

***A Novel Robust and Responsive
Hydrogen Sensor for Fuel Cell
Applications***

2011 Fuel Cell Seminar

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About our Company

NexTech Materials, Ltd.

- Founded in 1994
- Privately held by original co-founders
- Sixteen straight years of growth and profitability
- More than 500 customers in 50 countries
- 56,000 sq. ft. facility, equipped for manufacturing and R&D
- Over 2000 sq. ft. of newly built sensor manufacturing space



Corporate Vision

NexTech will provide solutions to global energy and environmental challenges through innovation and delivery of quality products.

NEXTECH
MATERIALS

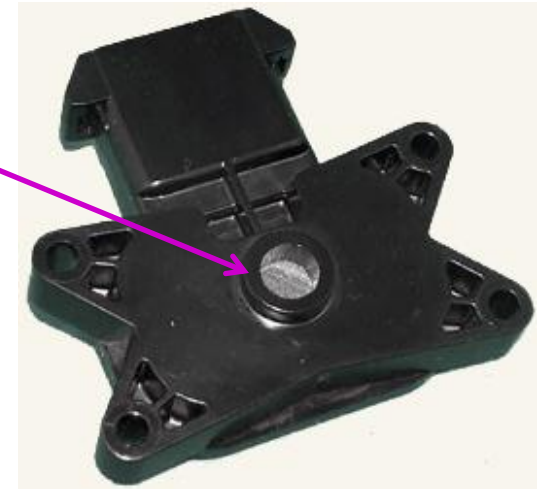
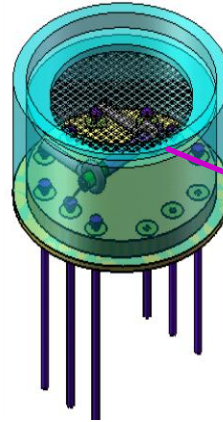
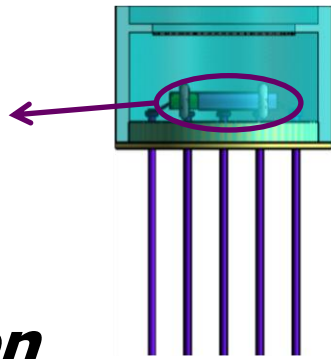
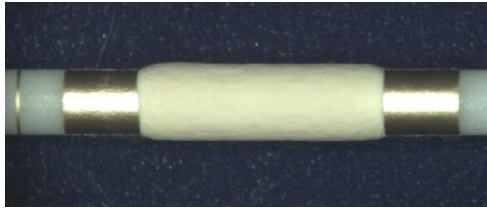


fuelcellmaterials.com
PERFORMANCE AND QUALITY DELIVERED

NTM Sensors
We sense a **Green** future™

ISO 9001:2008 Certified

NexTech's H₂ Sensor Implementation



Value Proposition

- Accurate and stable performance
- Fast response and recovery
- Robust to ambient variation (temperature, humidity)
- No cross-sensitivity to other combustible gases
- Low cost device platform
- Robust to silicone exposures



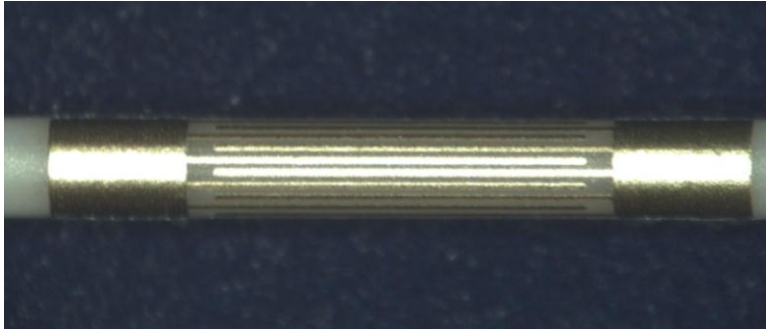
Hydrogen Sensors

Why Hydrogen Sensors?

- Safe practices in the production, storage, distribution and use of hydrogen are essential for safe implementation of hydrogen critical technologies.
- Hydrogen is a colorless and odorless gas.
- Lower flammability limit (LFL): 4% in air.
- Minimum ignition energy: 0.02 mJ



Technology Platform



Tubular Element Design

- Chemiresistive sensor element
- Resistivity of coating material is dependent upon H₂ concentration
- Formulation developed to maximize resolution in 0.2-4.0% H₂ range



Expertise Employed in NexTech's H₂ Sensor

- Ceria synthesis, from nanoscale to ceramic grade powders
- Precious metal based catalyst development and manufacturing
- Ceramic ink preparation and deposition methods
- H₂S, NO_x, and CO sensors developed using planar IDE platforms

Innovation



Technology



Manufacturing



Sensor Formulation

Ceria (support)

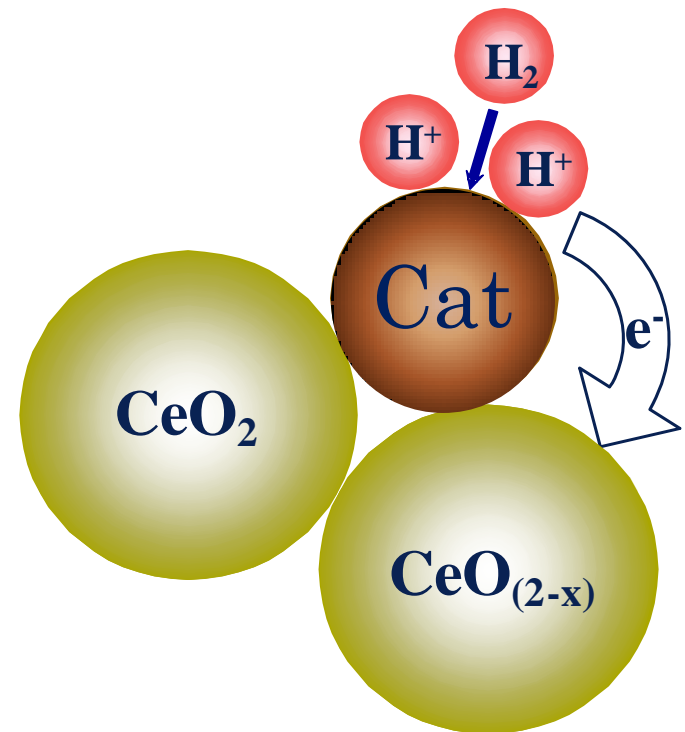
- Oxygen ion conductor
- Facile oxygen transfer reactions

MOS (modifier)

- Enhances H₂ absorption
- Enhances selectivity

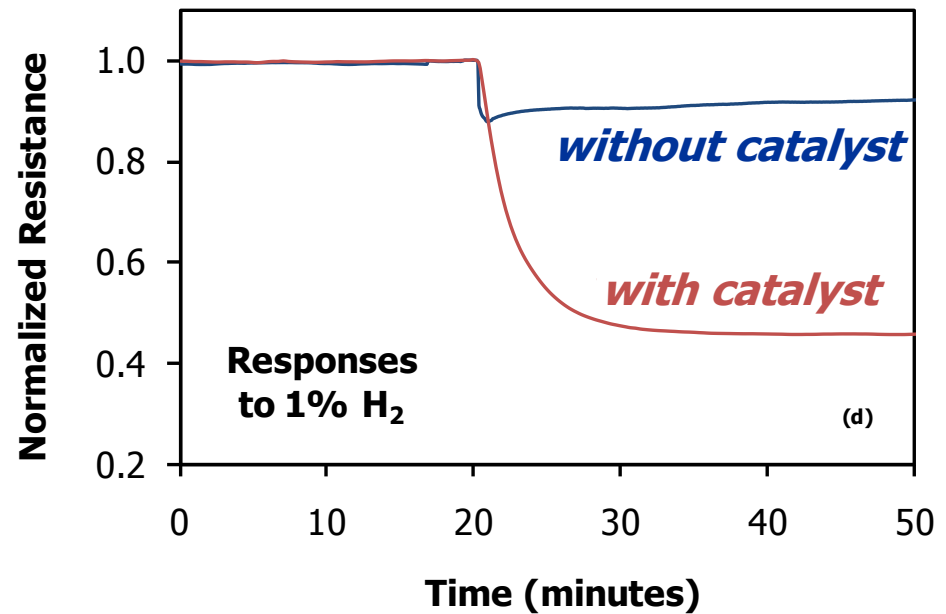
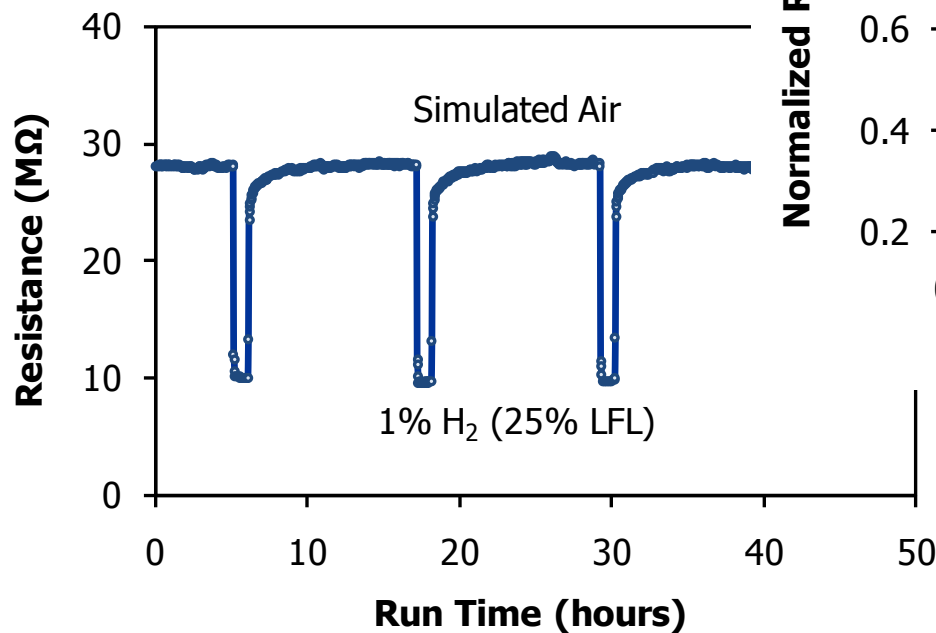
Catalyst (promoter)

- Enhances H₂ adsorption and disassociation
- Enhances sensitivity through catalytic mechanism



Sensor Material Development

*Ceria-based formulation
enables fast response and
recovery*



*Catalyst enhances
sensitivity for improved
accuracy and resolution*

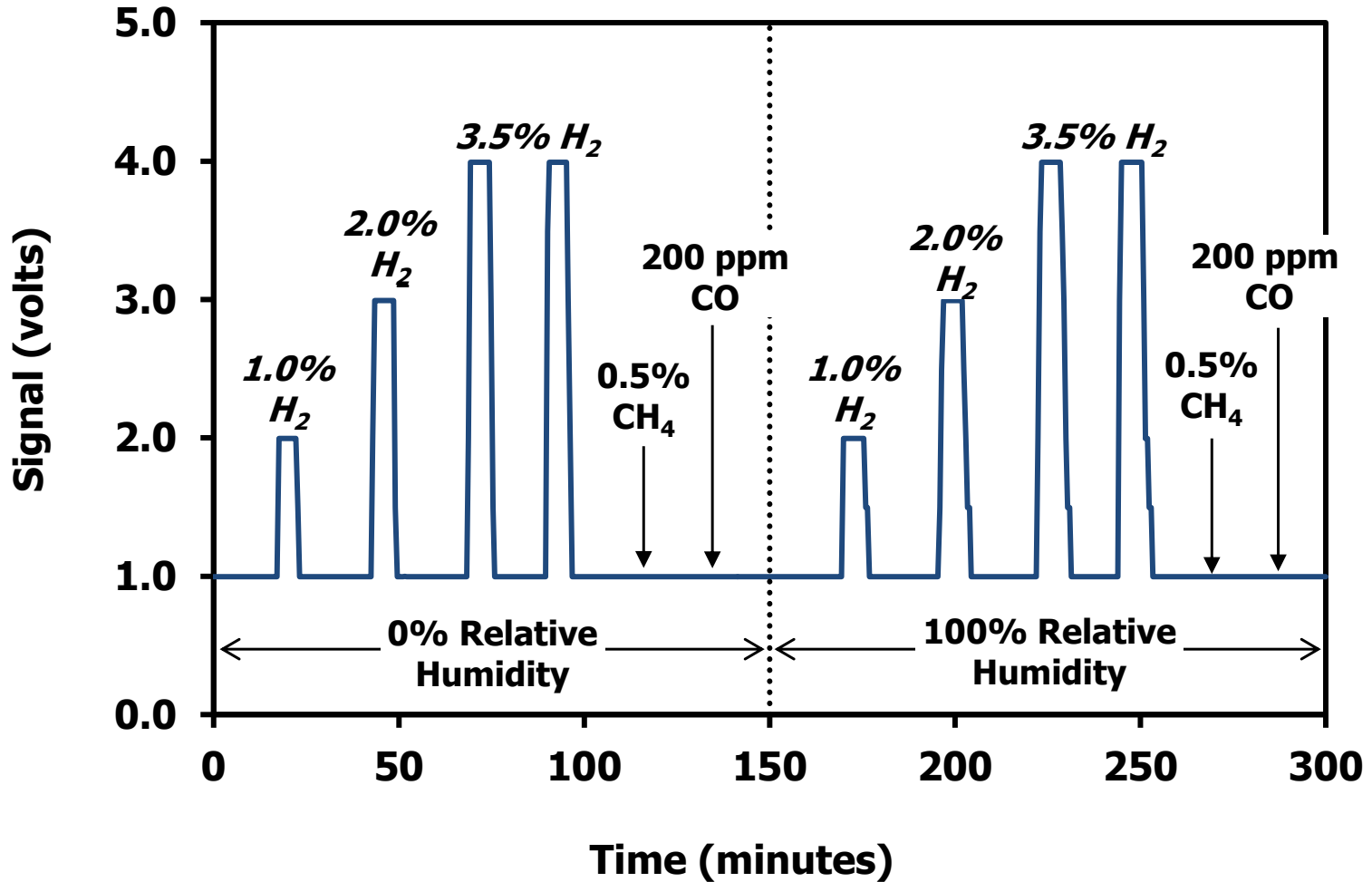
First Generation Product (NTM SenseH₂TM)



Standard Device Characteristics

Calibration Range	0.25 to 4% H ₂ in air
Sensor Output	1.0-4.5 VDC
Response Time (t ₉₀)	< 5 sec
Response Time (burst test)	< 600 ms
Recovery Time (t ₁₀)	< 5 sec
Humidity Range	5 to 95% RH
Temperature Range	-20 to 80°C
Current Draw (@25°C)	< 150mA @ 12VDC
Insensitive to:	CO, CH ₄ , VOCs
Robust to continuous H ₂ exposure (no signal saturation)	

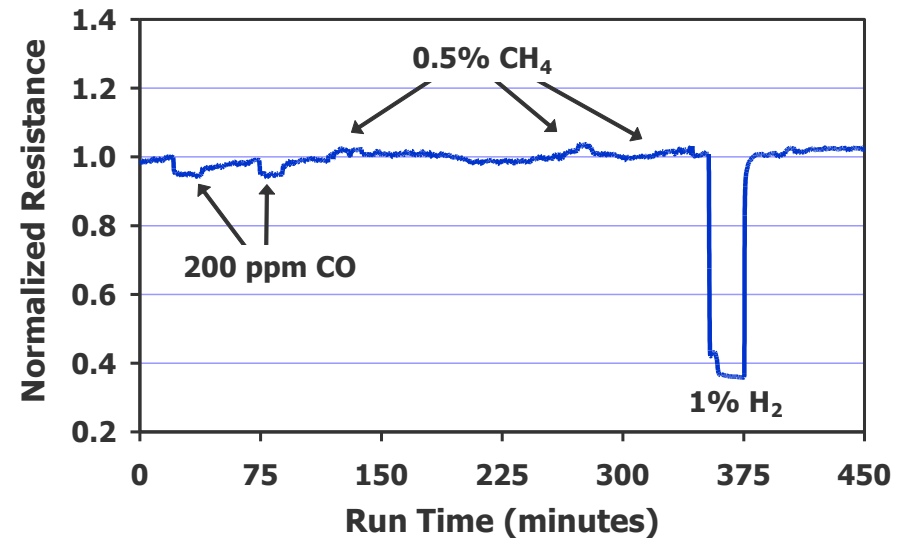
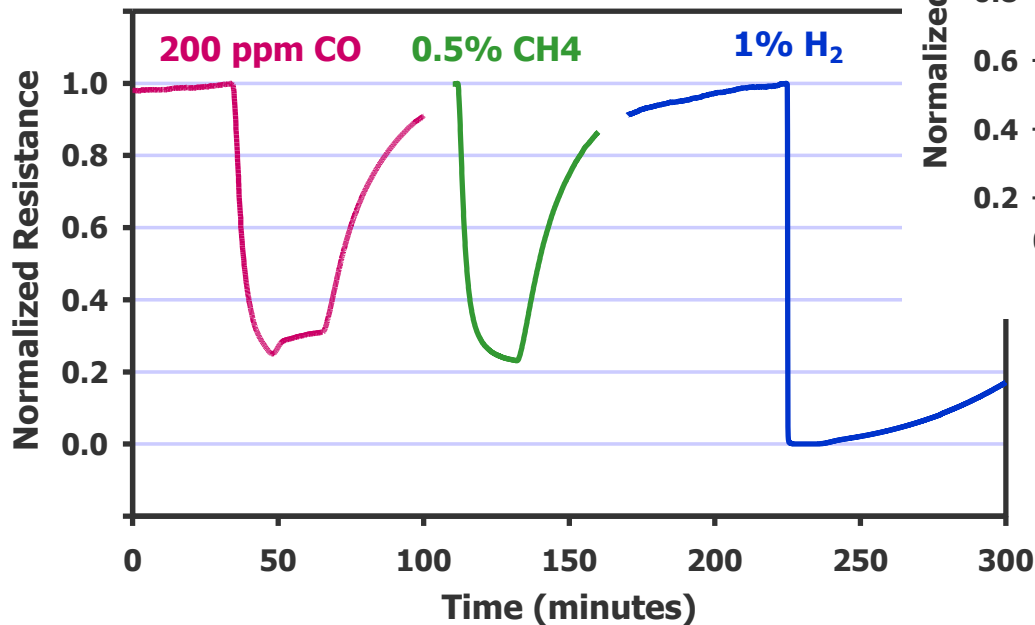
Key Sensor Characteristics



Competitive Analysis

Cross-Sensitivity

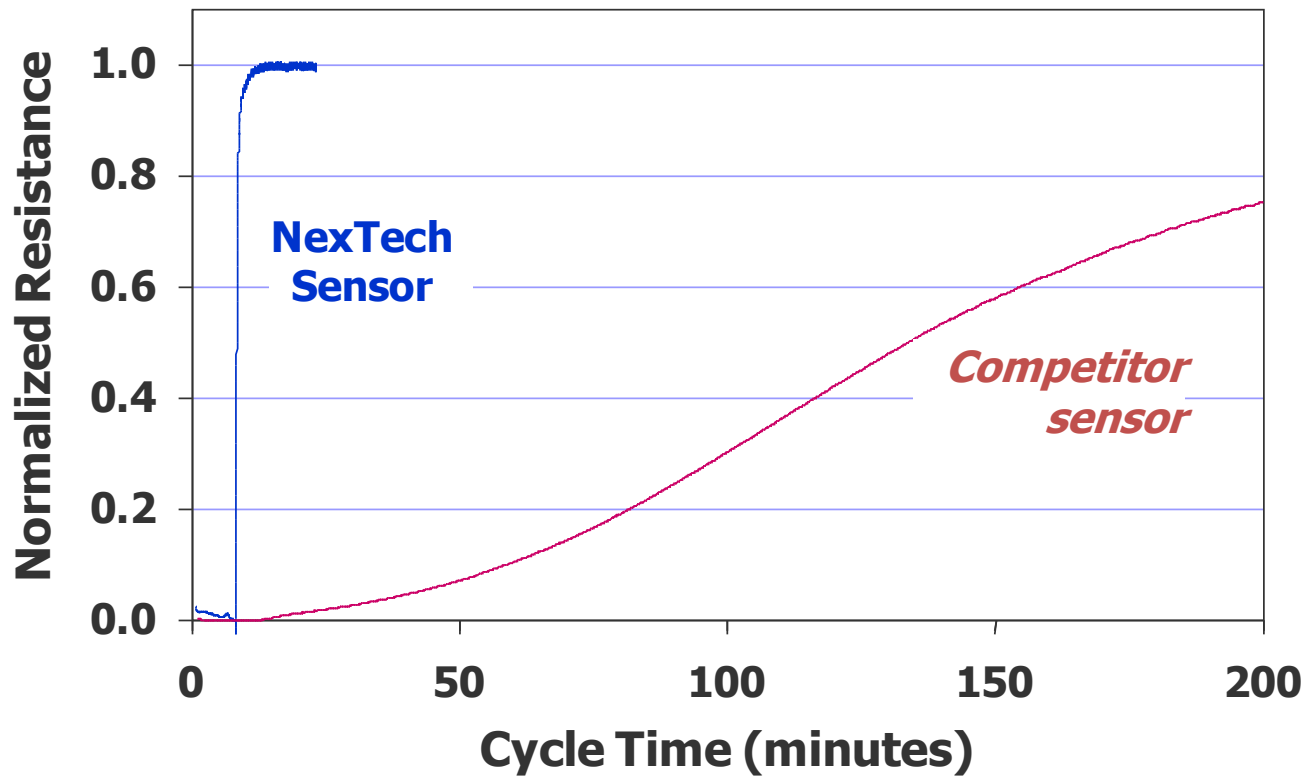
Competitive sensor



NexTech

NexTech's sensor is much less susceptible to false alarms

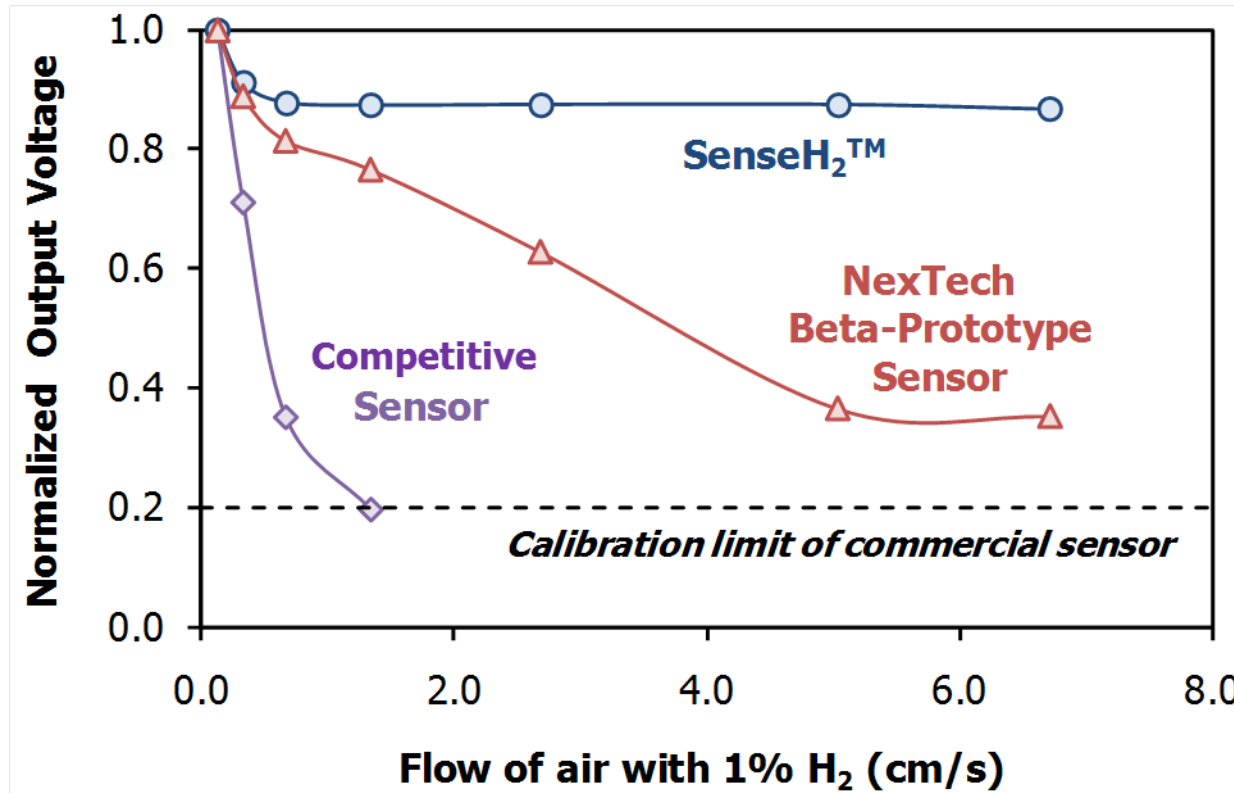
Competitive Analysis Recovery Characteristics



NexTech sensor can be used in applications with frequent or continuous exposures to low/safe levels of hydrogen

Competitive Analysis

Flow Sensitivity



Flow sensitivity was a key requirement for some of our customers, which was addressed by optimized packaging

Status of 1st Gen Sensor

Designed into multiple products

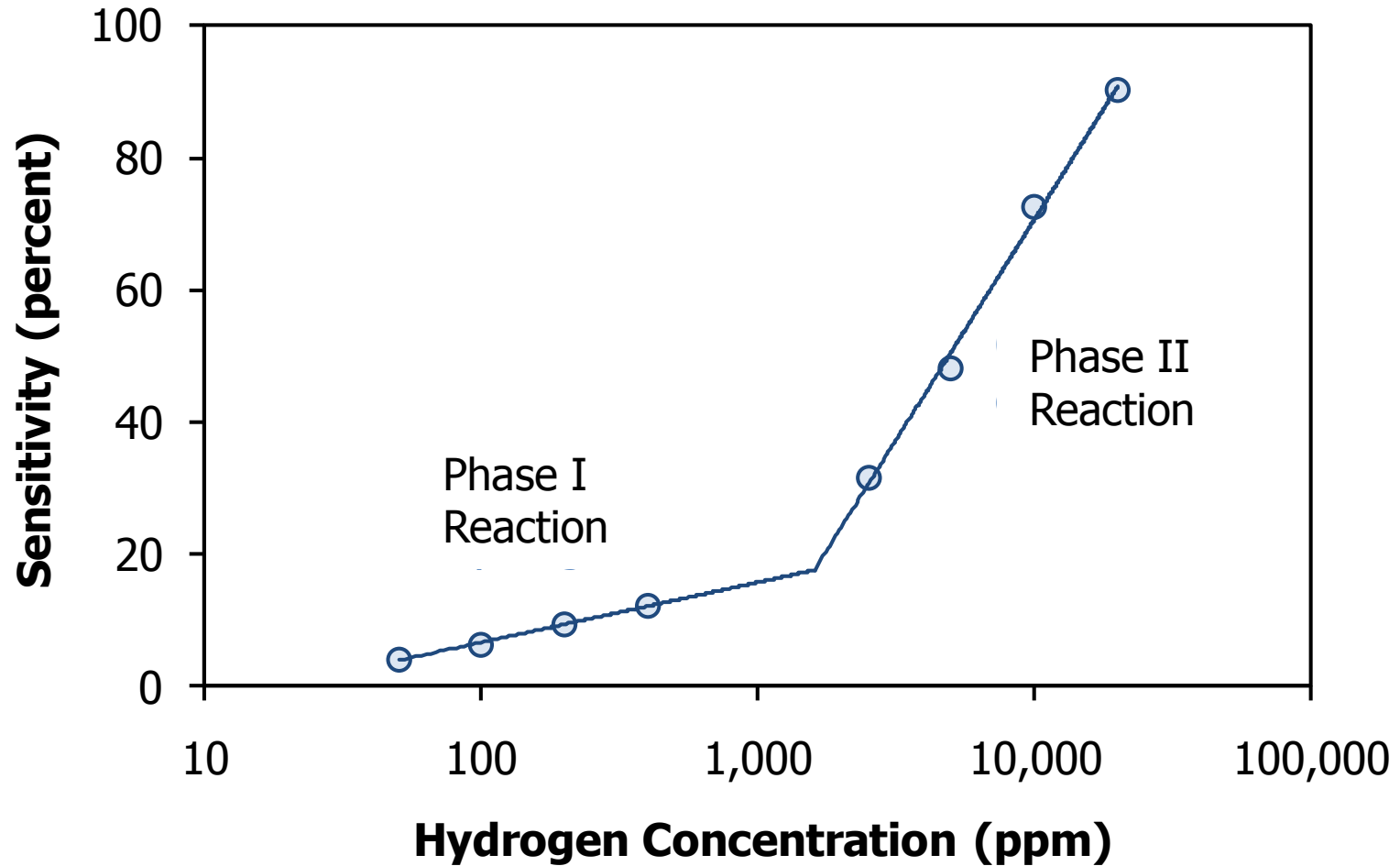
- Safety monitoring system for battery cabinets
- Hydrogen generator manufacturer in UK
- Two manufacturers of fuel cell test stands
- Fuel cell back-up system in Taiwan



UL/CE/ATEX certification

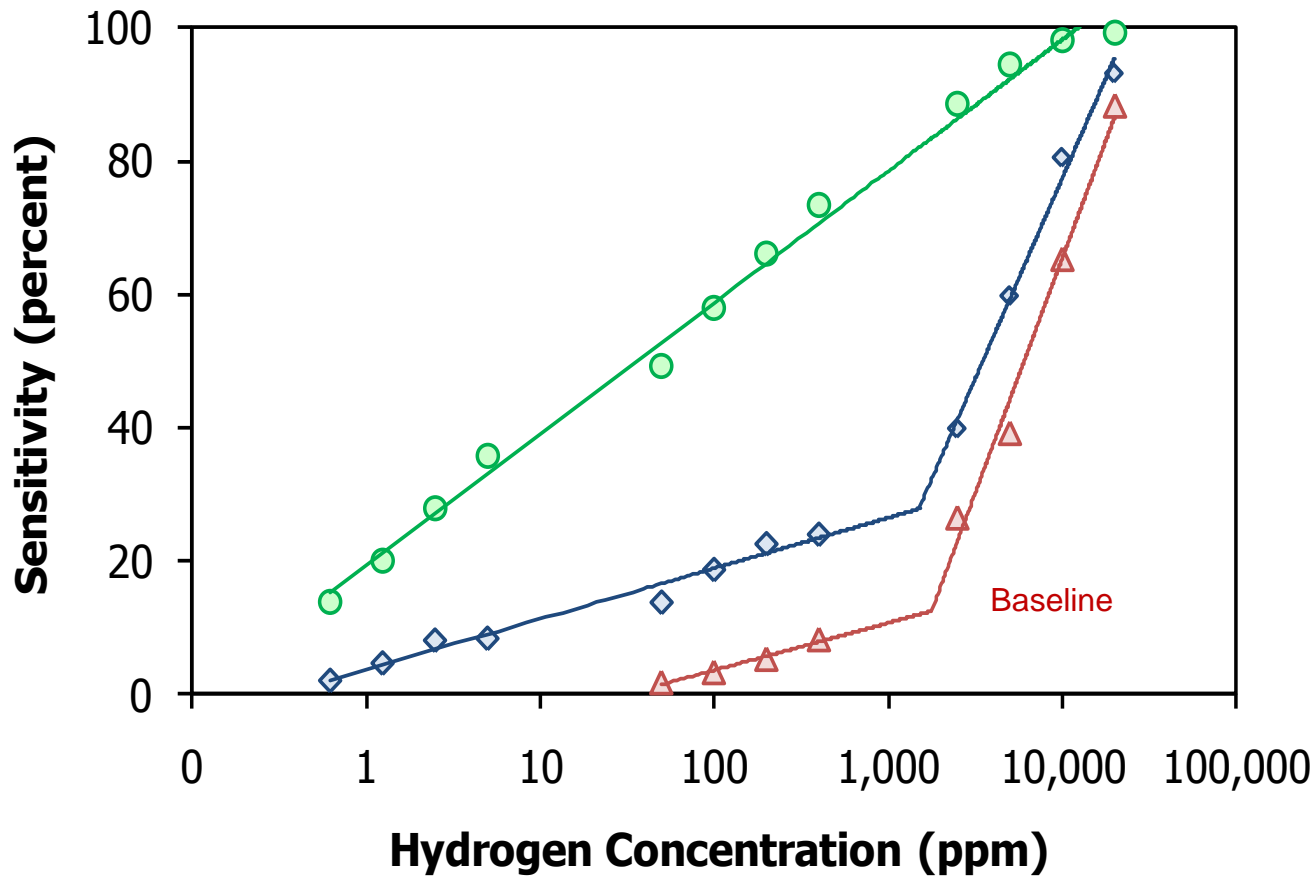
- Certified by the Underwriters Laboratories (UL) and can be found in the UL database.
- Meets all requirements for use in Class I, Division 2 and Zone 2 hazardous locations

Sensing Mechanism



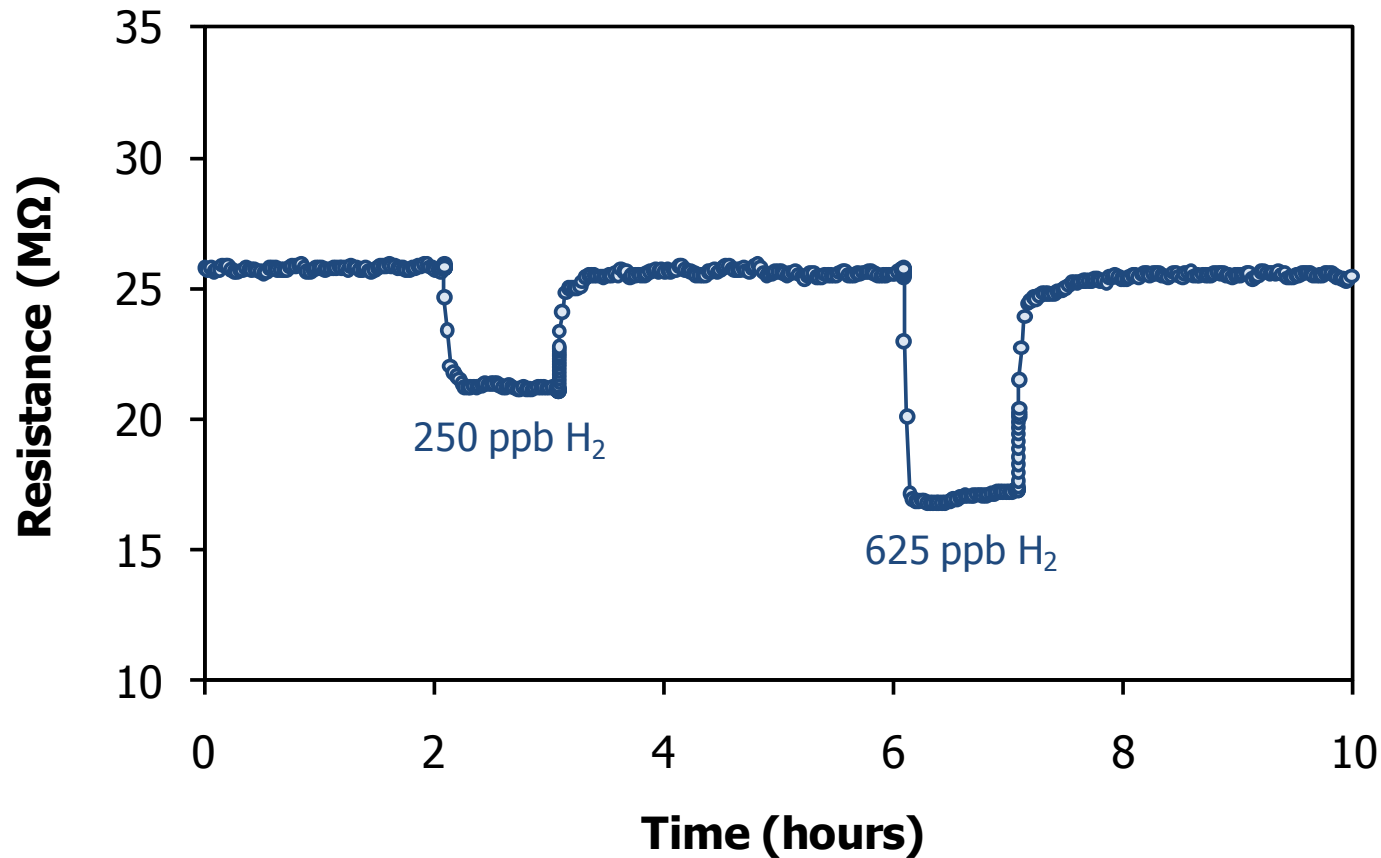
Low-Level H₂ Sensing

- Control sensing properties through manipulating the formulation



Low-Level H₂ Sensing

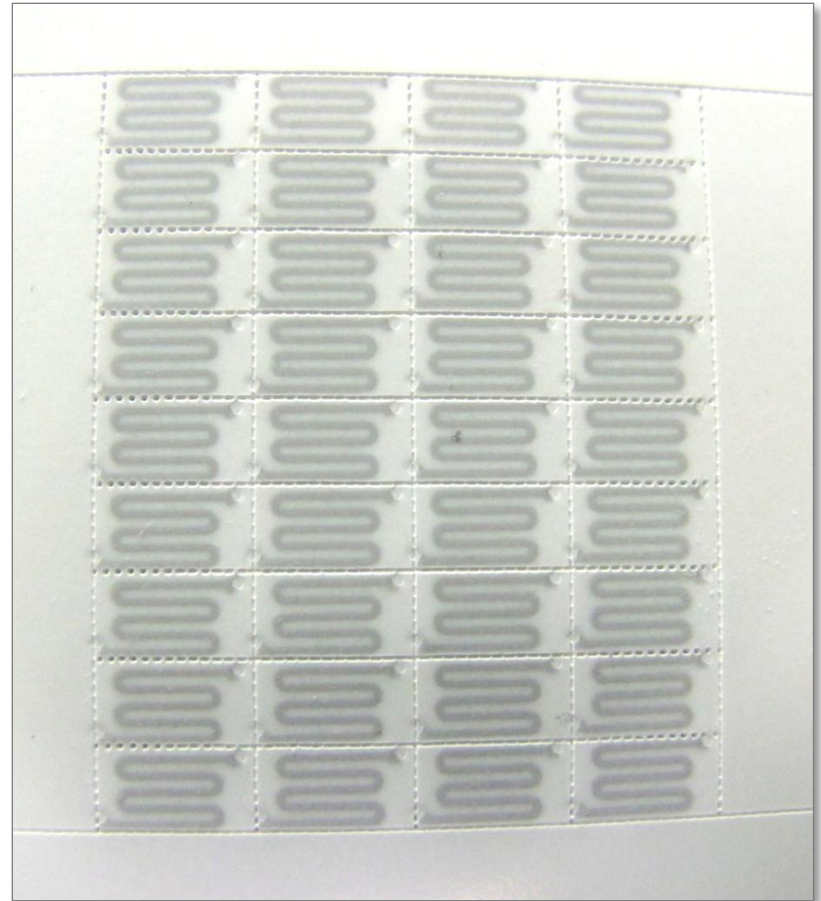
- Control sensing properties through manipulating the formulation
 - Sub-ppm quantification of hydrogen levels



Planar Sensor Development

Planar Hydrogen Sensor Development

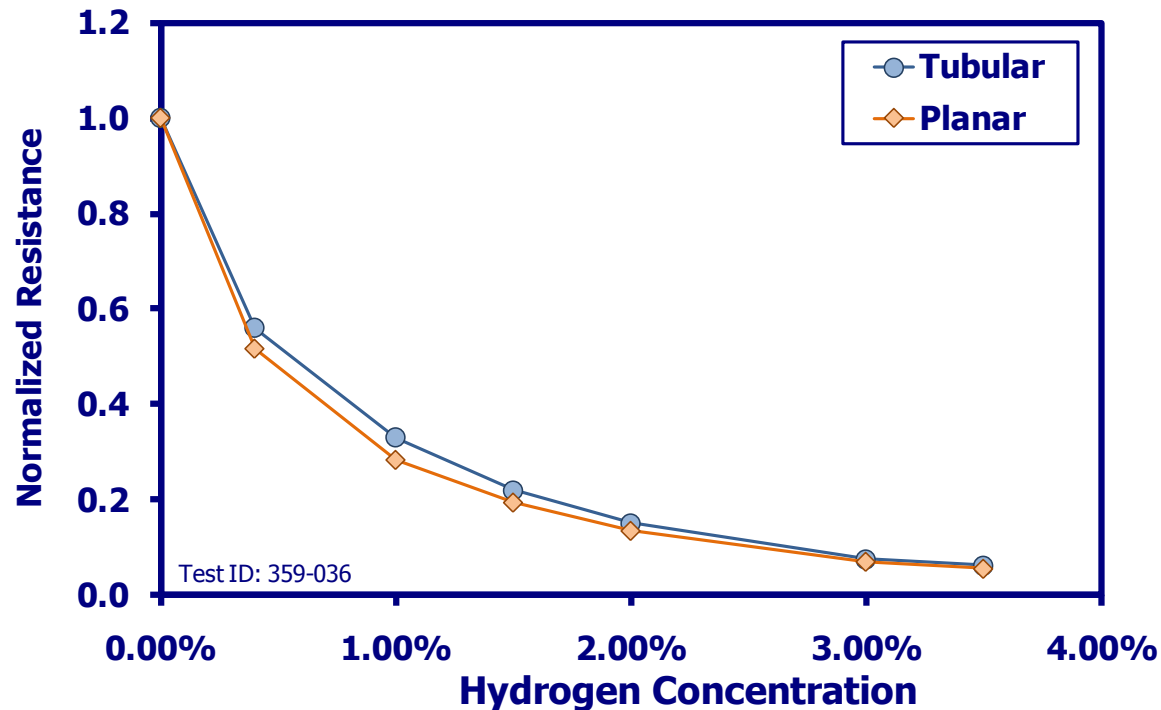
- Substrate geometry change to reduce manufacturing cost.
- Array processing for cost reduction
- Utilize established manufacturing processes used in the semi-conductor industry
- Same NTM Sensor sensing technology.
- Direct replacement for tubular substrate
- 4Q2011 – Prototype assembly/evaluation



Planar Sensor Development

Tubular performance is reproducible on the planar platform

- Temperature and sensing characteristic duplicated on planar substrate



Product Roll-out



NTM Sensors:
Current product
ntmsensors.com

Volume Manufacturing

**NexTech
Sensor
Technology**

**Planar Element
Manufacturing**
Cost Reduction

2009

Launched 3Q2010

3Q2012

2013+

Acknowledgements

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LCCC SMART Commercialization Center

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