Direct Ammonia SOFC

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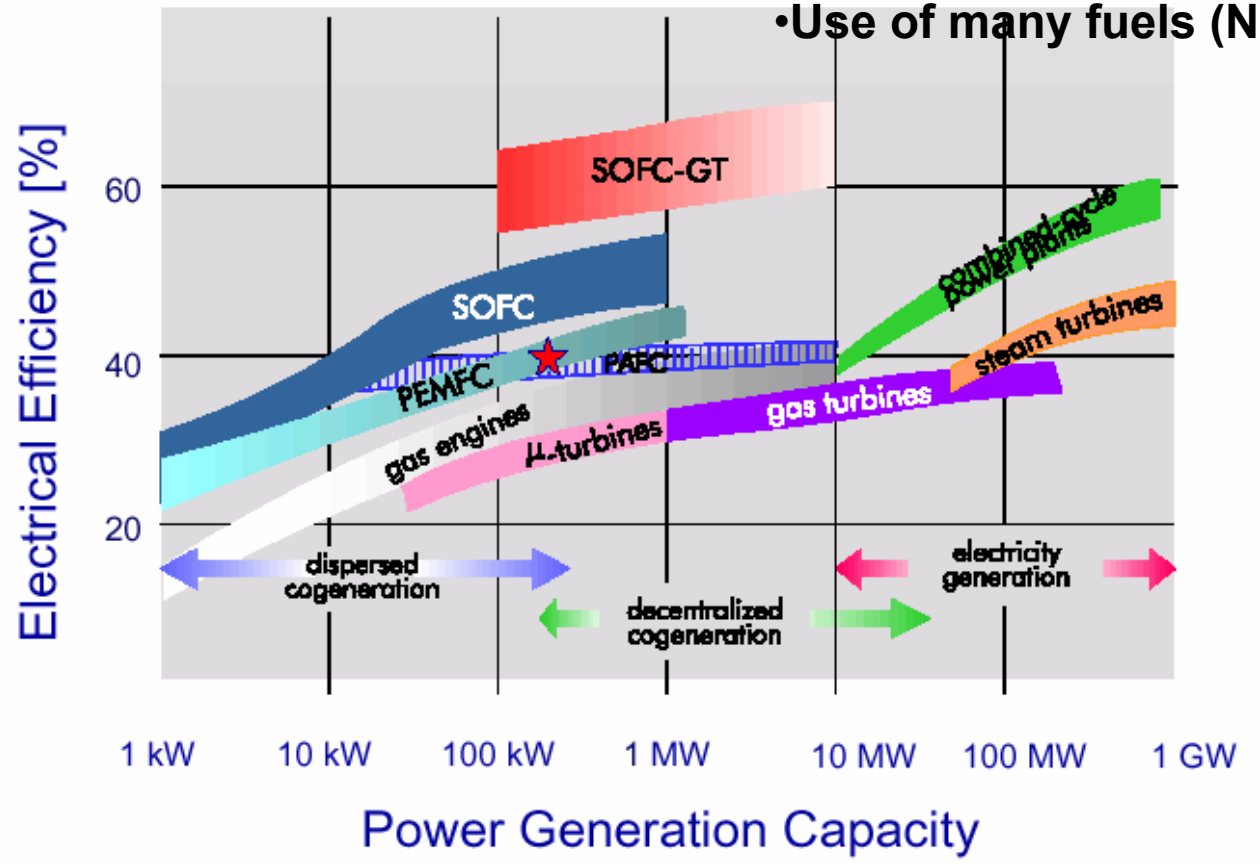
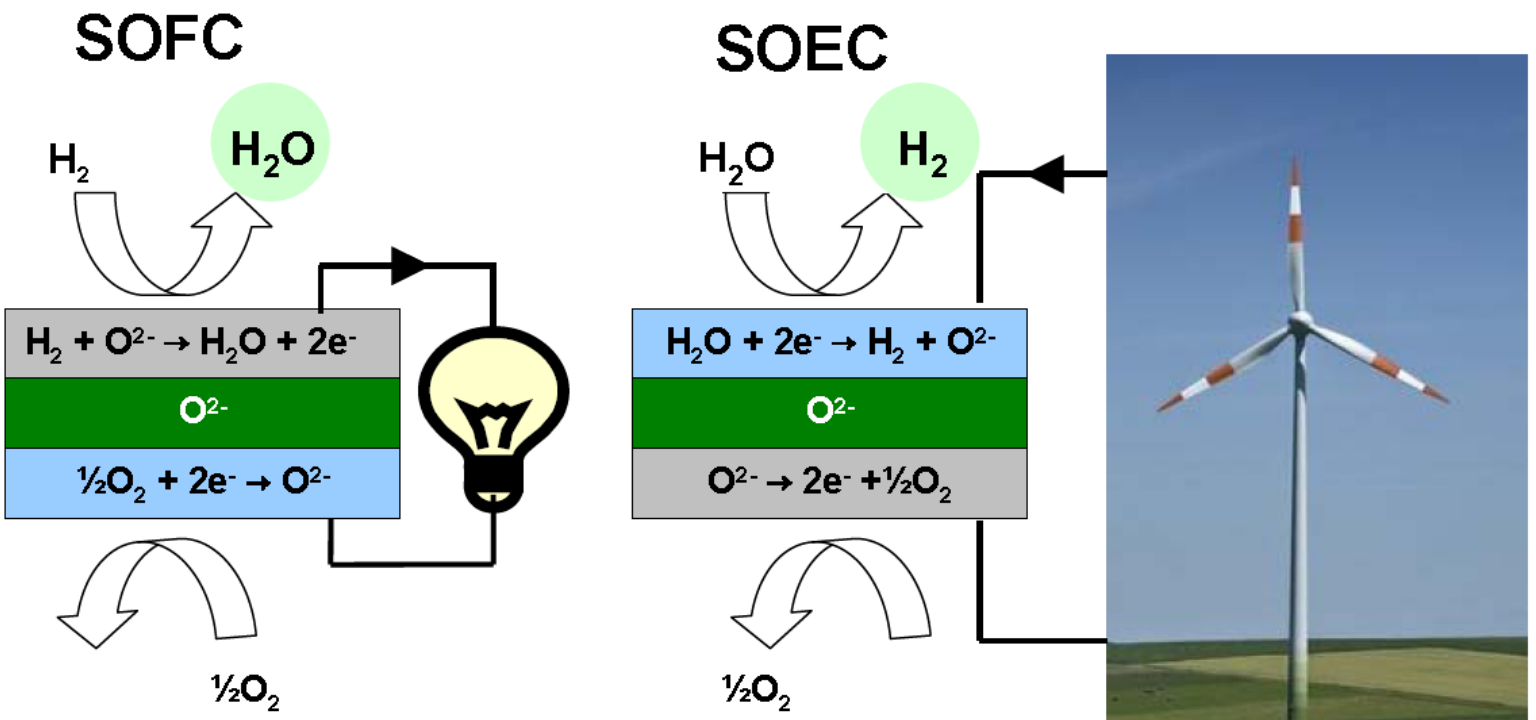
Why SOFC and Why Ammonia?

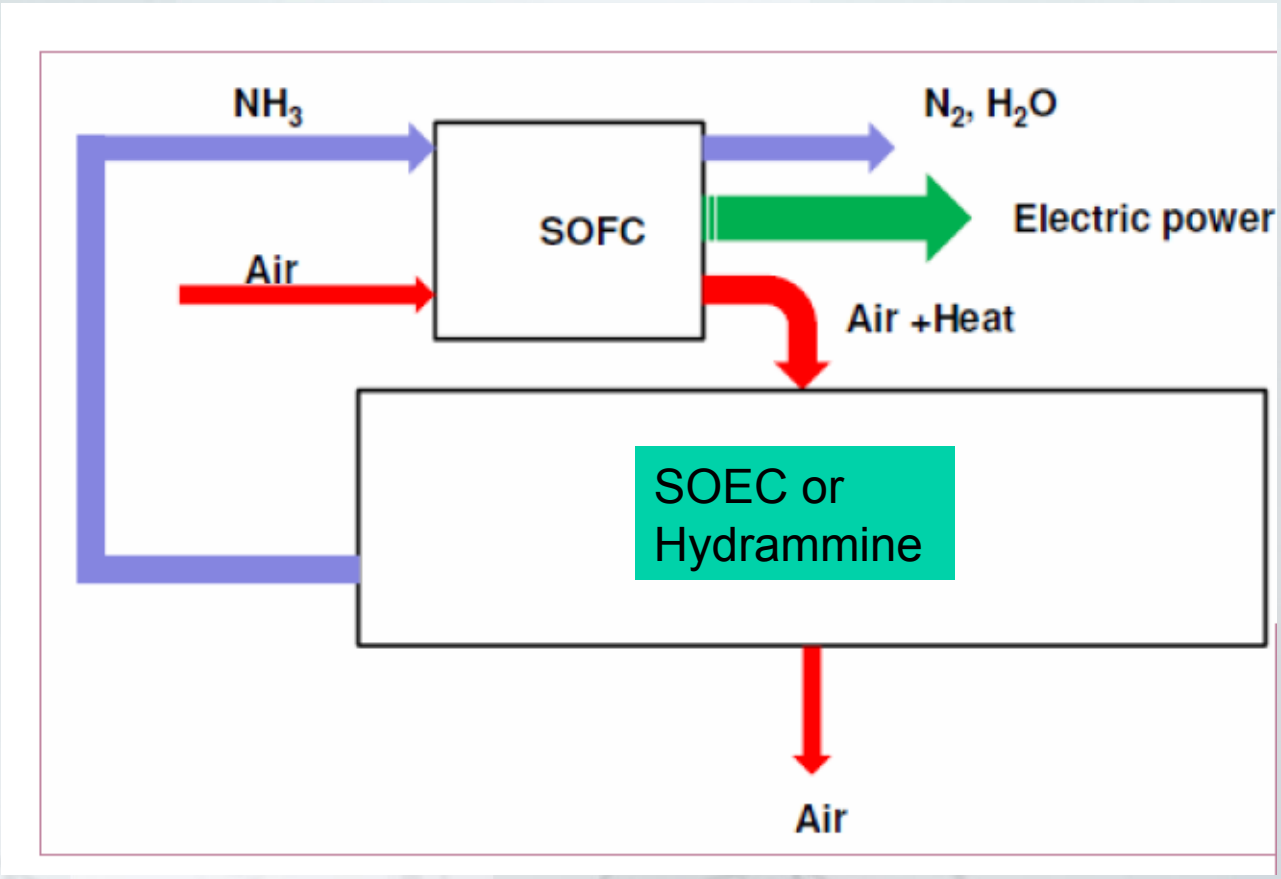
- High efficiency
  - Efficient at part load
- Fast response
- Use of many fuels (NH_3)



SOFC/SOEC Basic Concept



Ammonia SOFC/SOEC – Potentially Reversible



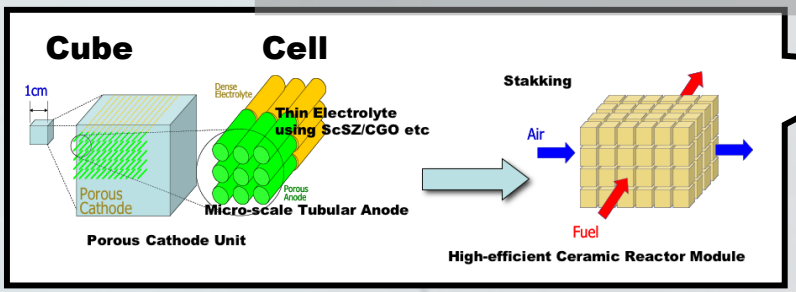
Why Small and Micro-Tubular SOFC?

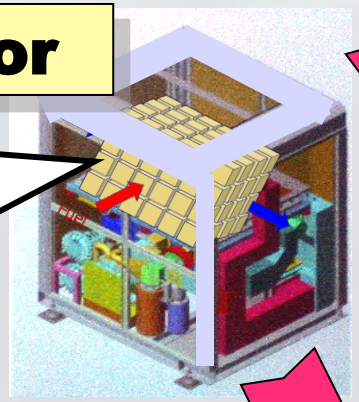
- The small-scale tubular solid oxide fuel cells (SOFC), have many advantages over larger tubular and planar designs, including:
  - ✓Excellent thermal shock properties giving rapid start-up ability,
  - ✓High mechanical integrity
  - ✓Easy and Cheap to Fabricate
  - ✓Easy design for stacking and manifolding

SOEC/SOFC Applications

high efficiency on energy conversion and Selective reactions

Ceramic reactor

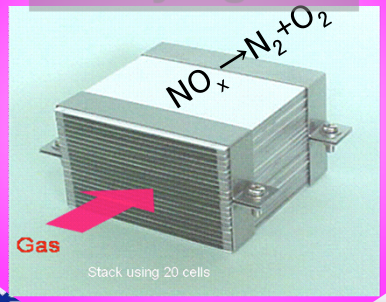




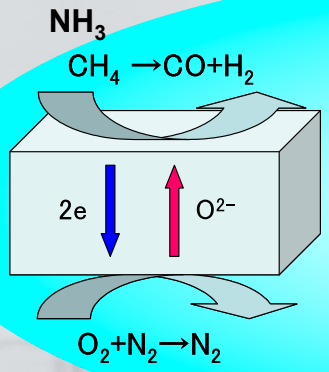
Fuel Cells

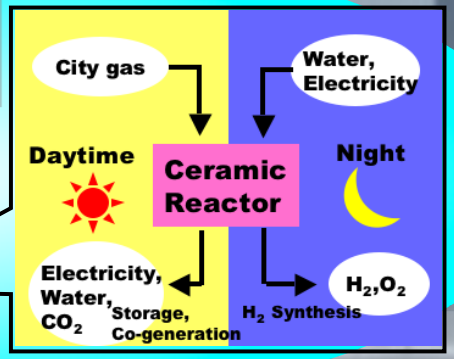
APU for Vehicles

Environment Purifying

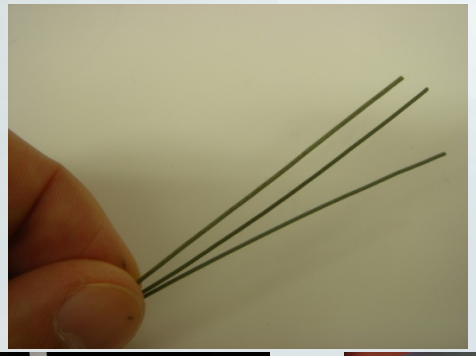


Chemical Syntheses

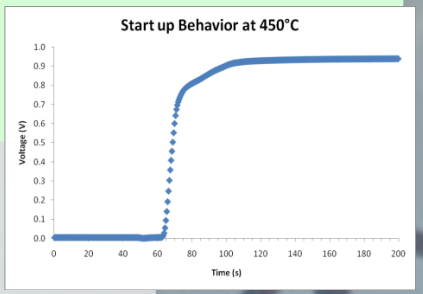


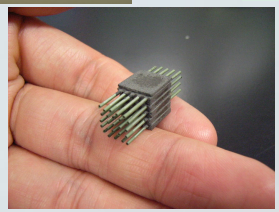


Overview of SOFC/SOEC Program



- micro-tubular designed cell
  - → high thermal shock proof
  - → high productivity
- intermediate temperature operation (650°C)
  - → quick start-up (in a few minutes)
- modularized design
  - → high cubic power density

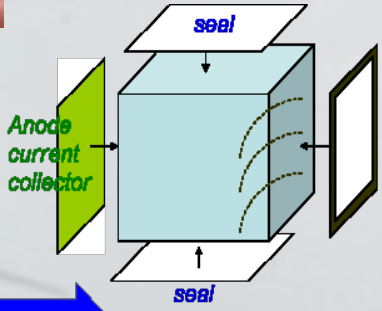


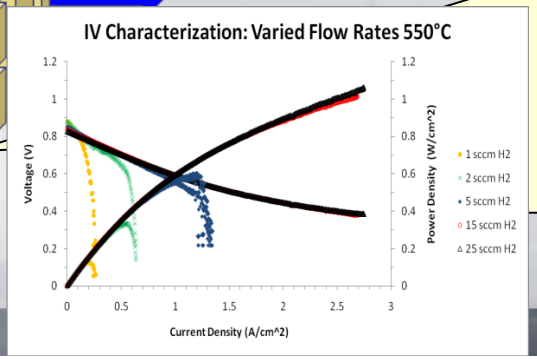


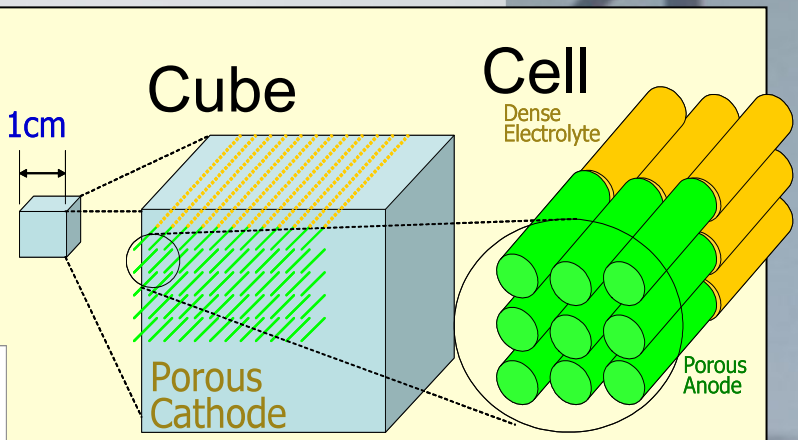
Modular

Air

Fuel

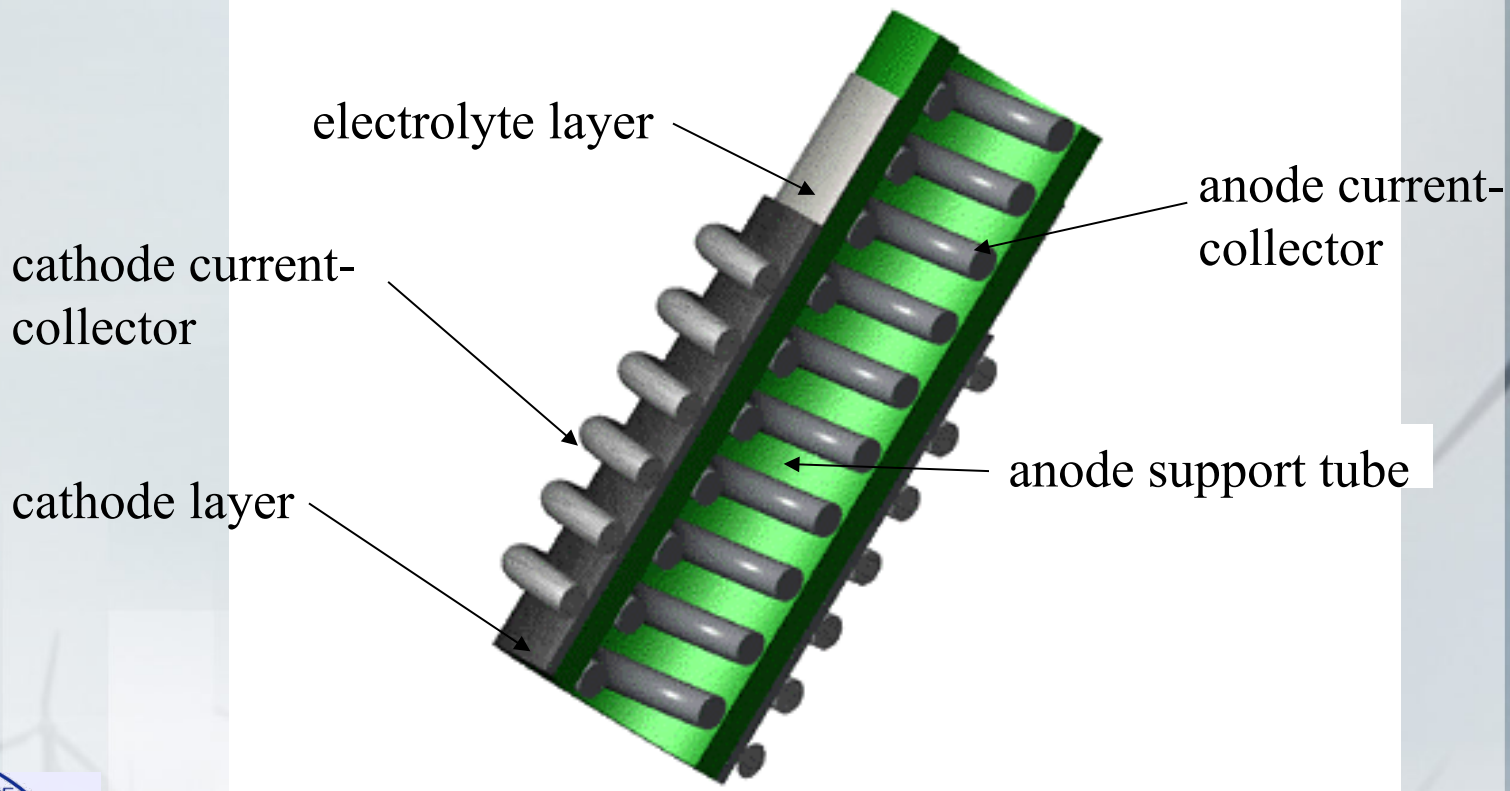




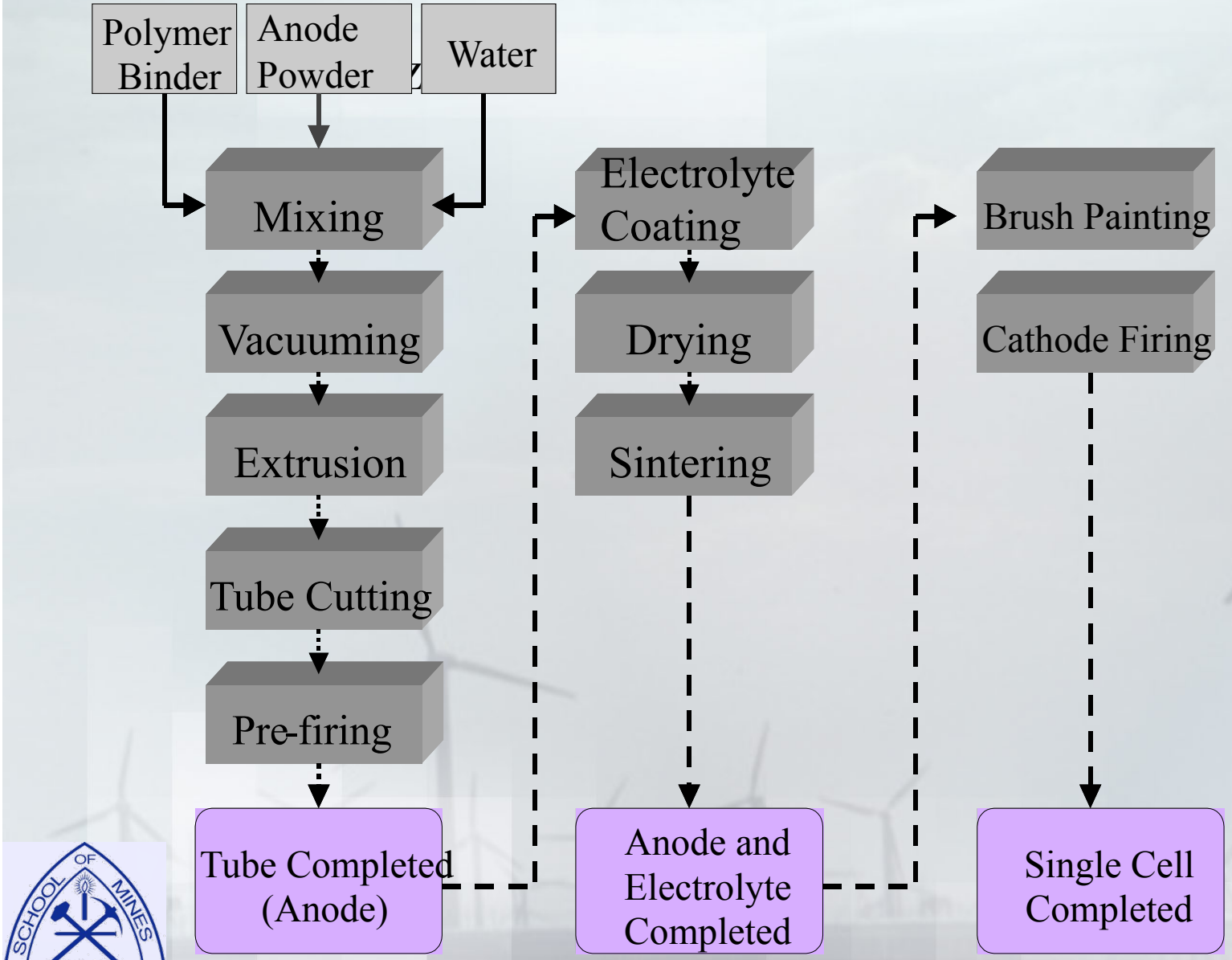


Micro-tube cells are integrated in a porous cathode cube.

Concept


electrolyte layer
anode current-collector
cathode current-collector
anode support tube
cathode layer

Cell Fabrication Process



Powder Preparation and Mixing

Example of our Extrusion Capability

Fabrication of Micro-tubular Protonic Electrolyte on Anode Support

Cell Preparation

0.8-1.8 mmΦ support tube

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Electrolyte Application

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Co-fired at 1450°C

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Application of electrode

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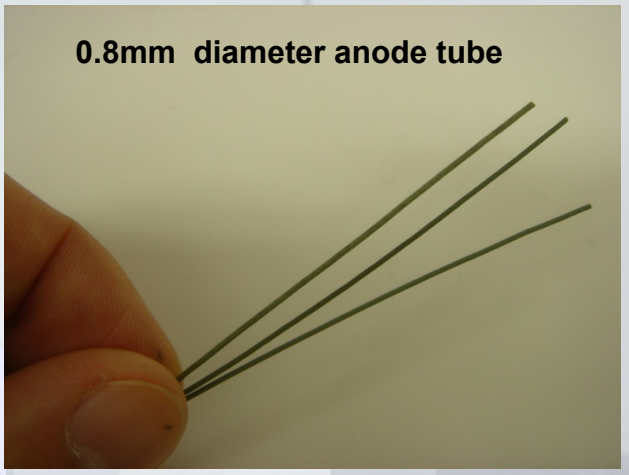
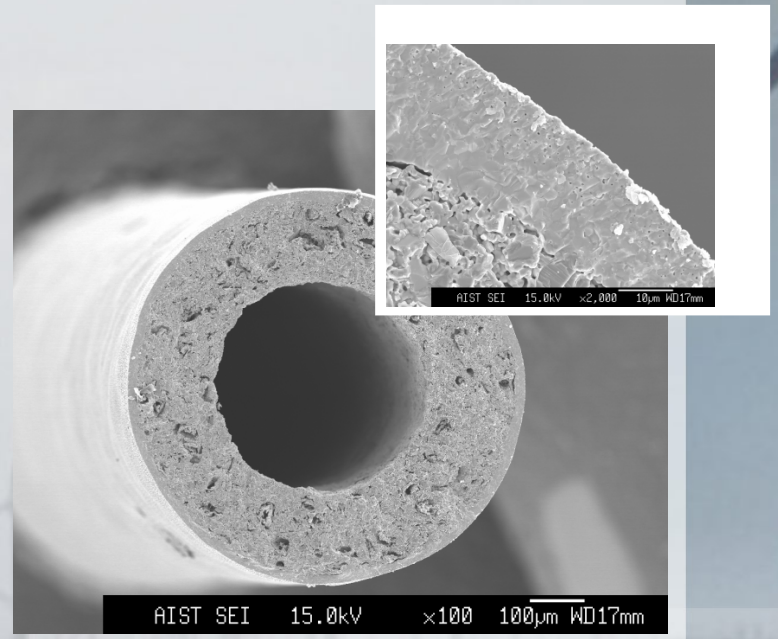
Sintered at 1000°C for 1 h.

Support : Metal oxide-ceramic composite (200μm in thickness)
Electrolyte : Perovskite protonic ceramic (10-20μm in thickness)
Electrode : Metal oxide-ceramic composite (40μm in thickness)

0.8mm diameter anode tube

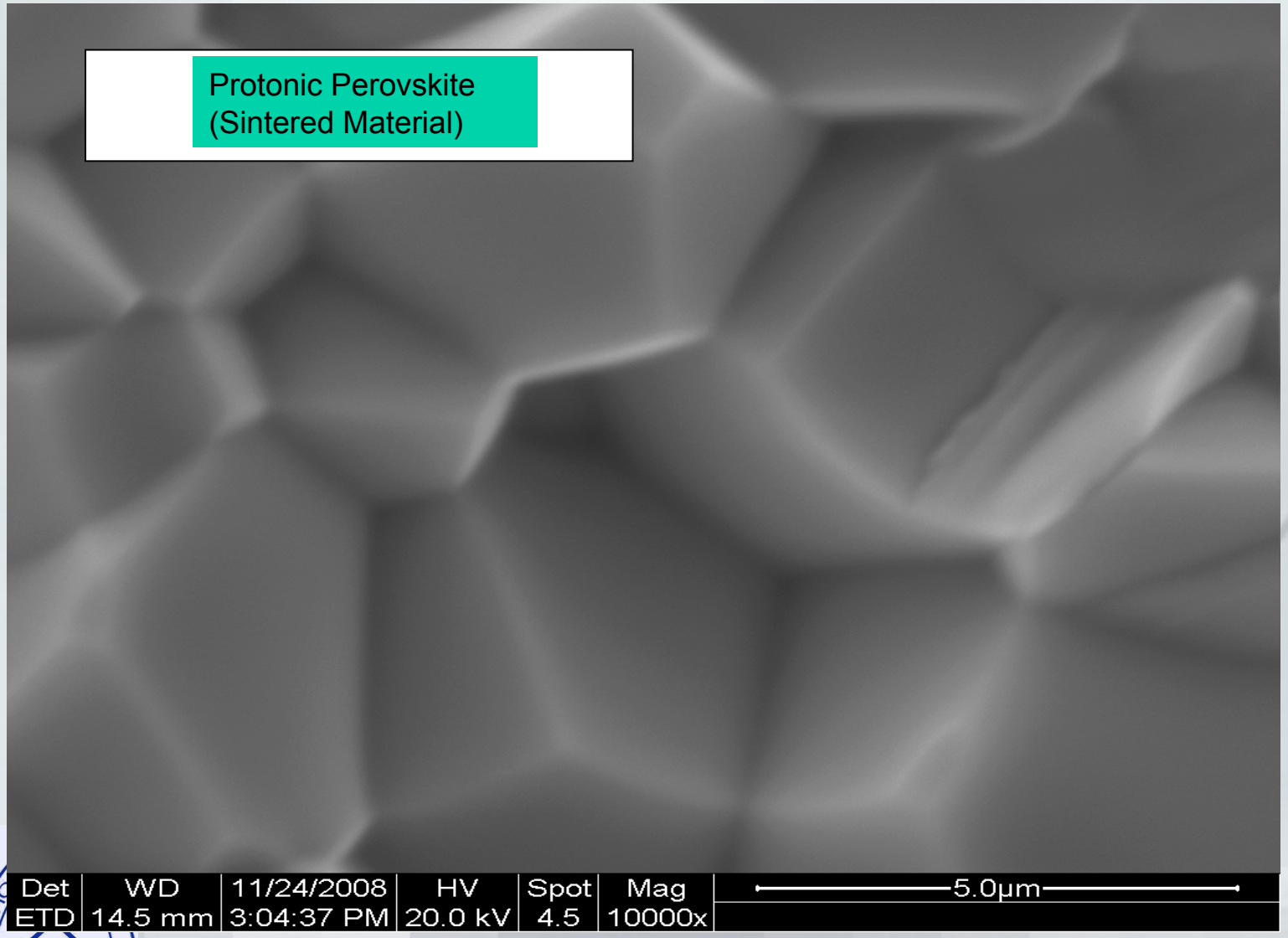


0.8mm diameter support tube with electrolyte

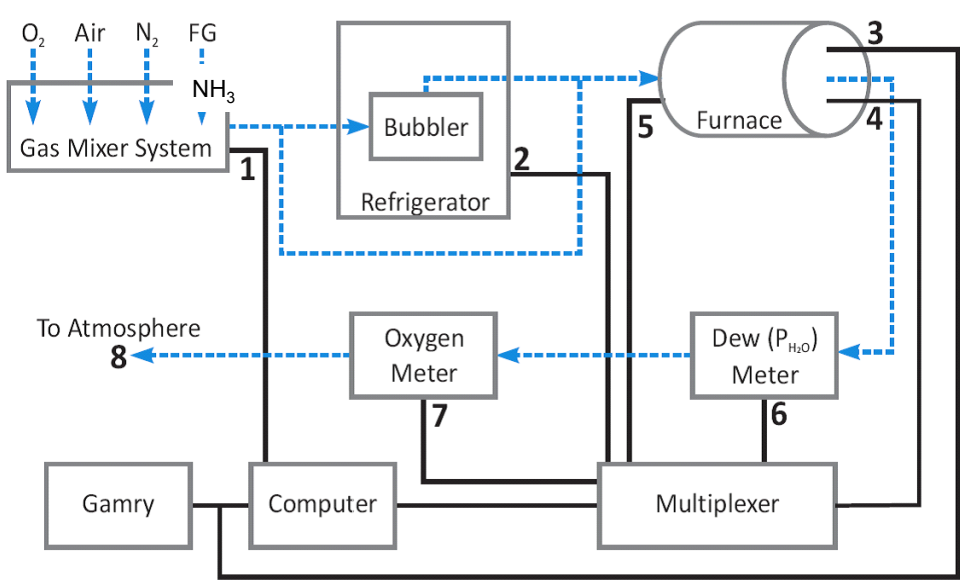


Details of the Perovskite Tube

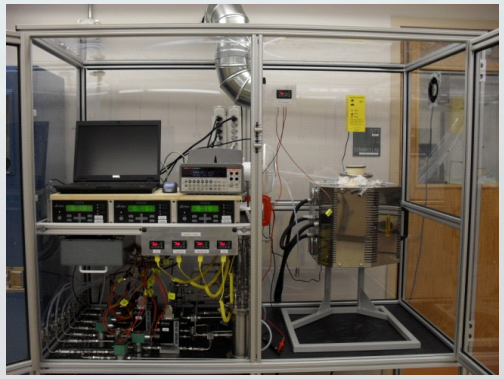
Microstructure

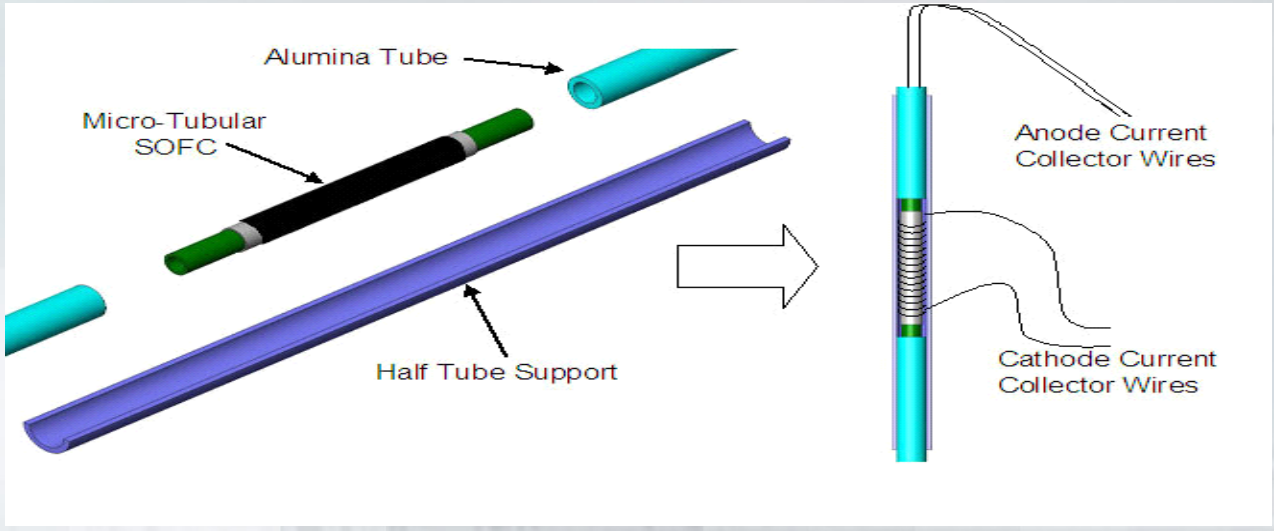


Test Set up for Ammonia in a PCFC and Production in a PCEC

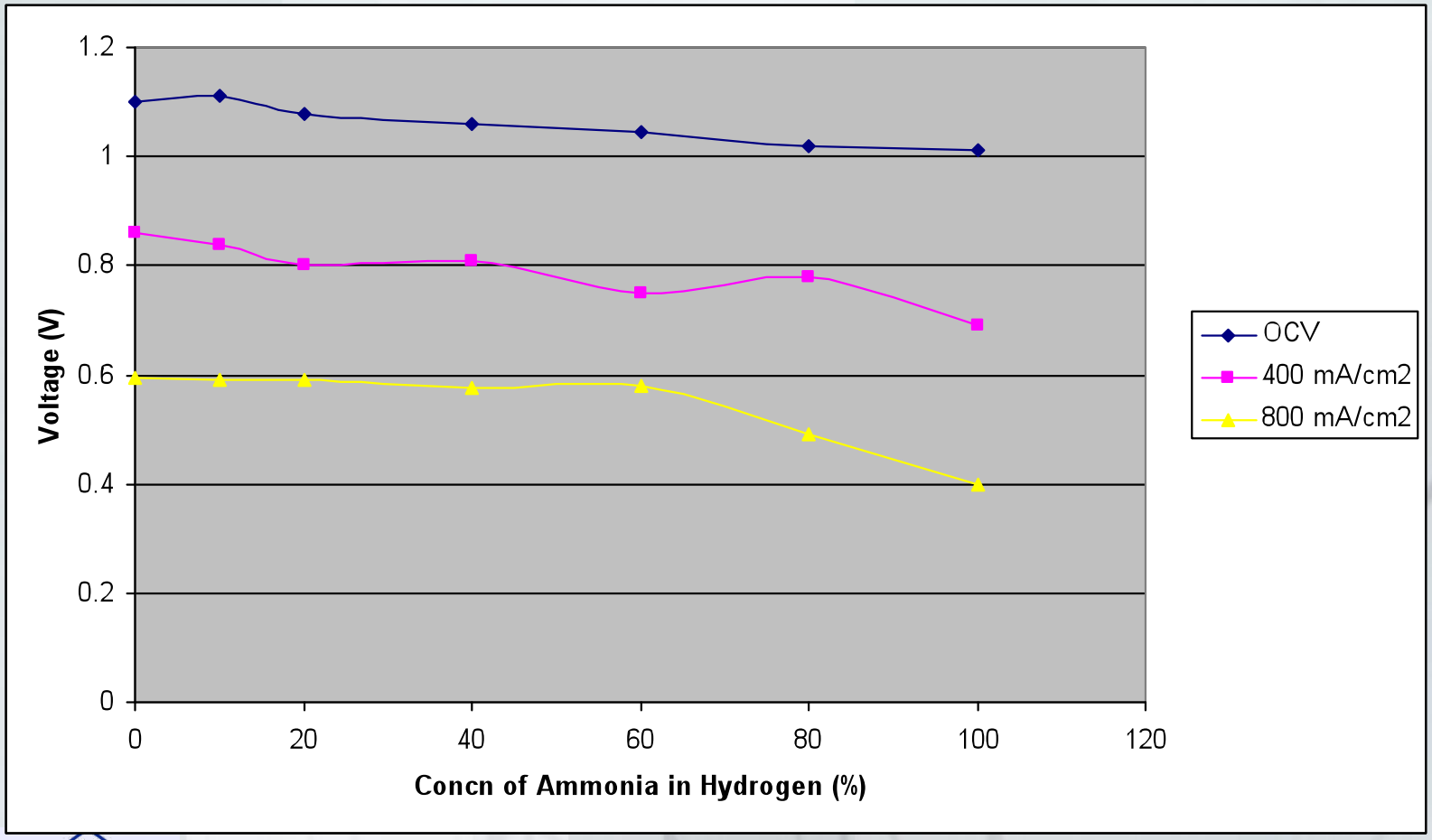


PCEC

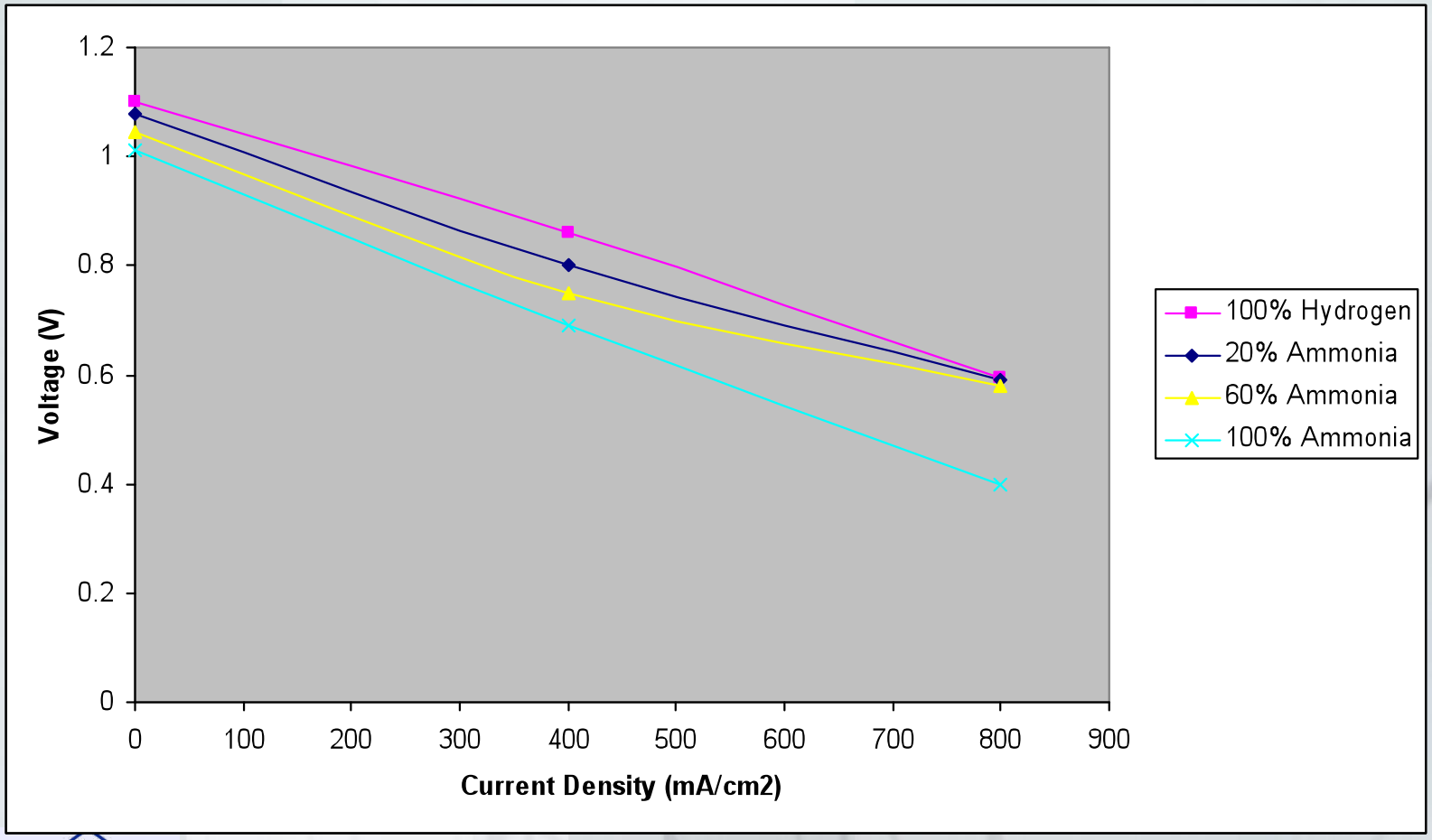




Results from PCFC Testing on Ammonia at 700°C



IV Curves at 700°C



Power Curves at 700°C