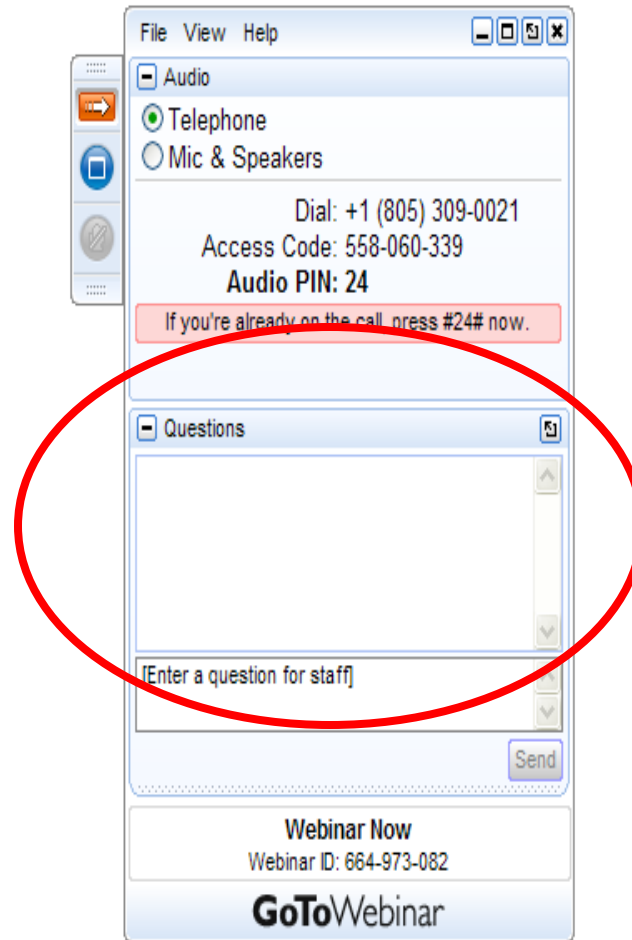


Presenter:
Bill Hoagland – Element One
John Poplawski – Midsun Specialty Products

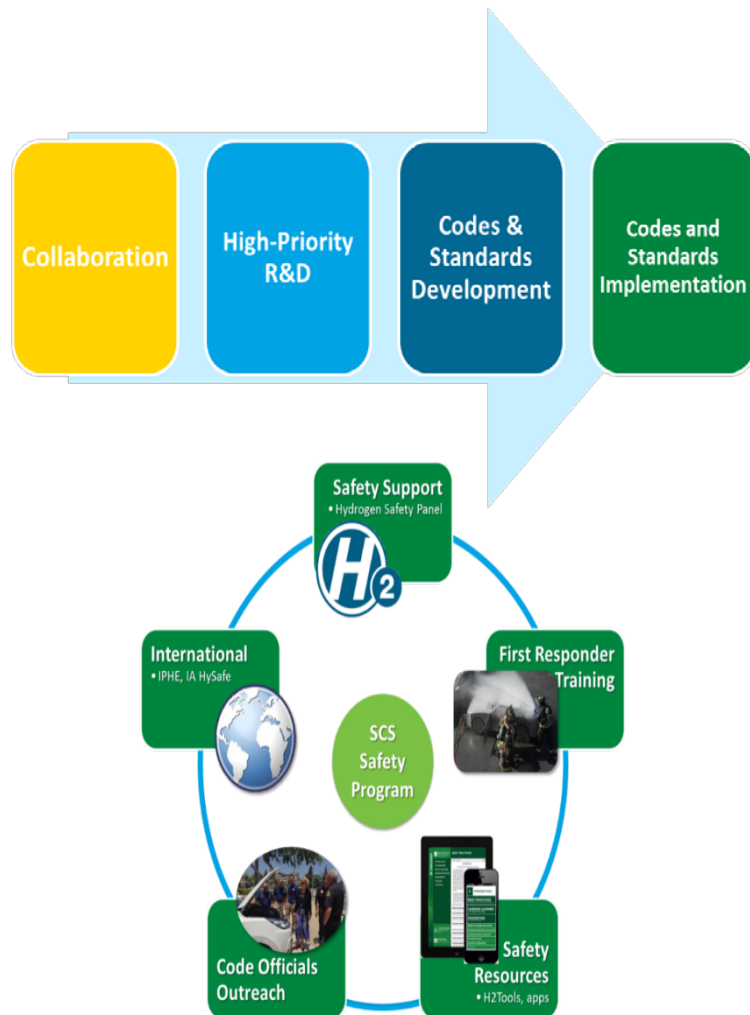
DOE Host:
Will James – Safety, Codes, and Standards Program Manager

U.S. Department of Energy
Fuel Cell Technologies Office
March 14th, 2016

- Please type your questions into the question box



Safety, Codes and Standards Overview



Emphasis

- **R&D Activities:** H₂ Behavior, Risk Assessment/Mitigation, Materials Compatibility, H₂ Fuel Quality, Metering, Sensors, Component Testing
- **Safety Management & Resources:** Hydrogen Safety Panel, Databases, and Training Props
- **Outreach:** Codes & Standards and Permitting, Continuous Codes and Standards Improvement, Resource Dissemination

Enable the widespread commercialization of hydrogen and fuel cell technologies through the timely development of codes and standards and dissemination of safety information

- Provide independent assessment of hydrogen sensor performance
- Interact with manufacturers to improve sensor performance to meet DOE 2012 targets
- Support deployment with information and expertise on sensor use and performance
- Test/validate new sensor R&D
- Support hydrogen sensor codes and standards development (national and international)
- Outreach and Education
 - Publications, presentations, consultations
 - Student Internships
- Client confidentiality



The ultimate goal of the Hydrogen Sensor Testing Laboratory is to ensure that end-users get the sensing technology they need



Visual Leak Detectors for Hydrogen Equipment

Presented by



PRESENTERS



Bill Hoagland | *Element One*
20+ Years in Hydrogen Research

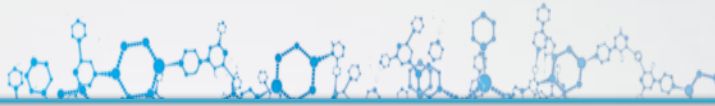


John Poplawski | *MSP*
12+ Years in Silicone Manufacturing



WEBINAR SUMMARY

- Company Backgrounds
- Leak Detection Summary
- Benefits of Low-Cost Visual Leak Detectors
- DetecTape™ H₂ Technology and Performance
- Applications and Markets
- Availability and Upcoming Developments



ELEMENT ONE BACKGROUND

- Incorporated in 2005 and began R&D of products based on core patent (U.S. Patent #6,895,805).
- Key members are veterans of NREL. Collaboration with NREL 2005 - present.
- Conduct thin film research in NREL's Hydrogen Sensor Laboratory.
- Funded contracts with DOE/NREL, NASA, Industry. Licensing agreements with industry. One technology license with NREL.
- Four patents, three pending.
- In 2015, partnered with MSP to create and market DetecTape™.

www.elem1.com

DOE Recognition

March 2013

March 2012

August 2014



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Home » Science & Innovation » Innovation » America's Next Top Energy Innovator » America's Next Top Energy Innovator Challenge

AMERICA'S NEXT TOP ENERGY INNOVATOR CHALLENGE


The America's Next Top Energy Innovator Challenge, a part of the Startup America initiative, made it easier for start-ups to use inventions and technology developed at the U.S. Department of Energy's 17 National Laboratories and the Y-12 National Security Complex.

The companies highlighted below signed option agreements allowing them to license valuable, cutting-edge technologies from one of the labs.

You can see the winners of the 2012 competition [here](#).

We counted your "likes" and then left it up to the panel of experts to evaluate which three of these companies are selected to attend the **2012 ARPA-E Energy Innovation Summit**, the premier annual gathering of clean energy investors and innovators around the country.

INNOVATORS Sort by: [Random](#) | [Alphabetical](#) | [Rating \(High to Low\)](#) | [Rating \(Low to High\)](#)

 <p>Element One, Inc.</p> <p>National Renewable Energy Laboratory 101524 likes</p>	 <p>Umpqua Energy, Inc.</p> <p>Argonne National Laboratory 142564 likes</p>	 <p>Vorbeck Materials Corp.</p> <p>Pacific Northwest National Laboratory 45458 likes</p>	 <p>Teknikem, A Division of RockinBoat LLC</p> <p>Y12 National Security Complex 17256 likes</p>
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NREL: 2012 Industrial Growth Forum Presenting Company
2014 NREL Commercialization Assistance Program
2016 Small Business Voucher Award



U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

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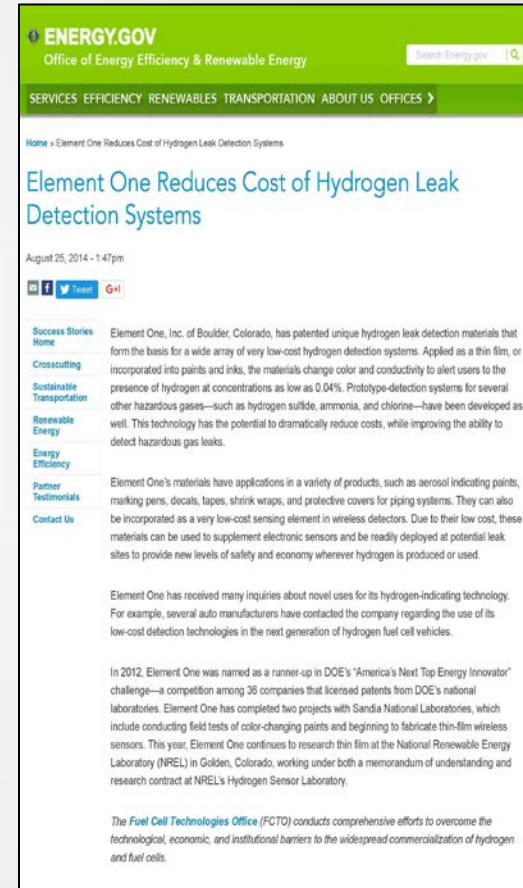
DOE Webinar April 3: America's Next Top Energy Innovator Runner-Up Presents Hydrogen Detection Technologies

March 28, 2012

The U.S. Department of Energy will present a live webinar on April 3, 2012 featuring Element One, runner-up in America's Next Top Energy Innovator competition, which will present its Hydrogen Detection Technologies. The webinar will take place on April 3 from 12:00 to 1:00 p.m. Eastern Daylight Time.

Element One, Inc., of Boulder, Colorado, developed and patented a unique family of hydrogen and gas sensing technologies that form the basis for a wide array of low cost and reliable gas detection systems, an effort earning them the runner-up position in DOE's "America's Next Top Energy Innovator" competition. These hydrogen detection systems are based on simple chemochromic chemistry that visually indicates the presence or absence of hydrogen. These low cost hydrogen sensors have the ability to indicate the presence of leaking hydrogen at concentrations as low as 0.04%, or 1/100th of the lower flammability limit. Element One has developed similar detection systems and prototypes for several other hazardous gases, including hydrogen sulfide, ammonia and chlorine.

The prolific use of low cost gas sensors, like those developed by Element One, will significantly reduce the potential for undetected releases of hazardous gases in industry and fuel cell energy systems. This technology has the potential to reduce costs while improving the ability to detect leaks wherever such gases are used, whether it is used as a feedstock, reagent or fuel.



ENERGY.GOV Office of Energy Efficiency & Renewable Energy **SEARCH**

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Home » Element One Reduces Cost of Hydrogen Leak Detection Systems

Element One Reduces Cost of Hydrogen Leak Detection Systems

August 25, 2014 - 1:47pm

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Element One, Inc. of Boulder, Colorado, has patented unique hydrogen leak detection materials that form the basis for a wide array of very low-cost hydrogen detection systems. Applied as a thin film, or incorporated into paints and inks, the materials change color and conductivity to alert users to the presence of hydrogen at concentrations as low as 0.04%. Prototype-detection systems for several other hazardous gases—such as hydrogen sulfide, ammonia, and chlorine—have been developed as well. This technology has the potential to dramatically reduce costs, while improving the ability to detect hazardous gas leaks.

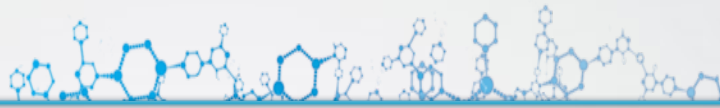
Element One's materials have applications in a variety of products, such as aerosol indicating paints, marking pens, decals, tapes, shrink wraps, and protective covers for piping systems. They can also be incorporated as a very low-cost sensing element in wireless detectors. Due to their low cost, these materials can be used to supplement electronic sensors and be readily deployed at potential leak sites to provide new levels of safety and economy wherever hydrogen is produced or used.

Element One has received many inquiries about novel uses for its hydrogen-indicating technology. For example, several auto manufacturers have contacted the company regarding the use of its low-cost detection technologies in the next generation of hydrogen fuel cell vehicles.

In 2012, Element One was named as a runner-up in DOE's "America's Next Top Energy Innovator" challenge—a competition among 36 companies that licensed patents from DOE's national laboratories. Element One has completed two projects with Sandia National Laboratories, which include conducting field tests of color-changing paints and beginning to fabricate thin-film wireless sensors. This year, Element One continues to research thin film at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, working under both a memorandum of understanding and research contract at NREL's Hydrogen Sensor Laboratory.

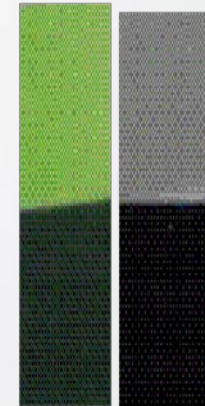
The Fuel Cell Technologies Office (FCTO) conducts comprehensive efforts to overcome the technological, economic, and institutional barriers to the widespread commercialization of hydrogen and fuel cells.





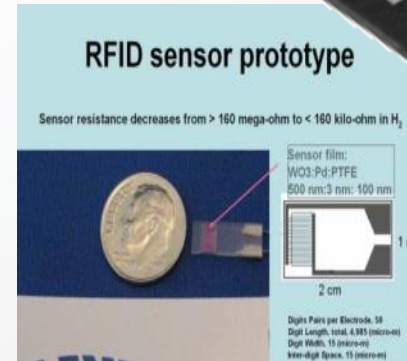
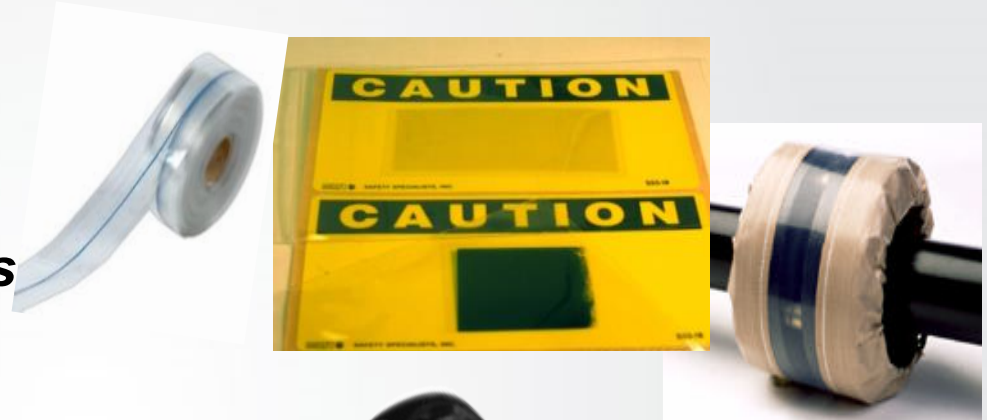
DETECOAT® AND DETECTAPE™

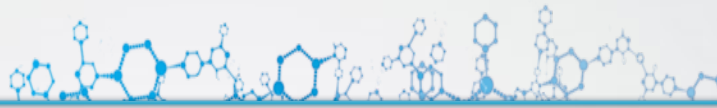
Thin films and “Smart” coatings for the detection of leaked or leaking hydrogen to achieve a **new level of reliability** and make possible a wide array of **very low cost** gas detection products.



APPLICATIONS

- ✓ *Tapes and wraps*
- ✓ *Leak detecting pipe covers*
- ✓ *Safety badges and warning s*
- ✓ *Leak detection coatings*
- ✓ *Pressure/reaction vessels and storage containers*
- ✓ *Sensors*





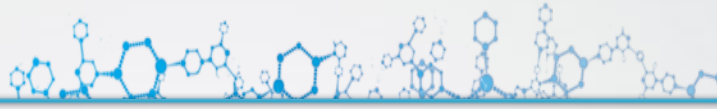
HYDROGEN CHARACTERISTICS

- **Odorless and colorless**
- **High propensity to leak**
- **Low ignition energy**
- **Invisible flame**
- **High energy content**
- **Lighter than air - diffuses rapidly**



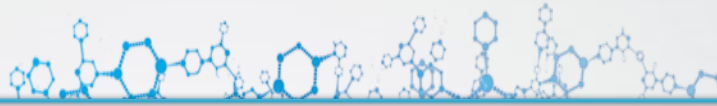
Difficult to Detect Leaks

- Gas detection is a **critical element** of the safe manufacture, handling and use of many industrial gases.
- The **\$700+ million gas detection market**, served by more than twenty-five OEMs and hundreds of maintenance contractors, is mature and stable with a projected annual **growth in the 3 to 6% range**.
- The **global hydrogen market** in 2015 was estimated at **53 million metric tons** with 12% in the merchant hydrogen market with a **growth rate of 5-6% per year**.



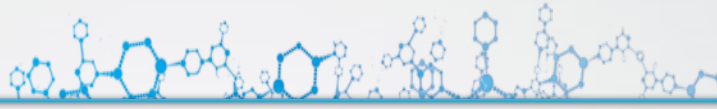
CURRENT LEAK DETECTION METHODS

- **Bubble Testing** – Simple spot test method with **no continuous monitoring** at low pressures.
- **Thermal Conductivity** – Works well in stable environments with minimal temperature change, **background gas must have conductivity very different from hydrogen**.
- **Catalytic Combustion** – Detects heat of combustion, works well for low concentrations. **Not for pure hydrogen**.
- **Electrochemical** – Sensors use a liquid electrolyte, but **varying temperature affects gas diffusion** making the sensor unreliable.
- **Mass Spectrometers** – Extremely sensitive, expensive, **require skilled operators** and may have long response times.
- **Gas Chromatographs** – Similar to mass spectrometers and have the same disadvantages.
- **Ultrasonic** – Technology improving, but **cannot determine exact location** or whether combustible mixture is present.
- **Semi-Conducting Oxide** – Sensor relies on surface effects with a **minimum oxygen concentration**. Performance degrades at lower temperatures.



THE IDEAL LEAK DETECTOR

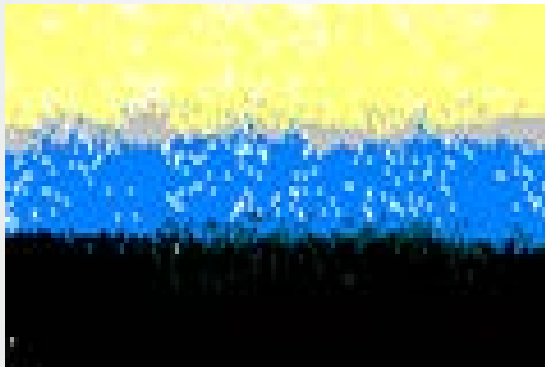
- ✓ **Very Low-cost** – affordably used prolifically at potential leak sites;
- ✓ **Positive Indication** of **both** the **presence** and the **absence** of hydrogen;
- ✓ **Simple, reliable, easily incorporated** into the system, no power source;
- ✓ **Hydrogen specific and sensitive**;
- ✓ **Quick response, but no false indications**;
- ✓ **Durable, long useful life requiring little or no maintenance**; and
- ✓ **Detectable by one or more of the human senses** (sight, smell, sound).



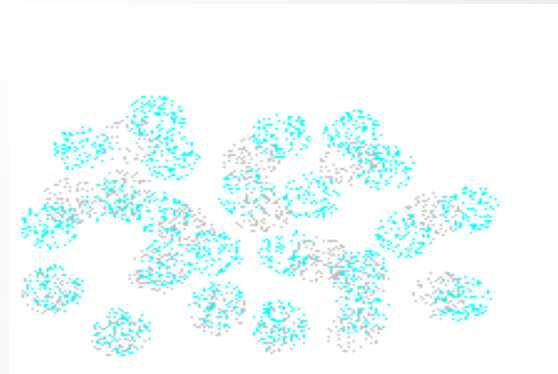
TECHNICAL APPROACHES

To meet varying requirements, Element One's research has taken two directions:

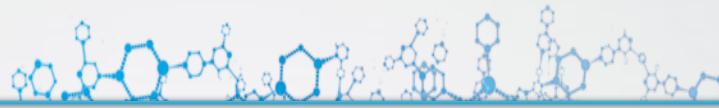
1. **Thin films** that both change color and resistance for use in low cost wireless sensors; and
2. **Color changing pigments** for coatings for visual indication.



**Vacuum deposited
multi-layer thin film**

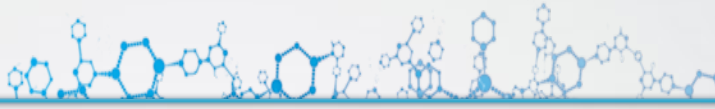


**Synthesized
nano-particles**



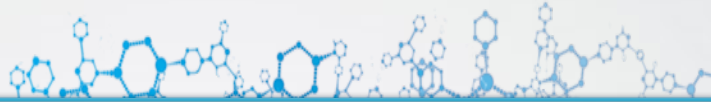
PIGMENTS VS. THIN FILMS

	Pigments	Thin Films
Response Speed	Slower	Faster
Manufacture	Easier to produce	Vacuum deposition process
Detection method	Visual only	Both visual and resistance change
Physical Structure	Incorporated into carriers	Multi-layer thin-film devices
Material required	More pigment per unit area	Less pigment per unit area
Durability	Extremely durable, resistant to contamination, sunlight (UV), acids, bases, moisture.	Less durable, requires selectively permeable protective coating.
Applications	Thick coatings, paints, inks, wraps, molded	Resistive/wireless H ₂ sensors, detection of



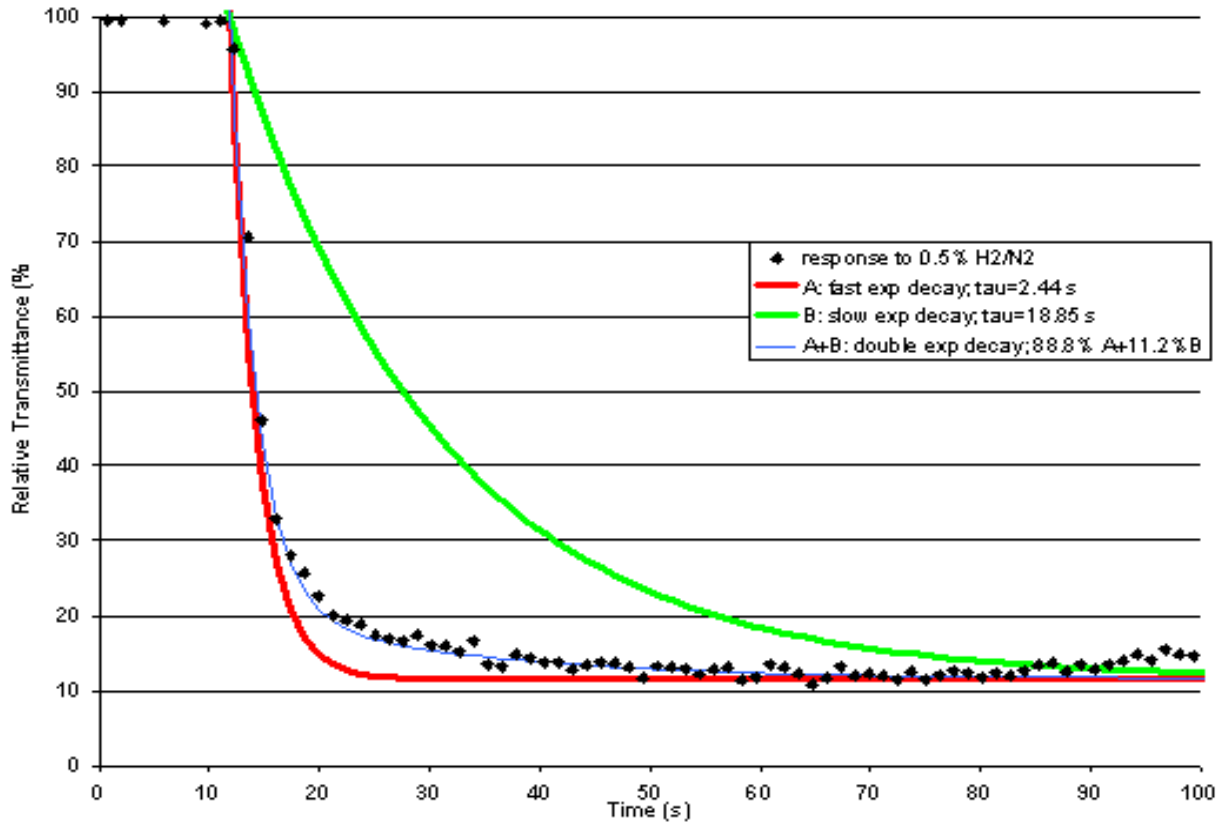
Chemo-chromic chemical reactions: result of a partial reduction of a transition metal oxide

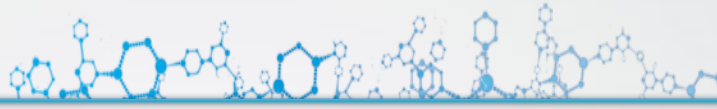
a partial oxidation of a catalyzed transition metal oxide pigment of < 20% effects a readily visible color change from light gray to virtually black.



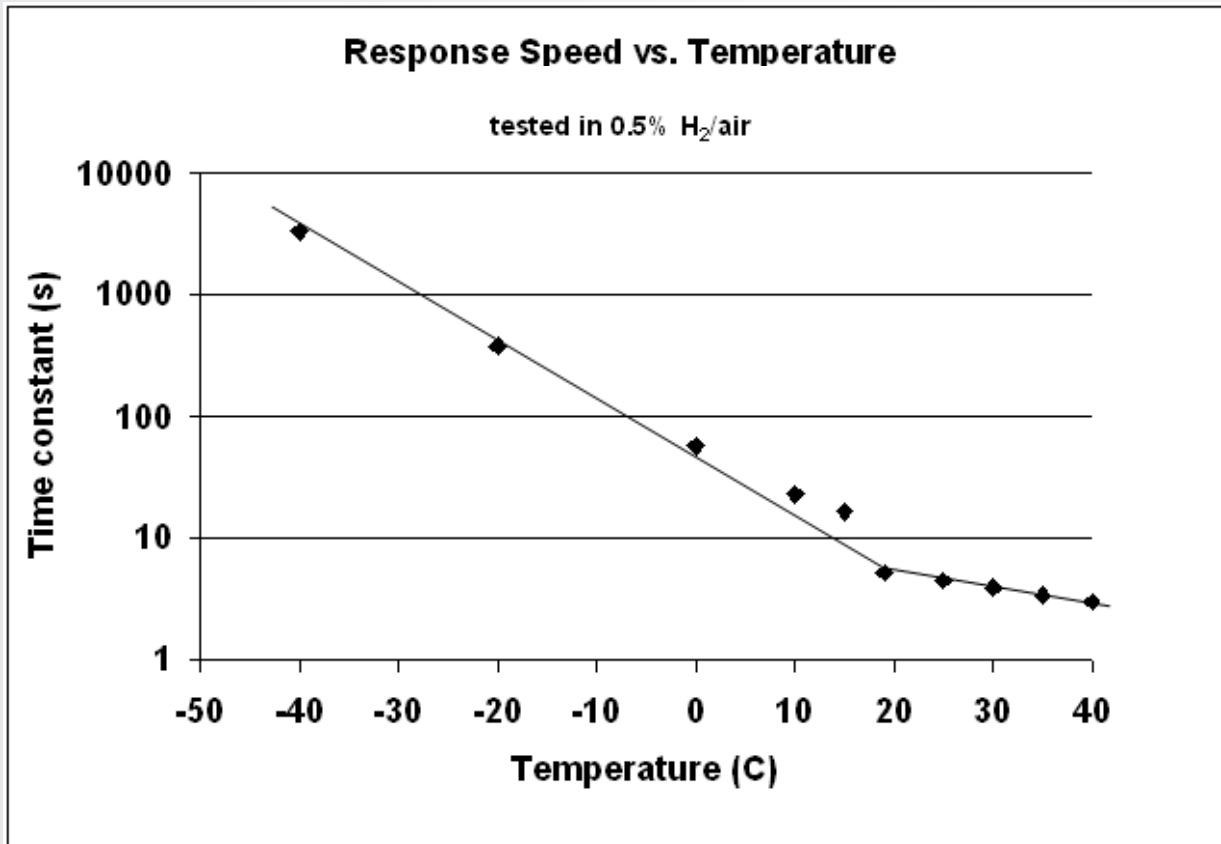
CHEMO-CHROMIC RESPONSE

Transition Metal Oxide Powder (no encapsulant)

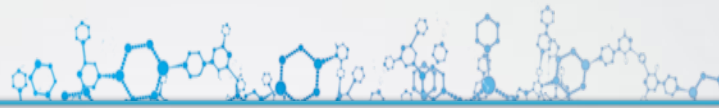




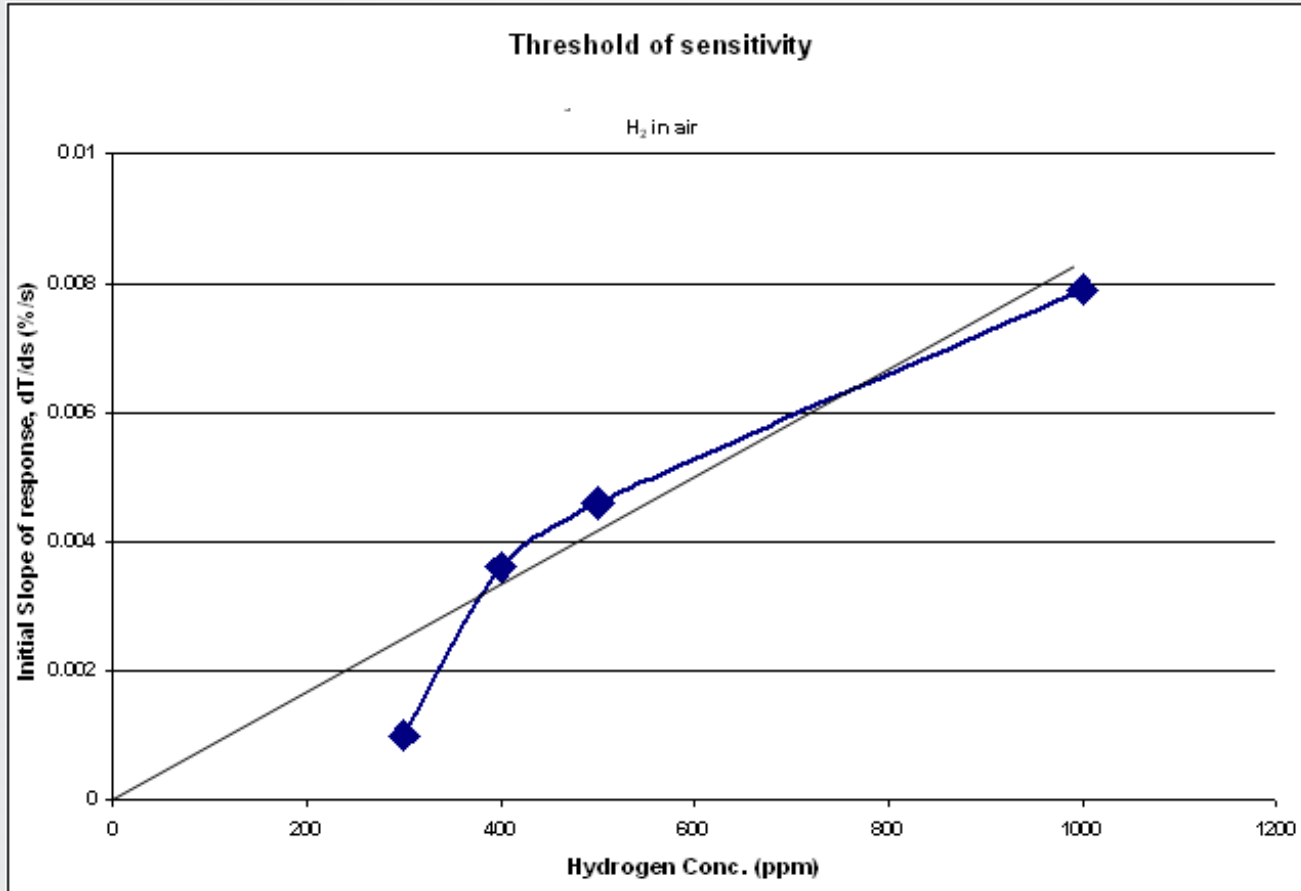
RESPONSE VS. TEMPERATURE



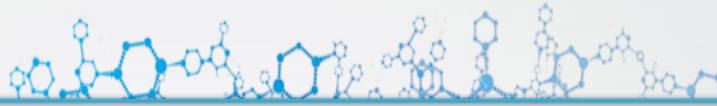
✓ Responds more quickly at higher temperatures.



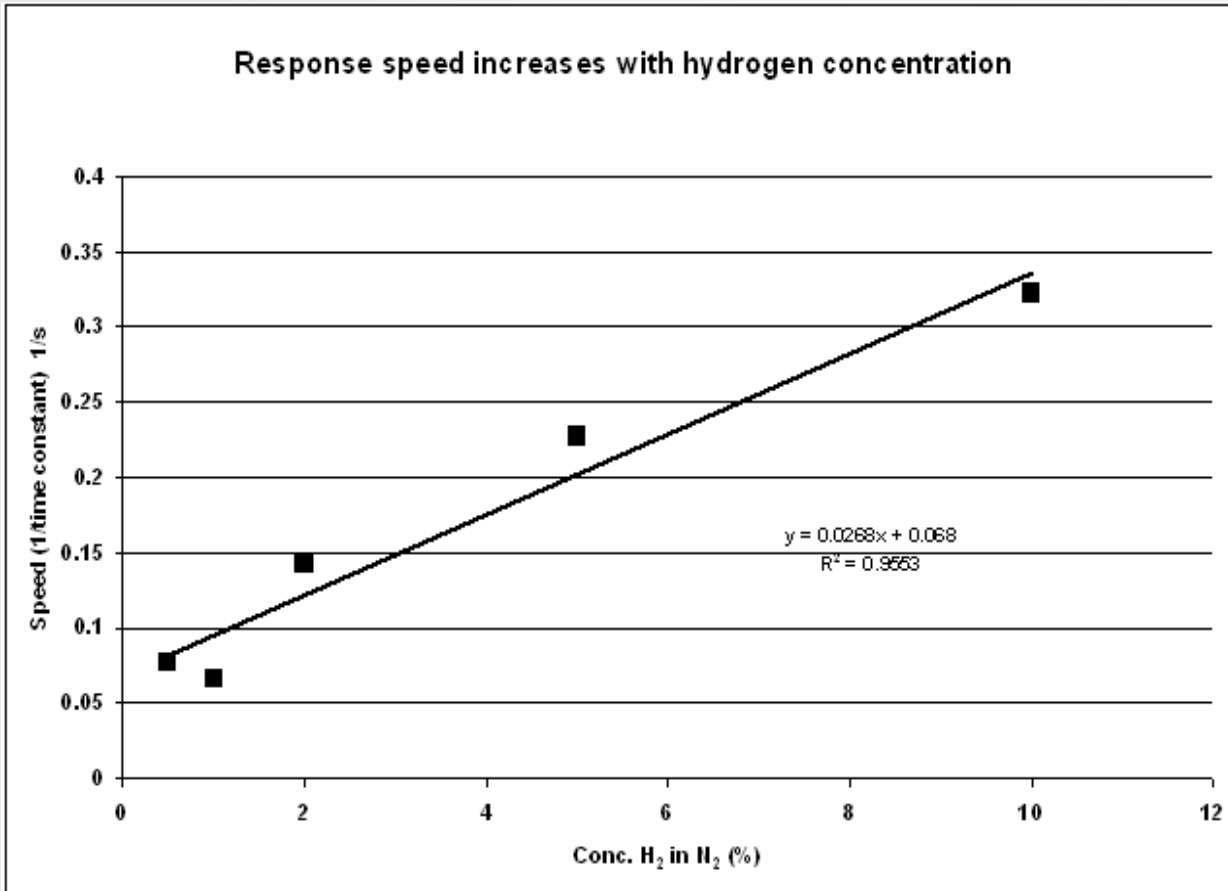
THRESHOLD of SENSITIVITY



✓ Thin film indication threshold in air is less than 400 ppm H_2



RESPONSE VS. CONCENTRATION

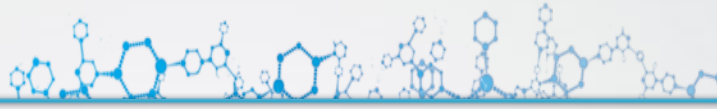


✓ Speed of Response is proportional to Hydrogen concentration.

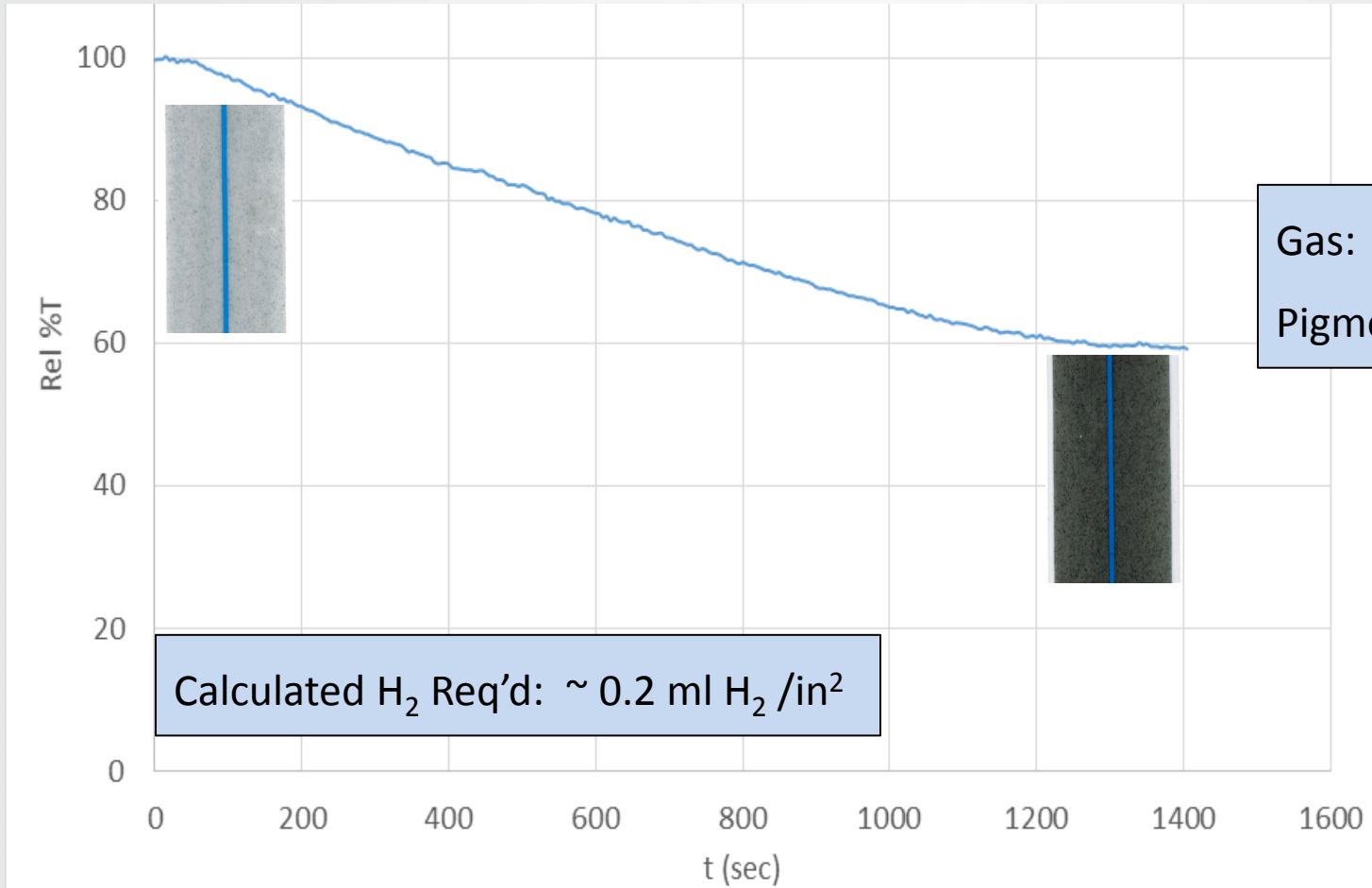
DETECTAPE™ H₂
(patent pending)

A chemo-chromic (color changing), self-fusing silicone tape designed to detect hydrogen gas (H₂) leaks in storage, transmission and generation facilities.



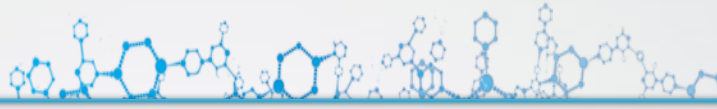


DETECTAPE™ H₂ RESPONSE TEST



Gas: 5.7% H₂/N₂
Pigment ~ 0.004g/in²

Calculated H₂ Req'd: ~ 0.2 ml H₂ /in²



E1 DETECTAPE H₂ TESTS

- Controlled leak at ~ 0.5 ml/sec, 15 psi

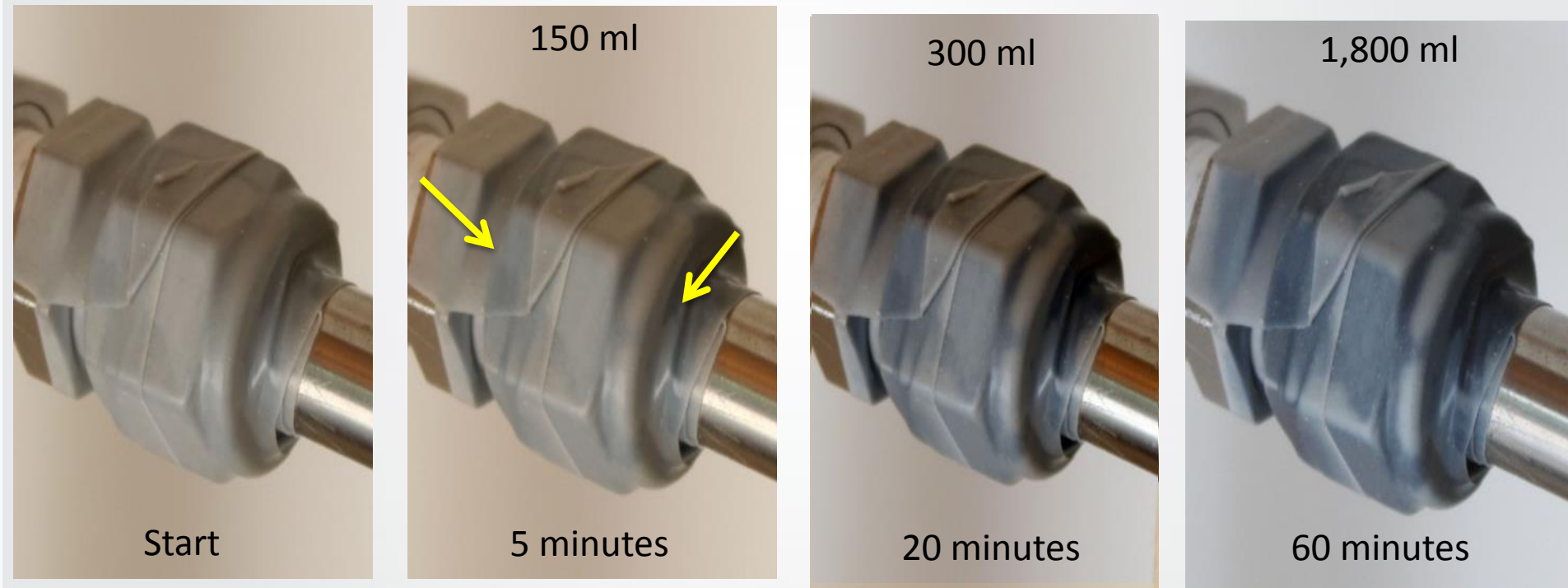
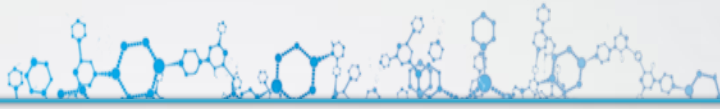


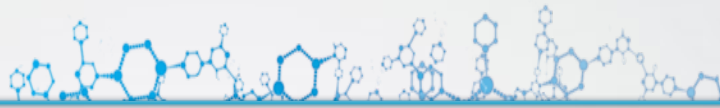
Photo credits: Element One, Inc.



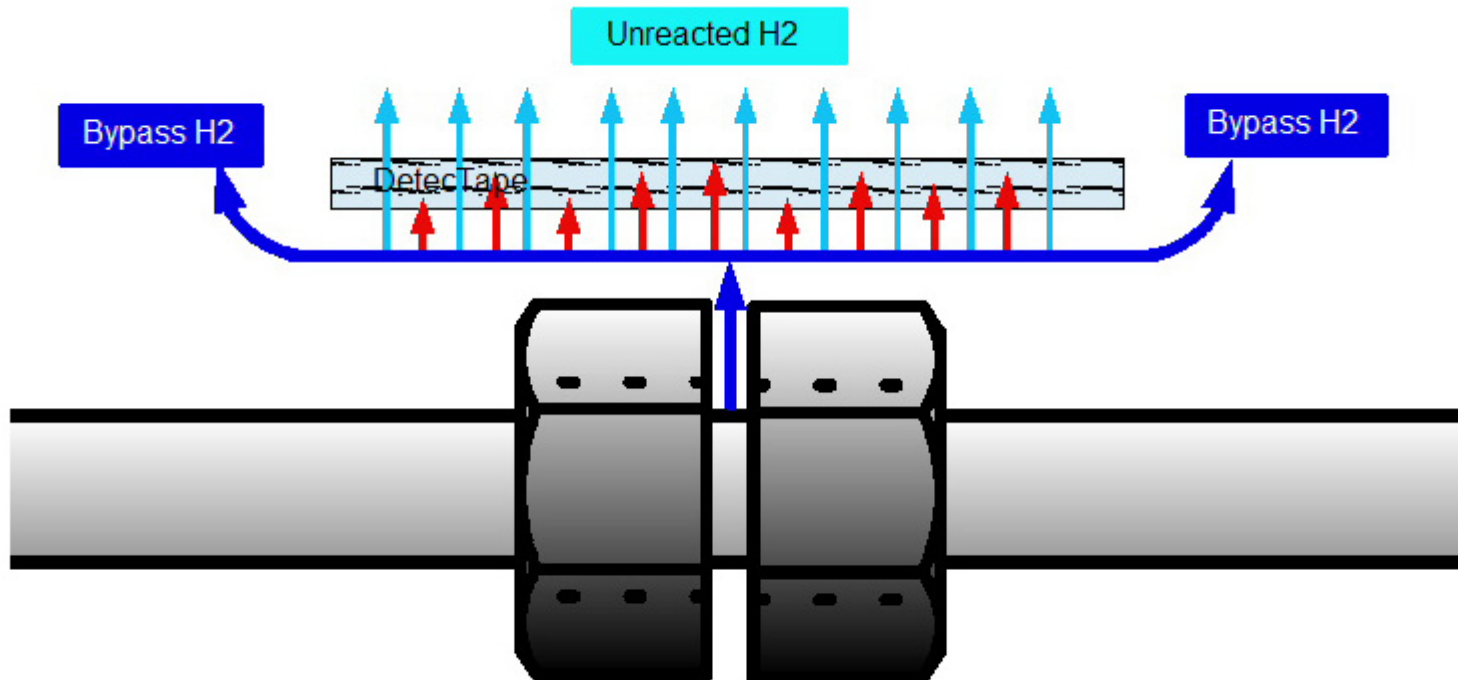
So...

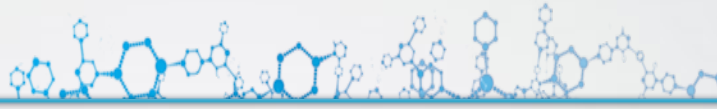
If a typical wrap of DetecTape™ H₂ is 6 in²;
and if it takes only .2 ml to change 1-in²....

Why does it take a leak of >300ml to completely change color?



Not all leaked gas reacts with the DetecTape™ H₂ pigment





E1 DETECTAPE EXPOSURE TESTS (60 days and counting)

- ✓ 67° C under water
- ✓ 113° C in air
- ✓ 126° C in air
- ? 195° C in air
- ✓ south-facing outdoors (sun)
- ✓ south-facing outdoors (shade)
- ✓ under NaOH solution pH 10
- ✓ under HCl solution pH 2

When exposed to hydrogen, all samples except the one exposed to 195° +/-5° C turned dark within 2 minutes. A significant darkening was apparent within 1 minute.

NREL TESTING OF DETECTAPE™ H₂

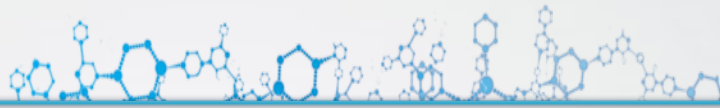
- Test duration: 8 months (on-going)
- 55 applications of DetecTape™ H₂ at NREL H₂ compressor and dispensing station
- Nine clear and verified leaks were indicated
- Four were “out-of-normal” requiring repair; four were “normal” (e.g., valve weep holes); one was noted for further monitoring



The deployment study was initiated with laboratory exposure testing

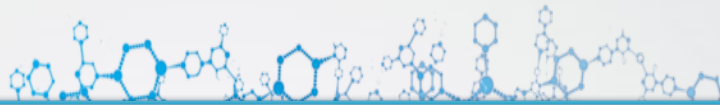
- Temperature cycling (-7° C to 44° C)
- Humidity cycling at ambient temperature (dry to 94% rh)
- Humidity cycling at elevated temperatures (56% and 75% relative humidity at 43° C)
- Hydrogen exposures - after the temperature and humidity cycling, the indicator response was verified using 5.7 vol.% H₂ in N₂.

Result: Temperature and humidity cycling did not affect the functionality of the indicators.

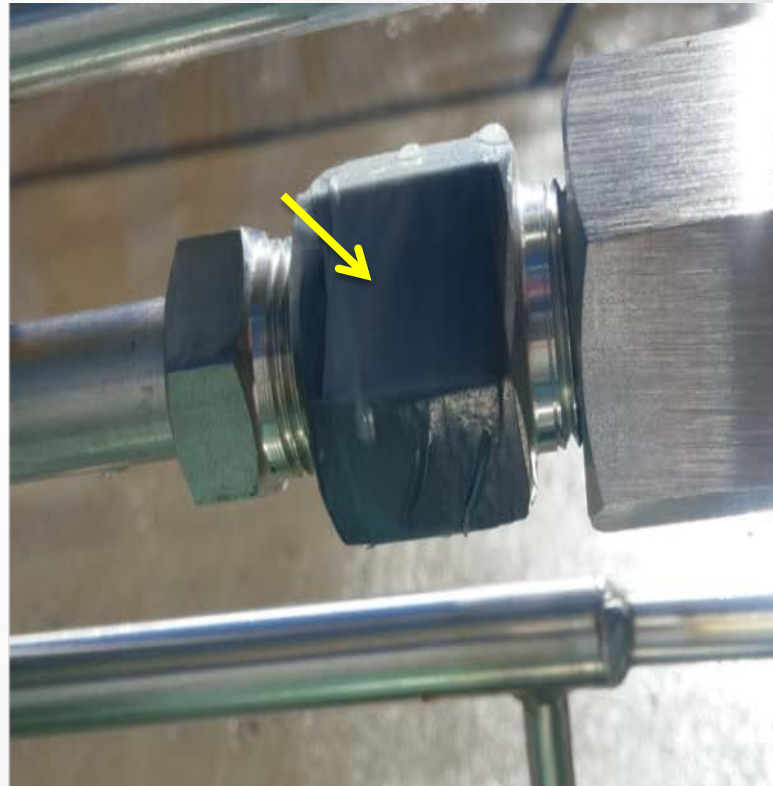


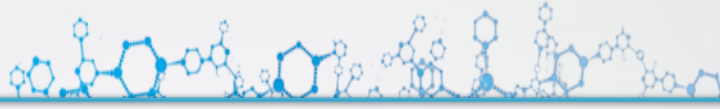
NREL DEPLOYMENT STUDY





NREL Deployment tests: Clear indication of a leak





NREL TESTING DATA



Photo credits: K. Hartman/W. Buttner, NREL

NREL TESTING DATA

- This indication was seen as the initiation of a slight darkening of the pigment. Since the color change was not as obvious as other indications, this indicator will continue to be monitored.

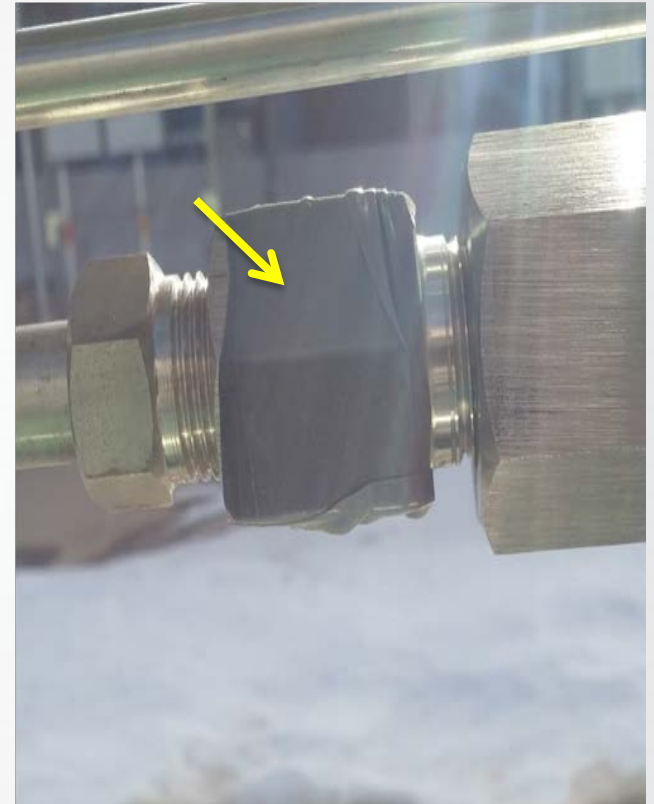
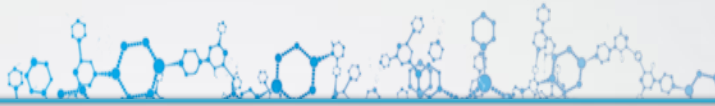
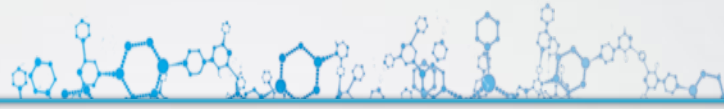


Photo credits: K. Hartman/W. Buttner, NREL



Conclusions drawn from data by Element One

- 1. DetecTape™ H₂ was shown to reliably identify unintended hydrogen releases from complex pneumatic systems.*
- 2. DetecTape™ H₂ was verified as a viable technology to identify small hydrogen leaks which would otherwise go undetected. The identification of such leaks facilitates implementation of appropriate corrective action before the potential occurrence of major adverse events.*



DETECTAPE™ H₂
PRODUCTION AND MARKETING

MSP, Inc.

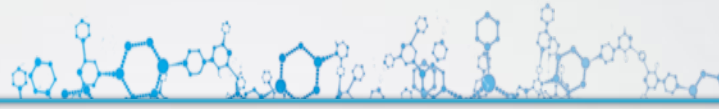
John Poplawski

Executive VP / COO

MSP BACKGROUND

- **1997** – Established as “Tommy Tape Manufacturing”
- **2000** – Acquired by Midsun Group (est. 1992 Southington, CT), a leading provider of animal mitigation and corrosion coating products designed for electric utilities
- **2006** – Renamed to Midsun Specialty Products, Inc.
- **2009** – Moved operations to Berlin, CT
- **40** employees
- Manufacturer and distributor of self-fusing silicone tapes, corrosion protection, and specialty products worldwide

<http://www.midsunsp.com>



CHANGES COLOR UPON DETECTION



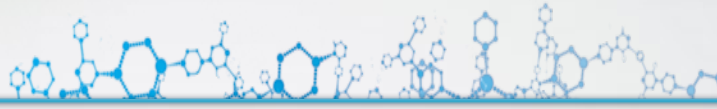
No Leak Detected



Hydrogen Leak Detected

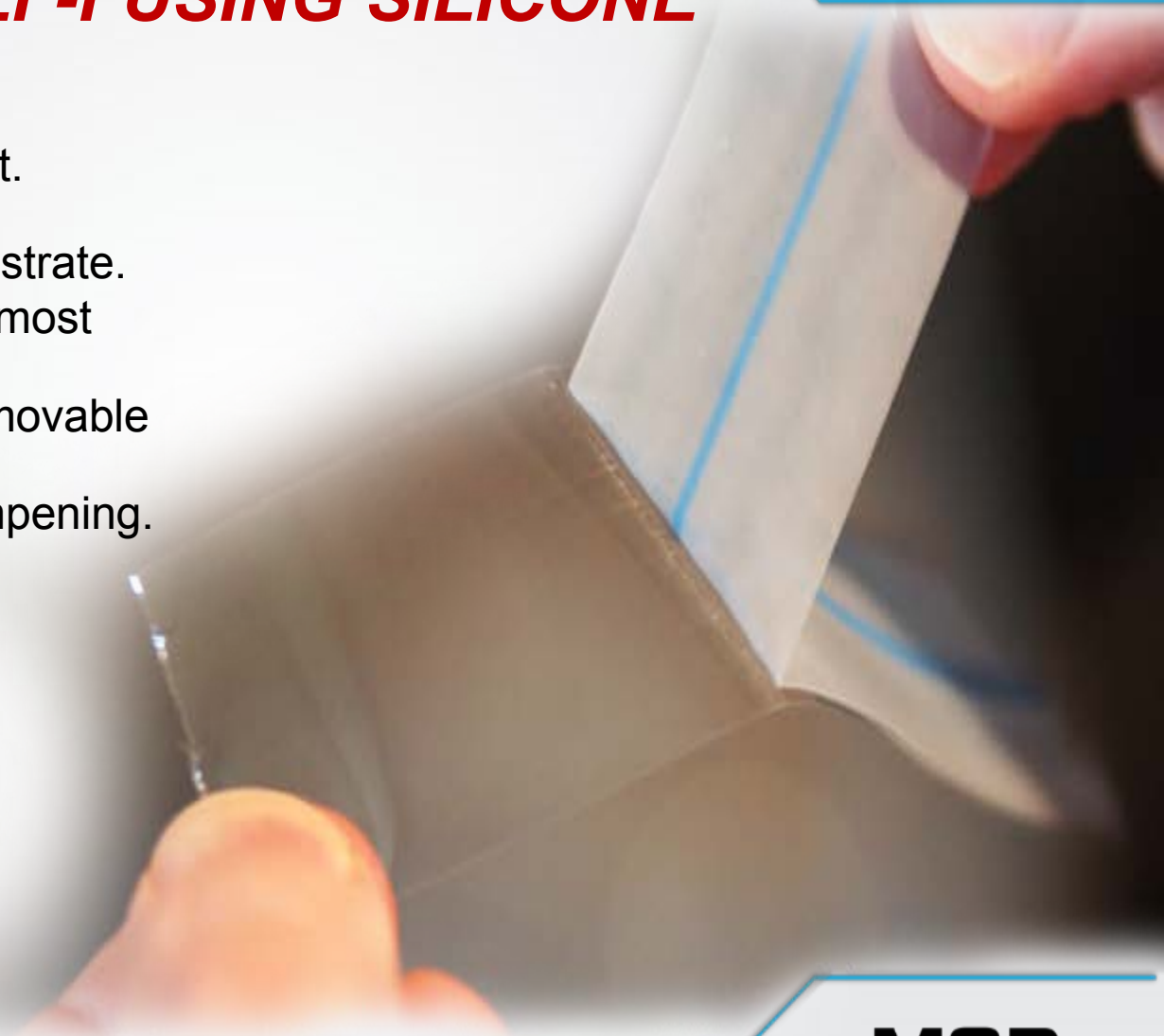
Upon hydrogen detection, tape changes color from light grey to dark black.

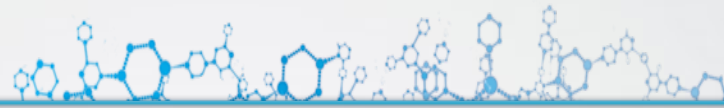
- Noticeable change within 3 minutes.
- Significant change within 30 minutes.



SELF-FUSING SILICONE

- Cross-linking silicone **bonds to itself** on contact.
- Does not use adhesives, leaves **no residue** on substrate.
- Naturally **resists UV** and most corrosive chemicals.
- Protected by a special removable liner before installation.
- Potential for vibration dampening.
- Conforms smoothly when wrapped around **irregular shapes**.





FEATURED IN



DetecTape™ from Midsun Specialty Products (MSP) identifies hydrogen leaks

LEAK DETECTOR

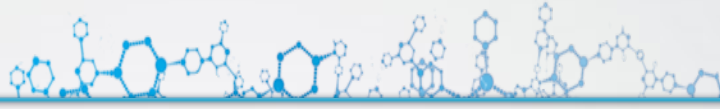
One of the first reliable, low cost and easily portable leak detectors has recently hit the hydrogen market. Created by Berlin-based Midsun Specialty Products, Inc. (MSP) and US outfit Element One, Inc., the innovation will bring a new visual leak detection technology to industries and companies that create, store and deliver hydrogen. DetecTape™ employs a patent pending colour changing pigment that is

dispersed into a UV protected gas permeable silicone membrane. Within minutes of a gas leak, the highly sensitive pigment reacts with the hydrogen and changes colour from light grey to black, thus allowing inspectors to visually identify leaks. The technology utilizes a self fusing technique that contains no glues and, instead, chemically bonds itself on contact to prevent extreme condition related adhesive failure. During a recent visit to the MSP facility, Dr. Sunita



© Midsun Specialty Products | DOE visit to MSP DetecTape. Satyapal, Director of Fuel Cell Technologies at the US Department of Energy, emphasised the importance of new technologies like these that improve facility safety and strengthen the reliability of the nation's growing hydrogen infrastructure. www.gasworld.com/technology

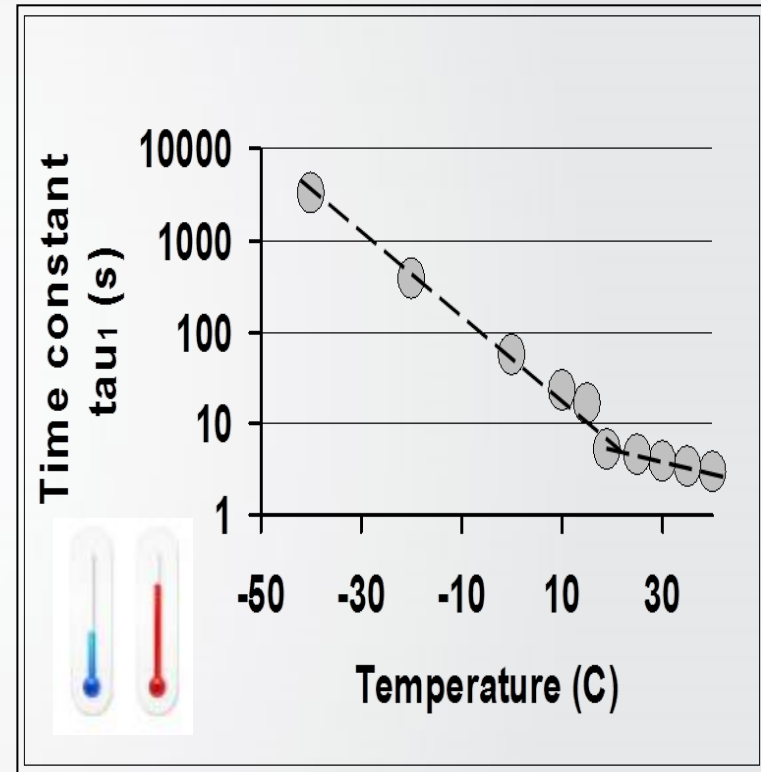


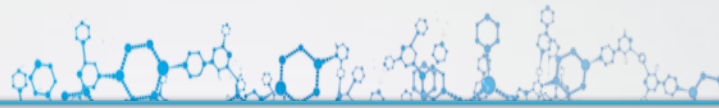


TEMPERATURE RANGE

- Extreme Temperature Range
- As low as 0°F (-17°C)
- As high as 350°F (176°C)
- Detection reaction time may be reduced or improved depending on temperature.

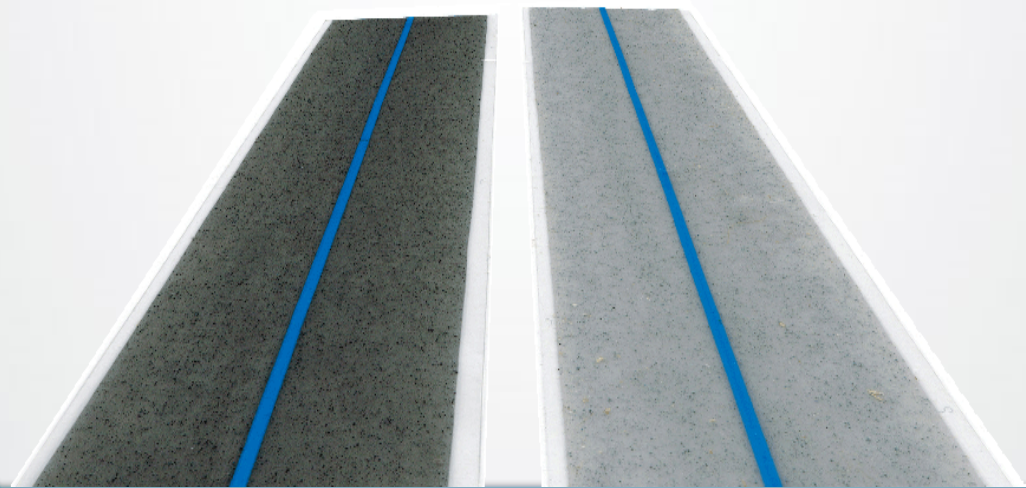
*** Temperature data still being collected. Subject to change ***

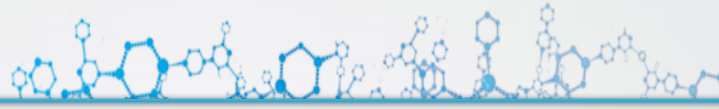




HYDROGEN REACTION

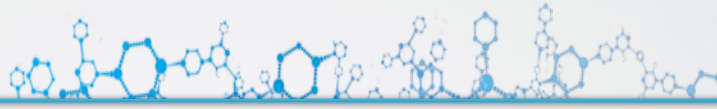
- Silicone is a hydrogen permeable carrier for chemo-chromic pigment that changes color when exposed to hydrogen.





HYDROGEN SAFETY INTEREST

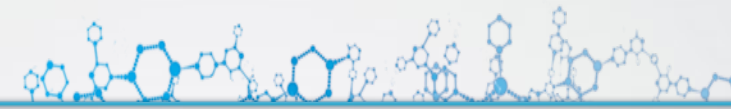
- Very large quantities of hydrogen are safely used in industry today, but it's hard to contain and difficult to detect leaks.
- Hydrogen is a very large industrial commodity with a growing market.
- The introduction of hydrogen as a consumer fuel has caused heightened concerns over its safety with a corresponding increased interest in hydrogen sensors.



HYDROGEN REACTION

- **Leak Rate** and **Concentration**
Determine Speed of Color Change.
Formula in Development
- **Cumulative Effect** –
Slow or small leaks can lead to significant color change over a long period of time.
- Reaction is **permanent** after hydrogen is detected, tape replacement is recommended after repair.





EASY TO USE

- Can be easily installed by on-site maintenance, inspection teams or equipment operators.
No certified training required.
- Does not require power to operate.
- **Can be used in unison with existing leak detection tools** including sniffers and ultrasonic detectors.



INTENDED USAGE

DetecTape™ H₂ can be wrapped on **most objects** including:

- Connections, Fittings and Reducers
- Swagelok and NPT
- Rigid Pipeline
- Flexible Tubing
- Flanges
- Welded Seams and Joints





INTENDED USAGE

- Initially wrap DetecTape™ H₂ on all hydrogen connections that may be leak prone or susceptible to vibration damage.
- Leave DetecTape™ H₂ on connections permanently or until a leak is detected and a repair needs to be made.
- Can be easily removed with a blade or scissor.
- Once repair is complete and connection is in working order, wrap with DetecTape™ H₂ to monitor for future leaks.



USAGE LIMITATIONS

DetecTape™ H₂ is **not** intended to:

- be used to stop nor slow down a leak.
- be used to detect anything other than hydrogen gas.
- prevent other gases from mixing with hydrogen.

COUNTRY OF ORIGIN

- All components of DetecTape™ H₂ are manufactured in the United States.
- Tape core denotes Country of Origin.
- Hydrogen reactive pigment synthesized in Boulder, Colorado USA.
- Tape manufactured in Berlin, Connecticut USA.



MADE IN USA

DOCUMENTATION

- New Product Announcement Sheet
- Product Data Sheet
- Safety Data Sheet
- Instruction Sheet
- Videos (Coming Soon)
- NREL Deployment Study Coming Soon

SAFETY DATA SHEET

PRODUCT DATA SHEET

PROPERTY	TEST METHOD	VALUE
Continuous Temperature Range	-40°F to +100°F -40°C to +38°C	
Expendable Temperature Range	-40°F to +100°F -40°C to +38°C	
Dielectric Strength	ASTM D-140	400 V/MI
Cold Brake Point Max	ASTM D-2187	-45°F -52°C
Water Absorption	ASTM D-691 Method B251	3% Max by weight
Tensile Strength	ASTM D-412	700 PSI Minimum
elongation	ASTM D-412	80% Minimum
Tear Resistance		85 PSI
Durability Hardness		50 Shore A
Thickness Tolerance		± 0.02 in ± 0.02 mm
Moisture Tolerance		± 0.125 in ± 3.175 mm

APPLICATION INSTRUCTIONS

STEP 1: Full size strip roll-up to perforation point.

STEP 2: Tear away strip from roll at perforation point and without tear tearing.

STEP 3: Press tape strip firmly approximately 1 inch (2.5 cm) away from the intended detection point and begin the first wrap with side 100% complete overlap.

STEP 4: Slightly stretching the tape around irregular contours can provide a closer penetration.



TAPE ROLL SPEC

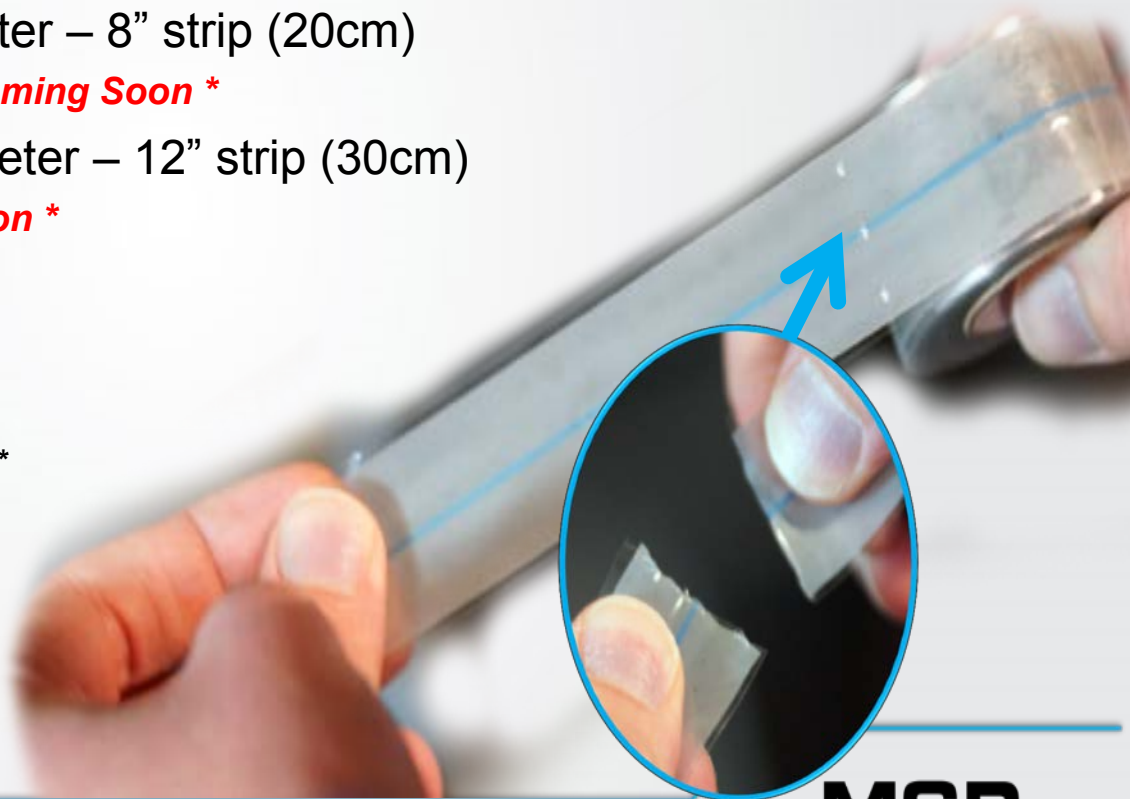
- **Thickness** – 10 mil (0.01 inch / 0.254mm) thick
- **Profile** – Rectangular / 10 mil across
- **Width** – 1 inch (25mm) wide
- **Length** – 15 feet (4.57m) long
- **Color** – No leak detected : Light grey
Leak Detected : Cumulative dark black blotches
- **Guideline** – Blue to denote Hydrogen Gas Detector
- **Current Perforation** – 4 inch (10cm) strips

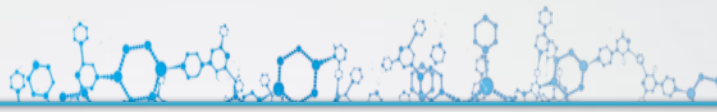
PERFORATION

Strips **perforated** to specific lengths depending on object diameter.

- 1/16" – 1/8" (1mm - 4mm) diameter – 4" strip (10cm)
40-45 applications per roll **NOW AVAILABLE**
- 1/4" – 1/2" (6mm – 12mm) diameter – 8" strip (20cm)
25-30 applications per roll *** Coming Soon ***
- 1" – 4" (25mm – 100mm) diameter – 12" strip (30cm)
10-12 applications *** Coming Soon ***
- Multiple strips can be used on large diameters.

**** Configurations still in trial stages.
Subject to change based on user feedback ****





CONTAINER

- DetecTape™ H₂ 15 foot rolls are shipped in a re-usable clarified polypropylene container to keep roll clean and dry while not in use.
- Portable enough to fit a roll in pocket, tool belt or toolbox.



USER INSTRUCTIONS

- Every roll comes with user installation and detection instructions.
- More information and documentation (SDS, PDS, FAQ) is available to users on <http://www.detectape.com>



APPLICATIONS



Fuel Cell Plant

- Use on connections inside cabinets that are inspected on a routine schedule.
- Quickly identify hydrogen leaks during inspections.

APPLICATIONS



Fueling Station

- Use on hydrogen supply connection points in fueling stations.
- Attendants and maintenance crews can react quickly with a visual alert that there is a hydrogen leak present.

APPLICATIONS



Gas Refinery

- Use on all hydrogen network connections that are within visual range of inspection routes.
- Prioritize leak repair based on quantity of alerts in a zone to maximize efficiency.

APPLICATIONS



Research Laboratory

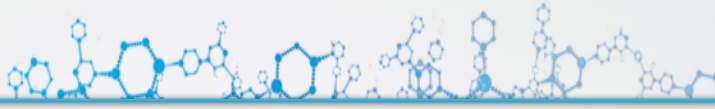
- Use on hydrogen-related research equipment to improve laboratory safety.
- Once a leak is detected, equipment operator can safely shut down equipment for repair.


APPLICATIONS



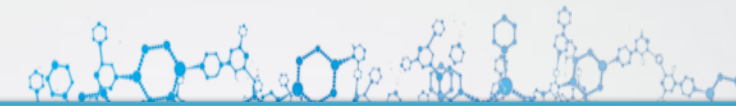
Storage Facility

- Useful in conjunction with other gas detection alarm systems.
- Expedite repairs by visually identifying localized connections.



OTHER APPLICATIONS

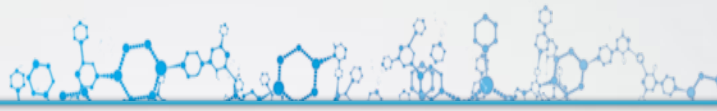
- On-Site Hydrogen Generation
- Manufacturing (Semiconductor, Aerospace, Etc.)
- Power Plants (Using Hydrogen Coolant)
- Gas Processing and Production
- Metallurgy and Welding
- Portable Power Units
- Pharmaceutical
- And More



AVAILABILITY

- Samples available upon request through website.
- Limited trial rolls available at introductory rate in exchange for user feedback and data.
- Case pack – 36 rolls / case
- Single rolls available with 5 roll MOQ
- Available for Purchase

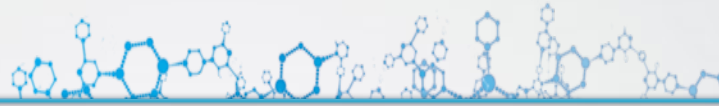




UPCOMING DEVELOPMENTS

- **H₂ Reversible Tape** - Hydrogen reaction is reversible. Designed for tightly enclosed spaces where in-air hydrogen may be a concern over time.
- **H₂S Tape** – Hydrogen Sulfide leak detection for use as a marker for natural gas pipeline leaks.



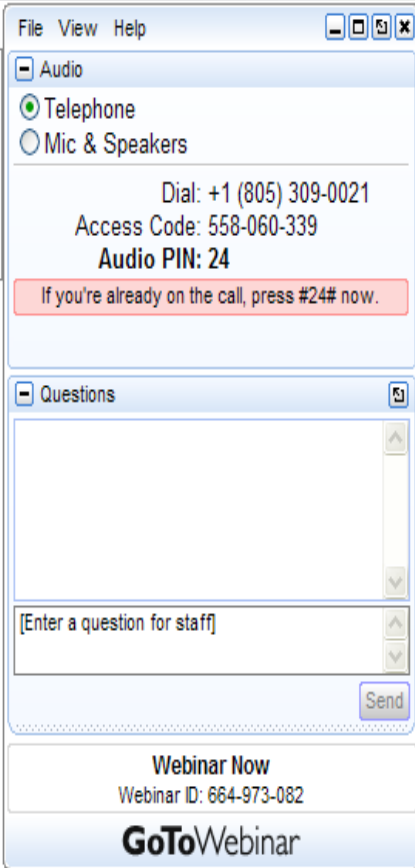


ACKNOWLEDGEMENTS

- We would like to thank the Office of Energy Efficiency and Renewable Energy's Fuel Cell Technologies Office for their continued support.
- We would like to thank Dr. William Buttner and NREL for the cooperation and assistance provided to Element One, Inc.

**THANK YOU FOR
WATCHING**

**Q & A
SESSION**



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<http://www.detectape.com>

Thank You

Presenters:

- Bill Hoagland - Element One
 - whoagland@elem1.com
- John Poplawski – MSP
 - info@detectape.com

DOE Host:

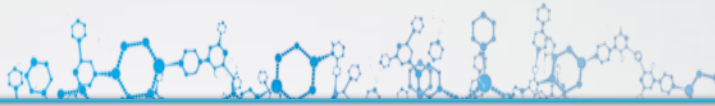
- Will James – Safety, Codes , and Standards Program Manager
 - Charles.James@EE.Doe.Gov

Webinar Recording and Slides:

(<http://energy.gov/eere/fuelcells/webinars>)

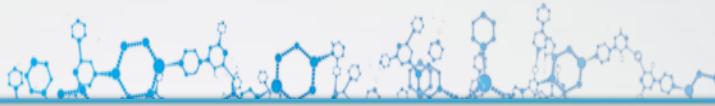
Newsletter Signup

(<http://energy.gov/eere/fuelcells/subscribe-news-and-financial-opportunity-updates>)



FREQUENTLY ASKED QUESTIONS

1. What range of hydrogen concentration has the tape been measured / proven with?
2. What other components have been included in the testing for Question 1?
3. What is the repeatability of the tape's performance, i.e. does the same size leak produce color at the same rate?
4. Is there a correlation of leak amount versus color change rate?
5. What is the impact on temperature on the color change?



FREQUENTLY ASKED QUESTIONS

6. What is the longest that the tape is been in use for any of the tests?
7. How can we tell if the tape is still working after it has been in service for a time? (eliminate false negatives)
8. Are there any other components that may cause false positives?
9. Are there any other components that may interfere with the hydrogen response? (eliminate false negatives)
10. Is the tape sample we received the same as will be sold for commercial use?