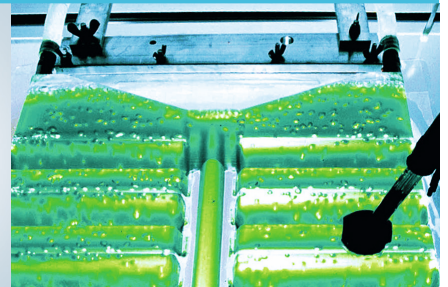
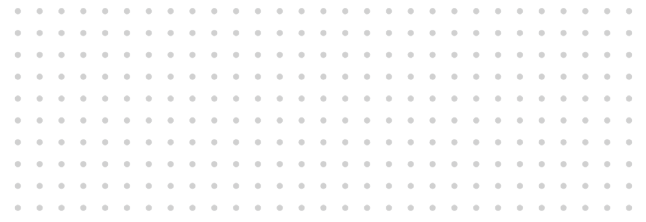




# Optical CO<sub>2</sub> Sensors & Meters



- CO<sub>2</sub> measurement in solutions
- Pre-calibrated sensors
- Contactless measurement of dissolved CO<sub>2</sub>
- From  $\mu\text{L}$  to  $\text{m}^3$  scale
- 0.04 – 5 % CO<sub>2</sub>, 1- 25 % CO<sub>2</sub> measurement range



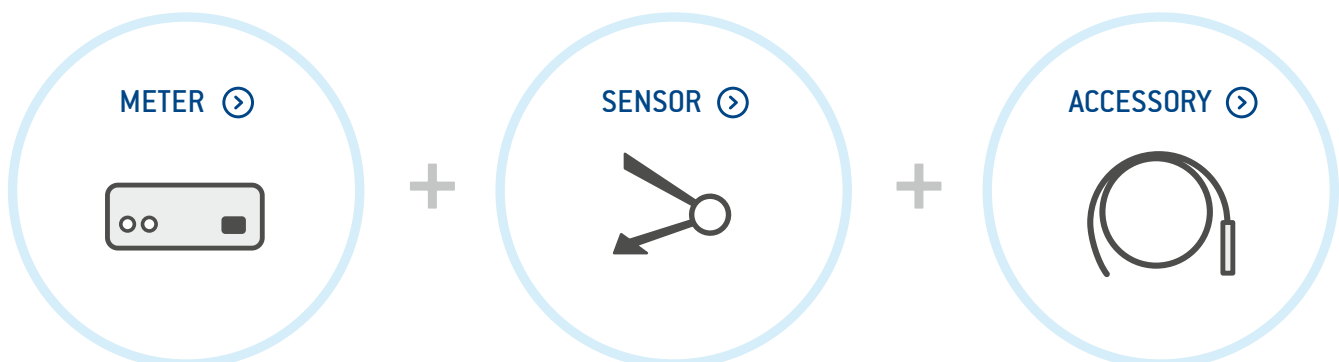
CO<sub>2</sub>

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

# Content

- 04 Company
- 05 Industries
- 06 Meters
- 08 Sensors
- 12 Microsensors
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- 20 Imaging Solutions
- 24 Accessories
- 26 Product Range

## Functional Principle



# 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, the Food & Beverage industry as well as other industrial applications.

### We offer systems for

- Oxygen measurement in gases and liquids
- Non-invasive online pH, CO<sub>2</sub> and oxygen measurement
- Oxygen and pH sensors for single-use bioreactors
- Microsensors pH, oxygen and CO<sub>2</sub>
- Process control in shake flasks incl. biomass monitoring
- 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-mapping of oxygen-, pH-, and CO<sub>2</sub>-distribution

Our product range is constantly expanding.

## Company Profile

Based on research activities in the 1980's at the University of Regensburg, Germany, PreSens Precision Sensing GmbH was founded in 1997.

The company combines long-time experiences of different researchers in the fields of electronic engineering and sensor development. Right from the beginning, microsensor systems were sold to customers in life sciences. Already in its first decade of operation PreSens became one of the leading companies in the field of chemical optical sensor technology. Together with its partners it offers full service in Europe, America and Asia.

## Service

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



Quality Management  
ISO 9001  
ISO 13485  
Voluntary participation in regular monitoring

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## ...and work for the following industries.



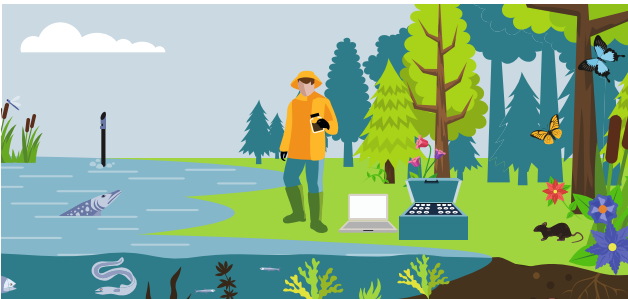
### Biotech & Pharma

Our Biotech & Pharma business field helps pharmaceutical companies such as Roche and DSM to improve their bioprocess development with PreSens sensors. With two decades of customer feedback our product development provides efficient solutions for your needs.



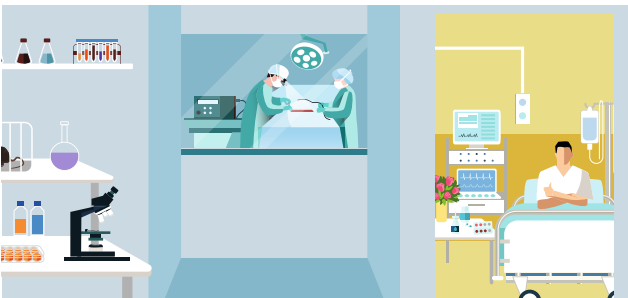
### Food & Beverage

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



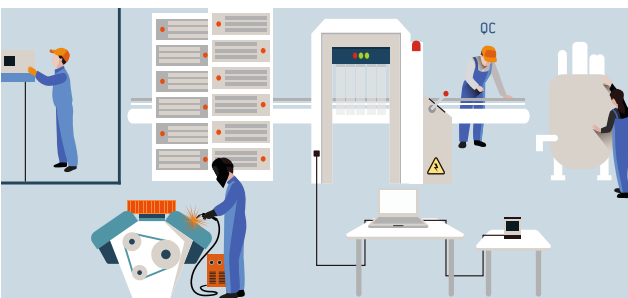
### Biology & Environmental

Our worldwide customer base in biological & environmental research has now grown to hundreds of users coming from the University of Alaska in Anchorage to the University of Wellington in New Zealand. For more than two decades we have delivered special sensor systems for various applications such as respirometry, or environmental monitoring.



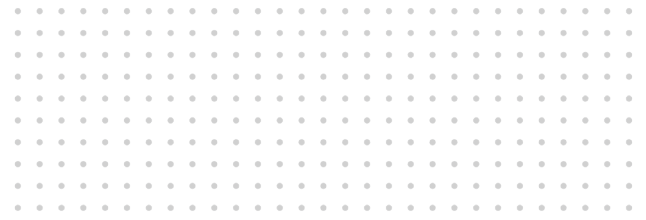
### Medical Research & Life Sciences

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. Microsensors, sensor spots, and imaging systems are applied in tissue engineering, microfluidics, and many other medical research fields.



### Industry & Technical Applications

Robust probes with excellent long-term stability or sensors for contactless measurement find use in technical or industrial applications. Specially designed flow-through connectors for integration in pipes are already applied to monitor the oxygen content in liquids or gases. OEM sensor components can be designed to be integrated in customer systems.



# METERS

## Optical CO<sub>2</sub> Meters

### Online Monitoring of Dissolved CO<sub>2</sub>

---

The PreSens CO<sub>2</sub> meters are precise fiber optic CO<sub>2</sub> measurement devices. While the CO<sub>2</sub>-1 SMA can be used with different types of optical CO<sub>2</sub> sensors based on a 2 mm fiber, the pCO<sub>2</sub> micro works with microsensors in different designs with 250 µm tip diameter. The meters are connected to a PC to run the control software. They are versatile and small and can be used in manifold applications.

- CO<sub>2</sub>-1 SMA for non-invasive sensors, robust probes & flow-through cells
- pCO<sub>2</sub> micro for high resolution measurements with CO<sub>2</sub> microsensors
- Software included
- USB or RS232 interface

---

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

## Specifications

	CO <sub>2</sub> -1 SMA	pCO <sub>2</sub> micro
<b>Specifications</b>		
Carbon dioxide sensors	CD 1 (optical SMA connector)	CDM1
Temperature sensor	1 x Pt1000 temperature connector (sensor not included)	-
Temperature performance	0 °C to + 50 °C, resolution: ± 0.1 °C, accuracy ± 1.0 °C	-
Power supply	5 VDC (USB-2.0-Mini-B, cable included)	18 VDC / 5 W (110 – 240 VAC, 50/60 Hz, adapter included)
Temperature: operating / storage	From 0 °C to +50 °C / - 20 °C to + 70 °C	From 0 °C to +50 °C / - 10 °C to + 60 °C
Relative humidity		0% to 80 % (non-condensing)
Dimensions	95 mm (with connectors) x 34 mm x 30 mm	210 mm x 120 mm x 50 mm
Weight	128 g	0.65 kg
Digital interface	USB interface cable to PC, cable included	RS232 interface (with RJ connector to serial port, cable included)
External trigger	-	TTL-compatible with galvanic isolation (BNC connector)
Analogue output specifications	-	Single output, 0 - 4095 mV, resolution: 12 bit, accuracy ± 10 mV (BNC connector) 10 mV represent
		Phase 0.25 °



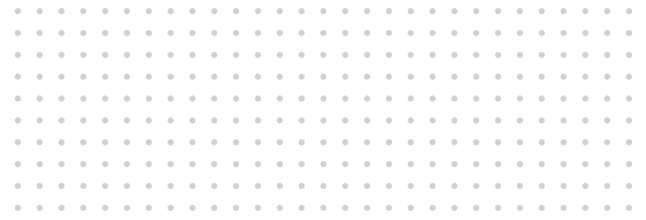
### CO<sub>2</sub>-1 SMA

The CO<sub>2</sub>-1 SMA fits in any measurement set-up. It is compatible with the only proven non-invasive CO<sub>2</sub> sensors on the market, dipping probes and flow-through cells of type CD1 (1 – 25 % CO<sub>2</sub>). It has temperature compensation, is USB-powered and operated with the PreSens Measurement Studio 2 software, which enables simultaneous control of several devices. Optionally, the CO<sub>2</sub>-1 SMA can be expanded with 4 – 20 mA analog output (via a converter box).



### pCO<sub>2</sub> micro (Prototype)

The pCO<sub>2</sub> micro is a precise fiber optic CO<sub>2</sub> meter. It is used with pCO<sub>2</sub> microsensors with a sensing tip of 250 µm. The pCO<sub>2</sub> micro is connected to a PC via USB or RS232 interface to run the user-friendly control software.



# SENSORS

## Optical CO<sub>2</sub> Sensors

### Non-invasive & In-process Monitoring

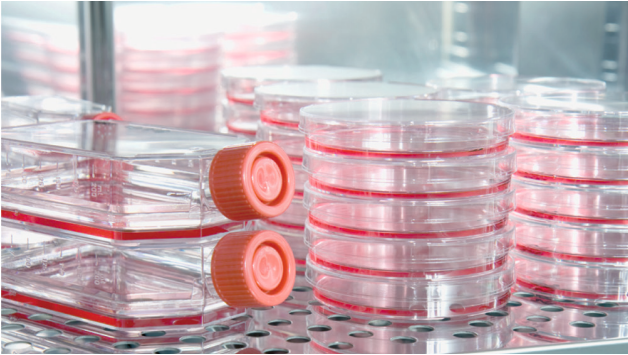
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The CO<sub>2</sub> sensors measure the partial pressure of dissolved carbon dioxide. Sensor spots can be fixed to the inner surface of glassware or transparent plastic material. The CO<sub>2</sub> concentration can then be measured from the outside through the vessel wall. The same principle of contactless measurement is used in the CO<sub>2</sub> flow-through cells to monitor perfusion systems. But also robust probes that can be dipped into the sample or be integrated via port adapters are available.

- Online dissolved carbon dioxide monitoring
- Contactless measurement
- Measurement range from 10 – 250 hPa pCO<sub>2</sub> (8 ... 180 mmHg)
- Beta-irradiated & autoclavable sensors available
- Optimized for physiological solutions and culture media

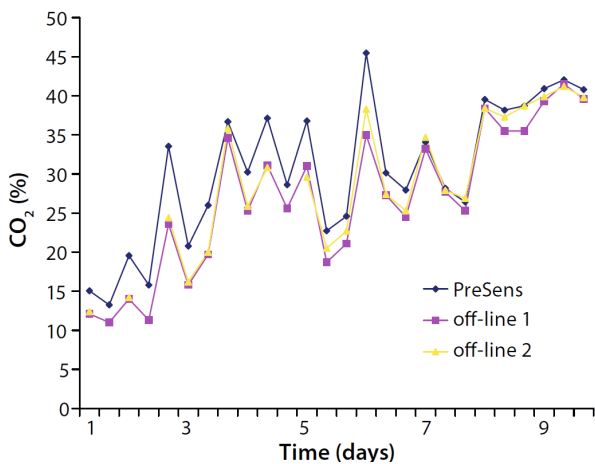


## Examples for Applications



### Biotechnology: CO<sub>2</sub> Monitoring in Process Development

In bioprocess development & production, monitoring dissolved CO<sub>2</sub> in addition to pH and O<sub>2</sub> 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 CO<sub>2</sub> can act as a stressor or even a toxin to the culture and has to be controlled. The optical CO<sub>2</sub> sensors can enhance performance of process monitoring during cultivation in disposables.



### PreSens CO<sub>2</sub> Sensors as an Alternative to Off-line Sampling

PreSens CO<sub>2</sub> sensors were used for monitoring the cultivation cells in a 3 L bioreactor. The sensors show excellent long-term stability over a period of 10 days during cultivation of CHO cells with an initial seed density of 400,000 cells/mL. The readings of the CO<sub>2</sub> Sensor Spots offer the possibility to continuously monitor CO<sub>2</sub> concentration between two off-line measurements.

Rick Baggio, Millipore Corporation, Bedford, MA, USA, Poster-presentation at ESACT 2009, Dublin

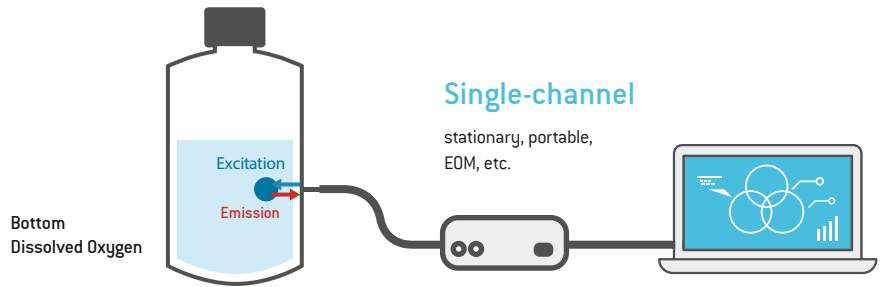


### Scientific: Carbon Dioxide Monitoring in Biological Applications

Increased CO<sub>2</sub> uptake from the atmosphere caused by anthropogenic sources is believed to cause ocean acidification with not yet foreseeable effects on marine life and ecosystems. Monitoring CO<sub>2</sub> in experimental set-ups simulating future levels of carbon dioxide can help gain knowledge on the effects of ocean acidification on marine fauna. Besides the marine application, monitoring pCO<sub>2</sub> also allows knowledge to be gained on land-based plant physiology. Monitoring pCO<sub>2</sub> helps increasing yield during aquaculture of fish by providing convenient growth conditions. Excess carbon dioxide levels need to be monitored as this leads to hyperventilation of sea animals.

## SPECS

MEASUREMENT RANGE	<b>1-25% CO<sub>2</sub></b> at atmospheric pressure
RESPONSE TIME	<b>&lt; 3 min.</b>
RESOLUTION	<b>±0.06</b> at 2% CO <sub>2</sub>



## Hard- & Software

measurement control, evaluation,  
export, settings, alerts, etc.

## APPLICATION

### Plastic & Glass

from µL to production scale



### Indoor & Outdoor

Research & Industry



## CO<sub>2</sub> Sensor Spots SP-CD1

The CO<sub>2</sub> sensor spots are the most versatile version of CO<sub>2</sub> sensors. They are attached to the inner surface of any transparent vessel, like e. g. glass bioreactors, sight glasses, or flasks. Measurements are then taken contactless from the outside – through the vessel wall. CO<sub>2</sub> sensor spots can be delivered untreated or beta-irradiated.



## CO<sub>2</sub> Flow-Through Cell

### FTC-SU-CD1-09NaCl-S

This miniaturized optical CO<sub>2</sub> sensor is attached to a color coded stick, which can be attached to flow-through cells of different size and shape. The cell is delivered in NaCl solution, so the sensor does not dry out. The FTC-SU-CD1-09NaCl-S is compatible with the CO2-1 SMA meter.



## CO<sub>2</sub> Flow-Through Cell FTC-CD1

This flow-through cell consists of a miniaturized optical CO<sub>2</sub> sensor which is integrated in a glass tube of 3 cm length and 7 mm outer diameter. With a customized holder the sensor inside the cell can be read out via optical fiber. The flow-through cell can easily be integrated in the flow path to monitor CO<sub>2</sub> content inside perfusion systems.



## CO<sub>2</sub> SensorPlug

The CO<sub>2</sub> SensorPlug is an optical sensor which enables online pCO<sub>2</sub> monitoring in milli- and microfluidic applications. It can be integrated on your milli- or microfluidic device. The optical CO<sub>2</sub> sensor is attached to an e.g. Mini-Luer based plug, which can easily be integrated in your chip. A 1 mm polymer optical fiber connects the plug with a compact CO<sub>2</sub> meter.

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



## CO<sub>2</sub> Dipping Probe DP-CD1

The CO<sub>2</sub> dipping probe is an optical sensor based on a 2 mm polymer optical fiber. The end of the fiber is coated with the CO<sub>2</sub> sensitive sensor and covered with a high-grade steel tube to protect both the sensor material and the optical fiber. It is the solution for invasive measurements and monitoring.

## Specifications

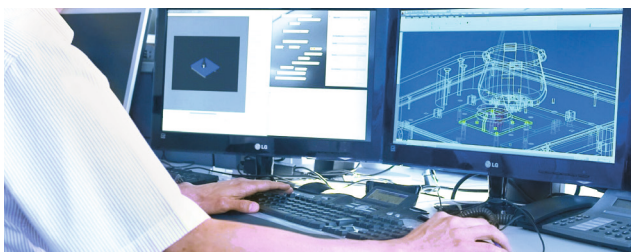
pCO <sub>2</sub> Sensors (CD1)	
<b>Specifications*</b>	
Measurement range	1 – 25 % CO <sub>2</sub> at atmospheric pressure (1013.15 hPa) 10 – 250 hPa pCO <sub>2</sub> 8 – 180 mmHg pCO <sub>2</sub>
Resolution at + 20 °C	± 0.06 % at 2 % CO <sub>2</sub> ± 0.15 % at 6 % CO <sub>2</sub> ± 0.5 mmHg at 15 mmHg pCO <sub>2</sub> ± 1.2 mmHg at 45 mmHg pCO <sub>2</sub>
Accuracy**	± 5 % of reading or 0.2 % (1.5 mmHg); whichever is higher
Drift at + 37 °C ***	typically < 5 % of reading per week
Measurement temperature range	From + 15 °C to + 45 °C
Response time (t <sub>90</sub> ) at + 20 °C	< 3 min. for change from 2 % to 5 % (15 mmHg - 38 mmHg) pCO <sub>2</sub>
<b>Properties*</b>	
Compatibility	Aqueous solutions, pH 4 – 9
Cross-sensitivity	Optical pCO <sub>2</sub> sensors display reduced cross-sensitivity to ionic strength (salinity); acetic acid, SO <sub>2</sub> , HCl vapours
Stability	pCO <sub>2</sub> sensors do not stand: organic solvents, pH above 10 or below 4
Cleaning procedure	Depends on the sensor type used - please ask our experts
Calibration	pCO <sub>2</sub> spots are pre-calibrated; re-calibration is possible
Storage	12 months provided the pCO <sub>2</sub> sensor is stored in its original package Beta-irradiated or autoclavable pCO <sub>2</sub> sensors available

\* provided pCO<sub>2</sub> spots are used without further handling in physiological solutions

\*\*after multipoint calibration

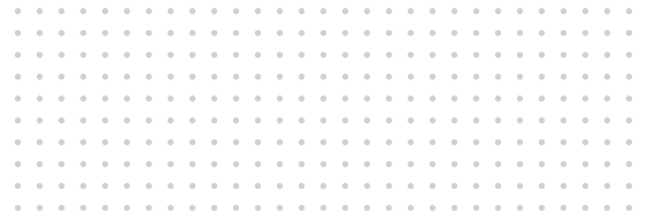
\*\*\* in a carbon dioxide incubator with 100 % rel. hum. at 5 % CO<sub>2</sub>; measurement interval of 1 min.

## OEM Solutions for You



PreSens offers customized sensor technology solutions. Right from the beginning PreSens can be your partner while finding new approaches: from specifications to implementation up to production of your tool.

**Don't hesitate to ask for your individual solution:**  
[engineering@presens.de](mailto:engineering@presens.de)



# SENSORS

## CO<sub>2</sub> Microsensors

Measuring with High Spatial Resolution –  
Sensor Tip below 250 μm

pCO<sub>2</sub> Microsensors are designed for measuring in small volumes and with high spatial resolution. These sensors are based on a silica fiber with 250 μm diameter, which enables integration into manifold small scale environments. The pCO<sub>2</sub> Microsensors are available in different designs - needle-type, implantable or profiling microsensors - and are ideally suited for physiological solutions.

- pCO<sub>2</sub> measurements in liquids (0.04 to 5 % pCO<sub>2</sub>)
- High spatial resolution (250 μm) - precise on-the-spot measurements
- Ideal for physiological solutions

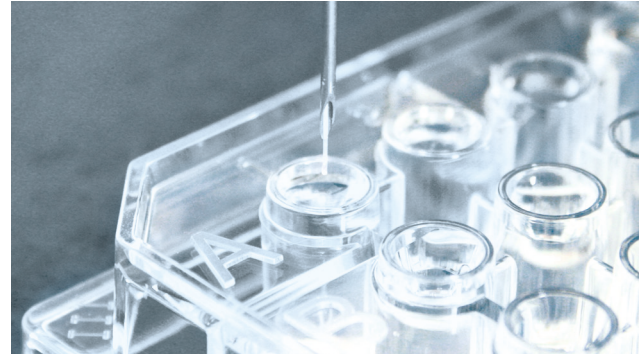
**Is your application missing?** Contact us and we find your customized solution!

## Examples for Applications



### CO<sub>2</sub> Measurement in Plants and Animals

CO<sub>2</sub> Microsensors can be implanted even in small animals. Due to the small size of the probes only a minimal disturbance will occur and new insights in physiological aspects can be obtained.



### CO<sub>2</sub> Measurement in Small Volumes

Due to the small dimension of the probe, CO<sub>2</sub> measurements can be done in very small volumes – even in microtiter plates of a higher format like 384 or 1,536. Of course, the measurement is independent of electromagnetic fields – this even allows measuring in NMR spectrometers.



### CO<sub>2</sub> Microprofiling

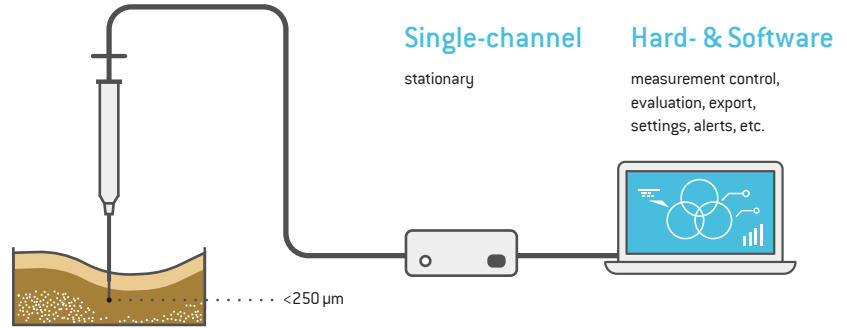
Perform high spatial resolution measurements down to  $\mu\text{m}$  level with our microprofiling solutions to detect even the smallest CO<sub>2</sub> gradients. For more information on our microprofiling product range see page 16

## SPECS

MEASUREMENT RANGE	0.04 - 5 % CO <sub>2</sub>
RESPONSE TIME (t <sub>90</sub> )	< 5 min.*
RESOLUTION	±0.01 <small>at 1 % CO<sub>2</sub></small>
TIP SIZE	250 μm

\*at + 25°C

## SET-UP



## APPLICATION

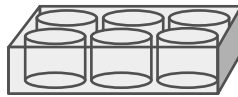
### Profiling



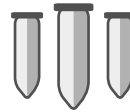
### Plant & Animal Tissue



### Cell & Microbial Culture



### Small Volumes



### Indoor & Outdoor

Research & Industry



## Implantable CO<sub>2</sub> Microsensor IMP-CDM1 (Prototype)

This implantable microsensor is not mounted into any additional housing and therefore ideally suited for implementation in customized applications. The bare glass fiber tip can be mounted to your own housing, steel tubes, catheters, etc. This tiny probe has a tip size of 250 μm and a maximum outer diameter of 900 μm. As the microsensor is free of metal, it can be used in the presence of electromagnetic fields and even NMR environments.



## Needle-type CO<sub>2</sub> Microsensor NTH-CDM1 (Prototype)

This microsensor is designed for measuring in small volumes. The sensor with its 250 μm tip can be integrated into manifold small scale environments. With the protective syringe needle housing the NTH-CDM1 can easily penetrate tissue, septum rubber or packaging materials. After penetration, the sensor tip is extended for measurements. They are compatible with all PreSens micro-manipulators and their safe-insert function.

## Profiling CO<sub>2</sub> Microsensor PM-CDM1 (Prototype)

Profiling Microsensors (PM) are the most robust microsensor version PreSens offers – with a firmer fiber construction and a splash-proof metal housing. They are specifically designed for profiling applications and should be used whenever minimally invasive measurements need to be performed, e. g. in sediments, microbial mats or biofilms. They are compatible with all PreSens micromanipulators.

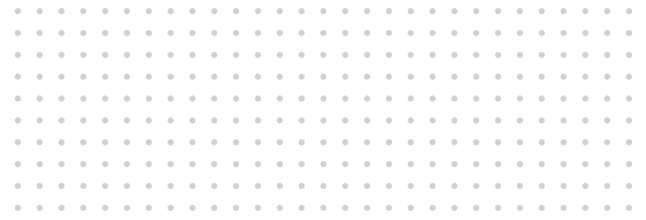
Is your application missing? Contact us and we find your customized solution!

# Specifications

pCO <sub>2</sub> Microsensors (CDM1) (Prototype)	
<b>Specifications*</b>	
Measurement range	0.04 - 5 % CO <sub>2</sub> at atmospheric pressure
Resolution at + 25 °C	± 0.01 % at 0.1 % CO <sub>2</sub> ± 0.1 % at 1 % CO <sub>2</sub>
Spatial resolution	250 µm
Measurement temperature range**	From + 12 °C to + 42 °C
Response time (t <sub>90</sub> ) for a CO <sub>2</sub> change from 0.5 to 1 %	< 5 min (at + 25 °C) < 3 min (at + 37 °C)
<b>Properties*</b>	
Compatibility	Aqueous solutions, pH 4 – 9
Cross-sensitivity	Organic solvents, volatile acids (e. g. HCl vapors, acetic acid) and sulfidic environments damage the sensor irreversibly
Calibration	pCO <sub>2</sub> sensors are pre-calibrated at the required temperature**, re-calibration is possible and recommended

\*preliminary data

\*\*temperature compensation not available yet; please contact our experts regarding your measurement temperature.



# MICROPROFILING

## Microprofiling Solutions

### Vibration-free, High-resolution Control for Your Microsensor

The Automated and Manual Micromanipulator are specifically designed for microprofiling applications with PreSens microsensors. The systems allow moving the microsensor vibration-free in 3 axes with  $\mu\text{m}$  reading accuracy and enable exact localization of the sensor in the sample. Automated microprofiling can be performed along one dimension in  $\mu\text{m}$  resolution. Whenever insertion of a microsensor in semi-solid or hard substrates is required, the micromanipulators are the safest way to do it, achieving highest accuracy, spatial resolution and stability.

- Vibration-free micromanipulation in 3D
- Fine drive with  $\mu\text{m}$  reading accuracy
- Safe-insert function
- Fully automated or manual system
- No electrical interferences due to optical measurement
- Adaptable to any sample

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



## Examples for Applications



### Microprofiling in Biological & Environmental Research

The different types of CO<sub>2</sub> microsensors allow e. g. measurements in smallest sample volumes or inside tissue. The micro-manipulators should be applied whenever it is necessary to insert the microsensor safely into semi-solid samples and when exact localization and stabilization of the microsensor tip within the sample is required. Using the safe-insert function the microsensor tip can be securely inserted and localized at the exact position where you want to conduct your measurements.



### Microsensor Measurements in Medical & Life Science Research

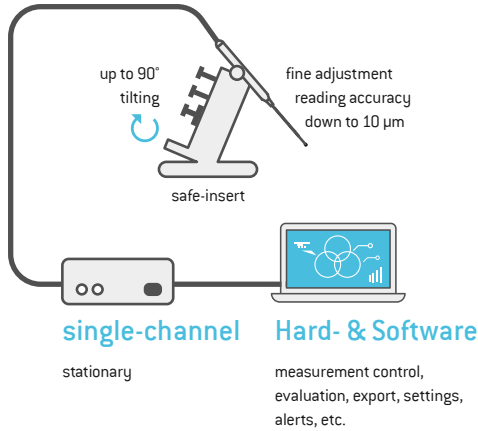
PreSens microsensors are ideal tools for medical and life science research, as they allow for precise on the spot measurement and microprofiling inside tissue constructs. The Manual Micromanipulator is an indispensable equipment in these applications for exact localization of the microsensor inside the sample and microprofiling in step sizes down to 10 µm. PreSens needle-type microsensors are already applied in many tissue engineering applications.



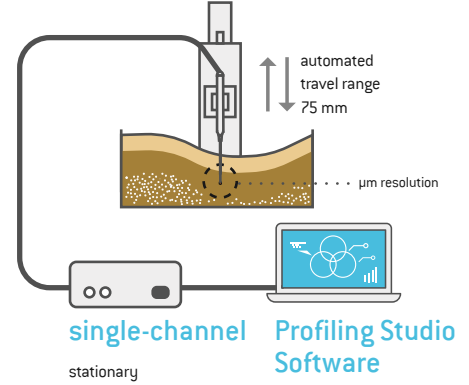
### Microprofiling of Sediments, Soils & Biofilms

Together with the specially designed PreSens Profiling Microsensors (PM) the Automated Micromanipulator is the ideal tool for CO<sub>2</sub> measurements in sediment, soil and biofilm applications. With a free choice of step zones, travel velocities and wait times different layers inside the sample can be monitored and assessed in step sizes down to 10 µm. The software visualizes the online measurements, so you can follow gradients and identify boundaries immediately while the sensor is automatically moved inside the sample.

## MICROMANIPULATOR SET-UP



## AUTOMATED MICROMANIPULATOR SET-UP



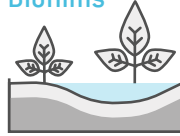
### SPECS

MEASUREMENT RANGE	0.04 - 5 % CO <sub>2</sub>
RESPONSE TIME (t <sub>90%</sub> )	< 5 min.*
RESOLUTION	±0.01 at 1 % CO <sub>2</sub>

\*at 25°C

## APPLICATION

Sediments & Biofilms



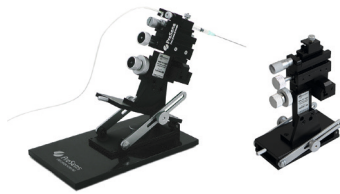
Biology & Environment



Medical Research & Life Science



Indoor & Outdoor Research & Industry



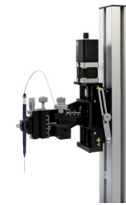
## Manual Micromanipulator MM and MM33

The Manual Micromanipulator is specifically designed for PreSens needle-type microsensors (NTH). The system allows moving the microsensor vibration-free in 3 axes with μm reading accuracy. With its solid base plate for a stable set-up the MM can be tilted safely up to 90°. The MM33 comes without the base plate so it can be mounted to customized measurement set-ups. The safe-insert function enables secure insertion of the NTH retracted in its steel needle into your area of interest. The sensor tip can then be extended safely. Whenever insertion of a microsensor in semi-solid or hard substrates is required, this is the safest way to do it, achieving highest accuracy and spatial resolution.



## Profiling Microsensors PM

The PM is specially designed for microprofiling applications with a close-fitting fiber guidance and a mechanical interlock for precise vertical localization of the measurement tip. A PM should be used for all microprofiling applications in semi-solid substrates.



## Automated Micromanipulator AM

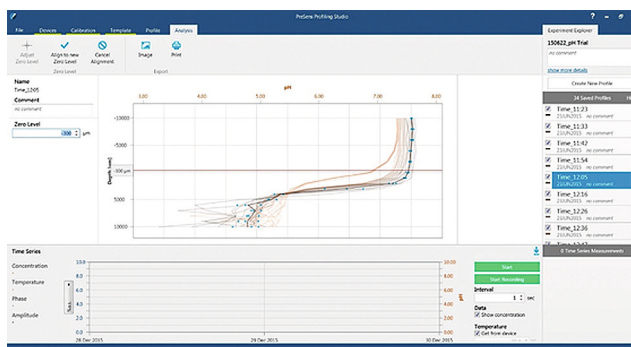
The Automated Micromanipulator AM is specifically designed for microprofiling applications with the PreSens Profiling Microsensor (PM), and can also be operated with needle-type housed (NTH) and implantable (IMP) microsensors. The system allows moving the microsensor vibration-free with μm reading accuracy and enables exact localization of the sensor in the sample. Automated microprofiling can be performed along one dimension in μm resolution. The associated database-supported software PreSens Profiling Studio allows complete control of the AM and the respective oxygen, pH or CO<sub>2</sub> meter via USB. Different step zones, variable travel velocities and waiting times can be defined. The AM is compatible with all PreSens oxygen, pH and CO<sub>2</sub> transmitters.

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

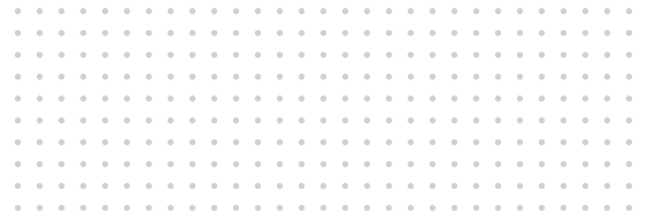
## Specifications

	Manual Micromanipulator (MM)	Manual Micromanipulator (MM33)	Automated Micromanipulator (AM)
<b>Specifications</b>			
Compatibility	Profiling (PM), needle-type housed (NTH) and implantable (IMP) oxygen, pH & CO <sub>2</sub> microsensors	Profiling (PM), needle-type housed (NTH) and implantable (IMP) oxygen, pH & CO <sub>2</sub> microsensors	Profiling (PM), needle-type housed (NTH) and implantable (IMP) oxygen, pH & CO <sub>2</sub> microsensors
Dimensions	230 mm x 130 mm x 200 mm	160 mm x 90 mm x 190 mm	275 mm x 95 mm x 220 mm
Weight	Weight w/o base plate: 1.1 kg Weight with base plate: 3.03 kg	Weight: 1 kg	Weight of AM: 2.07 kg Weight of Heavy Stand: 14 kg
Travel range automated	-	-	x-axis: 75 mm
Travel range manual	x-axis: 37 mm, fine drive 10 mm y-axis: 20 mm z-axis: 25 mm	x-axis: 37 mm, fine drive 10 mm y-axis: 20 mm z-axis: 25 mm	x-axis: 37 mm, fine drive 10 mm y-axis: 20 mm z-axis: 25 mm
Reading accuracy	Coarse adjustment: 0.1 mm Fine adjustment: 0.01 mm	Coarse adjustment: 0.1 mm Fine adjustment: 0.01 mm	-
Coarse positioning	x-axis: 70 mm	x-axis: 70 mm	-
Rotatability	360°	360°	-
Material	Aluminium & steel	Aluminium & steel	Aluminium & steel
Resolution	-	-	1 µm
Repeatability	-	-	< 2.5 µm
Mounting adapter	M6 screw, 13 mm length	M6 screw, 13 mm length	M6 screw, 13 mm length
Power supply	-	-	100 - 240 VAC, 50/60 Hz. Use supplied power adapter (15 VDC, 2.1 mm center positive plug) only.
Digital interface	-	-	USB interface (cable included)
Control software	-	-	PreSens Profiling Studio (compatible with Windows 7, 8, 10 at 32 or 64 bit)

## PreSens Profiling Studio Software



This software enables control of the Automated Micromanipulator (AM) and the connected oxygen, pH or CO<sub>2</sub> meter. PreSens Profiling Studio allows complete control with several step zones, variable travel velocity and waiting times of the AM. It is database supported and offers multiple features from clear data organization and export, annotations, easy creation of profiling templates, to different analysis functions.



# IMAGING SOLUTIONS

## VisiSens™ CO<sub>2</sub> Imaging System

### Measure and Visualize CO<sub>2</sub> Distributions in 2D

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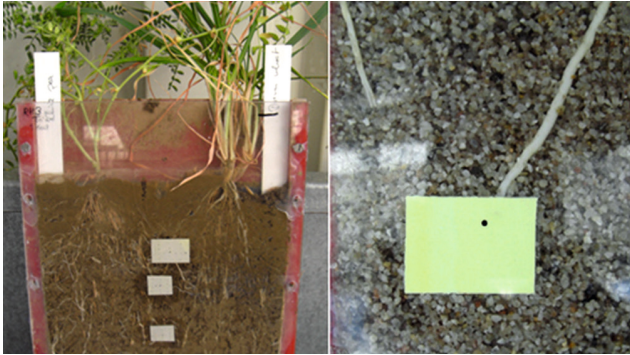
Fluorescent chemical optical sensor foils combined with imaging technology allow easy 2D visualization of carbon dioxide distributions in heterogeneous samples. For measurement the sample surface is covered with the sensor film, which translates the analyte content into a light signal. The sensor response is recorded pixel by pixel with a digital camera. With VisiSens™ A3 spatial and temporal changes of carbon dioxide concentration can be monitored.

- Reading multiple vials or cavities in one picture
- 2D mapping of metabolic activity over cross sections or surfaces
- Addressing regions with low or high CO<sub>2</sub>
- USB powered & portable

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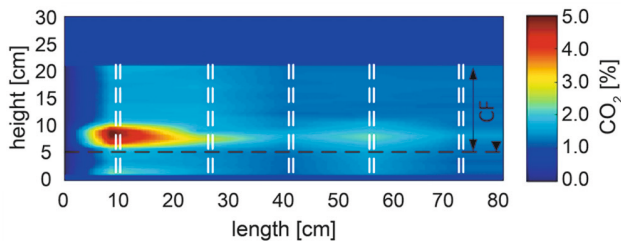
**Is your application missing?** Contact us and we find your customized solution!

## Examples for Applications



### CO<sub>2</sub> 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 plants. 2D imaging with VisiSens™ is performed to visualize CO<sub>2</sub>, pH and O<sub>2</sub> dynamics in complex root systems and the surrounding soil. Metabolic processes and how they change can be monitored over long time periods and parameters responsible for changes can be determined. The acquired CO<sub>2</sub> maps for distinct root regions are quantitative and have a resolution in sub-millimeter range.



### Visualizing CO<sub>2</sub> in Sediments

CO<sub>2</sub>, oxygen and pH are key factors and indicators for microbial activity in sediments. Microbial degradation of organic material can be detected in high resolution images recorded with VisiSens™. For a lab-scale experiment on the biochemical transformation potential in the capillary fringe (CF) VisiSens™ was combined with an automated linear positioning system. In this installation the camera could be moved along the CF in a Hele-Shaw cell. The system provided highly resolved local CO<sub>2</sub> concentration measurements which further allowed the approximation of analyte maps for the entire cell. With 2D imaging it could be validated that the CF offers optimal conditions for high biological activity, and further analysis in combination with O<sub>2</sub> sensor foils might allow the calculation of carbon mass balances.



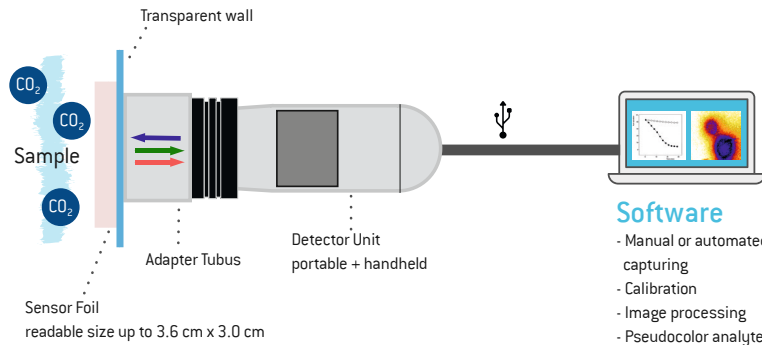
### Determination of Cell Activity in Closed Systems

Shipping of cell lines can take several days of transport depending on the destination. During transport cells have to stay in a tightly sealed environment to maintain sterility. It is difficult to predict the time at which depletion of nutrients or accumulation of end products limits survival of cells under these conditions. Using VisiSens™ CO<sub>2</sub> imaging metabolic activity of immobilized plant cells in a hermetically sealed transport vial could be observed for the first time. The sensor foils can be attached to the inside wall of the vessel, which is then sealed, and measurements are taken contactless from the outside through the vessel wall. With this monitoring approach it could be revealed that immobilized plant cells show metabolic activity even after 10 days of storage in a closed system. As transport usually takes less than those 10 days, fitness of the cells can be guaranteed.

## SPECS

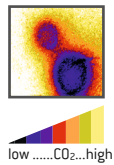
pCO <sub>2</sub>	0 - 1%	1 - 25 %
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## SET-UP

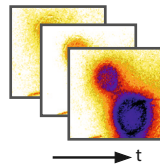


## EXEMPLARY RESULTS

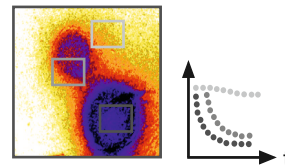
### 2D Read-Out



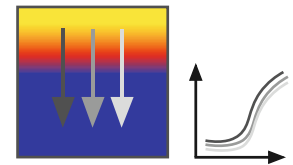
### Time Series



### Multiple ROI

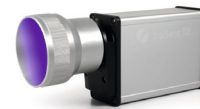


### Gradients



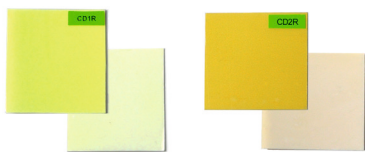
## VisiSens™ Detector Unit DU03

The detector unit DU03 is a spectral 2D detection device for CO<sub>2</sub> imaging. It is designed for read-out of fluorescent optical sensor foils. The device is portable and connected via USB 2.0 to a PC / notebook for measurement. For fields of view from microscopic to 3.6 x 3.0 cm<sup>2</sup>.



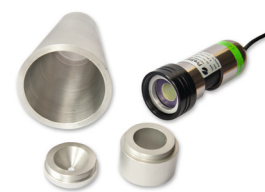
## VisiSens™ TD

The VisiSens TD Basic System is a modular 2D read-out unit for O<sub>2</sub>, pH and CO<sub>2</sub> sensor foils, even simultaneously in one experiment. The field of view ranges from 4 x 3 cm<sup>2</sup> to 8 x 6 cm<sup>2</sup> or up to 20 x 30 cm<sup>2</sup> with Big Area Kit.



## CO<sub>2</sub> Sensor Foil SF-CD1R & SF-CD2R (Prototype)

The CO<sub>2</sub> sensor foil can be attached to any sample surface or the inner surface of any transparent glass or plastic vessel. CO<sub>2</sub> is measured contactless. The sensor foil measures in liquids only. SF-CD1R sensor foils have a measurement range of 1 – 25 % CO<sub>2</sub>, SF-CD2R from 0 - 1 % CO<sub>2</sub>.



## Adapter Tubes

Tubes in different sizes can be attached to the VisiSens™ detector unit to adjust the field of view.

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

## Specifications

VisiSens™ Detector Unit DU03*		
	SF-CD2R (Prototype)	SF-CD1R
<b>Specifications</b>		
Measurement range	0 - 1 % pCO <sub>2</sub> at atmospheric pressure (1013.15 hPa)	1 - 25 % pCO <sub>2</sub> at atmospheric pressure (1013.15 hPa)
Response time (t <sub>90</sub> )**	< 3 min.	< 3 min.
Size of sensor foil**	40 x 40 mm <sup>2</sup> to 100 x 100 mm <sup>2</sup>	
Number of sensing points within one image**	300,000	
Measurement temperature range	From + 5 °C to + 45 °C	
<b>Properties</b>		
Compatibility	Aqueous solutions, pH 4 - 9, 10 % ethanol	
<b>Device</b>		
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	~ 1.6 x 1.3 mm <sup>2</sup> to ~ 3.6 x 3.0 cm <sup>2</sup> ; typically ~ 1.2 x 1.0 cm <sup>2</sup>	
Output	15 fps live video preview (no storage) and 0.5 fps full-resolution picture storage (.png)	
Number of LEDs	8	
Dimensions	Length 10 cm, diameter 3.8 cm	
Weight	0.17 kg (without adapter tubus)	
Material	All-aluminum housing	
Digital interface	USB 2.0, high speed USB transmission	

\*VisiSens™ is no approved medical device

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

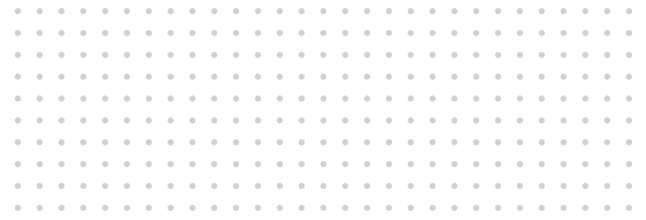
VisiSens™ TD*		
	SF-CD2R (Prototype)	SF-CD1R
<b>Specifications</b>		
Measurement range	0 - 1 % pCO <sub>2</sub>	1 - 25 % pCO <sub>2</sub>
Response time (t <sub>90</sub> )**	< 3 min.	< 3 min.
Size of sensor foil**	40 x 40 mm <sup>2</sup> to 100 x 100 mm <sup>2</sup>	
Precision (temporal)***	± 0.02 % CO <sub>2</sub> at 0.15 % CO <sub>2</sub>	± 0.02 % CO <sub>2</sub> at 2 % CO <sub>2</sub>
	± 0.01 % CO <sub>2</sub> at 0.8 % CO <sub>2</sub>	± 0.1 % CO <sub>2</sub> at 25 % CO <sub>2</sub>
Precision (spatial)****	± 0.08 % CO <sub>2</sub> at 0.15 % CO <sub>2</sub>	± 0.2 % CO <sub>2</sub> at 2 % CO <sub>2</sub>
	± 0.08 % CO <sub>2</sub> at 0.8 % CO <sub>2</sub>	± 1.2 % CO <sub>2</sub> at 25 % CO <sub>2</sub>
General sensor temperature working range	From + 5 °C to + 45 °C	
<b>Properties</b>		
Compatibility	Aqueous solutions, pH 2 - 9	
<b>Device</b>		
Camera chip	CCD Progressive with 12 bit ADC	
Image resolution	1.3 megapixel (1292 x 964 pixels)	
Field of view	~ 4 x 3 cm <sup>2</sup> to ~ 8 x 6 cm <sup>2</sup> ; up to 30 x 20 cm <sup>2</sup> with Big Area Imaging	
Output	Up to 15 fps live video preview (no storage) and 0.5 fps full-resolution picture storage (.png)	
Digital interface	Ethernet with power injection (via AC adapter)	

\* Prototype component. Please contact our service team!

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

\*\*\* Typical data of accuracy in a defined ROI (> 6,000 pixels) over time in dark lab conditions at + 20 °C, FoV 8 cm x 6 cm; strongly depends on used sensor foil

batch \*\*\*\* Typical data of spatial standard deviation in defined ROI (> 6,000 pixels) in dark lab conditions at + 20 °C, FoV 8 cm x 6 cm



# ACCESSORIES

## Accessories for CO<sub>2</sub> Measurement

### Add-ons and Extensions for Meters & Sensors

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PreSens offers numerous accessories for its measuring devices in order to extend the application possibilities. Sensor adapters allow the systems to be used in a wide variety of containers.

- Optical adapters for connecting the sensor to the meter
- Add-ons to extend application possibilities

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



## Specifications

POF	
<b>Specifications</b>	
Compatibility	All devices with SMA connectors
Dimensions	Optical diameter is 2 mm; outer diameter including the black cladding is approx. 2.8 mm
Length of fiber	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)
Connector type	SMA connectors on one or both sides available for use with Stick-On Adapter and Adapter for Round Containers
Temperature stability	The POF is resistant to temperatures up to + 70 °C

Adapter for Round Containers (ARC)		Stick-On Adapter (SOA)
<b>Specifications</b>		
Compatibility	All devices with SMA connectors	
Dimensions (D x W x H)	Velcro® strip 1000.0 mm x 22.0 mm x 4.0 mm	20.0 mm x 20.0 mm x 7.0 mm 12.0 mm total height w/ SMA socket
Connector type	SMA socket	



### FTC Holder

The FTC Holder is specially designed for the glass FTC-CD1. It ensures safe connection of the FTC with the CO<sub>2</sub>-1 SMA and holds the optical fiber in place for optimal sensor read-out.



### Adapter for Round Containers ARC

The 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 is connected to the polymer optical fiber (POF) and holds it in place opposite the integrated sensor spot.



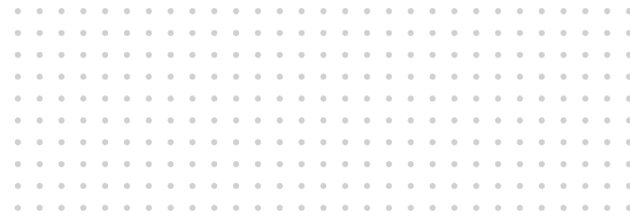
### Stick-On Adapter SOA

The SOA is used to attach the polymer optical fiber (POF) to a planar transparent glass or plastic container opposite the integrated sensor spot. The POF is attached via SMA connector and held in place by the adapter.



### Integration Set Sensor Spots IS-SP

This integration set, working like vacuum tweezers, is offered as an accessory for sensor spots. The suction pump is delivered with three suction tips in different sizes which are ideally suited for handling the spots. Using this pick-up system eases spot handling and integration into vessels that are difficult to access.



# Product Range

## Meters

CO<sub>2</sub>



**CO<sub>2</sub>-1 SMA**  
Fiber optic carbon dioxide meter



**pCO<sub>2</sub> micro (Prototype)**  
Fiber optic carbon dioxide meter

## Sensors

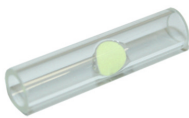
CO<sub>2</sub>



**CO<sub>2</sub> Sensor Spots SP-CD1**  
The most versatile version of optical carbon dioxide sensors



**CO<sub>2</sub> Dipping Probe DP-CD1**  
The solution for invasive CO<sub>2</sub> monitoring



**CO<sub>2</sub> Flow-through Cell FTC-CD1 and FTC-SU-CD1-09NaCl-S**

The FTC-CD1 is integrated in tubing systems for perfusion monitoring. FTC-SU-CD1-09NaCl-S is attached to a color coded stick, which can be attached to flow-through cells of different size and shape.



**CO<sub>2</sub> SensorPlug**  
The CO<sub>2</sub> SensorPlug is an optical sensor which enables online pCO<sub>2</sub> monitoring in milli- and microfluidic applications



**Implantable CO<sub>2</sub> Microsensor IMP-CDM1 (Prototype)**

This sensor is not integrated in any additional housing and ideally suited for customized measurement set-ups



**Needle-type and Profiling CO<sub>2</sub> Microsensor NTH/PM-CDM1 (Prototype)**

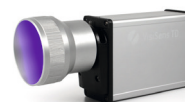
Protected by its syringe needle housing or more robust fiber construction these microsensors can be pierced through material

## Imaging Solutions

CO<sub>2</sub>



**Detector Unit DU03**  
Detection device for CO<sub>2</sub> imaging



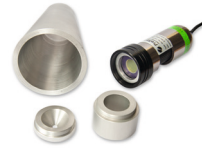
**VisiSens™ TD**  
Modular imaging detector unit that can be equipped with various imaging modalities for read-out of O<sub>2</sub>, pH or CO<sub>2</sub> sensor foils

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



### CO<sub>2</sub> Sensor Foil SF-CD1R & SF-CD2R

Sensor for CO<sub>2</sub> imaging in a range of 1 – 25 % pCO<sub>2</sub> (CD1R) and 0 - 1 % pCO<sub>2</sub> (CD2R)



### Adapter Tubes

Tubes in different sizes to adjust the field of view

## Profiling Solutions

CO<sub>2</sub>

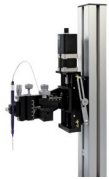
### Manual Micromanipulator MM

Vibration-free, high-resolution control for CO<sub>2</sub> microsensors and dipping probes



### Manual Micromanipulator MM33

Vibration-free, high resolution control for CO<sub>2</sub> microsensors



### Automated Micromanipulator AM

Fully automated, high-resolution control for CO<sub>2</sub> microsensors and dipping probes



### Safe-Insert

This accessory can be attached to the Automated Micromanipulator for safe insertion of NTHs in semi-solid and hard substrates.



### Heavy Stand

The Heavy Stand ensures save vertical mounting and operation of the Micromanipulators.



### Transport Case

High-quality travel case for one AM and one Heavy Stand

## Accessories

CO<sub>2</sub>

### FTC Holder

The FTC Holder is used to connect the FTC-CD1 to the CO<sub>2</sub>-1 SMA



### Adapter for Round Containers ARC & Stick-on-Adapter SOA

The adapter for round containers ARC and stick-on adapter SOA are used to attach the polymer optical fiber (POF) to a container opposite the sensor spot. The ARC is suitable for round containers, the SOA for planar transparent surfaces.



### Integration Set Sensor Spots IS-SP

Vacuum tweezers for easy integration of sensor spots



### Polymer Optical Fiber POF

It serves as a versatile connection from meter to sensor.

# Discover the complete PreSens portfolio



## Products

Optical Oxygen  
Sensors & Meters

Optical pH  
Sensors & Meters

Optical CO<sub>2</sub>  
Sensors & Meters

Optical Sensor  
Systems

VisiSens™  
Imaging Systems

OEM Solutions &  
Engineering



## Industries

Biology &  
Environmental

Industry &  
Technical

Biotech &  
Pharma

Medical &  
Life Sciences

Food &  
Beverage

Bring to light  
what's inside.

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

- precise and simple measurement of O<sub>2</sub>, pH, CO<sub>2</sub> and biomass
- systems for Pharma, Biotech, Food & Beverage, Biological & Environmental Research, Technical or Industrial Applications and Medical Devices
- sensors thinner than a hair, non-invasive and online
- optimum advice and support
- more than 1,000 items in stock
- prompt delivery worldwide

Ask our experts: PreSens Precision Sensing GmbH  
Am BioPark 11  
93053 Regensburg, Germany

Phone +49 941 942 72 100  
Fax +49 941 942 72 111  
info@PreSens.de

○ [www.PreSens.de](http://www.PreSens.de)