



PRODUCTS 2014/15

Precise sensors for industry and research measuring O_2 , pH and CO_2



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PreSens
PRECISION SENSING



O_2

pH

CO_2

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We bring to light what's inside...



Products made in Germany

PreSens offers a broad range of sensor systems for end users in Bioprocess Control, Biological & Environmental Research, Food & Beverage industry as well as other industrial applications.

We offer systems incl.

- Dissolved oxygen (DO) and CO₂ measurement in gases and liquids
- Non-invasive online pH, CO₂ and oxygen measurement
- Oxygen and pH sensors for single-use bioreactors
- Microsensors for pH and oxygen
- Process control in shake flasks
- Low-maintenance DO measurement for fermentation and bioreactor systems
- Online oxygen and pH measurement in disposables like multiwell plates and plastic bags
- Imaging Solutions for 2D-sensing of oxygen-, pH- and CO₂-distribution

Our product range is constantly expanded.

Company Profile

Based on research activities started in the 1980's PreSens Precision Sensing GmbH was founded in 1997 as a spin off from the University of Regensburg, Germany.

The company combines these long-time experiences of different researchers in the fields of electronic engineering and sensor development. Right from the beginning microsensors were sold to researchers in the life science area. During the last more than 17 years PreSens became one of the leading companies in the field of chemical optical sensors. Together with its partners it offers full service in Europe, America and Asia.

Service

Furthermore, we are developer and manufacturer of optoelectronic OEM sensor components for companies in the field of medical equipment and process control.



Quality Management
ISO 9001:2000
EN ISO 13485:2003 + AC:2007
Voluntary participation in regular monitoring

and work for the following industries.



Biotech & Pharma

Our Biotech & Pharma business field helps pharmaceutical companies such as Roche and DSM to improve their bioprocess development with PreSens sensors. Customer feedback has influenced our product development for several years and we can therefore serve your needs.



Food & Beverage

A cooperation with the market leader for beverage filling systems, Krones AG, Neutraubling, triggered our Food & Beverage business field in the late 1990's. PreSens supplies sensors for checking the air-tightness of packaging and a special system for determining the penetrability of oxygen in PET bottles at companies such as Nestle, Heineken or Danisco.



Scientific R & D

Our worldwide customer base in the scientific R&D business field has now grown to hundreds of users coming from the University of Alaska in Anchorage to the University of Wellington in New Zealand. Over the last 14 years, we have delivered our special microsensors and our non-invasive systems for various applications such as respirometry, biology, or medical research.



Medical Devices

Our most recent business field arose from a cooperation with renowned medical technology manufacturers from the Medical Devices sector. PreSens supplies OEM parts, which are integrated into more complex medical systems such as heart-lung apparatuses.

We offer a wide variety of sensors and transmitters. If your solution is missing, please contact us!

	Transmitters														Micro TX3 & Micro TX3 trace
	Microx 4 & Microx 4 trace		Fibox 4 & Fibox 4 trace		Fibox 3 & Fibox 3 trace		Fibox 3 LCD trace	OXY-4/-10 mini & OXY-4/-10 trace				EOM-02-mini			
	Microx 4	Microx 4 trace	Fibox 4	Fibox 4 trace	Fibox 3	Fibox 3 trace	Fibox 3 LCD trace	OXY-4 mini	OXY-10 mini	OXY-4 trace	OXY-10 trace	EOM-02-mini	Micro TX3	Micro TX3 trace	
Non-Invasive Oxygen Sensors															
SP-PSt3			X	X	X	X	X	X	X	X	X	X			
SP-PSt6				X		X	X			X	X				
SP-PSt9				X			X								
SP-PSt7	X	X													
SP-PSt8		X													
FTC-PSt3			X	X	X	X	X	X	X	X	X	X			
FTC-PSt6				X		X	X			X	X				
SV-PSt3-20mL			X	X	X	X	X	X	X	X	X	X			
Oxygen Microsensors															
NTH-PSt1														X	X
NTH-TOS7															X
NTH-PSt7	X	X													
NTH-PSt8		X													
IMP-PSt1														X	X
IMP-TOS7															X
IMP-PSt7	X	X													
IMP-PSt8		X													
FTCH-PSt1														X	X
FTCH-TOS7															X
FTCM-PSt1														X	X
FTCM-TOS7															X
FTCM-PSt7	X	X													
FTCM-PSt8		X													
Oxygen Probes															
OP for In-Line Measurement (PSt3)			X	X	X	X	X	X	X	X	X	X	X		
OP for In-Line Measurement (PSt6)				X		X	X			X	X				
Oxygen Dipping Probe (PSt3)			X	X	X	X	X	X	X	X	X	X	X		
Oxygen Dipping Probe (PSt6)				X		X	X			X	X				
Oxygen Dipping Probe (PSt9)				X			X								
Oxygen Dipping Probe (PSt7)	X	X													
Oxygen Dipping Probe (PSt8)		X													
Oxygen Exchange Cap (PSt3)			X	X	X	X	X	X	X	X	X	X	X		
Oxygen Exchange Cap (PSt6)				X		X	X			X	X				
Oxygen Probe integrated in Varivent valves (PSt3)			X	X	X	X	X	X	X	X	X	X	X		
Oxygen Probe integrated in Varivent valves (PSt6)				X		X	X			X	X				
Non-Invasive pH Sensors															
SP															
FTC															
pH Microsensors															
NTH															
IMP															
Carbon Dioxide Sensors															
SP															
FTC															
Dipping Probe															
Sensor Foils for Imaging															
SF-RPSU4															
SF-HP5R															
SF-CD1R															
SF-MT1R															
PDF	X	X	X	X	X	X	X	X	X	X	X	X	X		
Battery Cable					X	X	X							X	X
LP1 (LCD Control Panel)					X	X								X	X

Sensor Probes

Accessories

Non-Invasive Oxygen Sensors

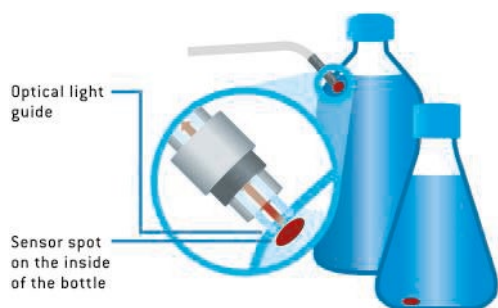
O₂



Robust & real conditions:
Look into any transparent vessel

- Glassware & disposables
- Bags & single-use bioreactors
- PET & glass bottles

Non-Invasive Oxygen Sensors



The non-invasive oxygen sensors measure the partial pressure of both dissolved and gaseous oxygen. These sensor spots are used for glassware and disposables. The sensor spots are fixed on the inner surface of the glass or transparent plastic material and can therefore be measured in a non-invasive and non-destructive manner from outside, through the wall of the vessel. Different coatings for different concentration ranges are available.

Features

- Non-invasive & non-destructive online measurement
- Measurement range from 1 ppb up to 45 ppm dissolved oxygen
- Ultra low gaseous oxygen measurement down to 0.5 ppm
- No consumption of oxygen
- Signal independent of flow velocity
- Measures oxygen in liquids as well as in gas phase
- Autoclavable (SIP: 130 °C / 266°F, 2 atm steam sterilization) & CIP (Cleaning in place)



Sensor Spots O2

Sensor spots (SP) are the most versatile version of non-invasive optical oxygen sensors. They are attached to the inner surface of any transparent vessel.

Examples are

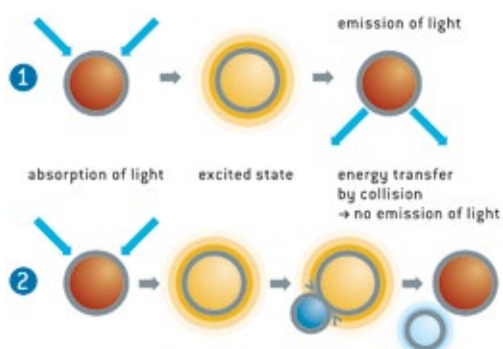
- Cultivation bags
- Spinners
- Glass reactors

The transmitter with its optical fiber can be fixed opposite the sensor spot by using our accessories (see accessories brochure) which can be adapted for nearly all kinds of vessels.



Flow-Through Cell O2

The flow-through oxygen minisensor (FTC) is a miniaturized chemical optical sensor integrated in a flow-through cell. It is connected to the transmitter by an optical fiber. A glass tube with an inner diameter of 2 mm is coated with an optical oxygen sensor at its inner wall. The volume for liquid inside the FTC is about 100 (± 10) microliter. The standard flow-through cell can be easily connected via Luer-Lock adapters to external tubings.



The Smart Measurement Method

The light from an LED excites the sensor spot to emit fluorescence. If the sensor spot encounters an oxygen molecule, the excess energy is transferred in a non-radiative way, decreasing or quenching the fluorescence signal. The degree of quenching correlates to the partial pressure of oxygen in the matrix, which is in dynamic equilibrium with oxygen in the sample. The decay time measurement is internally referenced.

Non-Invasive Oxygen Sensors



Examples for Applications

Pharma Industry: Oxygen Monitoring in Bags

Bags and single-use bioreactors are in the process of revolutionizing the way biopharmaceuticals are manufactured. Our non-invasive oxygen sensors are the tools to make the cultivation vessels fully disposable. As non-invasive pH sensors are also available, the two key parameters oxygen and pH can be controlled online.



Food & Beverage: Oxygen Permeation Measurement in PET Bottles

Non-invasive oxygen sensors measure both in liquid and in gaseous (headspace) phases. They perform through transparent materials up to a thickness of 10 mm and even through slightly opaque packaging. The measurement is carried out by firmly holding the fiber optic probe against the side of a PET bottle where the sensor spot is positioned. Adjustable mountings and bespoke fixtures are available. This system allows even the parallel measurement of different bottles as the fiber can be moved from bottle to bottle.



Bioprocess Development: Oxygen Monitoring in Shake Flasks

O₂ supply is one of the major issues in the cultivation of aerobic organisms. Shake flask cultures are widely applied in academic and industrial bioprocess development. As adequate methods for real monitoring of dissolved oxygen were missing, sufficient O₂ supply is usually assumed. The non-invasive oxygen sensors in shake flasks now ensure oxygen supply and give new insights into metabolic activity.



Respiration & Photosynthesis: Oxygen Monitoring in Glass Vials

Determination of respiratory activity is often performed for water organisms such as invertebrates, larval stages or eggs, but also for bacteria, cell cultures, yeasts or fungi. For algae measurement of photosynthetic activity is of great interest. Using our 20 mL SensorVial with an integrated sensor stripe oxygen can be measured simultaneously in the liquid sample and in the headspace. Autoclavable SensorVials for stirred and non-stirred applications are available.

Is your application missing?
Contact us and we will find your
customized solution!

Non-Invasive Oxygen Sensors

Specifications	Normal Oxygen Range		Trace Oxygen Range		Ultra Trace Oxygen Range
	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous Oxygen
Measurement range	0 – 100 % O ₂ 0 – 1000 hPa	0 – 45 mg/L 0 – 1400 µmol	0 – 10 % O ₂ 0 – 100 hPa	0 – 4.5 mg/L 0 – 140 µmol	0 - 200 ppm
Limit of detection	0.03 % oxygen	15 ppb	0.007 % oxygen	3 ppb	0.5 ppm
Resolution	± 0.01 % O ₂ at 1 % O ₂ ± 0.05 % O ₂ at 20.9 % O ₂ ± 0.1 hPa at 9.90 hPa ± 0.5 hPa at 207 hPa	± 0.005 mg/L at 0.4 mg/L ± 0.025 mg/L at 9.0 mg/L	± 0.002 % O ₂ at 0.008 % O ₂ ± 0.006 % O ₂ at 2.5 % O ₂ ± 0.02 hPa at 0.08 hPa ± 0.06 hPa at 24.8 hPa	± 0.7 ppb at 3 ppb ± 2.5 ppb at 1000 ppb	10 ± 0.5 ppm 100 ± 0.8 ppm 200 ± 1.5 ppm
Accuracy	± 0.005 % O ₂ or < 3 % rel.		± 3 ppb or < 3 % rel.		± 2 ppm or ± 5 %; whichever is higher
Measurement temperature range	0 – 50 °C		0 – 50 °C		0 – 40 °C
Response time (t ₉₀)	< 6 sec.	< 40 sec.	< 6 sec.	< 40 sec.	< 3 sec.
Properties					
Compatibility	Aqueous solutions, ethanol, methanol				Gas phase only
No cross-sensitivity with	pH 1 – 14 CO ₂ , H ₂ S, SO ₂ Ionic species				CO ₂ , SO ₂
Cross-sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas				Organic vapor, chlorine gas
Sterilization procedures	Steam sterilization Ethylene oxide (EtO) Gamma irradiation				-
Cleaning procedures	Cleaning in place (CIP, 5 % NaOH, 90 °C, 194 °F) 3 % H ₂ O ₂ Acidic agents (HCl, H ₂ SO ₄), max. 4 – 5 %				-
Calibration	Two-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment		Two-point calibration in oxygen-free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen		Two-point calibration in oxygen-free environment (nitrogen 6.0) and a second calibration value optimally between 100 and 200 ppm gaseous oxygen
Storage Stability	2 years provided the sensor material is stored in the dark (-10 – 60 °C)				

Transmitters & Accessories



Fibox 4 / Fibox 4 trace
Stand-alone fiber optic oxygen transmitter



Microx 4 / Microx 4 trace
Stand-alone fiber optic oxygen transmitter



OXY-4 mini/OXY-4 trace
4-channel fiber optic oxygen transmitter



OXY-10 mini/OXY-10 trace
10-channel fiber optic oxygen transmitter



Fibox 3 LCD trace
Fiber optic oxygen transmitter with LCD display



Accessories
A variety of accessories like connectors to different vessels is available.

Oxygen Microsensors

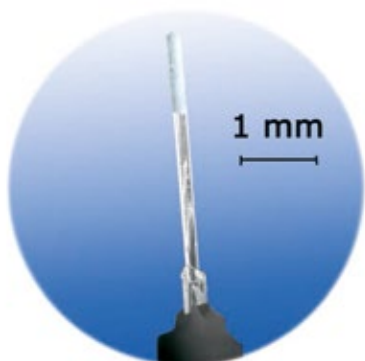
O₂



Sensor tip thinner than a hair ($< 50 \mu\text{m}$)
Integrate & measure on-the-spot

- Profiling of biofilms and sediments
- Insertion in plant and animal tissue
- Micro-respiration systems
- Micro-invasive measurement in packages

Oxygen Microsensors



Needle-type oxygen microsensors are miniaturized chemical optical oxygen sensors designed for all research and packaging applications where a small tip size ($< 50 \mu\text{m}$) and fast response time ($t_{90} < 3 \text{ s}$) are necessary. The optical oxygen microsensors are based on $140 \mu\text{m}$ and $230 \mu\text{m}$ silica fiber and are available with sensor tip diameters from $< 50 \mu\text{m}$ to $230 \mu\text{m}$. The oxygen microsensors are mounted in different housings (needle-type housing, implantable) and offer a unique research tool for investigating systems where micro-invasive and small sensors are needed.

Features

- High spatial resolution ($< 50 \mu\text{m}$)
- High temporal resolution ($t_{90} < 3 \text{ s}$)
- Measurement range from 3 ppb up to 15 ppb dissolved oxygen
- No consumption of oxygen
- Signal independent of flow velocity
- Measures oxygen in liquids as well as in gas phase

Needle-Type Oxygen Microsensors

Needle-type oxygen microsensors are perfectly suited for measuring oxygen distribution profiles in sediment and biofilms with a high spatial resolution of less than $50 \mu\text{m}$. The oxygen-sensitive tip of an optical fiber is protected inside a stainless steel needle. This design is optimal for easy penetration of tissue, septum rubber or packaging materials. After penetration the sensor tip is extended for measurement.



Implantable Oxygen Microsensor

Implantable probes are the miniaturized fiber optic oxygen sensors designed for various customized applications. The tiny probe has a tip size of $< 50 \mu\text{m}$ to $230 \mu\text{m}$ while the outer diameter ranges from $140 \mu\text{m}$ to $900 \mu\text{m}$.

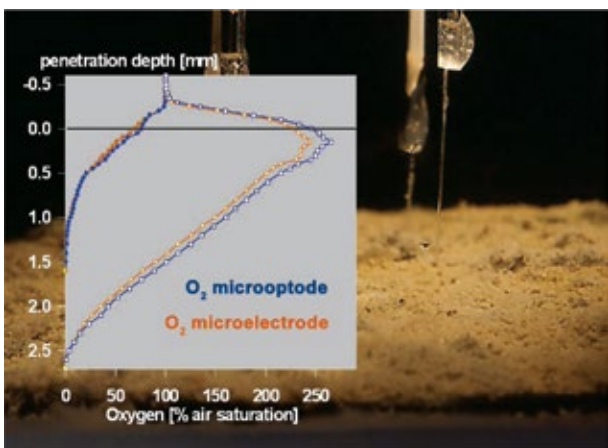
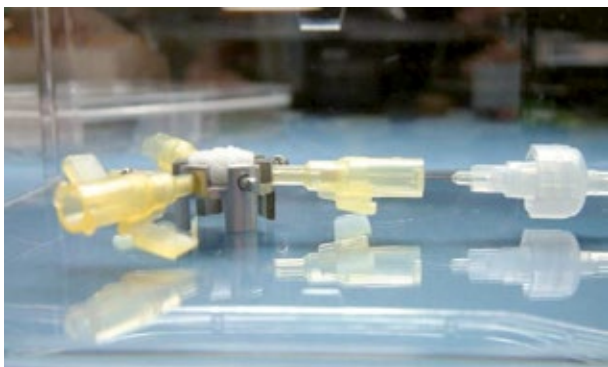
The microsensor tip is not mounted in any additional housing. The bare glass fiber tip can be mounted to your own housings, steel tubes and micro respirometer chambers etc. The small outer diameter even allows insertion into implantable Venlon-tubes. Moreover the microsensor can be deployed in sealed containers to measure the oxygen content directly.

Sensor Designs and Customization

Further microsensor designs are available, like e. g. microsensors integrated in a metal flow-through cell (FTCM) for oxygen monitoring in perfusion systems inside smallest volumes, or needle-type housings with fixed oxygen microsensor (NFS). These oxygen microsensors are solutions for special applications. If your application requires a customized oxygen microsensor design contact our service team!



Oxygen Microsensors



Examples for Applications

Packaging & Quality Control

Oxygen inside packaging can lead to oxidative deterioration of certain products. Therefore, determination of the oxygen content within packages or pharmaceutical vials is of essential importance to ensure both the filling quality and the long-term storage stability. With our micro-invasive needle-type oxygen microsensors we offer a simple tool to determine residual oxygen both in the headspace and in liquids. The septum of the vial or package is pierced with the needle and the sensor is extended for measurement. As the measurement is made inside the package no error-prone and time consuming sampling is necessary. These oxygen microsensors are ideal tools for quality control in the food & beverage, packaging, and pharmaceutical industries.

Tissue Engineering

Oxygen microsensors measure the oxygen content in various volume compartments of the tissue engineering constructs. To do so, hair-thin sensors are inserted into the constructs and the oxygen content is measured online. In this way, the oxygen partial pressure is measured with a high local resolution and correlated with the constructs tissue quality (composition of the extracellular matrix).

Profiling: Profile Measurements in Sediment and Tissue

Due to the extraordinary high local resolution ($< 50 \mu\text{m}$) our oxygen microsensors are ideally suited for recording microprofiles e.g. in sea-floor sediments, biofilms, plant physiology and human physiology. On the left you see oxygen profiles of a marine sediment populated with photosynthetically active microorganisms, measured in dark (closed symbols) and under strong illumination (open symbols). The measurement was performed simultaneously with an optical oxygen microsensor (blue) and a Clark-type micro-electrode (yellow). Both sensing tips have a distance of approx. $50 \mu\text{m}$.

Is your application missing?
Contact us and we will find your
customized solution!

Specifications	Normal Oxygen Range		Trace Oxygen Range	
	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous & Dissolved Oxygen	Dissolved Oxygen
Measurement range	0 – 100 % O ₂ 0 – 1000 hPa	0 – 45 mg/L 0 – 1400 µmol/L	0 – 10 % O ₂ 0 – 100 hPa	0 – 4.5 mg/L 0 – 140 µmol/L
Limit of detection	0.03 % oxygen	15 ppb	0.007 % oxygen	3 ppb
Resolution	± 0.01 % O ₂ at 1 % O ₂ ± 0.05 % O ₂ at 20.9 % O ₂	± 0.005 mg/L at 0.4 mg/L ± 0.025 mg/L at 9.0 mg/L	± 0.002 % O ₂ at 0.008 % O ₂ ± 0.006 % O ₂ at 2.5 % O ₂	± 0.7 ppb at 3 ppb ± 2.5 ppb at 1000 ppb
Accuracy	± 0.05 % O ₂ or < 3 % rel.		± 3 ppb or < 3 % rel.	
Measurement temperature range	0 – 50 °C		0 – 50 °C	
Response time (t ₉₀)	< 3 sec. (gas)	< 10 sec. (liquid)	< 3 sec. (gas)	< 10 sec. (liquid)
Properties				
Compatibility	Aqueous solutions, ethanol, methanol			
No cross-sensitivity with	pH 1 – 14 CO ₂ , H ₂ S, SO ₂ Ionic species			
Cross-sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas			
Sterilization procedures	Steam sterilization Ethylene oxide (EtO)			
Cleaning procedures	3 % H ₂ O ₂ , ethanol, soap solution			
Calibration	Two-point calibration in oxygen-free environment (nitrogen, sodium sulphite) and air-saturated environment		Two-point calibration in oxygen-free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen	
Storage stability	5 years provided the sensor material is stored in the dark at room temperature (20 °C +/- 5 °C)			

Transmitters & Accessories

**Microx 4 / Microx 4 trace**

Stand-alone fiber optic oxygen transmitter

**OXY-10 micro**

10-channel micro fiber optic oxygen transmitter for use with oxygen microsensors.

**OXY-4 micro**

4-channel micro fiber optic oxygen transmitter for use with oxygen microsensors.

Oxygen Probes

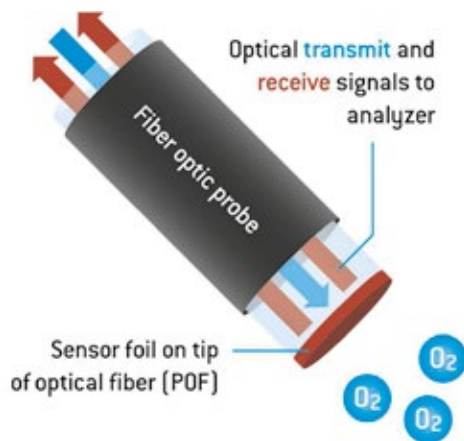
O₂



Robust, process conditions, autoclavable

- Oxygen in-line measurement in stainless steel fermenters
- In-line measurement of trace oxygen in brewing and beverage industries
- Small in size for environmental applications

Oxygen Probes



Oxygen probes measure the partial pressure of both dissolved oxygen and gaseous oxygen. The oxygen sensor coating is integrated into high grade stainless steel fittings. The oxygen probes show an excellent long-term stability and stand rough process conditions. PreSens oxygen probes operate in industrial process control, trace oxygen measurement in the brewing and beverage industry and in various research applications.

Features

- Autoclavable SIP (130 °C, 1.5 atm) & CIP (90 °C, 5 % NaOH)
- Probe is polarization free
- No membrane cleaning and replacement is necessary
- No electrolyte solutions to replenish
- Pressure resistant
- Long shelf-life



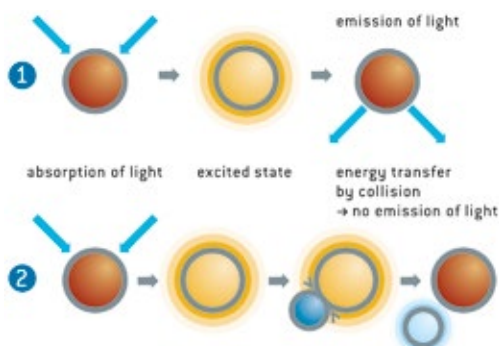
Oxygen Probe for In-line Measurement

The oxygen probe for in-line measurement (OIM) consists of a fitting made of stainless steel with an optical exchange cap (OEC). The OEC is screwed to the top of the metal fitting. The OIM is connected to the instrument via an optical fiber, has a standardized thread and length and is compatible with most bioreactors and port adapters. In addition, customized fittings for e. g. sight glasses are offered.



Oxygen Dipping Probe

The Oxygen Dipping Probe consists of a polymer optical fiber with a polished distal tip which is coated with an oxygen-sensitive foil. The end of the polymer optical fiber is covered with a high-grade steel tube to protect both the sensor material and the optical fiber. Due to the use of a polymer optical fiber, this probe is not compatible to temperatures above 70 °C. The steel tube has an outer diameter of 3 or 4 mm and a length of 10 cm. Other lengths are available on request.



The Smart Measurement Method

The light from an LED excites the oxygen sensor to emit fluorescence. If the sensor spot encounters an oxygen molecule, the excess energy is transferred to the oxygen molecule in a non-radiative transfer, decreasing or quenching the fluorescence signal. The degree of quenching correlates to the partial pressure of oxygen in the matrix, which is in dynamic equilibrium with oxygen in the sample. The decay time measurement is internally referenced.

Oxygen Probes



Process Control in Biotech & Pharma

The DIMs, the oxygen probes for in-line measurement, are designed for harsh conditions like high pressure or oil/water mixtures. These systems give high accuracy and are almost maintenance-free as they do not contain any membranes and electrolytes. The sensors are fully autoclavable and sterilizable (CIP & SIP).



In-line Oxygen Measurement in Brewing and Beverage Industry

Even low concentrations of oxygen influence shelf-life and the taste of certain beverages. Due to the extraordinary low detection limit and outstanding accuracy of PreSens trace oxygen sensors, the quality of oxygen-sensitive products such as beer, wine and soft drinks is secured.

The optical sensors have – compared to standard electrodes – a very fast response time and they are very easy to maintain.



Long-term Measurements in Soil

PreSens offers dipping probes for oxygen measurement that does not consume oxygen. Due to their small dimensions they do not disturb the flow and mass-transport and consequently display the in-situ oxygen concentration. As minisensors from PreSens are long-term stable they can be implanted in soil for many years! With this new method the process of soil aeration, which is very critical for plant productivity, can be investigated.

Dr. Heidi Heuberger, Technical University of Munich, Munich, Germany



Environmental Research – Investigation in Soil Filters

Due to the small outer dimension and mechanical robustness the oxygen dipping probe offers the possibility to measure the oxygen content in-situ in columns filled with filter sands during the flow of sewage (see picture on the left). The results show that a lack of oxygen stops the nitrification process.

Specifications	Normal Oxygen Range		Trace Oxygen Range		Ultra Trace Oxygen Range
	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous Oxygen
Measurement range	0 – 100 % O ₂ 0 – 1000 hPa	0 – 45 mg/L 0 – 1400 µmol	0 – 10 % O ₂ 0 – 100 hPa	0 – 4.5 mg/L 0 – 140 µmol	0 - 200 ppm
Limit of detection	0.03 % oxygen	15 ppb	0.007 % oxygen	3 ppb	0.5 ppm
Resolution	± 0.01 % O ₂ at 1 % O ₂ ± 0.05 % O ₂ at 20.9 % O ₂ ± 0.1 hPa at 9.90 hPa ± 0.5 hPa at 207 hPa	± 0.005 mg/L at 0.4 mg/L ± 0.025 mg/L at 9.0 mg/L	± 0.002 % O ₂ at 0.008 % O ₂ ± 0.006 % O ₂ at 2.5 % O ₂ ± 0.02 hPa at 0.08 hPa ± 0.06 hPa at 24.8 hPa	± 0.7 ppb at 3 ppb ± 2.5 ppb at 1000 ppb	10 ± 0.5 ppm 100 ± 0.8 ppm 200 ± 1.5 ppm
Accuracy	± 0.005 % O ₂ or < 3 % rel.		± 3 ppb or < 3 % rel.		± 2 ppm or ± 5 %, whichever is higher
Measurement temperature range	0 – 50 °C		0 – 50 °C		0 – 40 °C
Response time (t ₉₀)	< 6 sec.	< 40 sec.	< 6 sec.	< 40 sec.	< 3 sec.
Properties					
Compatibility	Aqueous solutions, ethanol, methanol				Gas phase only
No cross-sensitivity with	pH 1 – 14 CO ₂ , H ₂ S, SO ₂ Ionic species				CO ₂ , SO ₂
Cross-sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas				Organic vapor, chlorine gas
Sterilization procedures	Steam sterilization Ethylene oxide (EtO) Gamma irradiation				-
Cleaning procedures	Cleaning in place (CIP, 5 % NaOH, 90 °C, 194 °F) 3 % H ₂ O ₂ Acidic agents (HCl, H ₂ SO ₄), max. 4 – 5 %				-
Calibration	Two-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment		Two-point calibration in oxygen-free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen		Two-point calibration in oxygen-free environment (nitrogen 6.0) and a second calibration value optimally between 100 and 200 ppm gaseous oxygen
Storage Stability	2 years provided the sensor material is stored in the dark (-10 – 60 °C)				

Transmitters and Accessories



Fibox 4 / Fibox 4 trace
Stand-alone fiber optic oxygen transmitter



Oxygen Exchange Cap
OEC is designed for easy exchange.



Microx 4 / Microx 4 trace
Stand-alone fiber optic oxygen transmitter



Fibox 3 LCD trace
Fiber optic oxygen transmitter with LCD display



OXY-4 mini/OXY-4 trace
4-channel fiber optic oxygen transmitter



OAD-25, Adapter for 25 mm Ports
The OAD-25 is used to connect all OIMs to 25 mm ports.



OXY-10 mini/OXY-10 trace
10-channel fiber optic oxygen transmitter

Non-Invasive pH Sensors

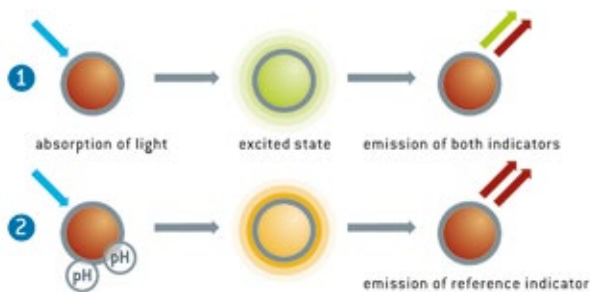
pH



Pre-calibrated, ready-to-use & real conditions:
Look into any transparent vessel

- Variety of disposables
- Bags & single-use bioreactors
- Microliter to production scale

Non-Invasive pH Sensors



The non-invasive pH sensors are optimized for physiological solutions and culture media. These sensor spots are mounted in transparent vessels made of plastics or glass for example. Plastic vessels with integrated pH sensors are ready-to-use as they are beta-irradiated and pre-calibrated. The pH is measured in a non-invasive and non-destructive manner from outside.

Features

- Online monitoring without sampling
- Non-invasive & non-destructive measurement
- Pre-calibrated
- Integrated in beta-irradiated disposables
- Applicable for micro-liter scale to production scale
- Optimized for culture media and physiological solutions

Sensor Spots

Sensor Spots (SP) are the most versatile version of non-invasive pH sensors. They are attached to the inner surface of any transparent vessel.

Examples are

- Shake flasks & spinners
- Tubes & petri dishes
- Cultivation bags

The transmitter with its optical fiber can be fixed opposite the sensor spot using our accessories (see our accessories brochure) which can be adapted for nearly all kinds of vessels.

Flow-Through Cell

The flow-through pH minisensor (FTC) is a miniaturized fiber chemical optical sensor integrated in a flow-through cell. It is connected to the transmitter by an optical fiber. The volume of liquid inside the FTC is about 250 microliters. The standard flow cell can be easily connected via Luer-Lock adapters to external tubing. The FTC is beta-irradiated and pre-calibrated.

Measurement Principle

The Patented Dual Lifetime Referenced (DLR) Method

The patented DLR method enables internally referenced measurements. A combination of different fluorescent dyes detects intensity changes in the time domain. It is essential for the pre-calibrated measurements and the easy parallelisation of measurement through the identical calibration of large numbers of sensor spots.

Non-Invasive pH Sensors



Examples for Applications

Pharma Industry: pH Monitoring in Bags

Bags and single-use bioreactors are in the process of revolutionising the way biopharmaceuticals are manufactured. Our non-invasive pH sensors are the tools to make the cultivation vessels fully disposable. As non-invasive DO sensors are also available, the two key parameters oxygen and pH can be controlled online.



Online Measurement in Perfusion Systems

Beta-irradiated and pre-calibrated pH and DO flow-through sensors can be integrated into perfusion systems. This allows easy control of process parameters in perfusion reactors. Typically Luer connectors are used, though different sizes for larger or smaller flow rates are available.



Bioprocess Development: pH Monitoring in Shake Flasks

The pH is one of the major issues in the cultivation of cells, yeast or bacteria. Shake flask cultures are widely applied in academic and industrial bioprocess development. As adequate methods for real monitoring of pH were not available, cumbersome at-line sampling was used. The combination with non-invasive oxygen sensors in shake flasks provides new insights into metabolic activity and changes in metabolic pathways.



Customized Micro Reactors and Ports

pH and DO sensor spots are mounted in customized micro reactors. They can be delivered beta-irradiated and pre-calibrated. Integration into a variety of polymeric surfaces is possible. Immobilisation on ports which are integrated into the reactors at the customer's facilities is a second application.

Is your application missing?
Contact us and we will find your
customized solution!

Non-Invasive pH Sensors	
Specifications*	
Measuring range	5.5 - 8.5 pH
Response time (t_{90})**	< 120 sec.
Resolution at pH = 7	± 0.01 pH
Accuracy at pH = 7	± 0.05 sensor spot calibration ± 0.10 sensor batch calibration
Drift at pH = 7	< 0.005 pH per day (sampling interval of 1 min.)
Temperature range	from 5 °C to 50 °C
Properties*	
Compatibility	Aqueous solutions, ethanol, methanol (max. 10 % V/V), pH 2 - 10
Cross-sensitivity	Reduced to ionic strength (salinity); a high concentration of small fluorescent molecules in the visible range can interfere
Storage stability	18 months provided the sensor is stored in the dark
Calibration	pH spots are pre-calibrated; re-calibration is possible
Cleaning	pH spots are delivered either beta-irradiated or untreated; a second irradiation or ethylene oxide treatment is not recommended

* provided pH spots are used without further handling in physiological solutions

** equilibrated sensor kept in well stirred solution at 37 °C

Transmitters & Accessories



pH-1 mini
Fiber optic pH transmitter for use with non-invasive pH sensors.



Coaster CFG
The coaster CFG is used for shake flasks.



pH-4 mini
4-channel fiber optic pH transmitter for use with non-invasive pH sensors.



SOA Adapter
The stick-on adapter SOA is used for transparent vessels with planar surface.



pH-10 mini
10-channel fiber optic pH transmitter for use with non-invasive pH sensors.



ARC Adapter
The adapter for round containers ARC is used for spinner flasks or similar vessels.

pH Microsensors

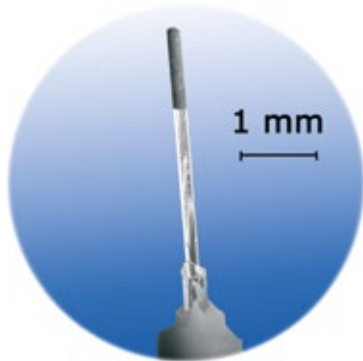
pH



Measuring with high spatial resolution Sensor tip below $150\ \mu\text{m}$

- Insertion in plant and animal tissue
- Measuring in smallest volume
- Profiling of pH gradients

pH Microsensors



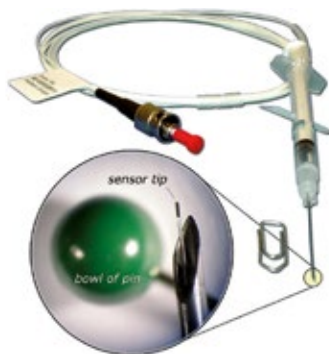
pH Microsensors are miniaturized pH sensors designed for measuring in small volumes and high spatial resolution. The sensor tip is below $150\ \mu\text{m}$. The sensors are based on a $140\ \mu\text{m}$ silica fiber which enables integration into a manifold of small scale environments. These sensors do not require reference electrodes and there is no leakage of electrolytes, a clear advantage over common electrodes.

Features

- High spatial resolution
- No need for reference electrodes
- Integration into plant and animal tissue
- Optimized for culture media and physiological solutions
- Independent on electromagnetic fields

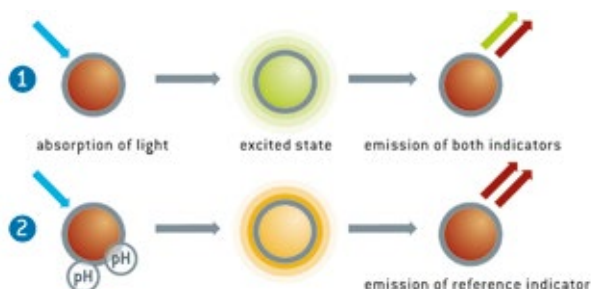
Needle-Type pH Microsensor

Needle-type pH Microsensors are the perfect tool for measuring in small volumes and for implementation into a variety of tissues. The protective housing enables a manifold of applications. The design is optimal for easy penetration of tissue, septum rubber or packaging materials. After penetration the sensor tip is extended for measurement.



Implantable pH Microsensor

Implantable probes are the miniaturized pH sensors designed for various customized applications. The tiny probe has a tip size of $150\ \mu\text{m}$ while the outer diameter ranges from $140\ \mu\text{m}$ to $900\ \mu\text{m}$. The microsensor tip is not mounted in any additional housing. The bare glass fiber tip can be mounted to your own housings, steel tubes, catheters, etc. As the probe is free of metal, it can be used in the presence of high electromagnetic fields and even NMR environment.



Measurement Principle

The Patented Dual Lifetime Referenced (DLR) Method

The patented DLR method enables internally referenced measurements. A combination of different fluorescent dyes detects intensity changes in the time domain. It is essential for the pre-calibrated measurements and the easy parallelisation of measurement through the identical calibration of large numbers of sensor spots.

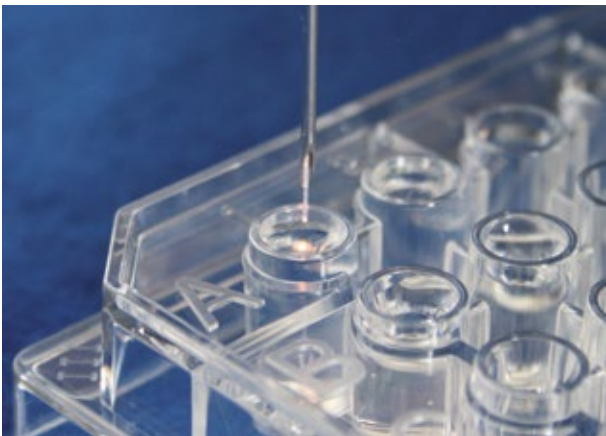
pH Microsensors



Examples for Applications

pH Measurement in Plants and Animals

pH Microsensors can be implanted even in small animals. New insights in the physiological aspects can be obtained. Due to the small size of the probes only a minimal disturbance will occur.



pH Measurement in Small Volumes

Due to the small dimension of the probe, pH measurements can be done in very small volumes - even in microtiter plates of a higher format like 384 or 1536. No need for reference electrodes - a real step forward, especially in small volumes. Of course, the measurement is independent of electromagnetic fields - this even allows measuring in NMR spectrometers.



Customized Microsensors

pH Microsensors can be implemented in a broad variety of customized housings. "Catheter" as well as special cannulas or needles will turn the pH Microsensor in the ideal tool for your special application.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

pH Microsensors	
Specifications*	
Measuring range	5.5 - 8.5 pH
Response time (t_{90}) at 25 °C	30 sec.
Resolution at pH = 7	± 0.01 pH
Accuracy at pH = 7	± 0.05 pH with sensor calibration
Drift at pH = 7	< 0.05 pH per day (sampling interval of 1 min.)
Temperature range	from 5 °C to 50 °C
Properties*	
Compatibility	aqueous solutions, ethanol, methanol (max. 10 % V/V), pH 2 - 10
Cross-sensitivity	reduced to ionic strength (salinity); a high concentration of small fluorescent molecules in the visible range can interfere
Storage stability	24 months provided the sensor is stored in the dark
Calibration	pH sensors are pre-calibrated; re-calibration is possible

*provided pH sensors are used without further handling in physiological solutions

Transmitters



pH-1 micro
Micro fiber optic pH transmitter for use with pH Microsensors.



pH-4 micro
4-channel micro fiber optic pH transmitter for use with pH Microsensors.

CO₂ Sensors

CO₂



Non-invasive & in-process monitoring

- Re-usable & disposable sensors
- Dissolved carbon dioxide monitoring

CO₂ Sensors



The CO₂ sensors measure the partial pressure of dissolved carbon dioxide. The spots are fixed on the inner surface of a glassware or transparent plastic material. The CO₂ concentration can therefore be measured in a non-invasive and non-destructive manner from outside, through the wall of the vessel.

Features

- Online monitoring
- Non-invasive & non-destructive measurement
- Measurement range from 10 – 250 hPa pCO₂ (8 ... 180 mmHg)
- No consumption of carbon dioxide
- Measures carbon dioxide in liquids
- Beta-irradiated and autoclavable sensors available

Sensor Spots

Sensor spots (SP) are the most versatile version of CO₂ sensors. They are attached to the inner surface of any transparent vessel.

Examples are

- Glass bioreactor
- Sight glass
- Flasks

The optical fiber of the transmitter can be fixed opposite the SP by using our accessories (see accessories brochure) which can be adapted for nearly all kinds of vessels.

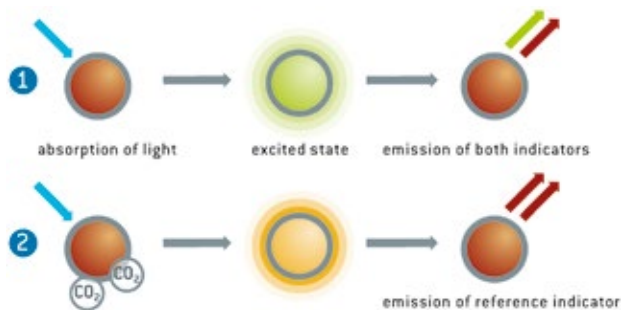
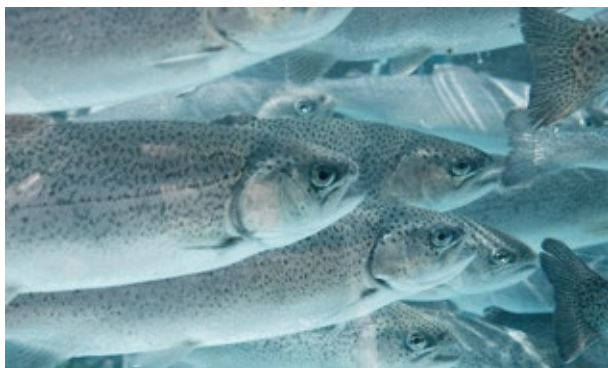
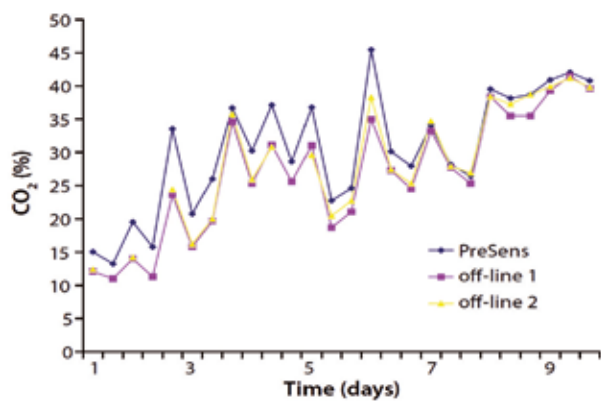
Flow-Through Cell

The flow-through cell carbon dioxide mini-sensor (FTC-CD1) is a miniaturized chemical optical sensor integrated in a flow-through cell. The cell is built from a 3 cm glass tube with 7 mm outer diameter with a CO₂ sensor integrated and a customized holder (FTC-Holder) fixing the polymer optical fiber for signal transduction. The cell is autoclavable.

Dipping Probe

The CO₂ dipping probe is a chemical optical sensor based on 2 mm polymer optical fiber (POF). The sensor membrane is fixed at the tubing end of the optical fiber connected to the transmitter. It is the solution for invasive measurements and monitoring.

CO₂ Sensors



Potential Applications

Biotechnology: Carbon Dioxide Monitoring in Process Development

In bioprocess development & production, monitoring dissolved CO₂ in addition to pH and O₂ provides valuable information. It ensures stress-free cultivation conditions during mammalian cell culture (e.g. CHO cell-line). Constant pH and / or oxygen supply and sufficient nutrition levels are key parameters to optimize yield. Thereby, excess CO₂ can act as a stressor or even a toxin to the culture and has to be controlled. The chemical optical CO₂ sensors can enhance performance of process monitoring during cultivation in disposables, leading to process optimization.

PreSens CO₂ Sensors as an Alternative to Off-Line Sampling

PreSens CO₂ sensors were evaluated for monitoring the cultivation cells in a 3-L bioreactor. The sensors show excellent long-term stability over a period of 10 days during cell cultivation of CHO cells with an initial seed density of 400,000 cells/mL. The readings of the PreSens CO₂ sensor offer the possibility to continuously monitor the CO₂ concentration between two off-line measurements.

Rick Baggio, Millipore Corporation, Bedford, MA, USA, Poster Presentation at ESACT2009, Dublin

Scientific: Carbon Dioxide Monitoring for Biological Applications

Increased CO₂ uptake from the atmosphere caused by anthropogenic sources is believed to cause ocean acidification, with not yet foreseeable effects on marine life and ecosystem. Monitoring pCO₂ in experimental set-ups simulating future levels of carbon dioxide can help to gain knowledge on the effects of ocean acidification on marine fauna. Besides the marine application, monitoring pCO₂ also allows knowledge to be gained on land-based plant physiology. Monitoring pCO₂ helps increasing yield during aquaculture of fish (fish farming) by providing convenient growth conditions. Excess carbon dioxide levels need to be monitored as this leads to hyperventilation of sea animals.

Dual Lifetime Referencing - An Internal Referencing Method

The chemical optical CO₂ sensor is based on our patented DLR measurement principle. The light of the blue LED excites the sensor to emit fluorescence. The luminescence lifetime measured is a superposition of the signals of an analyte sensitive indicator and an inert reference indicator, where both indicators exhibit very different luminescence lifetimes and the luminescence of the analytic sensitive indicator can be suppressed by CO₂. The measurement signal correlates to the partial pressure of carbon dioxide.

Sensor Probes

CO₂ Sensors

pCO ₂ Sensors	
Specifications*	
Measuring range	1 – 25 % CO ₂ at atmospheric pressure (1013.15 hPa) 10 – 250 hPa pCO ₂ 8 – 180 mmHg pCO ₂
Response time (t ₉₀) at 20 °C	< 3 min. for change from 2 % to 5 % (15 mmHg - 38 mmHg) pCO ₂
Resolution at 20 °C	± 0.06 % at 2 % CO ₂ ± 0.15 % at 6 % CO ₂ ± 0.5 mmHg at 15 mmHg pCO ₂ ± 1.2 mmHg at 45 mmHg pCO ₂
Drift at 37 °C **	typically < 5 % of reading per week
Precision	± 5 % of reading or 0.2 % (1.5 mmHg), whichever is higher
Operating temperature	From + 15 °C to + 45 °C
Properties*	
Compatibility	Aqueous solutions, pH 4 – 9
Cross-sensitivity	Optical pCO ₂ sensors display reduced cross-sensitivity to ionic strength (salinity); acetic acid, SO ₂ , HCl vapours
Stability	pCO ₂ sensors do not stand: organic solvents, pH above 10 or below 4
Storage	12 months provided the pCO ₂ sensor is stored in its original package
Cleaning	Depends on the sensor type used - please ask our experts
Calibration	pCO ₂ spots are pre-calibrated; re-calibration is possible Beta-irradiated or autoclavable pCO ₂ sensors available

* provided pCO₂ spots are used without further handling in physiological solutions

** in a carbon dioxide incubator with 100 % rel.Hum. at 5 % CO₂; measurement interval of 1 min.

Transmitters & Accessories



pCO₂ mini
Fiber optic carbon dioxide transmitter



FTC Holder
The FTC holder is used to connect the FTC-CD1 to the pCO₂ mini.



SOA Adapter
The stick-on adapter SOA is used for transparent vessels with planar surface.



Coaster CFG
The coaster CFG is used for shake flasks.



ARC Adapter
The adapter for round containers ARC is used for spinner flasks or similar vessels.

Disposables with Integrated Sensors

O₂ pH



Measuring oxygen and / or pH non-invasively

- Ready-to-use
- Pre-calibrated
- For microbes & cell culture

Disposables with Integrated Sensors

Disposables with integrated sensors are pre-calibrated and, therefore, ready-to-use. They monitor non-invasively through the transparent wall of the disposable.



Shake Flasks with Integrated pH and Oxygen Sensors (SFS)

Shake flasks with integrated pH and oxygen sensors are available in different volumes. Pre-calibrated plastic flasks are offered with and without baffles. They are obtainable at sizes from 125 ml to 2000 ml. They are read out either by the SFR Shake Flask Reader or by our transmitters in combination with the coaster for shake flasks (CFG). In addition, autoclavable glass flasks are available with integrated oxygen sensors.



Cell Culture Tubes with Integrated pH Sensors (iTube pH)

Plastic cell culture tubes with integrated pH sensors are pre-calibrated. They are read out either by the iTube96Reader, which allows parallel monitoring in up to 96 iTubes pH, or by the SFR Shake Flask Reader in combination with the specially designed iTube adapters. The iTubes pH come ready-to-use and in combination with the reader systems they reduce the work load for bioprocess development considerably.



Cell Culture Flasks with Integrated Sensors (CFS)

Cell culture flasks with integrated pH and oxygen sensors are available for different growth areas. They are pre-calibrated. The CFS are read out by our transmitter in combination with the coaster CFG or our SFR Shake Flask Reader.

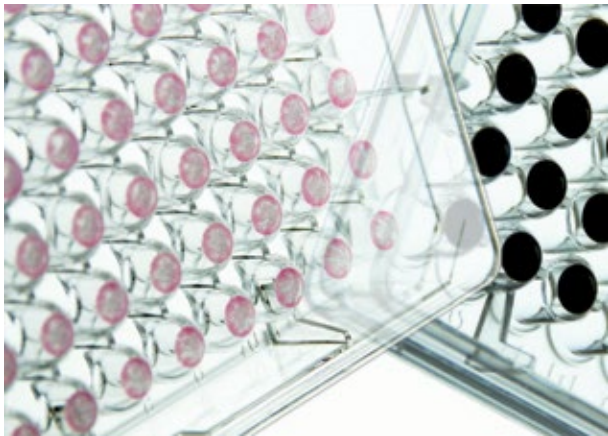
Disposables with Integrated Sensors



24- and 6-Well SensorDishes

Pre-calibrated oxygen (OxoDish®) and pH (HydroDish®) sensors integrated in 6- or 24-well multidishes are read out with the SDR SensorDish® Reader. For shaken cultures deep well plates with integrated oxygen sensors (OxoDish-DW, 24-well format) are available. The SDR can be placed in an incubator and on a shaker. This makes this system the ideal tool for cell cultivation: the cells do not have to be taken out of the incubator for measurement. Application examples are optimization of cultivation parameters like media composition in tissue engineering, toxicity tests and investigation of metabolism. Even small-scale fermentations are possible.

- See technical data and applications



96-Well SensorPlates

Oxygen (OxoPlate) and pH (HydroPlate) sensors are incorporated at the bottom of the wells of 96-well microplates. They are read out with conventional fluorescence microplate readers from the bottom side (requirements: see technical data). Only a few wells per batch are used for calibration. The SensorPlates are available in the round or flat bottom format. Fields of application are enzyme and drug screening, detection of the respiration of cells, bacteria or yeast, or monitoring of dairy starter cultures.



Customized Disposables

Integration of non-invasive sensors is available for almost any kind of transparent vessel. The experienced staff of PreSens offers integration in small and big series.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

SFS / CFS & iTubes pH		
Specifications	Dissolved Oxygen	pH
Measurement range	0 - 100 % O ₂	5.5 - 8.5 pH
Resolution	± 0.01 % O ₂ at 0.21 % O ₂ ± 0.1 % O ₂ at 20.9 % O ₂	± 0.01 pH at pH = 7*
Accuracy	± 0.4 % O ₂ at 20.9 % O ₂ ± 0.05 % O ₂ at 0.2 % O ₂	SFS / CFS: ± 0.05 pH at pH = 7 with one-point adjustment SFS / CFS: ± 0.1 pH at pH = 7 with pre-calibration
Drift	< 0.01 % O ₂ per day (sampling interval of 1 min.)	SFS / CFS: < 0.005 pH per day (sampling interval of 1 min.) i Tubes pH: < 0.01 pH per day (sampling interval of 1 min.)
Response time (t ₉₀) at 25 °C	< 30 sec. i Tubes pH: < 60 sec.	
Temperature range	From 5 °C to 50 °C	
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10	
Calibration	Pre-calibrated	
Disposables are delivered irradiated		
Additional Information		
Equipment	Fibox 3, Oxy-4/10 mini, SFR	pH-1/4/10 mini, SFR, ITR

Specifications	96-well OxoPlate	96-well HydroPlate	24 / 6-well OxoDish® & 24-Deep well OxoDish®	24 / 6-well HydroDish®
	Dissolved Oxygen	pH	Dissolved Oxygen	pH
Measurement range	0 - 30 % O ₂	pH 5.0 - 8.0	0 - 50 % O ₂	pH 6.0 - 8.5
Resolution**	± 0.2 % O ₂ at 0.21 % O ₂ ± 0.6 % O ₂ at 20.9 % O ₂	± 0.05 pH at pH = 7	± 0.4 % O ₂	± 0.05 pH at pH = 7
Precision**	± 0.4 % O ₂ at 0.21 % O ₂ ± 1.0 % O ₂ at 20.9 % O ₂	± 0.2 pH at pH = 7 (Sensor batch calibration) ± 0.1 pH at pH = 7 (Sensor spot calibration)	± 1 % O ₂	± 0.2 pH at pH = 7 (Sensor batch calibration) ± 0.1 pH at pH = 7 (Sensor spot calibration)
Drift**	< 0.04 % O ₂ per h (sampling interval 1 min.)	< 0.002 pH per h (sampling interval 1 min.)	< 0.2 % O ₂ within one week (sampling interval 10 min.)	< 0.1 pH within one week (sampling interval 10 min.)
Response time (t ₉₀) at 25 °C	< 30 sec.		< 30 sec.	
Measurement temperature range	From 15 to 45 °C		From 15 to 45 °C	
Formats	round and flat bottom	round bottom	low well: 24 / 6-well deep well: 24-well	
Maximum filling volume	300 µl (round bottom) 400 µl (flat bottom)	300 µl (round bottom)	3 ml (24-well, low well) 15 ml (6-well, low well) 10 ml (24-well, deep well)	
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10			
Calibration	Needs to be calibrated		Pre-calibrated	
Disposables are delivered irradiated				
Additional Information				
Equipment	Fluorescence Plate Reader (with bottom reading and dual mode)		SensorDish® Reader SDR	
Indicator filters	540 / 650 nm	485 / 538 nm		
Reference filters	540 / 590 nm	485 / 620 nm		

*for iTubes pH: 100 rpm / 5 cm orbit in culture medium

**in H₂O dest. or oxygen-free water (OxoPlate / OxoDish®); in physiological solutions (HydroPlate / HydroDish®)

Single-Use Flow-Through Cells O₂, pH

O₂ pH



Online Monitoring of O₂, and pH in Perfusion Systems

- Single-use flow-through cells
- Precise online monitoring of oxygen, and pH
- Different sizes and shapes for various flow rates
- Easy connection to external tubing
- Measurement of oxygen, and pH in one tubing



Single-Use Flow-Through Cells O₂, pH



Miniaturized chemical optical sensors integrated in single-use flow-through cells (FTC-SU) allow non-invasive online monitoring of oxygen, or pH in perfusion systems. The sensors are fixed to color coded sticks, which can be attached to flow-through cells of different size and shape, according to your requirements. A polymer optical fiber connects the sensor inside the flow-through cell to the respective measurement device (e. g. Fibox 4, pH-1 mini). The single-use cells are made of polycarbonate and can be delivered beta-irradiated or non-irradiated.

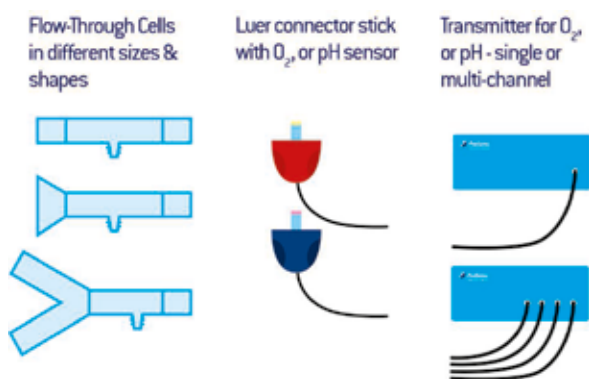
Features

- Single-use flow-through cells
- Precise online monitoring of O₂, or pH in perfusion systems
- Different sizes and shapes for various flow rates
- Easy connection to external tubing
- Simultaneous measurement of O₂, and pH in one tubing



Sensor Sticks (SST)

The miniaturized chemical optical sensor for O₂, or pH respectively is attached to a color coded stick. This color code (blue = O₂, red = pH) facilitates working with FTCs for different parameters simultaneously. The sensor sticks can be attached to FTCs of different size and shape [T-shape, Y-shape] via Luer connector. The oxygen sensor is available for measurement of normal and trace oxygen ranges. With the pH sensor values in a range of pH 5.5 - 8.5 can be measured, which is ideal for physiological solutions and culture media.



A Multitude of Combinations

Our flow-through cells of different sizes and shapes can be connected with one of the two sensor sticks for oxygen, or pH. The different single-use FTCs are available in T- or Y-shape and with different connection diameters (3/8, 1/4, and 1/2 inches according to requirements). The sensor sticks are connected to the respective measurement device with a 2 mm polymer optical fiber, which is available in lengths of 1.5, 2.5, or 5.0 m. This offers a maximum in flexibility - choose the combination which fits your needs!

Single-Use Flow-Through Cells O₂, pH



In-line Oxygen Monitoring in 3D Cell Culture

Since oxygen has a low solubility in culture medium it must be supplied to cells within 3D scaffolds via constant perfusion of the medium. The oxygen content of the medium before and after having passed by the cells can then help to determine whether the flow rate applied is sufficient. PreSens flow-through cells with integrated chemical optical sensors can be incorporated in the construct inlet and outlet and allow in-line measurement of oxygen tension.

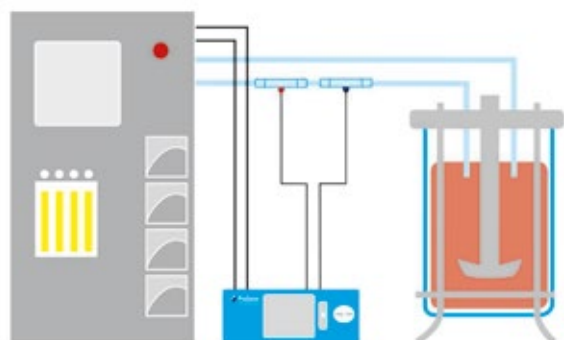
Application Note by R. Santoro, et al.: Perfusion Culture of Cell Seeded 3D Scaffolds for Tissue Engineering



pH Monitoring in Liver Cell Bioreactor

An important aspect of efficient liver cell bioreactors is the automated regulation of physio-chemical culture parameters. A non-invasive pH regulation device for a perfusion bioreactor has been developed. The high performance of the system is based on one of our chemical optical flow-through cells for pH detection and its combination with precision mass-flow controllers for gas. The new controller allows long time stable and contamination free online pH regulation in complex bioreactor systems - an important technical contribution for future clinical applications.

Application Note by Marco Decker: pH Regulation for a Liver Cell Bioreactor



pH and pO₂ Control in a Bioreactor via FTCs in a Bypass

The flow-through cells with oxygen and pH sensors can also be applied in combination with the Optrode Dual. The Optrode Dual converts the signal of the chemical optical sensors into an electrochemical signal, which is transferred to a conventional controller. By installing the FTCs in a bypass of a bioreactor and connecting them to the Optrode Dual, their signal can be used for automated regulation of oxygen and pH levels inside the bioreactor with your controller.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

	Oxygen (blue)	pH (red)
Specifications*		
Measuring range	0 – 45 mg/L 0 – 1400 µmol	pH 5.5 - 8.5
Resolution	± 0.14 µmol at 2.83 µmol ± 1.4 µmol at 283.1 µmol	at pH = 7: ± 0.02 pH
Accuracy	± 0.4 % O ₂ at 20.9 % O ₂ ± 0.05 % O ₂ at 0.2 % O ₂	at pH = 7: ± 0.05 **
Drift	at 0 % O ₂ : < 0.03 % O ₂ within 30 days (sampling interval of 1 min.)	at pH = 7: < 0.005 pH per day (sampling interval of 1 min.)
Measurement Temperature	from 0 to + 50 °C	from + 5 °C to + 50 °C
Response time (t ₉₀)***	< 30 sec.	< 120 sec.
Properties*		
Compatibility	Aqueous solutions, ethanol, methanol	Aqueous solutions, ethanol, methanol (max. 10 % V/V), pH 2 - 10
Cross sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride; Chlorine gas	Reduced to ionic strength (salinity); a high concentration of small fluorescent molecules in the visible range can interfere
Sterilization procedure****	Irradiation Ethylene oxide (EtO)	Irradiation Ethylene oxide (EtO)
Calibration	SST are pre-calibrated; Two-point calibration in oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment	SST are pre-calibrated; Single point calibration is recommended
Storage Stability	2 years provided the sensor is stored in the dark	2 years provided the sensor is stored in the dark

*provided pH sensors are used without further handling in physiological solution

**after single point calibration at pH 7

***equilibrated FTC with physiological solution and sufficient flow rate at 37 °C

****recalibration may be required

Transmitters



Fibox 4 / Fibox 4 trace
Stand-alone fiber optic oxygen transmitter



pH-1 mini
Fiber optic pH transmitter for use with non-invasive pH sensors.



Microx 4 / Microx 4 trace
Stand-alone fiber optic oxygen transmitter



pH-4 mini
4-channel fiber optic pH transmitter for use with non-invasive pH sensors.



OXY-4 mini/OXY-4 trace
4-channel fiber optic oxygen transmitter

Accessories



Numerous extensions and add-ons for our devices and sensors

- LCD display unit for single-channel oxygen transmitters
- Battery cable
- Optical adapters for connecting sensors to transmitters

We offer numerous accessories for our measuring devices. The application possibilities can be extended by LCD display units and battery cables. Optical sensor adapters allow our sensors to be used in a wide variety of containers.



LP-1 Control Panel

The control panel LP-1 is a device including a liquid crystal display (LCD) that is used to control PreSens single-channel oxygen transmitters without the need to connect them to a PC. The LP-1 supports Microx TX3, Microx TX3 trace, Fibox 3 and Fibox 3 trace. The integrated data logger allows up to 20,000 readings to be stored. Its graphic LCD with backlight enables full control of the devices. It offers both easy calibration and measurement using just four buttons.



Battery Cable

We offer battery cables as accessories for use of our single-channel transmitters in the field. They are compatible with all single-channel transmitters except for the Fibox 3 LCD trace, which already has an integrated battery. The cables are designed with alligator clips so that they can be connected to conventional batteries. Depending on the batteries capacity and the required measurement rate, operating times of up to several days are possible. (Batteries are not included.)



Vial Adapter for 20 mL SensorVials (VA)

The Vial Adapter is used to attach the POF (polymer optical fiber) to a 20 mL SensorVial (special glass vial with integrated oxygen sensor foil) using a screw. It can be attached to the vial in different heights for measurement in the liquid phase and the headspace and can also be used in a water bath. The POF is available as a separate accessory.



Coaster for Shake Flasks (CFG)

The coaster for shake flasks is used for online measurement of oxygen and / or pH in shake flasks and spinner flasks. The coaster is placed underneath the shake flask and can be adjusted for different shake flasks with different volumes. Two different coasters are available. The single coaster is used for one sensor spot; the dual coaster is used for two different sensor spots in the same flask. An optical fiber with an SMA connector is integrated into the adapter (2.5 m).



Adapter for Round Containers (ARC)

The adapter for round containers (ARC) is an adjustable Velcro®-type adapter. It can be used for round containers with diameters of 2.5 to 20 cm (1 to 8 inches). The SMA socket on this adapter must be connected to the polymer optical fiber (POF), which is available as a separate accessory.



Stick-On Adapter (SOA)

The stick-on adapter (SOA) is used to attach the POF (polymer optical fiber) cable to a planar transparent glass or plastic container. It is equipped with a SMA socket, which must be connected to the polymer optical fiber (POF).

Polymer Optical Fiber (POF)

For all our transmitters with SMA sockets, a polymer optical fiber is needed as a light guide between the transmitter and the sensor foil (e.g. oxygen or pH). This POF enables non-invasive and non-destructive measurements to be made from the outside through the transparent wall of the flask. The POF is compatible with minisensor devices Fibox 3, Fibox 3 trace, OXY-4 mini, OXY-10 mini, OXY-4 trace, OXY-10 trace or pH-1 mini, pH-4 mini, pH-10 mini, pCO₂ mini or Fibox 3 LCD and Fibox 3 LCD trace.

We offer different standard lengths, e.g. 2.5 m, and fibers with SMA connectors on one or both sides, depending on your adapter or sensor application.

Sensor Probes Accessories

LP-1		Battery Cable
Specifications		
Power Supply	Provided by connected instrument (e.g. Fibox 3), Input voltage range: 9 – 24 VDC, 5 W (nominal 18 VDC)	Input voltage range: 9 – 24 VDC, 5 W (nominal 18 VDC)
Compatibility	Microx TX3 (trace) Fibox 3 (trace v3)	o For single-channel transmitters: Microx TX3 (trace), Fibox 3 (trace), pH-1 mini, pH-1 micro, pCO2 mini o For LCD transmitters: Fibox LCD (trace)
Dimensions (D x W x H) / Weight	190 x 125 x 45 mm / 550 g	Length: 2.0 m / 100 g
Oxygen Units	% air saturation, % O ₂ , hPa, Torr, mg/L (ppm), μmol/L	
Data Logger	More than 20,000 samples stored in internal EEPROM	
Graphic Display	128 x 64 pixels, backlight, automatic contrast control	
Operating / Storage Temperature	0 °C to 50 °C / - 10 °C to 65 °C	
Relative Humidity	Up to 60 % (IP20)	

	Adapter for Round Containers (ARC)	Stick-On Adapter (SOA)	Vial Adapter for 20 mL SensorVials (VA)
Specifications			
Dimensions (D x W x H)	Velcro® strip 1000.0 x 22.0 x 4.0 mm	20.0 x 20.0 x 7.0 mm	ø 41.0 mm x 11.0 mm, inner ø 28.5 mm
Connector Type	SMA socket	SMA socket	slotted-head plastic screws
Compatible with All Devices	Fibox 3, pH-1 mini, OXY-4 mini,	Fibox 3, pH-1 mini, OXY-4 mini,	20 mL SensorVial-PSt3 together with all
With SMA Connectors	OXY-10 mini, and others	OXY-10 mini, and others	oxygen transmitters with SMA connectors: Fibox 3, OXY-4 mini, OXY-10 mini, and others

	Coaster for Shake Flasks (CFG) / Centrifuge Tube Adapter (CTA)	POF
Specifications		
Dimensions (D x W x H)	Approx. 93.0 x 41.0 x 16.0 mm	Optical diameter is 2 mm; outer diameter including the black cladding is approx. 2.8 mm
Connector Type	SMA socket	SMA connectors on one or both sides available for use with stick-on adapter and adapter for round containers
Length of Fiber	2.5 m	Available lengths for the POF are 1.0, 2.5 and 5.0 m (for lengths of more than 5 m, please contact our service team)
Compatibility	All devices with SMA connectors, e.g. Fibox 3, pH-1 mini, OXY-4 mini, OXY-10 mini	All devices with SMA connectors, e.g. Fibox 3, pH-1 mini, OXY-4 mini, OXY-10 mini
Details	Compatible with shake / spinner flasks up to 1 L	Temperature stability: The POF is resistant to temperatures up to 70 °C

Fibox 3 & Fibox 3 trace

Fiber optic oxygen transmitters Temperature compensated system

- For use with non-invasive oxygen sensors & sensor probes
- One calibration for a multitude of sensor spots
- Software included

The Fibox 3 and Fibox 3 trace are precise fiber optic oxygen transmitters. They are temperature compensated and used with oxygen sensors based on a 2 mm optical fiber. A PC is connected to run the easy-to-use software. On top, analogue outputs and a trigger input are integrated.

Fibox 3 is used for sensor coatings type PSt3 (detection limit 15 ppb, 0 - 100 % oxygen). Fibox 3 trace additionally works with the trace oxygen sensor coating type PSt6 (detection limit 1 ppb, 0 - 4.2 % oxygen).



	Fibox 3	Fibox 3 trace
Specifications		
Oxygen sensors	PSt3 only (optical SMA connector)	PSt3 and PSt6 (optical SMA connector)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)	
Temperature performance	0 - 50 °C, resolution: ± 0.1°C, accuracy: ± 1.0 °C	
Power supply	18 VDC/5 W (110 - 240 VAC, 50/60 Hz, adapter included)	
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 60 °C	
Relative humidity	Up to 80 % (non condensing)	
Dimensions, weight	210 mm x 120 mm x 50 mmm , 0.65 kg	
Digital interface	RS232 interface (with RJ connector to serial port, cable included)	
External trigger	TTL compatible with galvanic isolation (BNC connector)	
Analogue output specifications	Dual outputs, 0 - 4095 mV, resolution: 12 bit, accuracy: ± 10 mV (BNC connectors)	
		10 mV represent
	Oxygen	1 % air saturation
	Temperature	1 °C
	Phase	0.25 °

Sensors & Accessories



Sensor Spots O₂
 Sensor spots are the most versatile version of non-invasive oxygen sensors.



Oxygen Dipping Probe
 The dipping probe is a robust invasive oxygen sensor with excellent long-term stability.



Flow-Through Cell O₂
 This oxygen minisensor is a miniaturized fiber optic sensor integrated in a T-shape flow-through cell.



LP-1 Control Panel
 The control panel is a device for controlling single-channel oxygen transmitters.

Fibox 4 & Fibox 4 trace



Stand-alone fiber optic oxygen transmitter

- Worry-free measurement due to unique sensor ID
- Measure from 1 ppb to 100 % oxygen with one device
- Easy calibration via barcode scan
- Compensation of temperature, pressure and salinity
- Energy management for long term measurements
- Optional database supported software offers simultaneous control of multiple devices



Fibox 4 & Fibox 4 trace



The Fibox 4 works with sensor type PSt3 (detection limit 15 ppb dissolved oxygen, 0 - 100 % oxygen). With the Fibox 4 trace additionally trace and ultra low oxygen concentrations can be measured. It is compatible with sensors type PSt3, PSt6 (detection limit 1 ppb dissolved oxygen, 0 - 4.2 % oxygen), and PSt9 (detection limit 0.5 ppm, 0 - 200 ppm gaseous oxygen).

Features

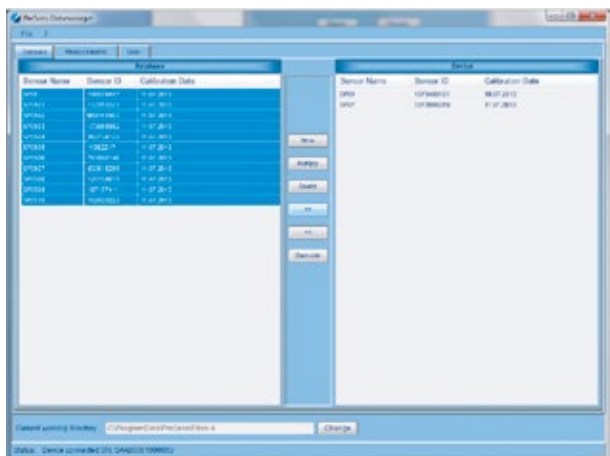
- Worry-free measurement due to unique sensor ID
- Vast measurement range from 1 ppb to 100 % oxygen
- Easy sensor handling and calibration via barcode reader
- Compensation of temperature, pressure & salinity
- Splash proof, robust housing
- Energy management for long term measurements
- Extended database supported software version allowing simultaneous control of multiple devices

The wireless Fibox 4 and Fibox 4 trace are designed for easy handheld use. The robust, light housing is splash proof and the controls - color display and buttons - were contrived so they can be operated even while wearing heavy gloves. The devices adapt to dry and humid environmental conditions. Like all other PreSens transmitters they are temperature compensated systems and have additional automatic compensation for pressure and salinity. The integrated long lasting battery - rechargeable via USB - together with the immense storage capacity allow for prolonged computer-independent use.



Sensors & Sensor Management

Fibox 4 and Fibox 4 trace are compatible with the existing PreSens sensor portfolio. All PreSens oxygen sensors will be delivered with a barcode. With the oxygen transmitters' integrated barcode reader sensor identification and calibration can be realized by performing just one scan, and measurements can be started immediately. A new sensor management system has been implemented where data of up to 100 sensors can be stored. This ensures a fast work flow while conducting most precise oxygen measurements.



Software

Fibox 4 and Fibox 4 trace are delivered with the PreSens Datamanager software allowing data transfer to a PC for further data analysis. Sensor and user management as well as all measurement data can easily be transferred between the device and the PC. The data management and data export will improve and speed up your analysis.

The optional extended software version is database supported and offers simultaneous control of multiple devices so measurement networks can be set up.

Fibox 4 & Fibox 4 trace



Examples for Applications

Oxygen Transmission Rate & Permeation Measurement

The Fibox 4 trace is the ideal tool for the packaging industry and material research. Easy sensor handling and calibration speed up measuring oxygen ingress and transmission rates in hundreds of containers and packages. Only one scan of the barcode is enough to start precise trace oxygen measurements. In combination with the PSt9 type sensor, which allows measurements down to 0.5 ppm oxygen, even the oxygen transmission rate of high barrier materials for oxygen sensitive applications - like vacuum insulating panels or photovoltaic modules - can be determined.

Food & Beverage Quality Control

Designed as portable, handheld devices the Fibox 4 and Fibox 4 trace can easily be applied for quality control in the food & beverage sector. Together with the versatile PreSens oxygen sensors which can be integrated in pipes, containers or directly held into samples the Fibox 4 and Fibox 4 trace offer complete freedom and multiple options for application to check the quality and shelf-life of your products in different stages of the production and filling process.

Biological & Environmental Research

The Fibox 4 and Fibox 4 trace are ideally suited for field research. With the robust, splash proof housing the devices can be operated even in harsh conditions. The long lasting battery and almost unlimited storage capacity allow for prolonged computer-independent use. Additionally, special energy management settings for long term measurements can be applied. The intuitive user interface and implemented functions like graphical display of the measurements ensure comfortable and comprehensive application without having to connect the device to a PC / notebook. Combined with different types of dipping probes, and non-invasive sensors the compact Fibox 4 and Fibox 4 trace can be applied in any situation where precise oxygen measurement is needed.

Process Industry

The new sensor management system together with the barcode reader ensures a fast work flow while working with a multitude of sensors integrated in different vessels or flow-through systems. Non-invasive measurements with chemical optical sensors can reduce the risk of contaminations and the Fibox 4 and Fibox 4 trace ensure precise oxygen measurements in critical processes. Working with the devices and the respective PC software huge amounts of data can be easily handled while ensuring a maximum of safety, due to the improved data and user management.

	Fibox 4	Fibox 4 trace
Specifications		
Oxygen sensors	PSt3 (optical SMA connector)	PSt3, PSt6, and PSt9 (optical SMA connector)
Temperature sensor	Pt 100 temperature connector (sensor not included)	
Temperature performance	0 to 50 °C, resolution: ± 0.1 °C	
Power supply	4 AA Nickel-metal hybrid cells (min. 2200 mAh) Use only AC adapter (5 VDC / min. 1 A) supplied for recharging.	
Max. battery operating time	16 hrs. (3 sec. Interval measurement, Default LED Intensity, Display backlight OFF, at room temperature)	
Temperature: operating / storage	0 °C to 50 °C / - 20 °C to 70 °C	
Relative humidity	0 % to 80 % (non condensing)	
Dimensions, weight	37 mm x 180 mm x 119 mm, 0.65 kg (w/o batteries & protection kit), 0.78 kg (w/ batteries & protection kit)	
Digital interface	USB interface (cable included)	
Display	3,5" color TFT, 320 x 240 Pixel	
Internal Memory	4 GB memory (~ 10.000.000 data sets) Export via included software.	

Sensors & Accessories



Sensor Spots O₂

Sensor spots are the most versatile version of non-invasive oxygen sensors.



Flow-Through Cell O₂

This oxygen minisensor is a miniaturized fiber optic sensor integrated in a T-shape flow-through cell.



Oxygen Dipping Probe

The dipping probe is a robust invasive oxygen sensor with excellent long-term stability.



Oxygen Probe for In-line Measurement

Compatible with most bioreactors or port adapters.



Oxygen Probe Integrated in Varivent Valves

For in-line measurements in e. g. breweries.



Oxygen Probe Integrated in a Metal Flow-Through Connector

For integration in steel-pipes

A wide variety of sensors is offered.
If your housing is missing,
please contact us!

Fibox 3 LCD trace



Portable fiber optic oxygen transmitter Stand-alone system

- For use with non-invasive oxygen sensors & sensor probes
- One calibration for a multitude of sensor spots
- Portable device with rechargeable battery

The Fibox 3 LCD trace is a stand-alone fiber optic oxygen transmitter. It is temperature compensated and used with oxygen sensors based on a 2 mm optical fiber. It is a portable device with a rechargeable battery and a built-in data-logger. It can be controlled via an integrated, programmable LCD control panel. Alternatively, the Fibox 3 LCD trace can be connected to a PC for measurement. Fibox 3 LCD is used for sensor coatings type PSt3 (detection limit 15 ppb, 0 - 100 % oxygen) and type PSt6 (detection limit 1 ppb, 0 - 4.2 % oxygen).



Fibox 3 LCD trace	
Specifications	
Oxygen sensors	PSt3 and PSt6 (optical SMA connector)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)
Temperature performance	0 to 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C
Power supply	14,8 V / 4 Ah
Max. battery operating time	8 hrs. (sampling rate 1 sec.)
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 60 °C
Relative humidity	Up to 80 % (non condensing)
Dimensions, weight	215 mm x 120 mm x 95 mm, 1.65 kg
Digital interface	RS232 interface (cable included)
Analogue interface	Dual current outputs, 4 - 20 mA, with galvanic isolation, O ₂ range programmable
	Dual voltage output, 0 - 10 V, with galvanic isolation, O ₂ range programmable
	Dual voltage input, 0 - 10 V, with galvanic isolation, resolution: 12 bit, programmable
Display	Dot matrix LCD, foil keyboard, 4 keys
Data logger	25,000 Data sets, export via incl. software

Sensors & Accessories



Oxygen Probe for In-line Measurement

Compatible with most bioreactors or port adapters.



Oxygen Probe Integrated in Varivent Valves

For in-line measurements in e. g. breweries.



Oxygen Probe Integrated in a Metal Flow-Through Connector

For integration in steel-pipes



Flow-Through Cell O₂

This oxygen minisensor is a miniaturized fiber optic sensor integrated in a T-shape flow-through cell.



Sensor Spots O₂

Sensor spots are the most versatile version of non-invasive oxygen sensors.



Oxygen Dipping Probe

The dipping probe is a robust invasive oxygen sensor with excellent long-term stability.

OXY-4/10 mini & OXY-4/10 trace

Multi-channel fiber optic oxygen transmitters Parallel monitoring of up to 10 sensors

- For use with non-invasive oxygen sensors & sensor probes
- One calibration for a multitude of sensor spots
- Software included

The OXY-4 mini, OXY-10 mini, OXY-4 trace and OXY-10 trace are precise multi-channel fiber optic oxygen transmitters. They are used with oxygen sensors based on a 2 mm optical fiber. A PC is connected to run the easy-to-use software. OXY-4 mini and OXY-10 mini are used for sensor coatings type PSt3 (0 - 100 % oxygen). OXY-4 trace and OXY-10 trace additionally work with the trace oxygen sensor coating type PSt6 (detection limit 1 ppb, 0 - 4.2 % oxygen).



Transmitters

OXY-4/10 mini & OXY-4/10 trace

	OXY-4 mini & OXY-10 mini	OXY-4 trace & OXY-10 trace
Specifications		
Oxygen sensors	PSt3 only (optical SMA connector)	PSt3 and PSt6 (optical SMA connector)
Power supply	110 - 230 VAC, 50/60 Hz, max. 40 vA (cables included)	
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 60 °C	
Relative humidity	Up to 80 % (non condensing)	
Dimensions	300 mm x 250 mm x 135 mm	
Weight OXY-4 mini & OXY-4 trace	3.3 kg	
Weight OXY-10 mini & OXY-10 trace	3.9 kg	
Digital interface	RS232 interface (with RJ connector to serial port, cable included)	

Sensors & Accessories

**Sensor Spots O₂**

Sensor spots are the most versatile version of non-invasive oxygen sensors.

**Oxygen Dipping Probe**

The dipping probe is a robust invasive oxygen sensor with excellent long-term stability.

**Flow-Through Cell O₂**

This oxygen minisensor is a miniaturized fiber optic sensor integrated in a T-shape flow-through cell.

**Accessories**

A variety of accessories like connectors to different vessels is available.

A wide variety of sensors is offered.
If your housing is missing,
please contact us!

Electro-Optical Module EOM-02-mini

Non-invasive oxygen measurement Fast integration w/ integration package

- More than thousand systems in the field
- Experienced customer support
- Assembled according to ISO 9001:2008 and EN ISO 13485:2003 + 2007 AC

The electro-optical module EOM-02-mini is a precise OEM solution for non-invasive oxygen sensor spots. Assembled according to ISO 9001:2008 they deliver certified quality. In addition, validation and customization of the integrated software is offered to the medical device manufacturing standard EN ISO13485:2003 + 2007 AC. Self-contained test procedures of every individual system ensure high product safety. EOM modules are offered for sensor coatings type PSt3 (0 - 100 % oxygen) and trace oxygen sensor coating type PSt6 (detection limit 1ppb, 0 - 4.2 % oxygen).



Transmitters

Electro-Optical Module EOM-02-mini

	EOM-02-mini	EOM-t02-mini
Specifications		
Oxygen sensors EOM-02-mini	PSt3 only (optical SMA connector)	PSt3 and PSt6 (optical SMA connector)
Phase resolution	0.05 °	
Sampling rate	0.5 sec. - 120 sec. (PSt6: 3 sec. - 120 sec.)	
Temperature sensor	Four-wire Pt 100	
Temperature performance	0.1°C + Pt 100 accuracy	
Supply voltage	7 - 18 V	
Power consumption in active mode	1.5 W	
Power consumption in stand-by mode	0.6 W	
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 70 °C	
Relative humidity	up to 80 % (non condensing)	
Dimensions (with add-on board)	40 mm x 100 mm x 22 mm (25 mm)	
Weight	70 g	
Digital interface	RS232 interface (optional RS485)	

Sensors & Accessories

**Sensor Spots O₂**

Sensor spots are the most versatile version of non-invasive oxygen sensors.

**Oxygen Probe for In-line Measurement**

Compatible with most bioreactors or port adapters.

**Oxygen Probe Integrated in Varivent Valves**

For in-line measurements in e. g. breweries.

**Add-on Temperature Board**

Expands the capabilities of EOM by measuring the temperature.

**Polymer Optical Fiber (POF)**

They serve as a versatile connection from transmitter to sensor probe.

**Non-Invasive Oxygen Sensors**

These sensors are used in bags and other single-use bioreactors

A wide variety of sensors is offered. If your application is missing, please contact us!

Microx TX3 & Microx TX3 trace



Micro fiber optic oxygen transmitters Temperature compensated system

- For use with oxygen microsensors
- Analogue in- and outputs
- Software included

The Microx TX3 and Microx TX3 trace are precise micro fiber optic oxygen transmitters. They are temperature compensated and used with oxygen microsensors based on a 140 μm optical fiber. A PC is connected to run the easy-to-use software. On top, analogue outputs and a trigger input are integrated. Microx TX3 is used for microsensors type PSt1 (detection limit 20 ppb, 0 - 50 % oxygen). Microx TX3 trace additionally works with the trace oxygen microsensor type TOS7 (detection limit 1 ppb, 0 - 3 % oxygen).



	Microx TX 3	Microx TX 3 trace
Specifications		
Oxygen sensors	PSt1 (optical ST connector)	PSt1 and TOS7 (optical ST connector)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)	
Temperature performance	0 – 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C	
Power supply	18 VDC / 5 W (110 – 240 VAC, 50/60 Hz, adapter included)	
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 60 °C	
Relative humidity	Up to 80 % (non condensing)	
Dimensions, weight	210 mm x 120 mm x 50 mm, 0.65 kg	
Digital interface	RS232 interface (with RJ connector to serial port, cable included)	
External trigger	TTL compatible with galvanic isolation (BNC connector)	
Analogue output specifications	Dual outputs, 0 – 4095 mV, resolution: 12 bit, accuracy ± 10 mV (BNC connectors)	
		10 mV represent
	Oxygen	1 % air saturation
	Temperature	1 °C
	Phase	0.25 °

Sensors & Accessories



Needle-Type Oxygen Microsensors

This oxygen microsensor is protected by its robust housing.



Implantable Oxygen Microsensors

This oxygen microsensor offers the probe without any additional housing.



Battery Cable

Accessories like battery cables for use in the field are available.



LP-1 Control Panel

The control panel is a device for controlling single-channel oxygen transmitters.

A wide variety of sensors is offered.
If your housing is missing,
please contact us!

Microx 4 & Microx 4 trace



Stand-alone fiber optic oxygen meter

- For use with non-invasive sensors, probes & microsensors
- Straightforward measurement due to unique sensor ID
- Simple calibration via barcode scan
- Compensation of temperature, pressure and salinity
- Energy management for long term measurements
- Optional database supported software offers simultaneous control of multiple devices



Microx 4 & Microx 4 trace



The Microx 4 & Microx 4 trace are completely stand-alone, portable fiber optic oxygen meters. They can be used with non-invasive sensors & probes (1 mm fiber) and oxygen microsensors (200 μm fiber) in different designs. The Microx 4 is compatible with the wide range sensors type PSt7 (detection limit 15 ppb, 0 - 100 % oxygen). The Microx 4 trace can additionally be used with sensors type PSt8 (detection limit 3 ppb, 0 - 10 % oxygen) for measuring oxygen traces.

Features

- For use with non-invasive sensors, probes & microsensors
- Easy sensor handling and calibration via barcode scan
- Compensation of temperature, pressure & salinity
- Splash proof, light, robust housing
- Energy management for long term measurements
- Extended database supported software version allowing simultaneous control of multiple devices



The handheld oxygen meters have a robust, light and splash proof housing. The control panel has a color display and few buttons that can be operated even while wearing heavy gloves. Settings allow adapting to dry or humid measurement conditions, and in addition to temperature compensation Microx 4 & Microx 4 trace offer automatic compensation of pressure and salinity. The implemented energy management, which allows long term measurement up to half a year (when taking a measurement every 30 min.) without recharging the batteries, and the huge storage capacity of the oxygen meters enable prolonged computer-independent use.

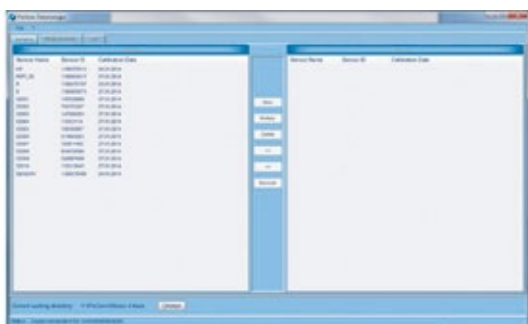


Sensors & Sensor Management

The oxygen meters are compatible with non-invasive sensors & probes (type PSt7-10, PSt8-10) and oxygen microsensors (type PSt7-02, PSt8-02). The sensors are available as sensor spots, for integration in vessels, dipping probes, flow-through cells, oxygen microsensors integrated in syringe canulas, for piercing container walls or tissue, or bare fiber microsensors, which can be used in customized applications. All sensors will be delivered with a barcode. With the oxygen meters' integrated barcode reader sensor recognition and calibration can be done in just one scan. The implemented sensor management system allows storing data of up to 100 sensors.

Software

Microx 4 & Microx 4 trace are delivered with the PreSens Datamanager software. Sensor, user and measurement data can be easily transferred between the PC and the oxygen meters. The data management and easy data export will facilitate and speed up your analysis. With the optional extended software version, which is database supported, multiple oxygen meters can be controlled simultaneously so measurement networks can be set up.



Microx 4 & Microx 4 trace



Biological & Environmental Research

The handheld Microx 4 & Microx 4 trace are ideal tools for field research, and can be applied for gaseous or dissolved oxygen measurements. Combined with different types of dipping probes, or oxygen microsensors they allow e. g. water quality assessment, respiration measurements, or measurements inside tissue. These oxygen meters are applicable wherever precise oxygen measurement is needed. With their splash proof, robust housing the oxygen meters can be used in harsh environments. Special energy settings for long term measurements, the almost unlimited storage capacity or features like graphical display of your measurements allow for prolonged and comfortable computer-independent use.



Medical & Life Science Research

Microx 4 & Microx 4 trace can be used with oxygen microsensors in different designs. These sensors allow for precise on the spot measurement and profiling inside tissue constructs. PreSens oxygen microsensors are already applied in several tissue engineering applications. Implantable microsensors without any additional housing are ideally suited for customized application set-ups, integration in catheters or direct implantation into soft tissue. As the oxygen meters can also be applied with sensor spots, even non-invasive measurements inside cell culture vessels can be performed, without the risk of contamination.



The Ideal Tool for Packaging & Quality Control

Oxygen inside packaging can lead to oxidative deterioration and shorten the shelf life of products. The portable, handheld Microx 4 & Microx 4 trace are ideally suited for quality control in the food & beverage industries, and can be applied in different stages of production. The oxygen sensors in various designs can be integrated in pipes, containers or directly held into samples taken for quality control. Calibration and sensor recognition via barcode scan will speed up the work flow when investigating oxygen ingress in hundreds of containers and packages. Applied with the needle-type oxygen microsensors the oxygen content in small scale headspace packages or non-transparent containers can be determined with the oxygen meters.



Oxygen Measurements in Biofilms & Sediments

Microx 4 & Microx 4 trace can be used with oxygen microsensors in different designs, which allow on the spot measurements. Needle-type oxygen microsensors housed in a syringe needle can be inserted in biofilms or sediments for oxygen profiling. Perform exact online oxygen measurements in different depths of your sample. Combined with micromanipulators the oxygen microsensors can be inserted in μm steps for exact positioning. Robust dissolved oxygen probes are available also, for easy application in sediments in the lab or out in the field.

Microx 4 & Microx 4 trace

Microx 4		Microx 4 trace		
Specifications				
Oxygen sensors	PSt7 (optical ST connector)	PSt7, and PSt8 (optical ST connector)		
Temperature sensor	Pt 100 temperature connector (sensor not included)			
Temperature performance	0 to 50 °C, resolution: ± 0.1 °C			
Power supply	4 AA Nickel-metal hybrid cells (min. 2200 mAh) Use only AC adapter (5 VDC / min. 1 A) supplied for recharging.			
Max. battery operating time	16 hrs. (3 sec. Interval measurement, Default LED Intensity, Display backlight OFF, at room temperature)			
Temperature: operating / storage	0 °C to 50 °C / - 20 °C to 70 °C			
Relative humidity	0 % to 80 % (non condensing)			
Dimensions, weight	37 mm x 180 mm x 119 mm, 0.65 kg (w/o batteries & protection kit), 0.78 kg (w/ batteries & protection kit)			
Digital interface	USB interface (cable included)			
Display	3,5" color TFT, 320 x 240 Pixel			
Internal Memory	4 GB memory (~ 10.000.000 data sets) Export via included software.			
Sensors				
	PSt7		PSt8	
Specifications	PSt7-10	PSt7-02	PSt8-10	PSt8-02
Measurement range	0 - 100 % O ₂ , 0 - 1000 hPa 0 - 45 mg/L, 0 - 1400 µmol/L		0 - 10 % O ₂ , 0 - 100 hPa 0 - 4.5 mg/L, 0 - 140 µmol/L	
Limit of detection	0.02 % O ₂ , 10 ppb		0.005 % O ₂ , 2 ppb	
Resolution	± 0.01 % O ₂ at 1 % O ₂ ; ± 0.005 mg/L at 0.4 mg/L; ± 0.05 % O ₂ at 20.9 % O ₂ ; ± 0.025 mg/L at 9.0 mg/L		± 0.002 % O ₂ at 0.008 % O ₂ ; ± 0.7 ppb at 3 ppb; ± 0.006 % O ₂ at 2.5 % O ₂ ; ± 2.5 ppb at 1000 ppb	
Accuracy	± 0.05 % O ₂ or < 3 % rel.		± 3 ppb or < 3 % rel.	
Measurement temperature range	0 - 50 °C			
Response time (t ₉₀)	< 3 sec. (gas), < 10 sec. (liquid)			

Sensors & Accessories



Sensor Spots O₂ Type PSt7 or PSt8

The most versatile version of non-invasive oxygen sensors.



Flow-Through Cell Metal Housing Oxygen Microsensor

Provides a gas tight & small measurement cell.



Needle-Type Oxygen Microsensor

This oxygen microsensor is protected by its robust housing.



Implantable Oxygen Microsensors

This oxygen microsensor offers the probe without any additional housing.



Oxygen Dipping Probe Type PSt7 or PSt8

Robust invasive oxygen sensors with excellent long term stability.



Single-Use Flow-Through Cell O₂

Single-use FTCs for various flow rates.

OXY-4 micro & OXY-10 micro



Multi-channel micro fiber optic oxygen transmitters Parallel monitoring of up to 10 sensors

- For use with oxygen microsensors
- Compact design
- Software included

The OXY-4 micro and OXY-10 micro are precise multi-channel micro fiber optic oxygen transmitters. They are used with oxygen microsensors based on a $140\ \mu\text{m}$ optical fiber. A PC is connected to run the easy-to-use software. OXY-4 micro and OXY-10 micro are used for microsensors type PSt1 (detection limit 20 ppb, 0-50 % oxygen).



	OXY-4 micro	OXY-10 micro
Specifications		
Oxygen sensors	PSt1 only (optical ST connector)	
Power supply	110 - 230 VAC, 50/60 Hz, max. 40 vA (cables included)	
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 60 °C	
Relative humidity	Up to 80 % (non condensing)	
Dimensions	300 mm x 250 mm x 135 mm	
Weight	3.3 kg	3.9 kg
Digital interface	RS232 interface (with RJ connector to serial port, cable included)	

Sensors & Accessories



Needle-Type Oxygen Microsensors

This oxygen microsensor is protected by its robust housing.



Implantable Oxygen Microsensors

This oxygen microsensor offers the probe without any additional housing.



Flow-Through Cell Housed Oxygen Microsensor

This sensor is integrated in a T-shaped cell.



Flow-Through Cell Metal Housing Oxygen Microsensor

Provides a gas tight & small measurement cell.

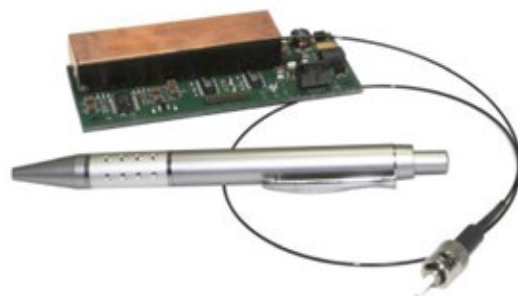
A wide variety of sensors is offered.
If your housing is missing,
please contact us!

Electro-Optical Module EOM-02-micro

Non-invasive or micro-invasive
oxygen measurement
Fast integration w/ integration
package

- Experienced customer support
- Variety of sensor integrations available
- Assembled according to ISO 9001:2008

The EOM-02-micro is a precise single channel module for measuring oxygen. It consists of a phase detection board for luminescence lifetime detection and a micro-optic, compatible with $140\ \mu\text{m}$ silica fibers. The small outer dimensions and low power consumption enable a simple integration into custom monitoring & control systems. A serial communication protocol is offered for data exchange between a PC or another host unit and the EOM-02-micro.



Transmitters

Electro-Optical Module EOM-02-micro

EOM-02-micro	
Specifications	
Oxygen sensors EOM-02-micro	PSt1 (optical ST connector)
Phase resolution	0.05 °
Sampling rate	1 sec. - 120 sec.
Supply voltage	7 - 18 V
Power consumption in active mode	1.5 W
Power consumption in stand-by mode	0.6 W
Temperature: operating / storage	0 °C to 50 °C / -10 °C to 70 °C
Relative humidity	up to 85 % (non condensing)
Dimensions	40 mm x 100 mm x 24 mm [25 mm*]
Weight	51.8 g
Digital interface	RS232 interface (optional RS485)

* with Add-on Temperature Board

Sensors & Accessories



Flow-Through Cell Housed Oxygen Microsensor

This sensor is integrated in a T-shaped cell.



Needle-type oxygen microsensors

offer the oxygen microsensor in a robust housing.



Implantable microsensors

Implantable microsensors offer the probe without any additional housing.



Add-on Temperature Board

Expands the capabilities of EOM by measuring the temperature.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

Optrode Dual



Transmitter for chemical optical pH and oxygen sensors Connects optical sensors to conventional controllers

- Connects conventional controllers to chemical optical sensors
- Simulates electrochemical signals (ECS)
- Additional 4 - 20 mA output
- Easy entering calibration data via barcode

The Optrode Dual™ is an electrode simulator. It converts the reading of chemical optical sensors to electrochemical signals (ECS). Connected to the electrode input of conventional controllers it expands their functionality to work with chemical optical sensors. In addition 4 - 20 mA outputs are integrated. Pre-calibration data for the chemical optical sensors can easily be entered via barcode. Temperature is compensated by a pre-set temperature or via the integrated temperature sensor. The Optrode Dual™ can be connected to any oxygen sensor type PSt3, and pH sensors type HP5 and HP8.



Transmitters

Optrode Dual

	Dissolved Oxygen	pH
Specifications		
Sensors	PSt3	HP5 / HP8
ESC interface	air current 60 nA at 25 °C*	-321... 321 mV [pH 2 - 12]**
4 - 20 mA current interface	4 - 20 mA [0 - 100 % O ₂], 16-bit resolution	4 - 20 mA [pH 2 - 12], 16-bit resolution
Temperature measurement (Sensor: 4-wire, PT100, Class A)	Range: 0 ... 50 °C	
	Resolution: 0.05 °C	
	Accuracy: 0.1 °C + sensor accuracy	
Device		
Relative humidity	Up to 85 % (non condensing)	
Temperature: operating & storage / transportation	10 °C to 40 °C / -10 °C to 70 °C	
Power supply (external, plug in power supply will be delivered)	Primary: 100 V - 240 V AC (60/50 Hz) Secondary: 18 VDC	
Enclosure	Alu housing, coated, without ventilation	
Dimensions	120 mm x 140 mm x 50 mm	
Weight	1000 g	

* Calculation according to linear response with 0 nA in the absence of oxygen

** Calculation according to linear response with 0 mV at pH 7, and slope of 64 mV / pH at 50 °C

Sensors & Accessories



Sensor Spots O₂ / pH

Sensor spots are the most versatile version of non-invasive sensors.



Oxygen Dipping Probe

The dipping probe is a robust invasive oxygen sensor with excellent long-term stability.



Flow-Through Cells O₂ / pH

A miniaturized fiber optic sensor is integrated in a T-shape flow-through cell.



Nice Ports

Ports with sensors for customized application in cultivation bags.

A wide variety of sensors is offered.
If your housing is missing,
please contact us!

pH-1/4/10 mini

pH

Fiber optic pH transmitters Parallel monitoring of up to 10 sensors

- For use with non-invasive pH sensors & sensor probes
- One calibration for a multitude of sensor spots
- Software included

The pH-mini are precise fiber optic pH transmitters. They are used with pH sensors based on a 2 mm optical fiber. A PC is connected to run the easy-to-use software. pH-1 mini is additionally equipped with an analogue out and a trigger in. pH sensors are optimized for physiological solutions.



	pH-1 mini	pH-4 mini & pH-10 mini
Specifications		
pH sensors		HP5 / HP8
Power supply	18 VDC / 5 W (110 – 240 VAC, 50/60 Hz, adapter included)	110 – 230 VAC, 50/60 Hz, max. 40 vA (cables included)
Relative humidity		Up to 80 % (non condensing)
Dimensions	210 mm x 120 mm x 50 mm	300 mm x 250 mm x 135 mm
Weight	0.65 kg	3.3 kg & 3.9 kg
Digital interface		RS232 interface (with RJ connector to serial port, cable included)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)	
Temperature performance	0 °C to 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C	
Temperature: operating/storage		0 °C to 50 °C / - 10 °C to 60 °C
External trigger	TTL compatible with galvanic isolation (BNC connector)	
Analogue output specifications	Dual outputs, 0 – 4095 mV, resolution: 12 bit, accuracy ± 10 mV (BNC connectors)	
		10 mV represent
	pH	0.1 pH
	Temperature	1 °C
	Phase	0.25 °

Sensors & Accessories



Flow-Through Cell pH
Miniaturized fiber chemical optical sensor.



Sensor Spots pH
The most versatile version of non-invasive pH sensors.



Accessories
A variety of accessories like connectors to different vessels is available.

Electro-Optical Module EOM-pH-mini

pH

Non-invasive pH measurement Fast integration w/ integration package

- Hundreds of systems in the field
- Experienced customer support
- Variety of sensor integrations available

The electro-optical module EOM-pH-mini is a precise OEM solution for non-invasive pH sensor spots. Assembled according to ISO 9001:2008 they deliver certified quality. In addition, validation and customization of the integrated software is offered. EOM-pH-mini supports patented DLR based pH sensors.



Transmitters

Electro-Optical Module EOM-pH-mini

EOM-pH-mini	
Specifications	
pH sensor	HP5 / HP8
Phase resolution	0.05 °
Minimal sampling rate	Below 1 sec.
Supply voltage	7 - 18 V
Power consumption in active mode	1.5 W
Power consumption in stand-by mode	0.6 W
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 70 °C
Relative humidity	Up to 80 % (non condensing)
Dimensions	40 mm x 100 mm x 22 mm
Weight	70 g
Digital interface	RS232 interface (optional RS485)

Sensors & Accessories

**Sensor Spots pH**

The most versatile version of non-invasive pH sensors.

**Polymer Optical Fiber (POF)**

They serve as a versatile connection from transmitter to sensor probe.

**Non-Invasive pH Sensors**

These sensors are used in bags and other single-use bioreactors.

**Accessories**

A variety of accessories like connectors to different vessels is available.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

pH-1 micro & pH-4 micro

pH

Fiber optic pH transmitters Parallel monitoring of up to 4 sensors

- For use with pH microsensors
- Simple one-point calibration possible
- Software included

The pH-micro are precise fiber optic pH transmitters. They are used with pH sensors based on a 140 μm optical fiber. A PC is connected to run the easy-to-use software. pH-1 micro is additionally equipped with analogue output and a trigger input. pH sensors are optimized for physiological solutions.



	pH-1 micro	pH-4 micro
Specifications		
pH sensors		HP5
Power supply	18 VDC / 5 W (110 – 240 VAC, 50/60 Hz, adapter included)	110 – 230 VAC, 50/60 Hz, max. 40vA (cables included)
Relative humidity		Up to 80 % (non condensing)
Dimensions	210 mm x 120 mm x 50 mm	300 mm x 250 mm x 135 mm
Weight	0.65 kg	3.3 kg
Digital interface		RS232 interface (with RJ connector to serial port, cable included)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)	
Temperature performance	0 °C to 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C	
Temperature: operating/storage	0 °C to 50 °C / - 10 °C to 60 °C	
External trigger	TTL compatible with galvanic isolation (BNC connector)	
Analogue output specifications	Dual outputs, 0 – 4095 mV, resolution: 12 bit, accuracy ± 10 mV (BNC connectors)	
		10 mV represent
	pH	0.1 pH
	Temperature	1 °C
	Phase	0.25 °

Sensors & Accessories



Needle-Type pH Microsensor

This pH Microsensor is protected by its robust housing.



Implantable pH Microsensors

This pH Microsensor offers the probe without any additional housing.



Customized Microsensors

Customized housings for special applications.

A wide variety of sensors is offered.
If your housing is missing,
please contact us!

pCO₂ mini

CO₂

Fiber optic CO₂ transmitter Temperature compensated system

- For use with non-invasive CO₂ sensors & sensor probes
- One calibration for a multitude of sensor spots
- Software included

The pCO₂ mini is a precise fiber optic CO₂ transmitter. It is used with CO₂ sensors based on a 2 mm optical fiber. A PC is connected to run the easy-to-use software. pCO₂ mini is additionally equipped with an analogue out and a trigger in. CO₂ sensors are optimized for physiological solutions.



Transmitters

pCO₂ mini

pCO ₂ mini	
Specifications	
pCO ₂ sensors	CD 1
Power supply	18 VDC / 5 W (110 – 240 VAC, 50/60 Hz, adapter included)
Relative humidity	Up to 80 % (non condensing)
Dimensions	210 mm x 120 mm x 50 mm
Weight	0.65 kg
Digital interface	RS232 interface (with RJ connector to serial port, cable included)
Temperature sensor	1 x PT 1000 temperature connector (sensor included)
Temperature performance	0 °C to 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C
Temperature: operating/storage	0 °C to 50 °C / - 10 °C to 60 °C
External trigger	TTL compatible with galvanic isolation (BNC connector)
Analogue output specifications	Dual outputs, 0 – 4095 mV, resolution: 12 bit, accuracy ± 10 mV (BNC connectors)
	10 mV represent
Temperature	1 °C
Phase	0.25 °

Sensors & Accessories



CO₂ Sensor Flow- Through Cell (FTC-CD1)
The FTC-CD1 is used for integration in a tubing system.



Sensor Spots CO₂
The most versatile version of carbon dioxide sensors.



Dipping Probe CO₂
The solution for invasive measurements and monitoring.



Accessories
A variety of accessories like connectors to different vessels is available.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

Electro-Optical Module EOM-CO2-mini

CO₂

Non-invasive CO₂ measurement Fast integration w/ integration package

- Experienced customer support
- Variety of sensor integrations available
- Assembled according to ISO 9001:2008

The electro-optical module EOM-CO₂-mini is a precise OEM solution for non-invasive CO₂ measurements. Assembled according to ISO 9001:2008 they deliver certified quality. In addition, validation and customization of the integrated software is offered. EOM-CO₂-mini supports patented DLR based CO₂ sensors.



Now available!

Transmitters

Electro-Optical Module EOM-CO2-mini

EOM-CO2-mini	
Specifications	
CO ₂ sensors	CD1
Phase resolution	0.05 °
Minimal sampling rate	1 sec.
Supply voltage	7 - 18 V
Power consumption in active mode	1.5 W
Power consumption in stand-by mode	0.6 W
Temperature: operating / storage	0 °C to 50 °C / - 10 °C to 70 °C
Relative humidity	Up to 80 % (non condensing)
Dimensions	40 mm x 100 mm x 24 mm
Weight	70 g
Digital interface	RS232 interface (optional RS485)

Sensors & Accessories

**Sensor Spots CO₂**

The most versatile version of carbon dioxide sensors.

**Polymer Optical Fiber (POF)**

They serve as a versatile connection from transmitter to sensor probe.

**CO₂ Sensor Flow Through Cell (FTC-CD1)**

The FTC-CD1 is used for integration in a tubing system.

**Accessories**

A variety of accessories like connectors to different vessels is available.

A wide variety of sensors is offered.
If your application is missing,
please contact us!

SFR Shake Flask Reader

O₂ pH



Oxygen and pH monitoring in Erlenmeyer flasks, Cultivation Tubes, and T-flasks

- Media evaluation and optimization
- Wireless data transfer
- Compatible with standard shakers
- For microbial cultivations & cell culture



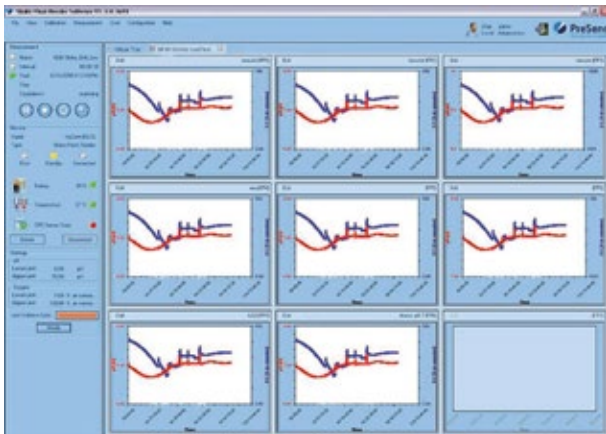
SFR Shake Flask Reader



The SFR Shake Flask Reader monitors oxygen and pH in up to 9 Erlenmeyer flasks, cultivation tubes, or T-flasks simultaneously. It fits in nearly all standard shakers. Measurement data is transferred wirelessly via Bluetooth to your PC / notebook. The corresponding ready-to-use vessels contain pre-calibrated sensor spots. The system monitors non-invasively through the transparent bottom of the vessels. Different types and sizes of flasks and tubes are available. Plastic, disposable flasks contain pre-calibrated oxygen and pH sensors. Glass flasks are equipped with autoclavable oxygen sensors only, and can be re-used.

Features

- Rapid, parallel online monitoring of up to 63 shake flasks
- For microbial cultivation and cell culture
- Pre-calibrated cultivation vessels are ready-to-use
- Compatible with standard shakers
- Glass & plastic flasks in different sizes available
- Non-invasive measurement
- Used in seed train & bioprocess development

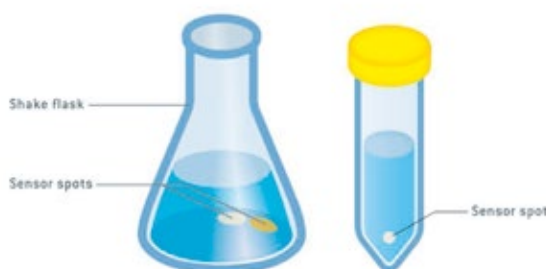


Software

The SFR Software SFRS is the integrated control center for the SFR Shake Flask Reader. In addition, it offers an integrated database to show and evaluate measurements. The connection between PC and SFR is wireless. Oxygen and pH are visualized in real-time during the entire cultivation. Results are displayed in a variety of graphical representations. The advanced graphic data handling supports Design of Experiment. All measured data can be exported to Excel® or as .csv for further evaluation. Furthermore, the current measurement can be compared to stored cultivations online.

Benefits

- Enables process monitoring in shake flasks
- Online Oxygen Uptake Rate monitoring
- Systematic optimization of cultivation parameters
- Compliant with FDA 21 CFR part 11
- Supports finding feeding points
- Facilitates optimization of harvesting strategies



The Smart Measurement Method

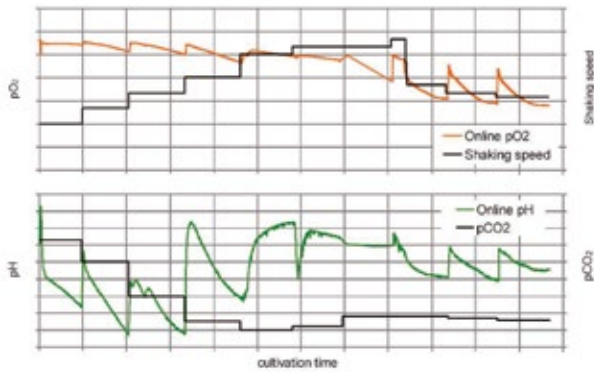
The sensor spots are fixed at the bottom of the shake flasks, cultivation tubes, or T-flasks. The luminescence of the dyes embedded in these sensor spots is excited by the Shake Flask Reader. The luminescence lifetime is detected non-invasively through the transparent flask. The luminescence lifetime of the sensor dye depends on the oxygen partial pressure and the pH of the sample, respectively. It is converted to oxygen and pH values by the software using the provided calibration data.

Examples for Applications

Process Monitoring in Suspension-Adapted CHO Cell Cultures

The online measurement of dissolved oxygen concentration and pH in shaken bioreactors paves the way for proper scale down activities from bench-top stirred-tanks to smaller scales. Adjustment of shaking speed as a function of pO_2 is now possible avoiding possible oxygen limitations at high cell densities. Even a simple pH readjustment by tuning the pCO_2 in the incubator is feasible to optimize the output from simple experiments with shaken bioreactors.

Dr. Robert Puskeiler, Roche Diagnostics, Penzberg, Germany

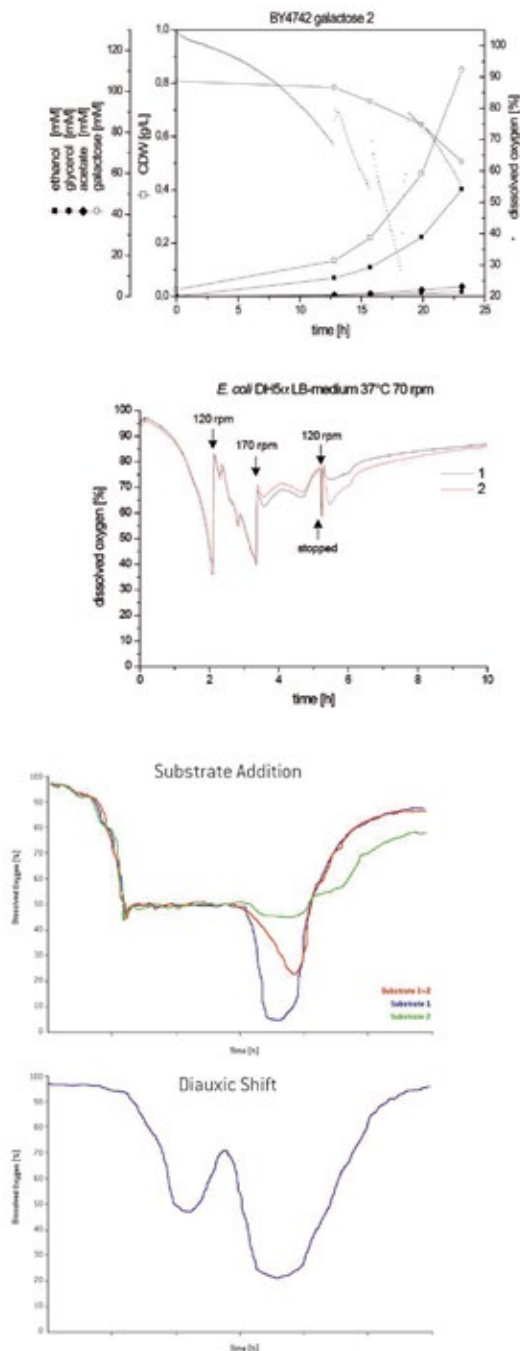


Yeast & E. coli: Ensure Enough Oxygen Supply

S. cerevisiae grows on different sugars as carbon source. While growth on glucose and fructose is mainly fermentative, growth on galactose is mainly respirative. This leads to low oxygen concentration in the shake flasks. The accurately measured oxygen indicates the need to increase rotation frequency to avoid oxygen limitation.

High oxygen demand is typical for *E. coli* in its exponential phase. In the cultivation shown on the left, rotation speed had to be changed twice in order to avoid oxygen limitation. In addition, changes in the metabolism can be detected by measuring DO.

*Schneider et al., University of Saarland, Saarbrücken, Germany
Bioprocess Biosyst Eng., 33(5), 541 - 547, 2009*



Media Optimization

SFR measurements provide insight to substrate consumption and help to determine limitations. In the example shown on the left limitation is detected after several hours. The cause of this limitation is identified by adding different substrates and substrate combinations to the media.

Also diauxic shifts can be determined by monitoring dissolved oxygen concentration in the culture. While the bacteria change the metabolic pathways for consuming another substrate their oxygen consumption is reduced, which can be observed in a rise of oxygen concentration in the culture medium. The following drop in oxygen concentration indicates that the bacteria passed over to consume the other substrate, and their oxygen demand rises again.

	Oxygen	pH*
Specifications		
Measuring range	0 - 100 % O ₂	5.5 - 8.0 pH
Response time (t ₉₀) at 25 °C	< 60 sec.	< 60 sec.
Resolution	± 0.01 % O ₂ at 0.21 % O ₂ ± 0.1 % O ₂ at 20.9 % O ₂	± 0.01 pH at pH = 7**
Accuracy	± 0.4 % O ₂ at 20.9 % O ₂ ± 0.05 % O ₂ at 0.2 % O ₂	± 0.1 pH at pH = 7 with one-point adjustment ± 0.2 pH at pH = 7 with pre-calibration
Drift	< 0.01 % O ₂ per day (sampling interval of 1 min.)	< 0.01 pH per day (sampling interval of 1 min.)
Properties		
Temperature range	from 5 °C to 50 °C	
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10	
Cross-sensitivity	Typically no cross-sensitivity in culture media	Reduced to ionic strength (salinity); a high concentration of small fluorescent molecules in the visible range can interfere
Storage stability	12 months provided the sensor is stored in the dark Sensor flasks are delivered irradiated.	

*provided Sensor Flasks are used without further handling in physiological solutions
** at 100 rpm & cell culture media

SET-UP



ACCESSORIES



SFR Software SFRS

O₂ pH



Your shake flask is not a black box anymore

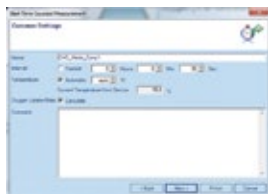
- Flexible data handling
- Wireless control
- Included in SFR Set
- Control up to 7 SFRs in parallel

SFRS is the integrated control center for the SFR Shake Flask Reader. In addition, it offers an integrated database to show and evaluate measurements. The connection between PC and SFR is wireless. Oxygen and pH are visualized in real-time during the entire cultivation. Results are displayed in a variety of graphical representations. Therefore, different cultivations are compared online. All measured data can be exported to Excel® or as .csv files for further evaluation.

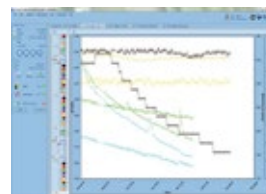


SFRS	
Specifications	
Version	2.0.0
Processor type	AMD/Intel 32/64 bit DualCore
Memory	min. 2 GB Ram
Free hard drive space	min. 1 GB recommended
Graphic card resolution	automatically adjusts to screen resolution, min. 800 x 600
Operating system	Windows XP 32 SP3, Windows XP 64 SP2, Windows Vista 32 / 64 SP2, Windows 7 32 / 64
Measurement views	Virtual tray displays current pH and DO data and informs about limit violations
	9 positions graph shows all 9 flasks positions with 9 individual diagrams
	Detailed graph enlarged view of one measurement
	Cumulated graph comparison of up to 72 measurements in one graph
Export formats	.xls [Excel]
	.csv [Comma Separated Values]
	.msn [native format]
	.pdf [compliant with FDA 21 CFR part 11]
Additional features	Audit trail / user management with 4 user levels / integrated database
Optional features	OPC Server interface

Features



Measurement Wizard
lets you start the measurement in just 4 steps.



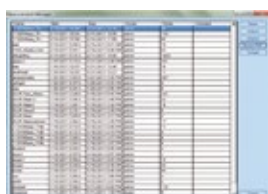
Advanced Graphic Handling
Compare up to 72 running and stored measurements online.



Compliant with FDA 21 CFR part 11
Integrated user management, audit trail and pdf export.



Multitray compatible
Run up to 7 SFRs with one PC / notebook.



Integrated Database
SQLite database offers data security and easy access.



Annotations
Notes can be stored at any time of the measurement.



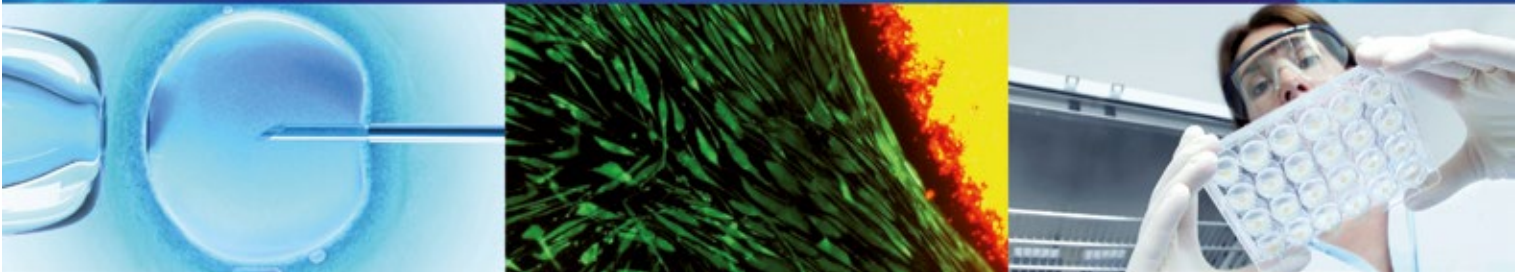
Additional Features
Online Oxygen Uptake Rate monitoring.



OPC Functionality
Combine your system with automation processes.

SDR SensorDish Reader

O₂ pH



Non-invasive online culture monitoring of oxygen and pH

- Measurement under real conditions in incubator atmosphere
- Low well & deep well plates
- Pre-calibrated & ready-to-use
- For microbial & cell culture



SDR SensorDish Reader



The SDR SensorDish® Reader is a small 24-channel reader for non-invasive detection of oxygen and pH in multidishes (SensorDishes®). These contain a sensor spot at the bottom of each well. They are read out non-invasively through the transparent bottom. SensorDishes® for oxygen (OxoDish®) and pH (HydroDish®) are available in the 24-well and 6-well format. Deep well plates with integrated oxygen sensors (OxoDish®-DW) allow measurements in shaken cultures. Read out of oxygen sensors integrated in glass vessels for respiration monitoring is also possible. The SensorDish® Reader can be used in incubators and on shakers and is thus the ideal tool for cell cultivation.



Features

- Parallel online monitoring in disposable 24- or 6-well plates
- Non-invasive & non-destructive measurement
- Deep well plates (for O₂ monitoring in shaken cultures) & low well plates available
- Pre-calibrated
- For use in incubators and on shakers
- Optional extension for monitoring of up to 240 samples

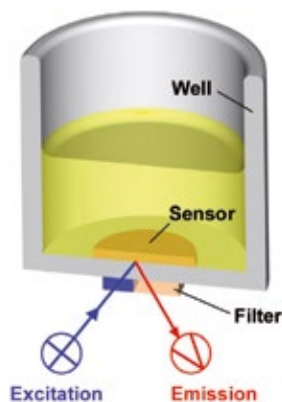


Software

Up to 10 SDRs are controlled by the user-friendly software. Oxygen and pH kinetics are visualized in real-time during the entire cultivation. Features like different graphical representations, optical display of deviations from the set point, trend analysis and other mathematical calculations are integrated. Calibration data are uploaded conveniently from a file. Measured data can be exported to Excel® or ASCII for further evaluation.

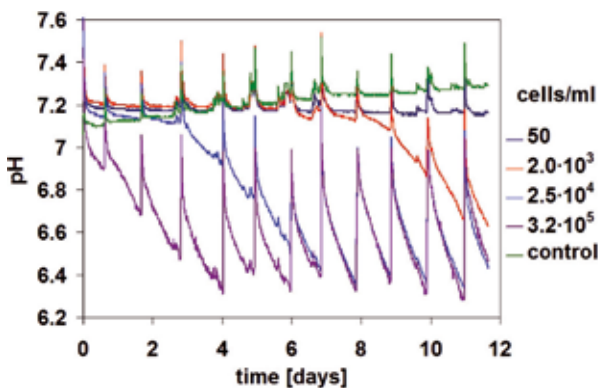
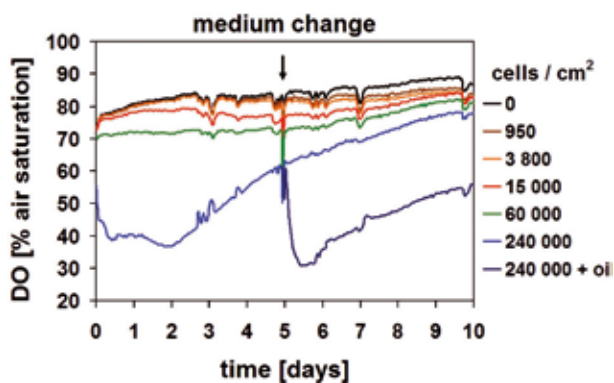
Benefits

- Improved process monitoring and security
- Systematic optimization of culture parameters
- Enhanced culture quality and efficiency
- Real-time data acquisition indicates necessary medium changes instantly
- Easy scale-up for parallel processing of up to 240 samples



The Smart Measurement Method

A sensor spot is fixed at the bottom of each well of the multidish. The sensor spot contains a luminescent dye. It is excited by the SensorDish® Reader placed below the multidish, and its luminescence lifetime is detected non-invasively through the transparent bottom. The luminescence lifetime of the dye depends on the oxygen partial pressure (OxoDish®) and the pH of the sample (HydroDish®), respectively. It is converted to oxygen and pH values by the software without plate calibration by the user.



Examples for Applications

More Security at Hypoxic Stem Cell Cultivation

The influence of medium change on dissolved oxygen (DO) at cultivation of human embryonic stem cells (hESC) was investigated at different oxygen tensions in the incubator atmosphere. Samples with full medium change using non-precalibrated medium showed a DO increase of 20 - 60 % air saturation. Other than expected, even half medium change with pre-incubated medium resulted in a notable DO increase of 10 - 30 % air saturation. The SensorDish® Reader can be used in hypoxia incubators, but also in small hypoxia chambers (see picture).

Barbara Ley, Prof. Oliver Brüstle, Life & Brain GmbH, Bonn, Germany

Oxygen and pH Monitoring in Tissue Engineering

Human chondrocytes with different start concentrations were cultivated in OxoDish® and HydroDish®. At medium change after 5 days, some samples with the highest cell concentration were covered with paraffin oil. Oxygen kinetics show a dynamic equilibrium between oxygen ingress and consumption. Oxygen increased after 5 days due to reduced metabolism and, for the highest cell concentration, after 2 days due to cell redifferentiation. The oil cover led to a temporary oxygen decrease due to a changed equilibrium. pH changes were detected for even lower start cell concentrations.

Dr. Andreas Thomsen, CellGenix GmbH, Freiburg, Germany

Process Monitoring in Suspension-Adapted CHO Cell Cultures

Oxygen and pH kinetics of suspension-adapted CHO cells at different start concentrations were monitored. The kinetics correlated well with the initial cell concentrations. pH values decreased only to a minimum of 6.3 due to daily media change. Samples with the lowest cell concentration did not show any pH change due to lack of cell growth. The oxygen uptake rate increased at each medium change. For the highest initial cell concentration it decreased at the end of the cultivation due to forming of aggregates. The results were confirmed by microscopic investigation.

Dr. Harry Abts, Celonic GmbH, Jülich, Germany, BioProcess Int., Jan 2008: 64-66

Real-time Monitoring of the Respiration of Marine Zooplankton

Oxygen consumption of 3 - 4 copepod nauplii per sample was monitored in air-tight glass vials for 6 h. The nauplii were offered phytoplankton at environmental concentrations. Feeding and faecal pellet production rates were estimated simultaneously. The respiration rates were linear and steady, thus revealing that the nauplii were neither influenced by the vessel walls nor by diminishing of food. The respiration rate was compared to literature values of other species. The higher oxygen consumption of the nauplii was presumably due to constant feeding.

Dr. Marion Köster, Ernst-Moritz-Arndt-Universität Greifswald, Germany, Mar Ecol Prog Ser 353: 157-164 (2008)

Systems

SDR SensorDish Reader

	pH	Dissolved Oxygen	
Specifications			
Measurement range	6.0 – 8.5	0 – 50 % O ₂	
Resolution*	± 0.05 pH at pH = 7	± 0.4 % O ₂ at 20.9 % O ₂	
Precision*	± 0.2 pH at pH = 7 (Sensor batch calibration) ± 0.1 pH at pH = 7 (Sensor spot calibration)	± 1 % O ₂ at 20.9 % O ₂	
Drift*	< 0.1 pH within one week (sampling interval 10 min.)	< 0.2 % O ₂ within one week (sampling interval 10 min.)	
Measurement temperature range	15 – 45 °C	15 – 45 °C	
Response time* (t ₉₀)	< 30 sec.	< 30 sec.	
Properties			
Compatibility	Aqueous solutions, ethanol, methanol (max. 10 % V/V), pH 2 – 10		
Cross-sensitivity	Reduced to ionic strength (salinity); high concentration of small fluorescent molecules in the visible range can interfere		
Calibration	HydroDishes and OxoDishes are pre-calibrated		
Device			
	SensorDish® Reader	Splitter	Power adapter
Type	SDR v3 or higher	SP1.1 or higher	Mascot 9920
Cleaning	Ethanol (moist cloth)		
Input	18 – 24 V DC 150 mA	18 – 24 V DC 1.5 A	100 – 240 V AC 50-60Hz max. 0.9 A
Weight	380 g	240 g	
Dimensions	16.3 cm x 8.9 cm x 2.2 cm	12.4 cm x 8.0 cm x 4.5 cm	

* in physiological solutions

SET UP

SET UP

Software

Splitter

Power Supply

SDR SensorDish® Reader

SDR SensorDish® Reader

(up to 9 Extension Sets)

SENSORS

OxoDish® OD24

HydroDish® HD24

OxoDish® OD6

HydroDish® HD6

OxoHydroDish OHD6

Deep well OxoDish® OD24-DW

5 mL glass vial with sensor spot SP-PSt5

Sensor spot SP-PSt5

Oxygen Ingress Measurement

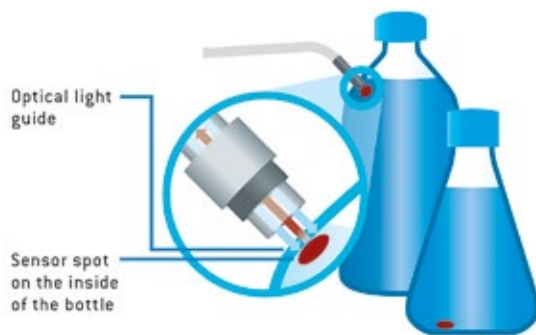
O₂



Non-invasive, non-destructive & real conditions:
Determine the shelf-life of your product

- Determination of oxygen ingress in PET bottles
- Determination of scavenger capacity
- Determination of oxygen permeation through closures

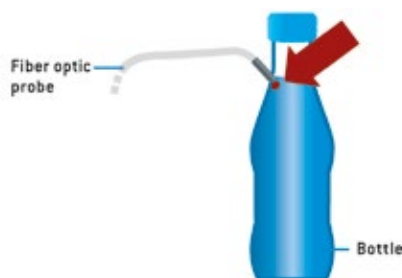
Oxygen Ingress Measurement



A new non-invasive and non-destructive fiber optic oxygen transmitter determines oxygen permeability of plastic bottles and containers. Trace oxygen concentrations inside the package are measured. Ideal for assurance, production and quality control, this system incorporates the latest state-of-the-art in chemical optical sensor technology. Permeation rates can be confirmed without piercing the package or bottle. The sensing principle is based on a fluorescence quenching method enabling oxygen measurements in a non-destructive way. A trace oxygen sensor spot is placed inside the transparent bottle or package and a fiber optic cable is positioned on the outside. The luminescence lifetime of the oxygen-sensitive spot changes with the oxygen concentration and is therefore acting as the oxygen dependent parameter.

Features:

- Non-invasive & non-destructive
- Real-conditions & online monitoring
- Shelf-life determination
- Sensitivity down to 1 ppb dissolved oxygen
- Easy & precise measurement



Single-Channel Set-up for Subsequent Measurement

The sensor spot can be glued into the PET bottle which then can be closed with a standard closure. For this direct coating, the bottles should be transparent but the measurement is even possible through slightly coloured (e. g. greenish or yellowish) or turbid bottles.



Measurement with an Oxygen-Sensitive Cap in Case of Non-Transparent Bottles

To determine the oxygen ingress in dark brown or non-transparent PET bottles, a direct coating of the PET bottle wall with a sensor spot is not possible. To enable non-invasive oxygen ingress measurement also for deeply coloured and non-transparent containers PreSens has developed an oxygen-sensitive cap (OSC) which can be used as closure.



Multi-Channel Set-up for Simultaneous Measurements

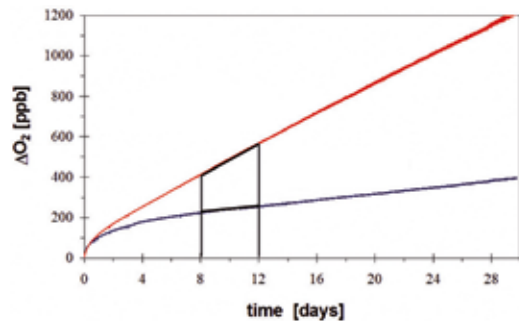
Transmitters for 4 and 10 oxygen sensors are offered. With this multi-channel set-up it is possible to monitor simultaneously up to 10 bottles.

Oxygen Ingress Measurement

Results

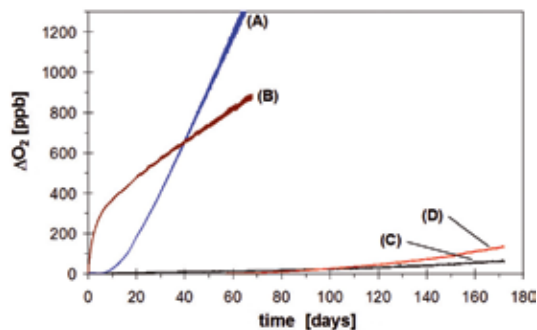
Bottle Type 1: External Coated PET Bottles

The oxygen ingress into an external coated (blue line) and the respective reference PET bottle without coating (red line) are shown over a period of more than 25 days. In the first 48 hours the increase of the oxygen concentration in non-coated bottles and bottles with the external coating is non-linear due to the additional migration of oxygen out of the PET bottle wall. The external barrier coating reduces the rate of permeation, resulting in a significantly decreased slope compared to the slope observed for non-coated PET bottles.



Bottle Type 2: PET Bottles with External Coating and / or Different Contents of Oxygen Scavenger

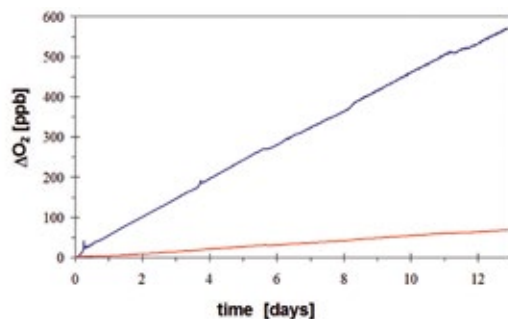
Oxygen ingress into differently treated PET bottles of the same type; (A) non-coated PET bottle with 2 % scavenger, (B) external coated PET bottle with no scavenger, (C) external coated PET bottle with 1 % scavenger, (D) external coated PET bottle with 0.5 % scavenger. The combination systems (C) and (D) hold oxygen ingress to less than 1 ppm over six months, which could not be accomplished with the active (scavenger (A)) or passive barrier (external coating (B)) alone.



Bottle Type 3: Internal Coated PET Bottles

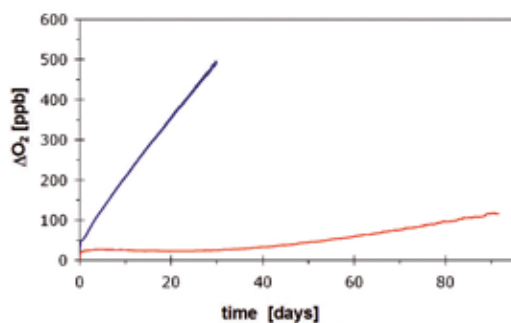
The inner coating provides an efficient barrier to oxygen (red line), and prevents oxygen desorption from the PET bottle wall into the product during the first few days of storage contrary to bottles coated externally.

In this case a thin layer of amorphous carbon, typically 100 to 200 nm thick, is applied to the inner surface of the bottle. This is deposited from high-energy plasma of acetylene gas within a high vacuum environment.



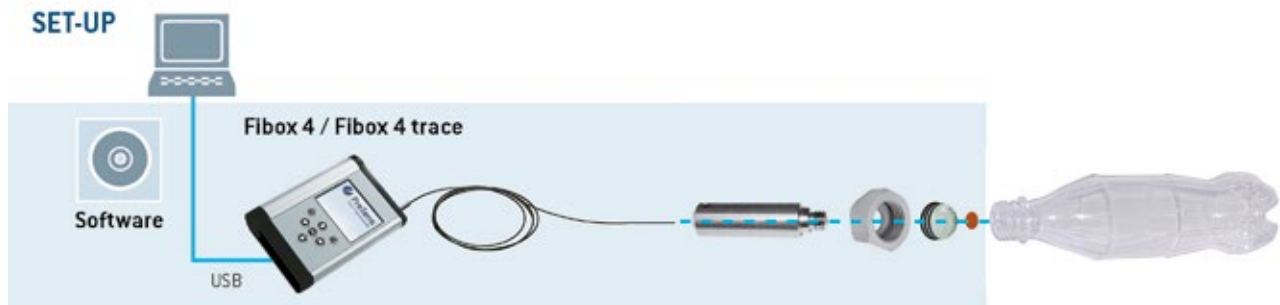
Bottle Type 4: Multilayer Bottles Containing Oxygen Scavenger

Most common multilayer structures combine two layers of PET and a middle layer of Nylon MXD6 (metaxylylene diamine nylon) in three layer structures. The high barrier material is present in separate layers which are made by simultaneous or sequential co-injection (blue line). The combination of a multilayer structure adding an active barrier within the middle layer decreases oxygen ingress significantly, which could not be accomplished with a multilayer structure without an active barrier (red line).



Specifications	Sensor Type PSt3		Sensor Type PSt6	
	Gaseous & Dissolved Oxygen	Dissolved Oxygen	Gaseous & Dissolved Oxygen	Dissolved Oxygen
Measurement range	0 – 100 % O ₂ 0 – 1000 hPa	0 – 45 mg/L 0 – 1400 µmol	0 – 4.2 % O ₂ 0 – 41.4 hPa	0 – 1.8 mg/L 0 – 56.9 µmol
Limit of detection	0.03 % oxygen	15 ppb	0.002 % oxygen	1 ppb
Resolution	± 0.01 % O ₂ at 0.21 % O ₂ ± 0.1 % O ₂ at 20.9 % O ₂ ± 0.1 hPa at 2 hPa ± 1 hPa at 207 hPa	± 0.14 µmol at 2.83 µmol ± 1.4 µmol at 283.1 µmol	± 0.0007 % O ₂ at 0.002 % O ₂ ± 0.0015 % O ₂ at 0.2 % O ₂ ± 0.007 hPa at 0.023 hPa ± 0.015 hPa at 2.0 hPa	± 0.010 µmol at 0.03 µmol ± 0.020 µmol at 2.8 µmol
Accuracy	± 0.4 % O ₂ at 20.9 % O ₂ ; ± 0.05 % O ₂ at 0.2 % O ₂ ;		± 1 ppb or ± 3 % of the respective concentration; whichever is higher	
Drift at 0% oxygen	< 0.03 % O ₂ within 30 days (sampling interval of 1 min.)		< 2 ppb within 30 days (sampling interval of 1 min.)	
Measurement temperature range	0 – 50 °C		0 – 50 °C	
Response time (t ₉₀)	< 6sec.	< 40 sec.	< 6sec.	< 40 sec.
Properties				
Compatibility	Aqueous solutions, ethanol, methanol			
No cross-sensitivity with	pH 1 – 14 CO ₂ , H ₂ S, SO ₂ Ionic species			
Cross-sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas			
Sterilization procedures	Steam sterilization Ethylene oxide (EtO) Gamma irradiation			
Cleaning procedures	Cleaning in place (CIP, 5 % NaOH, 90 °C, 194 °F) 3 % H ₂ O ₂ Acidic agents (HCl, H ₂ SO ₄), max. 4 – 5 %			
Calibration	Two-point calibration with oxygen-free environment (nitrogen, sodium sulfite) and air-saturated environment		Two-point calibration in oxygen-free environment (nitrogen) and a second calibration value optimally between 1 and 2 % oxygen	
Storage Stability	2 years provided the sensor material is stored in the dark (-10 – 60 °C)			

The System



Option: 4-channel transmitter



Option: 10-channel transmitter

ACCESSORIES



Glove Box

The Glove box supports the filling process under oxygen free atmosphere.



ARC

The adapter for round containments (ARC) is used for measurements with standard closure.

VisiSens TD

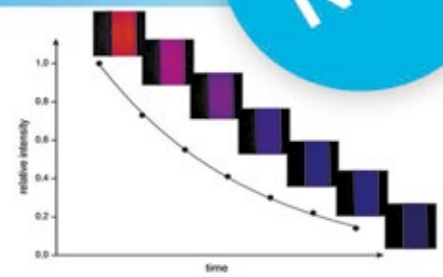
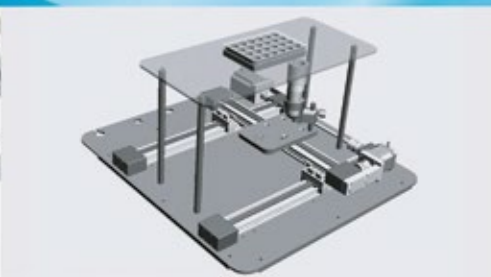
 VisiSens

CO₂

pH

O₂

NEW



2D Sensing of Oxygen, pH, or CO₂

- First standardized, modular system for time-domain fluorescence lifetime imaging
- Perfectly balanced components for your customized imaging solution
- Visualize analyte distributions in an area up to 30 cm x 25 cm within one image
- Variable sensor geometry and field of view
- Ratiometric and time-domain operation modes

Imaging VisiSens TD



VisiSens TD is the first standardized system for time-domain fluorescence lifetime imaging. The modular system can be composed out of single components according to customer specifications. It offers the key solution for oxygen, pH, or CO₂ imaging. Fluorescent sensor foils for the respective analyte are placed on the sample. Excitation light sources and cameras for sensor recording can be installed in a set-up specified by the customer. Sensor images up to a size of 30 cm x 25 cm can be recorded with VisiSens TD. The user-friendly system is delivered with a software which can be supplemented with certain modes according to the customer's requirements.

Features

- Non-invasive mapping of metabolic activity
- Imaging of living samples
- Free choice of measurement conditions
- One device instead of thousands of individual sensors
- Watch time-lapse videos of recordings



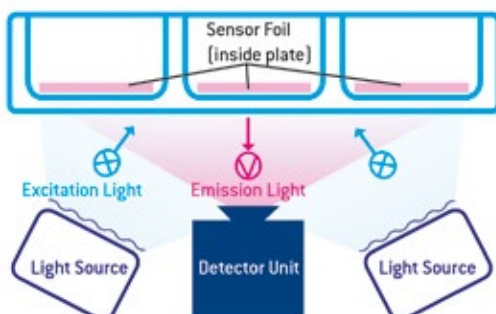
Fluorescent Sensor Sheets for Ratiometric and Lifetime Imaging

The fluorescent sensor sheets are available for imaging of oxygen, pH, or CO₂. The foils can be delivered in various sizes and cut into any desired shape. The sensors are placed directly on the sample surface or inside a transparent vessel. Larger areas can be covered by placing a number of sensor sheets next to each other and recording several images.



The VisiSens Scientific Software

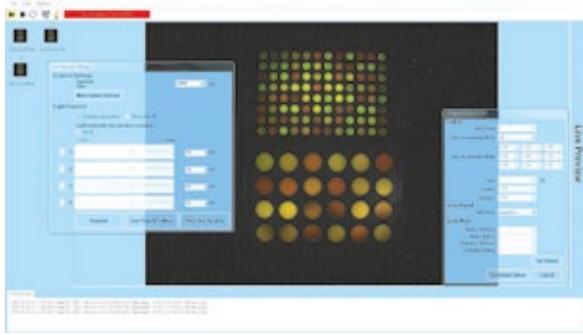
VisiSens TD is delivered with a control and evaluation software. Like the whole system the software is structured in a modular way. The customer has the opportunity to choose between different operation or measurement modes, that can be added to the software, according to his requirements. New modes can be easily added, if e. g. another analyte should be analyzed with VisiSens TD.



The Measurement Method

The light from the VisiSens TD light sources excites the sensor foil to emit fluorescence. The excess energy is transferred to a molecule of the respective analyte in a non-radiative way, decreasing or quenching the fluorescence signal. This fluorescence signal can be recorded pixel by pixel with the detector unit of the VisiSens TD. This way two-dimensional recordings of analyte distributions can be made.

Imaging VisiSens TD



Visualizing metabolic activity over large sample surfaces

The VisiSens TD system is applied to image larger areas and gather information about spatial and temporal changes of analyte distributions within these areas. As an example, VisiSens TD is already applied for large scale pH and CO₂ imaging within rhizotrons to analyze biogeochemical processes in root systems and root-soil interactions. Metabolic activity of living samples can be visualized, and further analyzed with the VisiSens Scientific software. As the system allows non-invasive data recording it is ideally suited for application in sensitive processes, e. g. tissue engineering, where oxygen distributions over a cross section of a 3D graft could be monitored. The sensor foils can also be mounted inside multiwell plates and several samples recorded in one image, showing differences between samples (see figure on the left).

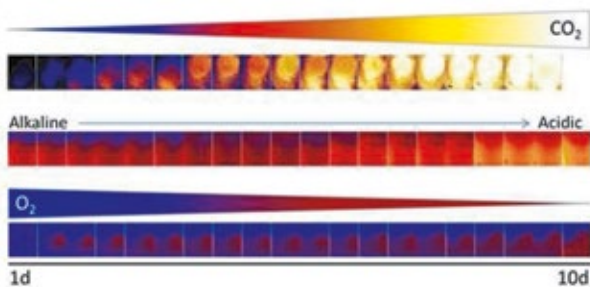


Multi-Sample and Large Area Imaging

VisiSens TD allows imaging large areas up to 30 cm x 25 cm within one image. This can be used to image analyte distributions in several samples at the same time. The fluorescent sensor foils can be mounted at the bottom of transparent vessels or vials containing different samples. The vessels / vials can be placed next to each other, e. g. in a small rack. One image taken with VisiSens TD from the bottom then contains the information about analyte distributions in a multitude of samples.

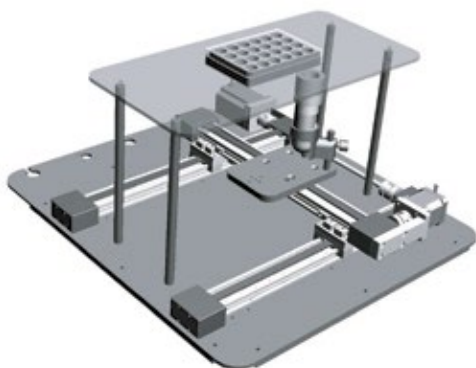
Imaging Different Analytes with one Device

VisiSens TD can be customized for imaging oxygen, pH, or CO₂. Due to its modular set-up its applicability can be expanded for imaging several analytes. In contrast to the VisiSens A1, A2, and A3 devices with VisiSens TD imaging of all three analytes can be realized with one system. The spatial and temporal change of analyte concentrations can be visualized. The combined information about distributions of several analytes can give valuable insight in metabolic activity or chemical processes inside samples, e. g. when investigating complex processes in root systems, inside tissues, or when phenotyping crop plants.



VisiSens TD Linear Motion Slide System

The linear motion slide system for VisiSens TD allows precise, automated positioning of the camera. The camera can be steered to certain positions for image recording. Large areas up to 4 m x 4 m can be scanned automatically and by image stitching a complete picture of analyte distributions can be created. This system also works for automated time-series image acquisition of many sensor sites.



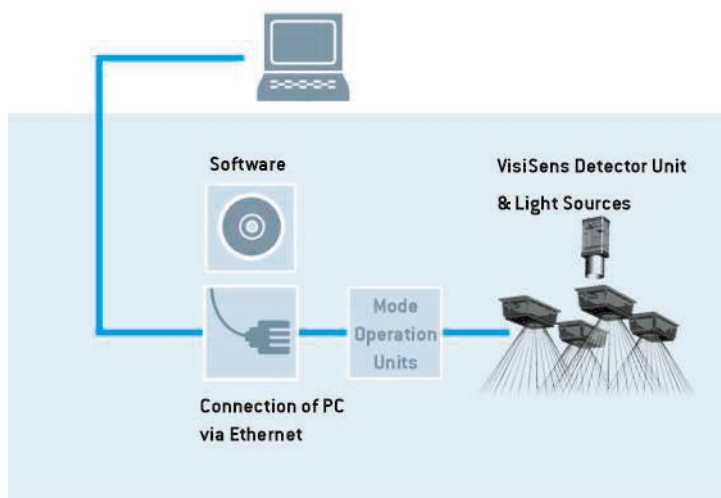
Specifications	Oxygen (blue)	pH (red)	CO ₂ (green)	
	[SF-RPSu4]	[SF-HP5R]	[SF-CD1R]	[SF-MT1R]
Measuring range	0 - 100 % air saturation (0 - 20.9 % O ₂)	pH 6 - 7.5	0 - 1 %	1 - 25 %
Response time* (t ₉₀)	30 sec.	30 sec.	< 3 min.	< 3 min.
Properties				
Temperature range	5 °C to 45 °C			
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10	Aqueous solutions, pH 4 - 9	Aqueous solutions, pH 4 - 9	

System Components	Ratiometric Imaging			Lifetime Imaging
	O ₂	pH	CO ₂	O ₂
Hardware				
Camera Ratiometric Imaging Set-up	x	x	x	
Camera Lifetime Imaging Set-up**				x
Light Source Set O ₂	x			x
Light Source Set pH		x		
Light Source Set CO ₂			x	
Mode Operation Units	x	x	x	x
Software				
Mode0001	x			
Mode0002		x		
Mode0003			x	
Mode0004**				x
Sensor				
SF-RPSu4	x			
SF-HP5R		x		
SF-CD1R			x	
SF-MT1R**			x	
SF-LPSu1**				x
Accessories (optional)				
Linear Motion Slide System				
Rack System				
Resolution Test Chart				
Diffusion Disk				

* typical data which may strongly differ with adapting the imaging set-up to specific needs

**Prototype component. Please contact our service team!

SET UP

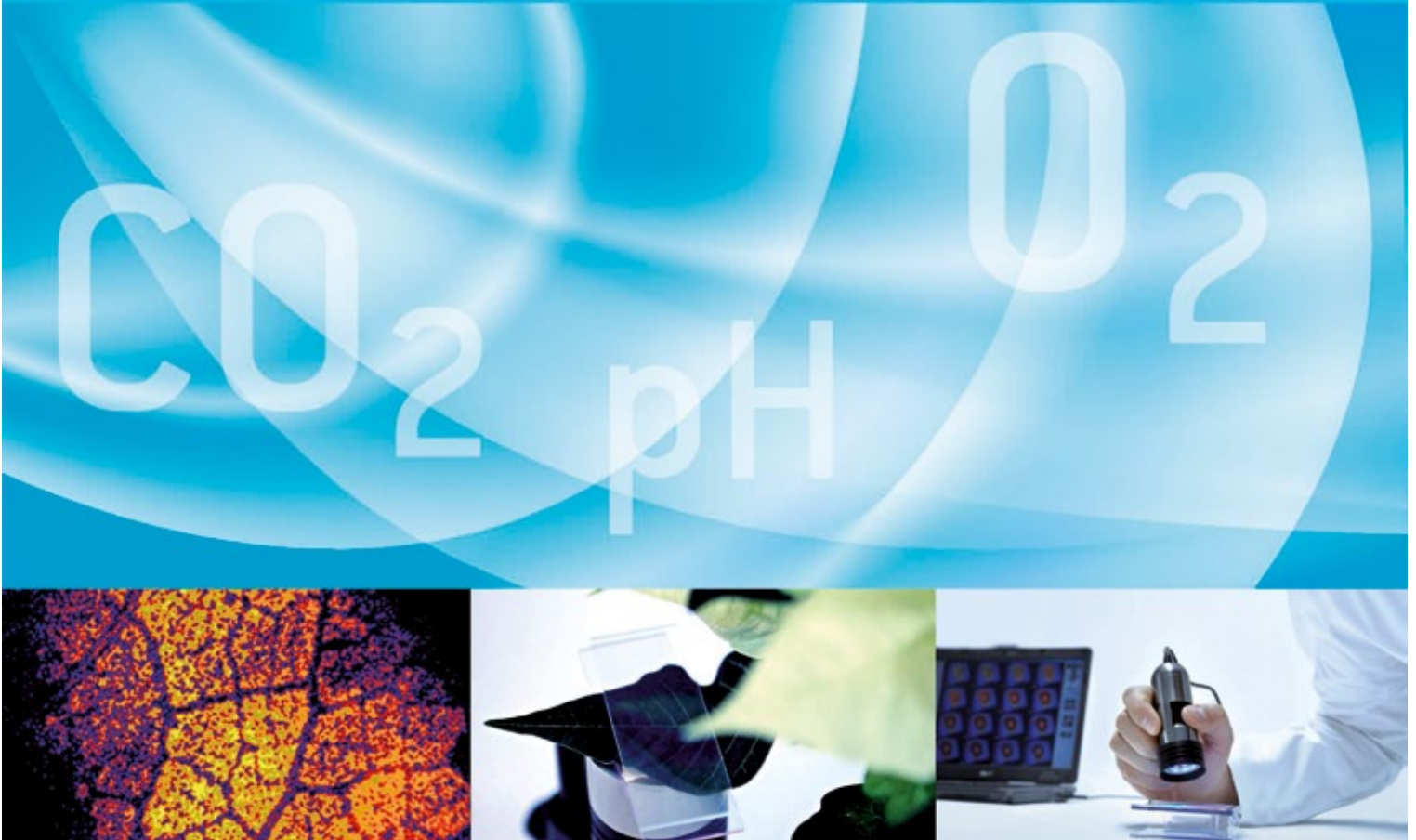


Disposables, e.g. MicroPlates, with Sensor Foil



Sensor Foils

Imaging Solutions

 VisiSens

Measure and Visualize Oxygen, pH or Carbon Dioxide Distributions in 2D for Biological Research

- Non-invasive mapping of metabolic activities
- Imaging of living samples
- Free choice of measurement conditions
- USB powered & portable device
- One device instead of thousands of individual sensors

Imaging

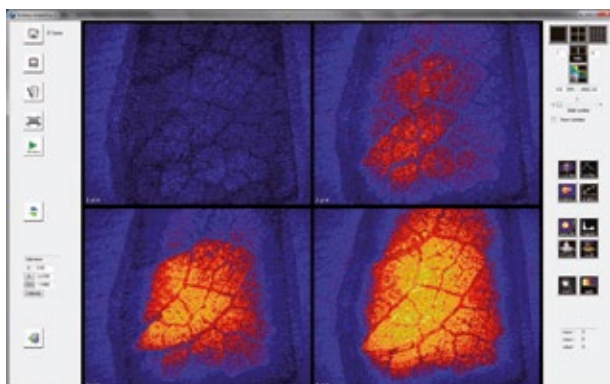
Imaging Solutions



Fluorescent chemical optical sensor foils combined with imaging technology allow easy 2D visualization of oxygen, pH or carbon dioxide distributions in heterogeneous samples. For measurement the sample surface is covered with the sensor film, which translates the analyte content into a light signal. The sensor response is recorded pixel by pixel with a digital camera. With VisiSens™ spatial and temporal changes of oxygen, carbon dioxide concentration or pH can be monitored.

Features

- Non-invasive mapping of metabolic activity using sensor foils
- Imaging of living samples
- Free choice of measurement conditions
- Reliable addressing regions with low or high O₂, CO₂ or pH
- More than 100,000 sensing points within one single image
- USB powered & portable
- Easy evaluation via image processing software



Software

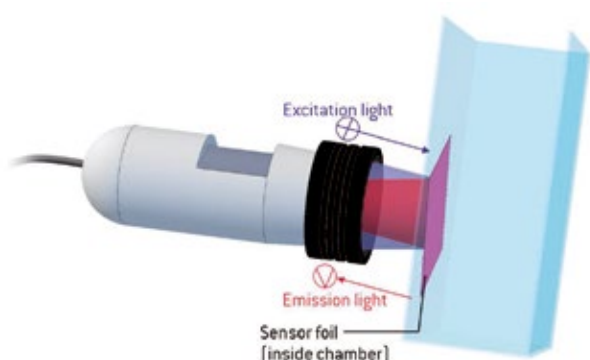
All software versions, whether for O₂, pH or CO₂ imaging, have the same user interface, so you only have to get familiar with it once to be able to work with all. The software allows controlling the image recording process, and assists image processing and evaluation. An easy to use camera controlling user interface manages image acquisition and storage. Measurements which belong together can be organized in user defined sessions as separate folders and annotated with a free text comment. Acquired images can be single images or automatically recorded time series.

Benefits

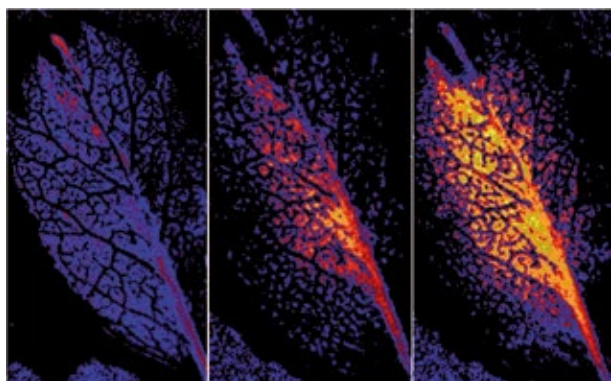
- Display the sensor response in false color image
- Display the actual pixel information
- Display ROI statistics of user defined polygon ROIs
- Interactive x- and y-axis profiles
- Z-axis profiles for plotting ROI average at defined coordinates
- Follow kinetics through a time series and display as 2D-plot
- Side-by-side image comparison of selected images
- Alpha blending of false color sensor response with color image

The Smart Measurement Method

Fluorescence Ratiometric Imaging (FRIM) is a method for reading out the signal of a fluorescent chemical optical sensor. Ratiometric measuring compensates most of the common interferences, e. g. inhomogeneous lightfields. An optical sensor foil contains an analyte sensitive dye and a reference dye which are immobilized in a permeable polymer matrix layer. The indicator dye is emitting red or green fluorescence, depending on the analyte and respective sensor foil type, which is dynamically quenched by the analyte while the reference dye is giving a constant green or red light signal respectively. These emissions meet exactly the red and green channel sensitivity of a color RGB chip.

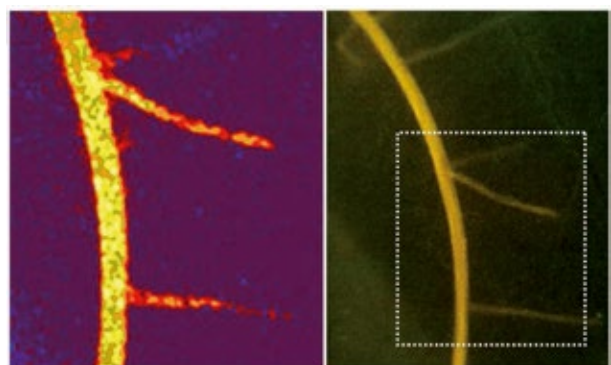


Imaging Imaging Solutions



Visualized Respiration in Leaves

Plants are both producers and consumers of oxygen, while CO_2 is constantly produced. Visualizing O_2 and CO_2 levels on the surface of plant leaves can give important information about oxygen demand and CO_2 production during light/dark conditions. The sensor foils attached to the leaf surface seal it against oxygen or CO_2 from ambient air and translate the respective analyte level with high spatial resolution. During a continuing dark phase the oxygen concentration on the surface of a rose petal, for example, decreases (see images left). The leaf consumes oxygen, while it produces a higher level of CO_2 . With VisiSens™ it is even possible to investigate different petal structures and compare them in terms of oxygen consumption. Findings in these experiments might be important information relevant for transport and storage of cut flowers.



O_2 , pH, and CO_2 Dynamics in the Rhizosphere of Crop Plants

Research on metabolic activity of plant roots and determining the best cultivation conditions for optimal growth will be of major importance for sustainable agriculture, as e. g. water supply and fertilizing could be adjusted for the respective crop plant. 2D imaging with VisiSens™ is performed to visualize O_2 , pH, and CO_2 dynamics in complex root systems and the surrounding media. With this easy-to-handle but extremely precise device metabolic processes and how they change can be monitored over long time periods; parameters responsible for changes can be determined. The acquired analyte maps for distinct root regions are quantitative and have a resolution in sub-millimeter range.

Blossfeld et al., Quantitative imaging of rhizosphere pH and CO_2 dynamics, Annals of Botany 2013, in press



Visualizing O_2 , pH, and CO_2 in Sediments

Oxygen, pH, and CO_2 are key factors and indicators for microbial activity in sediments. Microbial degradation of organic material under aerobic conditions can be detected in an increased oxygen consumption. With VisiSens™ high resolution images can be recorded detecting analyte dynamics in different sediments or sediment depth over long time periods. The portable device can be applied in the laboratory as well as out in the field. As experiment conditions can be changed during measurements the impact of changing parameters on microbial activity can be analyzed.



Controlling Microbial Biodeterioration of Historical Monuments

Historical monuments are often subject to microbial biodeterioration. Effective treatments that inhibit biological growth on ancient rock surfaces have to be found. Oxygen imaging with VisiSens™ allows determining the health status of e. g. lichen after biocide treatment and with it assessing the effectiveness of the biocide. This technique also allows for a direct in situ analysis of the health state of a small quantity of biological material on the facade of historical monuments or buildings. Showing fast results it can be implemented in evaluation studies and conservation.

C. Ascaso & J. Wierzchos: Assessing Biocide Actions on Lichen with VisiSens, Oxygen in Action Competition Report, 2012

Imaging Imaging Solutions

Specifications	Oxygen (blue)	pH (red)	CO ₂ (green)
Measuring range	0 - 100 % air saturation (0 - 20.9 % O ₂)	pH 6 - 7.5	0 - 1 % 1 - 25 %
Response time* (t ₉₀)	30 sec.	30 sec.	< 3 min. < 3 min.
Size of sensor foil*	5 x 5 mm ² to 40 x 40 mm ²		
Number of sensing points within one image*	300,000		
Properties			
Temperature range	5 °C to 45 °C		
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10	Aqueous solutions, pH 4 - 9	Aqueous solutions, pH 4 - 9
Device			
Camera chip	Enhanced Color CMOS		
Image Resolution	1.3 megapixel (1280 x 1024 pixels)		
Magnification	10-fold up to 220-fold, depending on adapter tubus used		
Field of View	~ 2.3 x 2.0 mm ² to ~ 4.1 x 3.3 cm ² ; typically ~ 1.5 x 1.2 cm ²		
Output	15 fps live video preview (no storage) and 0.5 fps full-resolution picture storage (.png)		
Interface	USB 2.0, high speed USB transmission		
Number of LEDs	8		
Material	All-aluminum housing		
Dimensions	Length 10 cm, diameter 3.8 cm		
Weight	170 g (without adapter tubus)		

*typical data which may strongly differ with adapting the imaging set-up to specific needs



Imaging Solutions

 VisiSens

Measure and Visualize Oxygen, pH or Carbon Dioxide Distributions in 2D for Life Science Research

- Non-invasive mapping of metabolic activities
- Imaging of living samples
- Free choice of measurement conditions
- USB powered & portable device
- One device instead of thousands of individual sensors

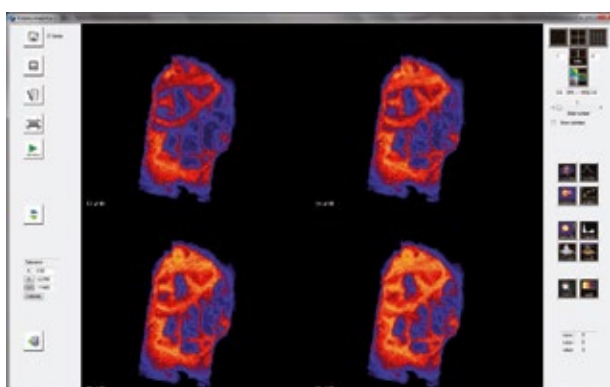
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- Reliable addressing regions with low or high O₂, CO₂ or pH
- More than 100,000 sensing points within one single image
- USB powered & portable
- Easy evaluation via image processing software

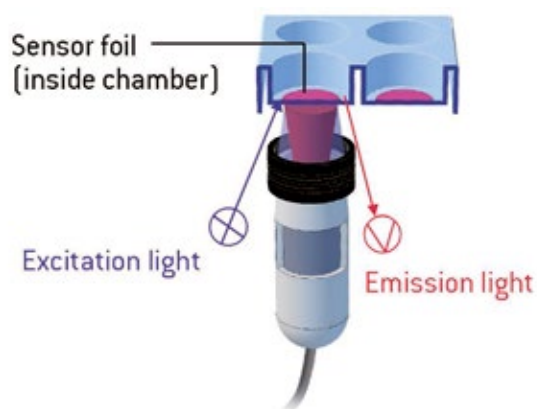


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Fluorescence Ratiometric Imaging (FRIM) is a method for reading out the signal of a fluorescent chemical optical sensor. Ratiometric measuring compensates most of the common interferences, e. g. inhomogeneous lightfields. An optical sensor foil contains an analyte sensitive dye and a reference dye which are immobilized in a permeable polymer matrix layer. The indicator dye is emitting red or green fluorescence, depending on the analyte and respective sensor foil type, which is dynamically quenched by the analyte while the reference dye is giving a constant green or red light signal respectively. These emissions meet exactly the red and green channel sensitivity of a color RGB chip.

Imaging

Imaging Solutions



Determination of Oxygen Gradients in Cell Culture and Engineered Tissue

Monitoring oxygen supply in cell culture or engineered tissue is very important. Especially cells towards the center of a culture can be subject to low oxygen levels. With VisiSens™ continuous, high-resolution oxygen measurements over cross sections of samples can be performed. The sensor foils can easily be applied in test or cultivation vessels, and samples are immobilized on top of the sensor. Measurements are taken non-invasively from outside the vessel, which reduces the risk of contamination. With its small footprint the VisiSens™ system can be mounted inside an incubator without any problems. Detecting oxygen gradients will allow taking measures, or apply new methods to avoid cell death due to hypoxia.

In upcoming studies hydrogels will be tested on their suitability as cell carriers in regenerative therapy. Oxygen releasing additives should sustain constant oxygen supply to the cultured precursor cells. VisiSens™ will be used to monitor the continuity and homogeneity of oxygen release and the actual oxygen supply of the cells.

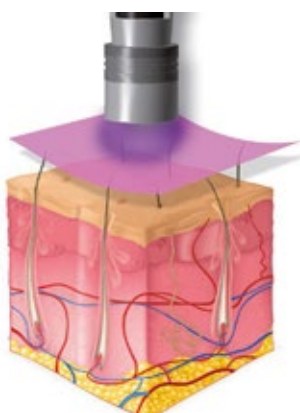
2D Imaging in Microfluidic Devices

Microfluidic devices are an emerging technology in the Biotech sector. Due to many advantages as e. g. low fluid volumes, faster analysis and response times which allow better process control, and the compactness of the chips which enables massive parallelization, these devices gain in importance. With VisiSens™ it is possible to continuously monitor the important culture parameters oxygen, pH, or CO₂ now in high resolution over the whole chip surface. During development, this allows determining suitable culture device materials, e. g. for their oxygen permeability, according to application and cell line. Oxygen, pH, or CO₂ monitoring with VisiSens™ will improve microfluidic device functionality even further, and it exhibits superior properties compared to similar sensing products.

C. Ochs, et al.: Cellular Oxygen Consumption in Microfluidic Devices, Oxygen in Action Competition Report, 2012

pH Imaging in Skin Models

pH imaging is an innovative method for investigating complex disease processes like e. g. wound healing and tumor biology. The pH of the wound fluid is known to greatly affect the healing process. Measurement techniques used so far have been very difficult to implement. The two-dimensional visualization of pH dynamics with VisiSens™ now allows monitoring spatially heterogeneous processes on skin models, which is a great advantage compared to single-point measurements with probes. Another future application of pH imaging will be tumor research giving insight in spatial and temporal changes of tumor metabolism.



Imaging Imaging Solutions

Specifications*	Oxygen (blue)	pH (red)	CO ₂ (green)
Measuring range	0 - 100 % air saturation (0 - 20.9 % O ₂)	pH 6 - 7.5	0 - 1 % 1 - 25 %
Response time** (t ₉₀)	30 sec.	30 sec.	< 3 min. < 3 min.
Size of sensor foil**	5 x 5 mm ² to 40 x 40 mm ²		
Number of sensing points within one image**	300,000		
Properties			
Temperature range	5 °C to 45 °C		
Compatibility	Aqueous solutions, ethanol (max. 10 % V/V), methanol (max. 10 % V/V), pH 2 - 10	Aqueous solutions, pH 4 - 9	Aqueous solutions, pH 4 - 9
Device			
Camera chip	Enhanced Color CMOS		
Image Resolution	1.3 megapixel (1280 x 1024 pixels)		
Magnification	10-fold up to 220-fold, depending on adapter tubus used		
Field of View	~ 2.3 x 2.0 mm ² to ~ 4.1 x 3.3 cm ² ; typically ~ 1.5 x 1.2 cm ²		
Output	15 fps live video preview (no storage) and 0.5 fps full-resolution picture storage (.png)		
Interface	USB 2.0, high speed USB transmission		
Number of LEDs	8		
Material	All-aluminum housing		
Dimensions	Length 10 cm, diameter 3.8 cm		
Weight	170 g (without adapter tubus)		

*VisiSens™ is no approved medical device

**typical data which may strongly differ with adapting the imaging set-up to specific needs



ITR iTube96Reader

pH



pH Transmitter for Parallel Monitoring of 96 Cultivation Tubes

- Bioprocess development tool
- Non-invasive measurement of pH in up to 96 iTubes
- Compatible with standard shakers
- For microbial cultivation & cell culture

The ITR iTube96Reader is a 96-channel transmitter for non-invasive pH monitoring in a multitude of samples. It is used with iTubes - plastic cultivation tubes with integrated optical pH sensors - which are ready-to-use. The reader fits into most standard shakers and has wireless connection to a PC. A light rack eases loading the reader and guarantees correct positioning of the iTubes on top. Optimize media composition, find feeding points and improve harvesting strategies with this innovative system. The simultaneous pH monitoring in a multitude of cultivation tubes eases the work load in bioprocess development considerably.

ITR iTube96Reader	
Specifications*	
Measurement range	5.5 - 8.0 pH
Response time (t_{90}) at 25 °C	< 60 s
Resolution	± 0.01 at pH = 7**
Accuracy	± 0.1 pH at pH = 7 with one-point adjustment
Drift	< 0.01 pH per day (sampling interval of 1 min)
Device	
Power supply	24V DC / max. 0.25A
Temperature: operating / storage	0 °C to 50 °C / -20 °C to 70 °C
Relative humidity	0 - 85 % [non condensing]
Dimensions [L x W x H], weight	485 mm x 380 mm x 85 mm, 6.990 kg
Digital interface	Bluetooth

*provided iTubes are used without further handling in physiological solution

**at 100 rpm & cell culture media

SET-UP



ACCESSORIES



iTubes
Cell culture tubes
with integrated
pH sensors.



iTube Rack
Light rack for
easy loading and
correct positioning
of the iTubes on top
of the reader.

Bring to light what's inside.

PreSens comes from **PRECISION SENSING** and means:

- precise and simple measurement of O₂, pH, CO₂ and temperature
- for Pharma, Biotech, Food & Beverage and Medical Devices
- with sensors thinner than a hair,
- non-invasive and online.
- Optimum advice and support,
- more than 1,000 items in stock
- and prompt delivery worldwide.

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