nanoscent

Technology Specifications

CES CLIMATE CHANGE INNOVATOR AWARD 2019

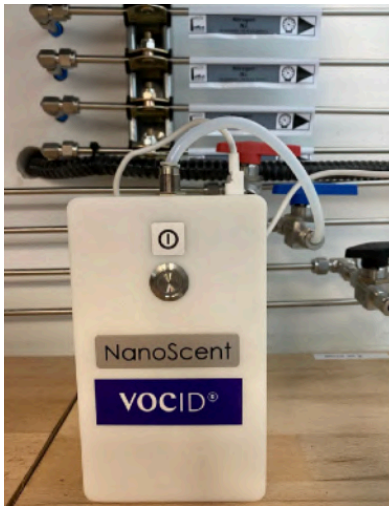
Gartner COOL VENDOR 2019

European Commission

Project 961108

VOCID® Technology

NanoScent's **VOC**ID® H2Confirm platform is a single solution designed to measure various gases and volatile organic compounds impacting hydrogen quality. Thanks to **VOC**ID® H2Confirm, you won't need to handle and deliver samples to a lab just to know your supply is clean. With our solution, you can monitor several target analytes, including those defined by the hydrogen fuel cell quality ISO-14687 standard.



Target customers of the **VOC**ID® H2Confirm are:

- hydrogen-based transportation fleet managers
- hydrogen refueling stations operators
- electrolyzer producers
- logistics: storage and transportation

VOCID® integration for inline or on-spot measurements.

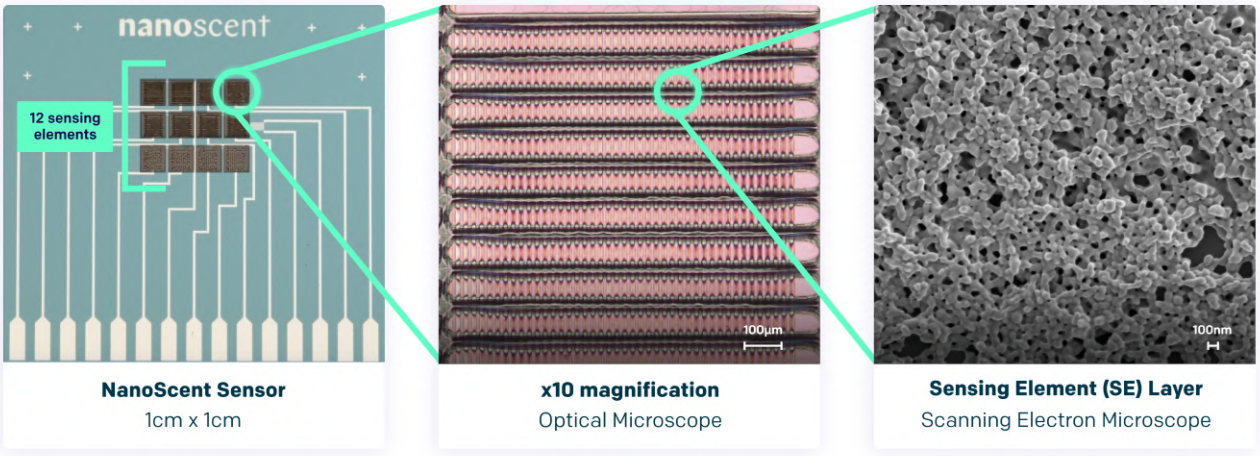
About the VOCID® System

Volatile organic compound identification (VOCID) is at the core of the **VOC**ID® system which runs on chemoresistor technology and provides sensitivity as low as ppb level for various gasses and VOCs, offering companies an innovative service for monitoring their manufacturing processes, including the purity or cleanliness of their production machines, while providing results in minutes-time.

Sensors

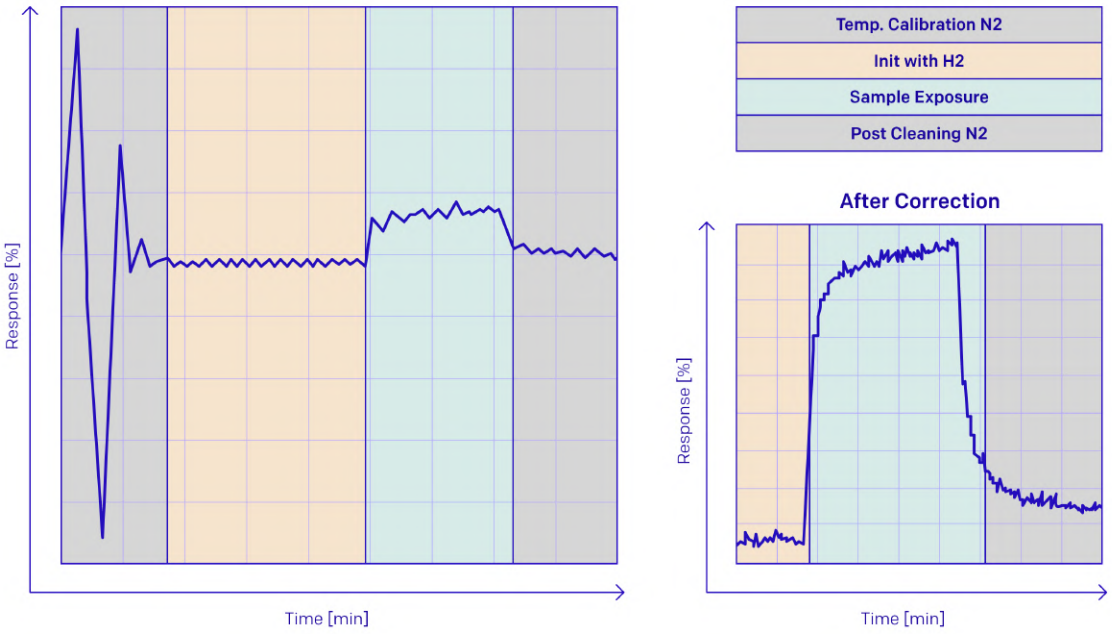
The patent-protected **VOC**ID® sensors are integral to the detection and monitoring process of gasses and VOCs and are at the core of our system.

The image below shows the NanoScent sensor under progressively increased magnification, demonstrating our use of nanoparticles which react with gasses in order to provide a measurement.



The sensor contains 12 sensing elements (the second image above shows a magnified sensing element at a scale of 100 micrometers). Each sensing element is sensitive to a specific chemical family of VOCs. The sensing element is a chemical resistor made of nanoparticles coated with an organic layer. The organic layer can be customized for different target analytes according to business needs, allowing you to monitor multiple gasses with a single solution.

Sensor Response



1. **Temperature Calibration with N2**: Used to measure a calibration curve of each sensing element measuring the response to different temperatures.
2. **Init with H2**: Creates a baseline based on the sensors' reading of reference H2.
3. **Sample Exposure**: Delivery of the sample to the sensor.
4. **Post Cleaning with N2**: Used to wash any residues of sample gas from the sensors.

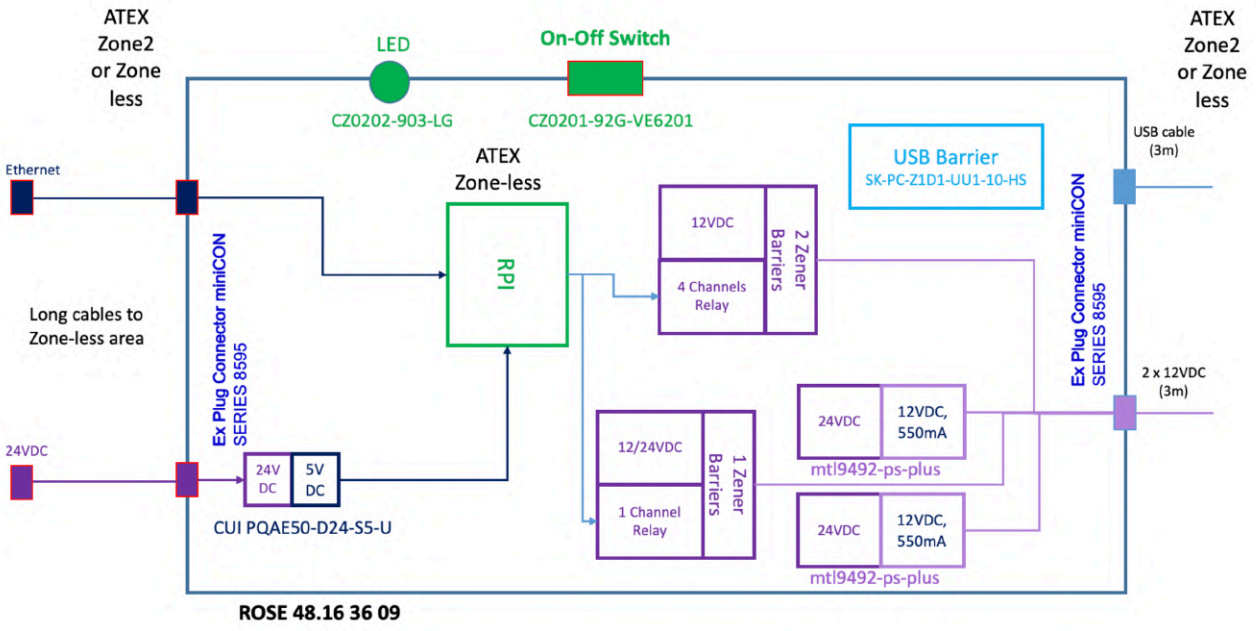
The 'After Correction' signal demonstrates the response of the sensor after you calibrate the response based on the calibration curve and the Init phase.

Integrating VOCID® System Parts & Components

NanoScent VOCID H2Confirm is based on a proprietary sensor. The sensor is housed in a chamber which facilitates a managed exposure process of the sensor to the sample of interest. To that end, the chamber is equipped with a set of valves and a temperature control system. The chamber design is currently under review to make it more suitable to work in an ATEX environment. The **VOC**ID® H2Confirm platform is composed of two units, an electrical unit and a pneumatic unit.

The Electrical Unit

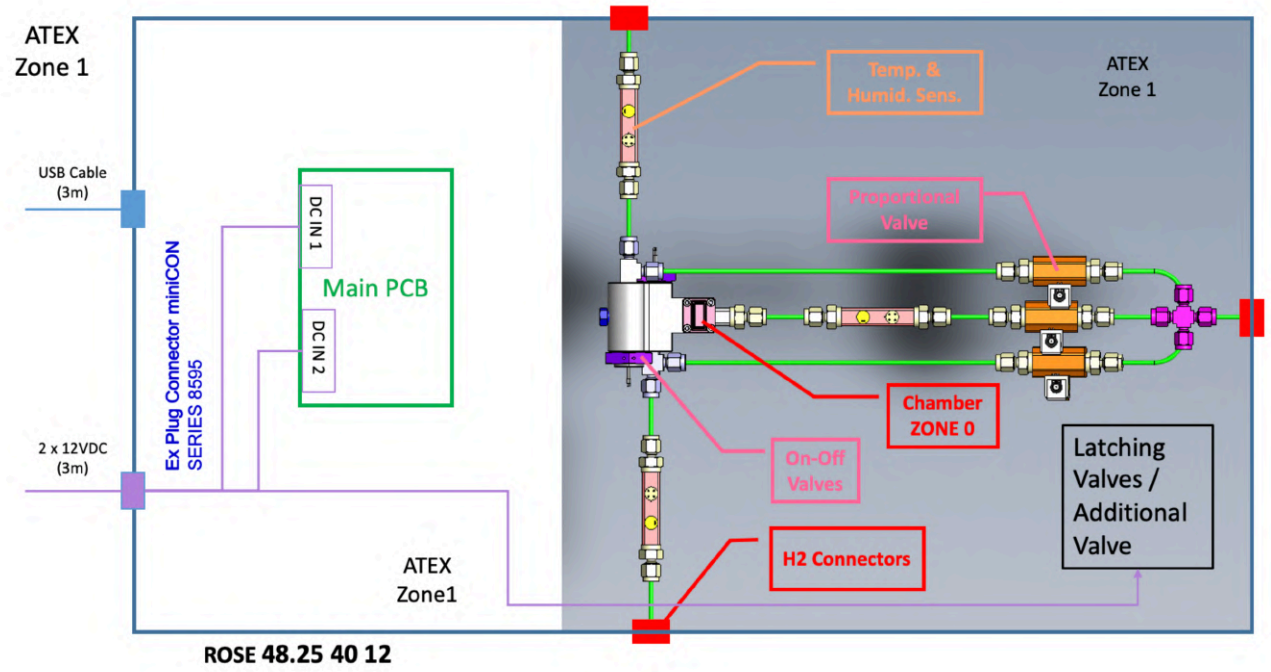
The electrical unit hosts all of the electricity boards including the RPi's used for reading the sensor's signals and the reading of the HTP sensor, i.e. an extra sensor that provides more information regarding humidity, temperature and pressure from the hydrogen line. The electrical unit has five connections, two that are used to connect to the Ethernet and to an electricity power source of 24VDC, and three are connected to the pneumatic unit (two 12VDC, one USB).



Design of the electrical unit.

The Pneumatic Unit

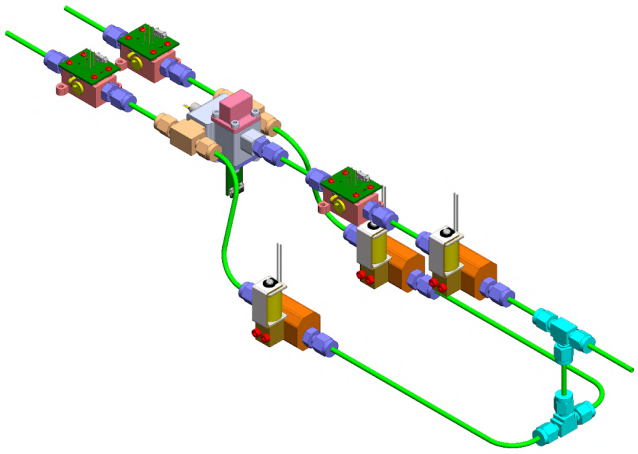
The second unit is the pneumatic unit where the sensors' chamber is connected to pressure regulators via pipelines and HTP sensors. Each panel is placed in a designated ATEX proof box according to the safety and standard requirements and are connected *via* USB cable 3-meters long. The pneumatic unit has two inlets, one is for the reference/maintenance gas and the other is for the sample gas. The pressure regulators are used to bring the gas at a stable pressure that is lower than 3 bar. The pneumatic unit has four outlets, one for the gas and two are for the USB that is connected to the electrical unit and 2 electrical sockets 12VDC also connected to the electrical unit.



Design of the pneumatic panel.

VOCID® H2Confirm System Description

Sample Gas	H_2			
Technology	Nanotechnology based chemiresistors			
Performance				
Detected Gasses (validated in NPL)	O2	CO	H2O	Ammonia
LOD [ppm]	5	0.2	0.2	0.1
Response time	5 minute			
Frequency	2/hour			
Zero drift/day	Negligible			
Signal Output/ Input				
Alarms	Up to **4 specific alarms**: above/ below the threshold (specifiec by the highest concentration levels in the ISO-14687), flow, temperature, sensor lifetime.			
Digital communication	Electronic panel: digital communication including Ethernet TCP/IP Pneumatic panel: control via USB serial lines, intrinsically safe 12V 2A			
Sample Condition				
Gas	Hydrogen 5.0 free of oil mist, dry gas			
Gas Temperature	0°C-50°C			
Gas Humidity	<50ppm			
Reference Gas	Hydrogen 5.0 with full certification analysis.			
Maintenance Gas	Nitrogen 5.0 with full certification analysis.			
Sample Pressure	1-3 bar			
Operating Environment				
Temperature	0°C-30°C			
Relative Humidity	0-90% RH at 25°C			
Warm up Time	Upon chip replacement, 2 hours under maintenance gas			
Physical				
Size	Electronic panel- 60X40X25 cm Pneomatic panel- 40X30X20 cm			

Weight	Electronic panel- 10 Kg Pneomatic panel- 5Kg
Connections	⅛'' Stainless Steel
Supply Voltage	24VDC
Hardware Storage temperature	Ambient, not need to connect to electricity
Sensor Storage Conditions	Ambient temperature, no humidity
Safety	
Electrical Safety	All electrical components (digital communication and power) pass through intrinsically safe barriers.
ATEX	All components are placed in an ATEX approved box: Polyester Ex cabinets Polyglas
Figures	 *Drawing of the VOCID® H2Confirm hardware design, all components are in compliance with hydrogen and can operate at 3 bar pressure.*

Methods of Measuring with VOCID® H2Confirm

There are two main ways of measuring hydrogen quality with **VOC**ID® Confirm:

1. **Spot measurements**: To perform spot measurements, a sample is collected from an electrolyzer or from a refueling station into a cylinder and placed near a reference gas cylinder and provides a measurement.

2. **In-line measurements**: In-line measurements require for the VOCID® H2Confirm device to be integrated directly into the gas line.

Note: Both measurements approaches bring results within 3 minutes and with only 1 hour recovery time and are much faster than sending samples to a central laboratory, even though the collection methods are the same.

Detecting Gasses and VOCs

The **VOC**ID® H2Confirm technology has broad sensing capabilities. Below is a list of different gasses and VOCs that the **VOC**ID® platform can detect and monitor. All of the gases and VOCs listed below were tested in our labs with nitrogen as the carrier gas:

Gas / VOC	LMC (PPB)	Measurement Method	Notes
1-pentene-3-one	1000	DS	
2-methylbutanal	1000	DS	
Acetaldehyde	1000	DS	
Acetic acid	1000	DS	
Acetone	10000	GG	
Ammonia	100	GG	Validated by NPL under hydrogen, Relevant for ISO-14687
Carbon monoxide	200	DS	Validated by NPL under hydrogen, Relevant for ISO-14687

Gas / VOC	LMC (PPB)	Measurement Method	
Carbon dioxide	100	DS	Relevant for ISO-14687
Dichloromethane	2000	DS	
Dimethyl trisulfide	600	DS	
Ethylene	5000	DS	
Formaldehyde	4000	GG	Relevant for ISO-14687
Formic Acid	100	GG	Relevant for ISO-14687
Heptanal	10	GG	
Hydrogen Sulfide	20	DS	Relevant for ISO-14687
Methane	8000	DS	Relevant for ISO-14687
Methyl salicylate	600	DS	
Nitric Oxide	500	DS	
Nonanal	0.15	GG	
Octanal	10	DS	
Oxygen	5000	DS	Validated by NPL under hydrogen; relevant for ISO-14687
Tetrachloroethylene	1000	DS	
Toluene	500	GG	Relevant for ISO-14687
Trans-2-nonenal	600	DS	
Water	5000	DS	Validated by NPL under hydrogen; relevant for ISO-14687
Xylene	1000	DS	

LMC= Lowest Measured Concentration; **PPB**= Parts per Billion;
DS= Dilution System; **GG**= Gas Generator

Patents

For the **VOC**ID® system, NanoScent has 7 patents:

Patent Number	Patent Title
US20210262965A1:	Particles for chemiresistor sensor
US20210231627A1:	Sensing element for chemiresistor sensor and method of making same
WO2020240556A1:	Method and device for identifying volatile compounds
WO2021111435A1:	Use of a chemiresistor sensor for improving health
WO2021079366A1:	System and method for providing and detecting volatile compounds (vcs), from liquids
WO2021161313A1:	System and method for collecting and sensing volatile compounds
US20210065901A1:	System and method of determining a condition of a subject based on volatile organic compounds

Core Competencies

NanoScent's core competencies are in 4 main areas which collectively distinguish NanoScent's R&D process and strengths as a startup:

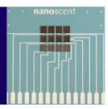
Business opportunity to monitize CAPEX and OPEX.

Production capability and partnerships.

Deep development capabilities in chemical and algorithmic processes.

Experience in scaling and establishing relationships with integrators.

Sensor Design



- Sensor adjustment to target VOCs
- Variety of in-house nanoparticle synthesis
- **All-in-one** solution: integrated VOC and gas sensors

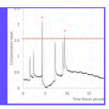
Sensor Production

- In-house production capacity
- Printable ink
- Producing ~10,000 sensors per month

Testing

- State of the art equipment for VOC and gas testing
- Validation of VOCs in specific use case using GC-MS

Data Analysis



- Data calibration
- Signal processing
- Feature extraction
- Web-based dashboard