Electrochemical Sensors for PEMFC Vehicles

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DOE National Laboratory Fuel Cells for Transportation Program Review-2002

*This work was performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

Objective

- To design, develop, and demonstrate solid state electrochemical sensors for various applications in PEMFC vehicles:
  - Hydrogen “safety” sensor (FY01-02)
  - Hydrogen sensor for reformed gas monitoring (FY03-04)

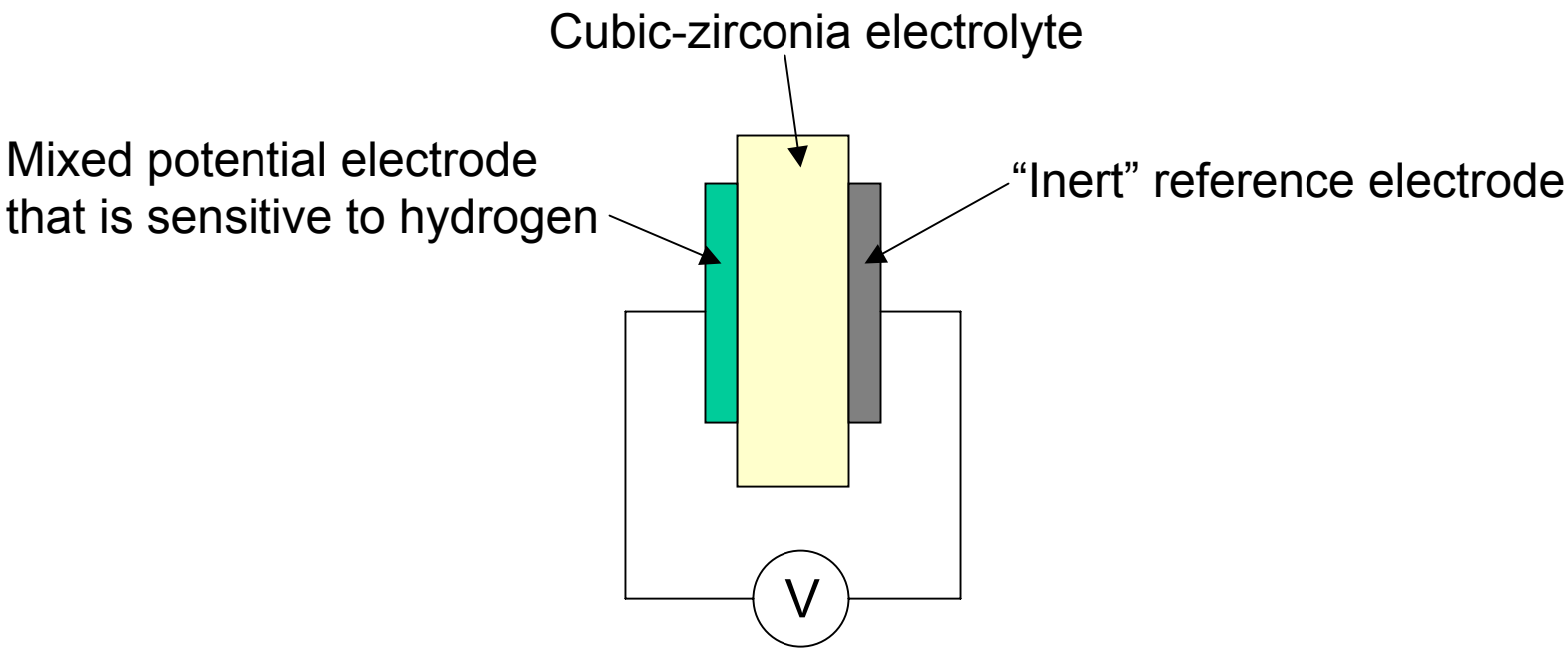
Technical targets

- Hydrogen “safety” sensor
  - 0.1 to 10% hydrogen in ambient air
  - Response time under 1 second
  - Selectivity versus hydrocarbons, humidity
  - Operating temperature: -30-80°C

- Hydrogen sensor
  - 1 to 100% hydrogen concentration in fuel gas
  - Response time of 0.1 to 1 second for 90% response
  - Operating temperature: 70-150°C
  - Environment: 1-3 atm, 10-30 mol% water

Approach

- Use proven technology: zirconia-based oxygen sensor
- Develop mixed potential electrodes that are sensitive to hydrogen for use without the need of a reference gas



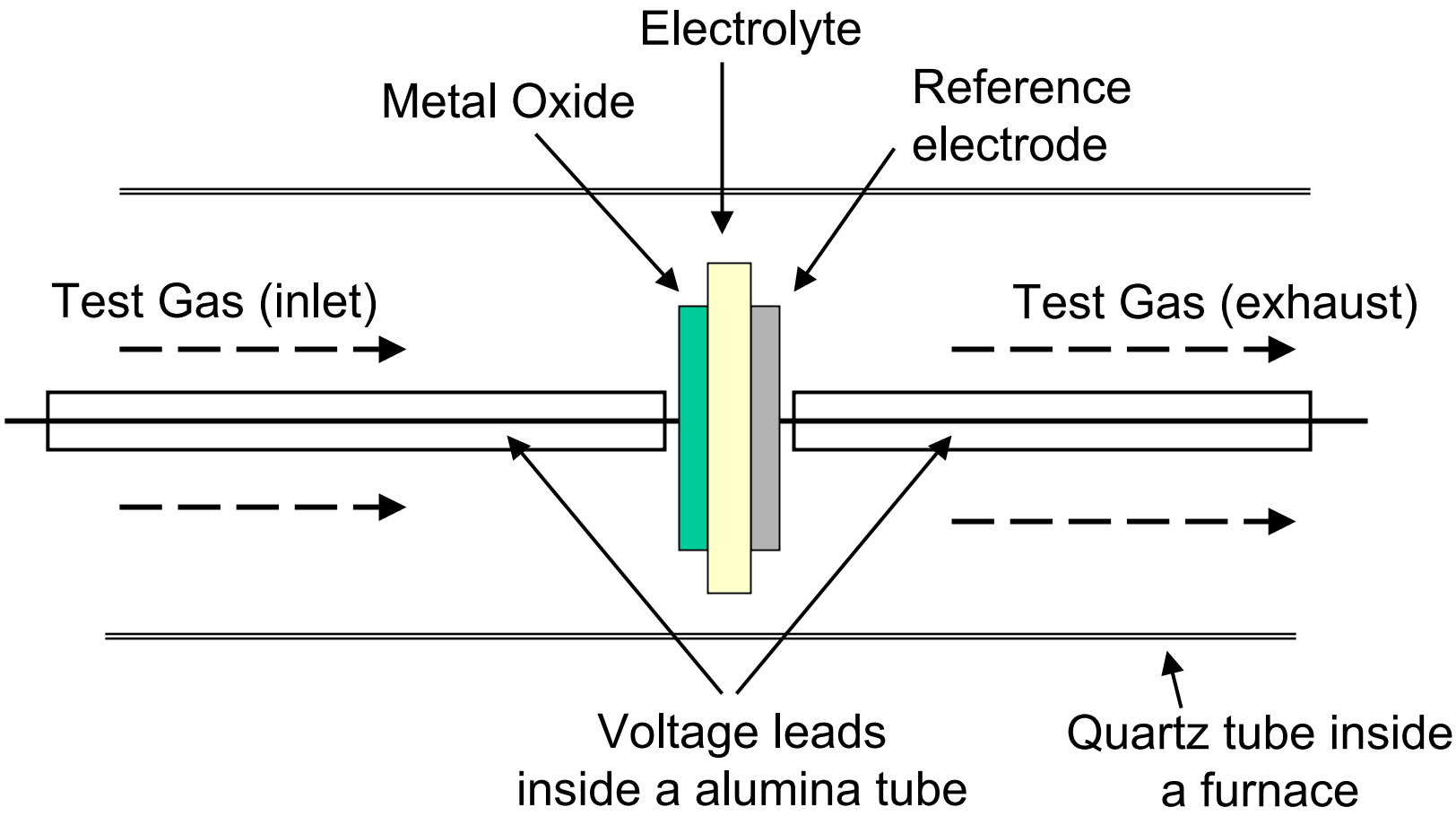
Status at last year review

- Developed first prototype sensor
- Demonstrated 1-2 s sensor response time to hydrogen. Response time was > 5 s at temperatures below 600°C
- Demonstrated zero sensitivity to humidity

Project timeline

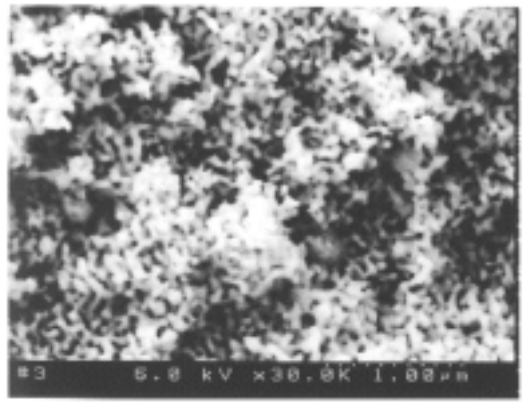
Task	Year			
	01	02	03	04
Develop hydrogen safety sensor				
Materials development				
Prototype development				
Integrated-sensor				
Develop hydrogen fuel sensor				
Materials development				
Prototype development				
Integrated sensor				

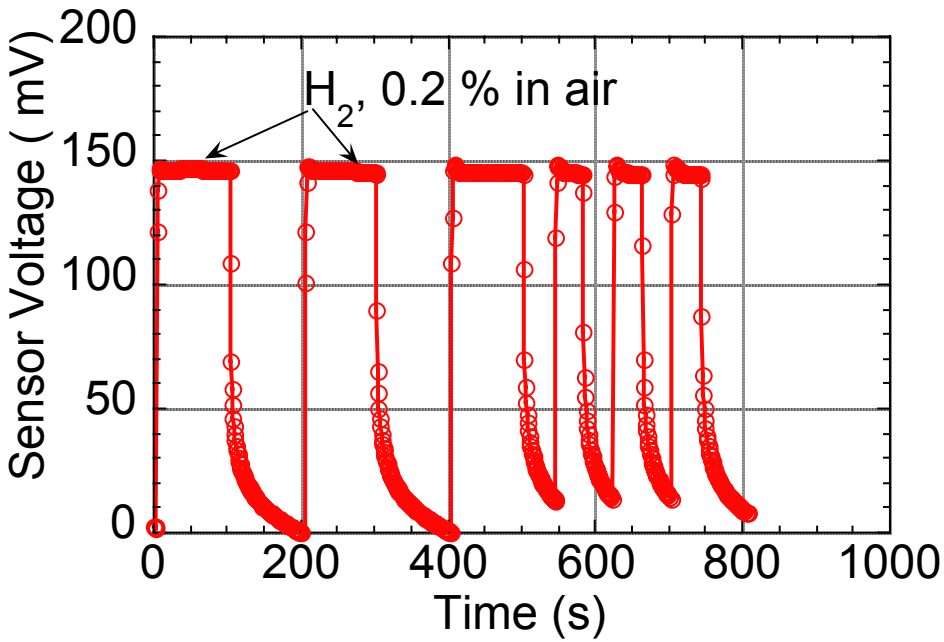
Experimental set up



With nanocrystalline electrode, sensor response time is reduced to 2-3 s

We use the Colloidal Spray Deposition technique to deposit the nanocrystalline metal oxide electrode.



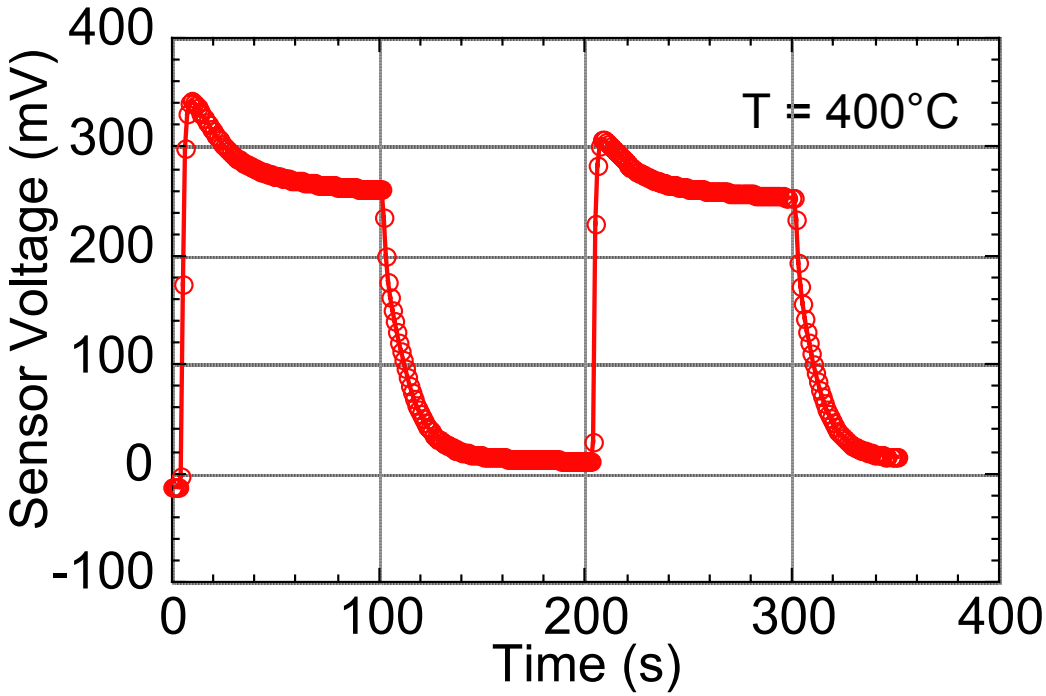


Time between 2 data points: 1 s

Sensor response to hydrogen in air at 500°C.

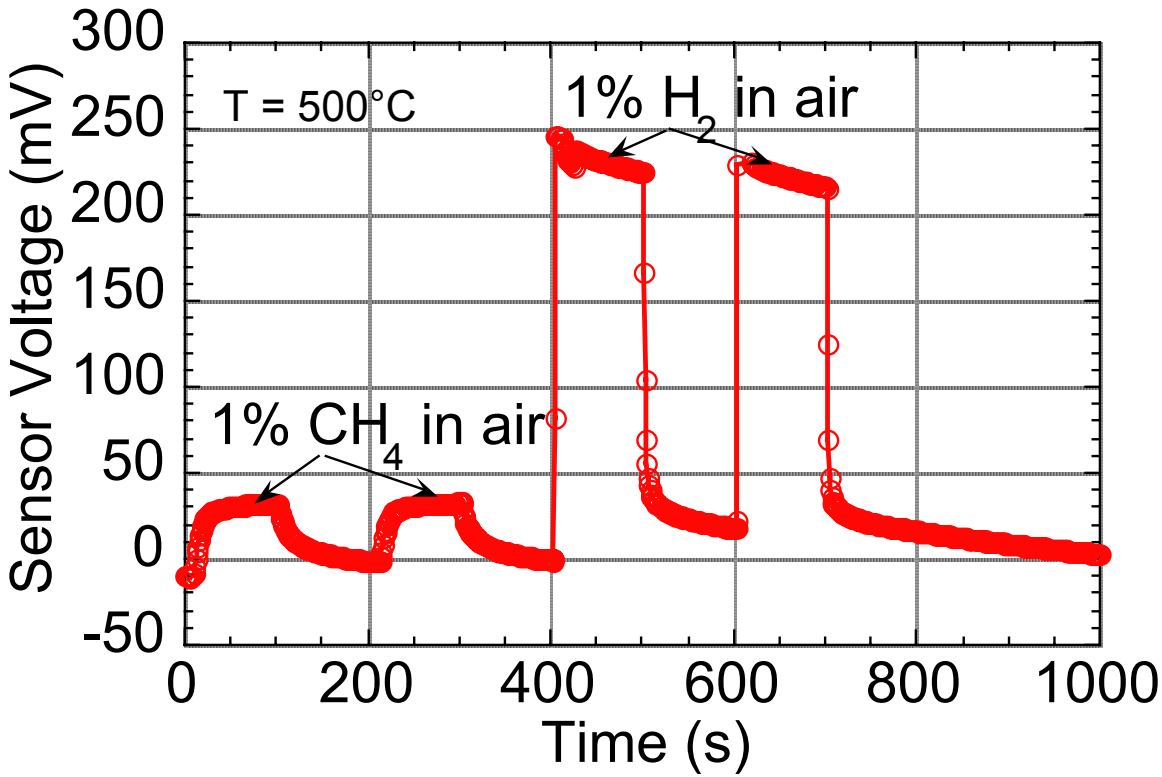
The response time is 2-3 s. However, the recovery time is much longer

Fast response can also be achieved at temperatures lower than 500°C



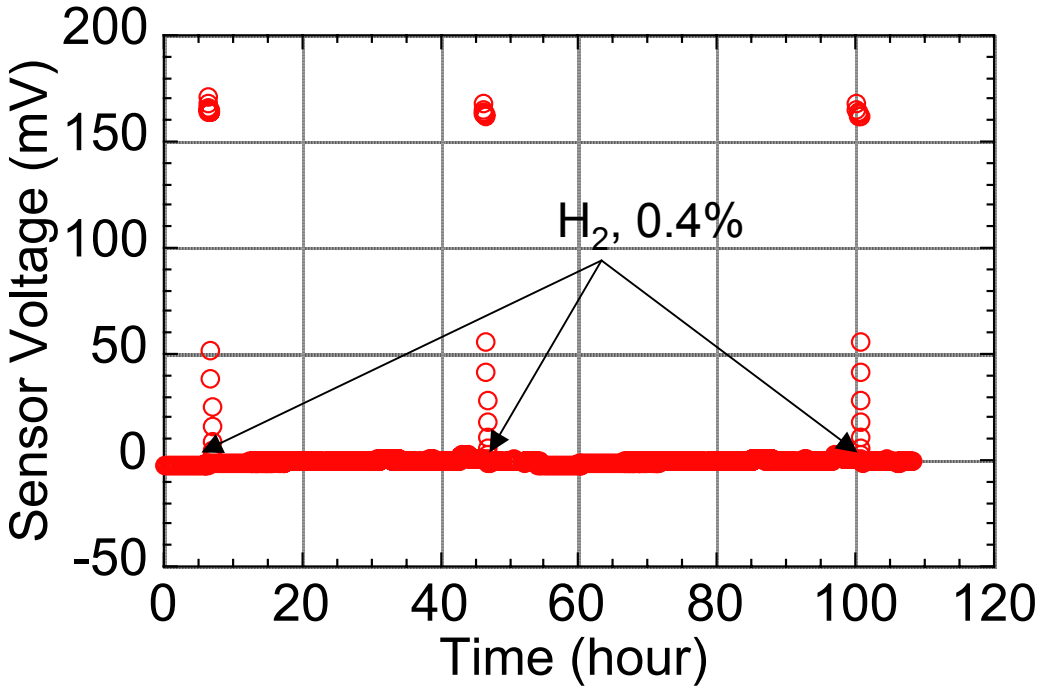
- The sensor high temperature operation is NOT incompatible with the operating requirement (30-80°C)
- However, lower operating temperature will reduce the power needed to keep the sensor hot

Selectivity



- Sensor is one order of magnitude more sensitive to hydrogen than to methane

No drifting has been observed



- Baseline drifting is a major issue with conventional resistive sensors
- No baseline drifting nor signal amplitude change were observed with the mixed potential sensor

Future work

- Integrate sensor with a self heating device (in progress)
- Complete sensor characterization
- Investigate ceramic proton conducting materials for hydrogen fuel sensor (FY03)
- Develop prototype amperometric hydrogen fuel sensor (FY03)