREL)



Project Vision

The proposed project aims to design and implement advanced components (e.g. catalyst and membrane) to transform the efficiency of electrochemical synthesis of ammonia (ESA) using air, water and renewable energy.

Project Impact

The proposed project is anticipated to significantly increase the efficiency of ESA at an appreciable current density; it may ultimately lead to the reduction of ammonia production cost by 30% compared to conventional Haber-Bosch process.

Innovation and Objectives

Innovation

- High-performance selective catalysts to boost ammonia synthesis while inhibiting hydrogen evolution
- Durable high-temperature alkaline membranes (>100 ℃) to promote the ammonia production reaction
- State-of-the-art electrolyzer cell design to maximize the ammonia production efficiency

Task outline, technical objectives

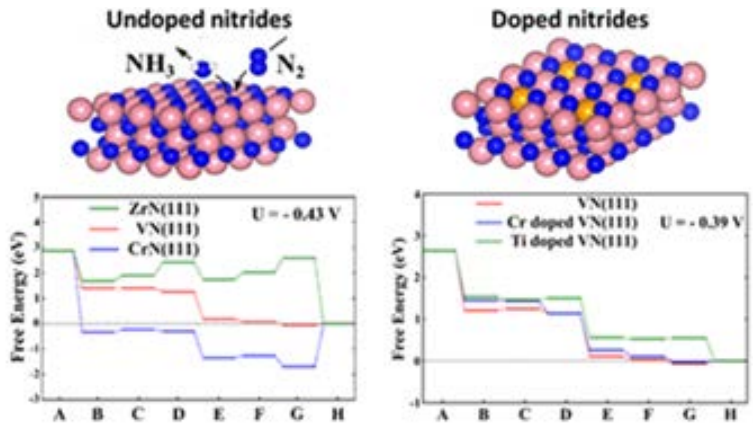
Institute	Tasks	Timeline
SUNY	N_2 Reduction Catalyst	Q1-Q6
UD	Alkaline Membranes	Q1-Q6
NREL	Cost Analysis	Q1-Q8
GINER	MEA Design and Test	Q3-Q8

Tech-to-Market strategy

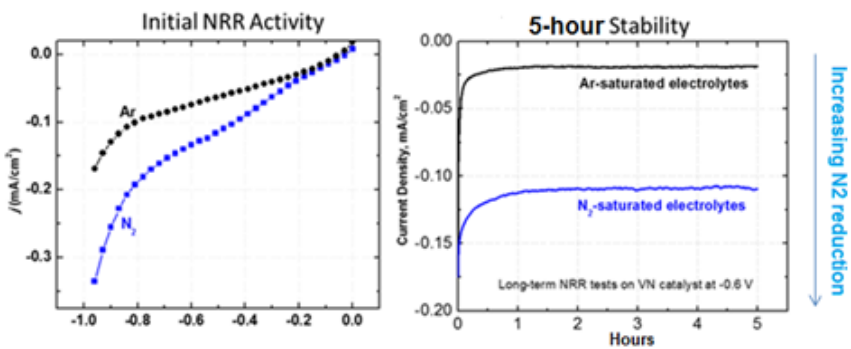
- Long-term focus: automotive sector as liquid hydrogen carrier
- 1st market: Wind power; 2nd market: Liquid fertilizers
- Licensing / partnership with renewable farms and distributed fertilizer plants

Innovation and Objectives

Catalysts

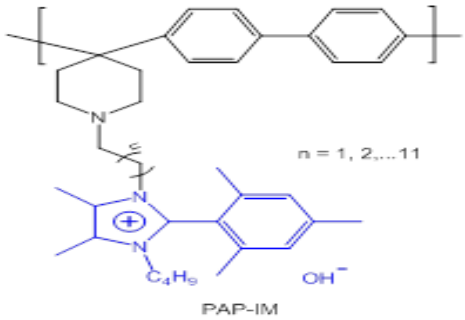


DFT

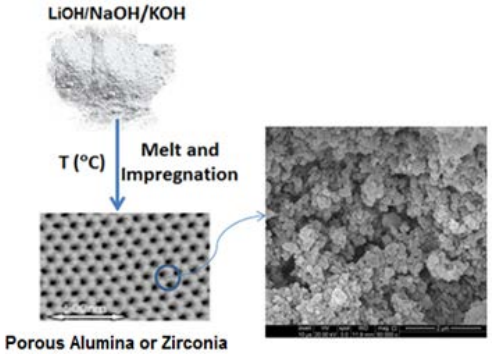


FeN RDE Data

Membranes



poly(aryl piperidinium) (PAP)-AEM



Molten Hydroxides in Porous Ceramics

Innovation and Objectives

Project history

- Giner initiated electrochemical NH_3 synthesis under USDA SBIR funding;
- Giner worked with SUNY on catalysts for reversible fuel cell under EERE funding
- Giner worked with UD on alkaline membranes under ARPA-E IONICS
- Giner worked with NREL on multiple projects for renewable energy utilization

Anticipated challenges

- Challenge 1: hydrogen evolution reaction becomes dominant
  Strategy: selective catalyst inhibiting hydrogen evolution will be developed
- Polymer membranes unstable at elevated temperatures (>120 ℃)
  Strategy: alternative ceramic alkaline membranes will be employed.

Proposed targets

Metric	State of the Art	Proposed
Ammonia production rate (mol/h-cm^2)	*10^{-5}*	*10^{-4}*
Faradaic efficiency	*30%*	*50%*
Current Density (mA/cm^2)	*25*	*150*

Desirable partnerships

Future partnerships are expected in 2019-2020; partners to test initial applications (renewable energy storage and distributed fertilizer plants)