Fed. funding:	$0.5M
Length	12 mo.

Membrane Reactor Synthesis of Ammonia at Moderate Conditions

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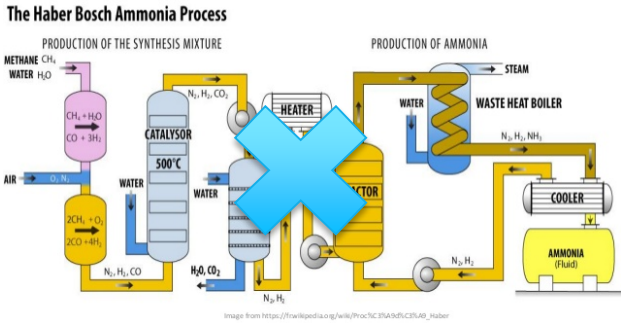
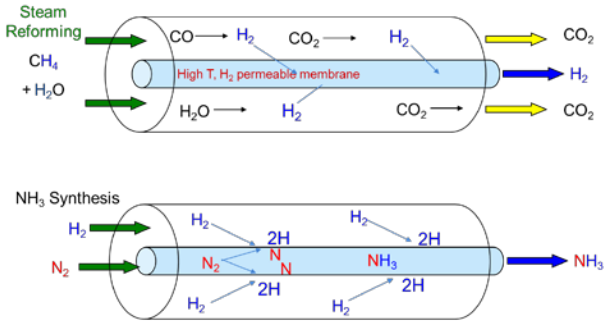
Co-PIs: Colin Wolden, Jason Ganley



Project Vision

We are developing an alternative to Haber-Bosch for ammonia synthesis based on membrane reactor technology that decouples H_2 and N_2 dissociation.

Membrane Reactor



Project Impact

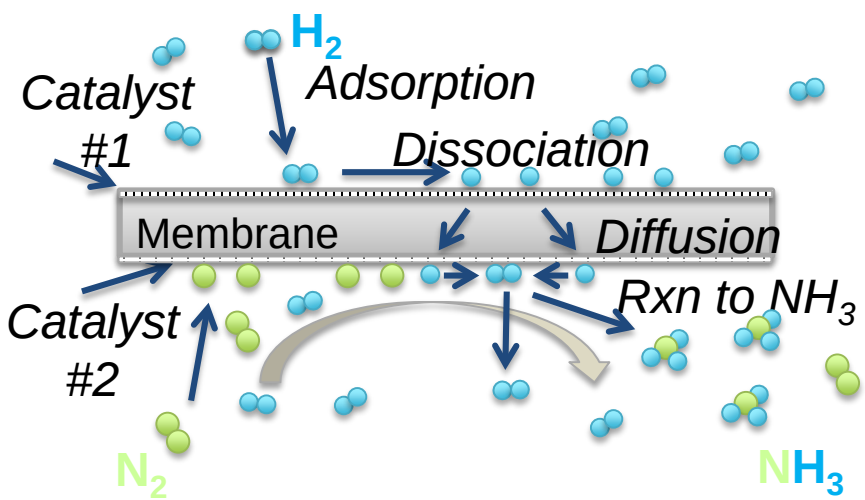
The goal is to create a low CapEx manufacturing process that is both scalable and dispatchable for distributed ammonia production.

Innovation and Objectives

Innovation

Use of dense, high permeable BCC metal membranes coupled to two independently optimized catalysts for H_2 dissociation and N_2 dissociation/NH_3 formation, respectively.

Analogous to proton conducting ceramics but no wires!



Task outline, technical objectives

- Install/employ custom sputter tool
- Optimize BCC/catalyst system for NH_3 synthesis
- Investigate alternate NH_3 synthesis catalysts
- Develop cost model

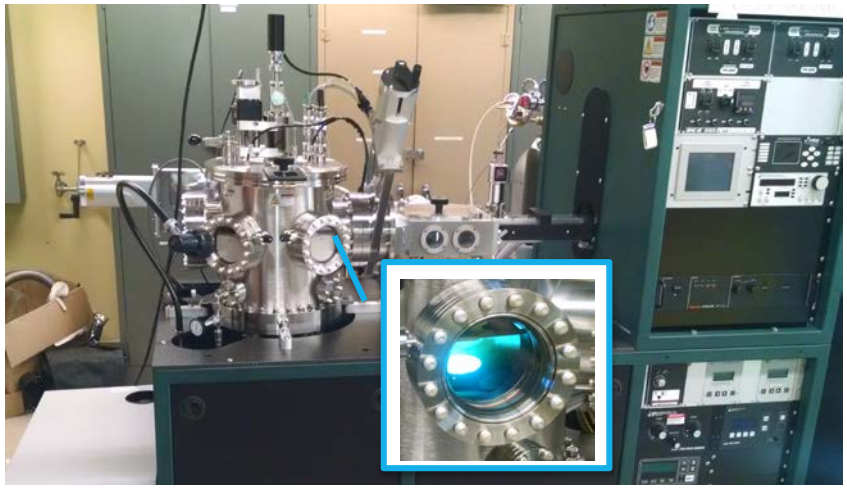
Tech-to-Market strategy

- Develop benchtop prototype membrane reactor for NH_3 synthesis
- Identify industrial partners
- Obtain follow-on funding for pilot scale membrane reactor

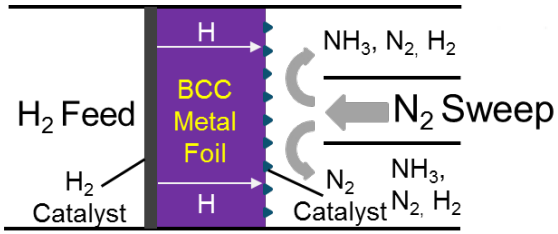
Proof of Concept Demonstration

Membrane Synthesis

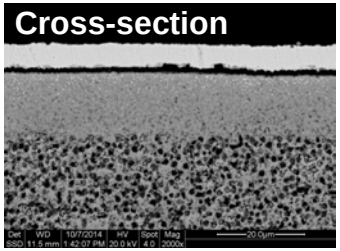
- Acquired/Installed Sputter Tool
- Sputter Clean
- Catalyst 1 Application
- Sputter Clean
- Catalyst 2 Application

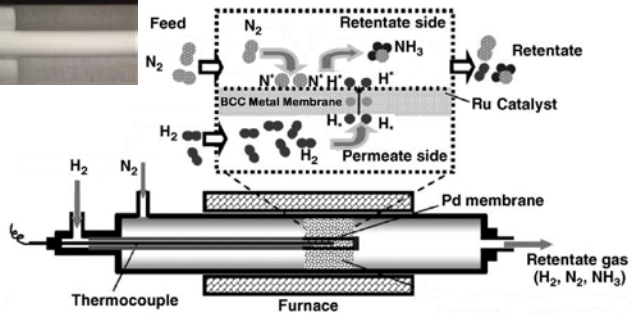


Lab Scale: VCR Cell



Scale-up: Tubular Membranes





Innovation and Objectives

Project history

- Developed composite BCC membranes for H_2 separations
- Demonstrated permeability >Pd and good stability
- Observed reduction of MgO to Mg by permeating atomic H
- Proposed to capture chemical potential of H for hydrogenation rxns

Proposed targets

Metric	State of the Art	Proposed
Pressure	~200 bar	< 10 bar
NH_3 Flux	~10^{-5} mol/m^2*s T= 500 ºC	~10^{-3} mol/m^2*s at T< 500 ºC
Capital Cost	\$200/ton NH_3	\$150/ton NH_3

Anticipated Challenges

- Limited by N_2 dissociation catalyst
- Catalyst stability with BCC metals

Pathways Forward

- Transition metal carbide / nitrides
- Use of structured / high surface area catalysts to overcome reactivity

Desirable partnerships

- Couple to low cost H_2 synthesis
- Expertise in catalyst development
- Tech to market partners