SENSOR PROBES

Oxygen Sensor Spots PSt3 / PSt6

Instruction Manual

PreSens
PRECISION SENSING

Oxygen Sensor Spots PSt3 / PSt6

Specification:

Chemical optical oxygen sensor spots for integration into transparent glass or plastic vessels

Document filename: IM_SP-PSt3_PSt6_dv4

Specifications may change without prior notice.

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1 Preface

You have chosen a new, innovative technology for measuring oxygen.

Chemical optical sensors (also called optodes) have several important features:

- They are small.
- Their signal does not depend on the flow rate of the sample.
- They can be physically divided from the measuring system which allows a non-invasive measurement.
- They can be used in disposables.

Therefore, they are ideally suited for the examination of small sample volumes, for highly parallelized measurements in disposables, and for biotechnological applications.
A set of different minisensors, flow-through cells and integrated sensor systems is available to make sure you have the sensor which matches your application.

Please feel free to contact our service team to find the best solution for your application.

Your PreSens Team

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE WORKING WITH THIS ITEM.

2 Safety Notes

! It is the customer’s responsibility to validate the sensor and transmitter under end-user conditions according to safety precautions of the application to ensure that the use of the sensor is safe and suitable for the intended purpose.

PreSens is explicitly not liable for direct or indirect losses caused by the application of these measurement systems. In particular it has to be considered that malfunctions can occur due to the naturally limited lifetime of the sensor depending on the respective application. The set-up of backup measurement stations is recommended when using the sensors in critical applications to avoid consequential losses. It is the customer’s responsibility to install a suitable safety system in the event of sensor failure.

3 Description of the Oxygen Sensor Spots

The chemical optical oxygen sensor spots can be attached to the inner surface of any transparent glass or plastic vessel like e. g. shake and spinner flasks, tubes, Petri dishes or cultivation bags. Oxygen is measured non-invasively and non-destructively through the transparent vessel wall. The oxygen sensor spots do not consume oxygen. They can be autoclaved and stand steam sterilization.

Fig. 1 Oxygen Sensor Spots PSt3 and PSt6

3.1 Scope of Delivery

The PSt3 / PSt6 sensor spots are delivered in a light-tight package. Each unit contains 10 (not autoclavable) or 1 (autoclavable) sensor spots packed individually in a transparent plastic sachet.

Additionally required equipment (not supplied):

- Fiber optic oxygen transmitter, e. g. Fibox 3 (more oxygen transmitters can be found on www.presens.de/products)
- PC / Notebook
- Glue, e. g. SG1
- Vacuum tweezers (can be obtained from major lab suppliers like e. g. VWR or Fisher Scientific.)
- Tweezers
- Spatula
- Dispenser pipette

3.2 Measurement Set-up

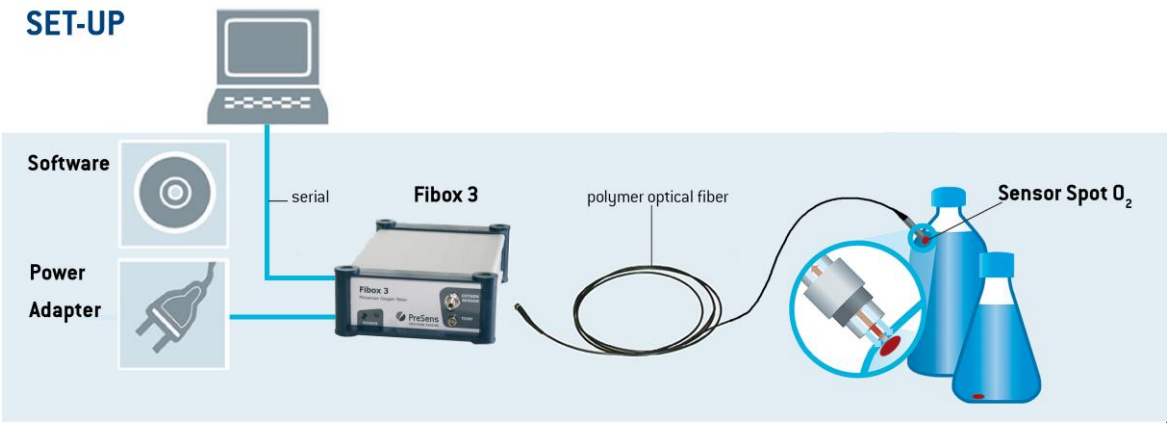

Fig. 2 Set-up for measurement with a sensor spot PSt3 or PSt6

A polymer optical fiber (POF), which is connected to a fiber optic oxygen transmitter, e. g. Fibox 3, is placed on the outer surface of the vessel, right opposite the sensor spot. The transmitter is connected via a serial COM port to a PC.

The POF can be fixed to the vessel and held in place by applying different accessories:

The stick-on adapter SOA can be adhered to the outer surface of the vessel and holds the polymer optical fiber in place.

Fig. 3 Stick on adapter (SOA)

If you have applied a sensor spot to a round vessel the adapter for round containers can be used. The ARC can be adjusted to different vessel sizes and holds the polymer optical fiber in place.

Fig. 4 Adapter for round containers (ARC)

A coaster CFG connected to a fiber optic oxygen transmitter can also be used. Place the CFG under the vessel and make sure its optical module is right opposite the sensor spot.

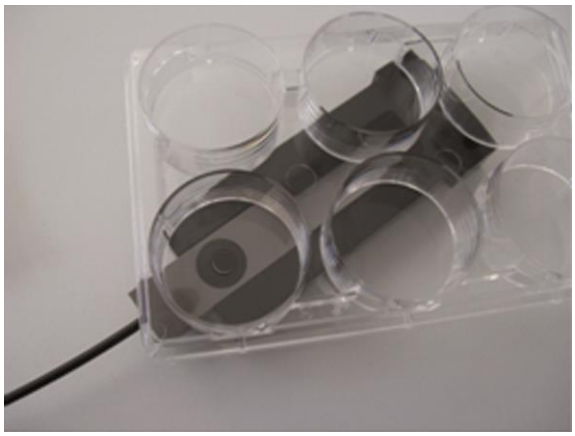

Fig. 5 Coaster CFG used to read the response of an oxygen sensor spot in a 6-well multidish

4 Operation

4.1 Unpacking the Oxygen Sensor Spots

The sensor spots are delivered in a light-tight package to ensure a long shelf-life, so do not open this packaging immediately at delivery. It is recommended to unpack the sensor spots just before using them. Carefully remove the sensor spots from the protective external cover. Each packing unit includes 1 (autoclavable) or 10 (not autoclavable) sensor spots packed individually in transparent plastic sachets.

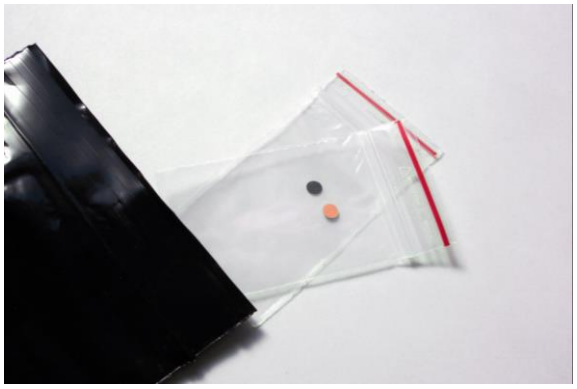

Fig. 6 Light tight package with individually packed sensor spots

An oxygen sensor spot has a red side (back) and a black side (front). The red side has to face the vessel wall when integrating it.

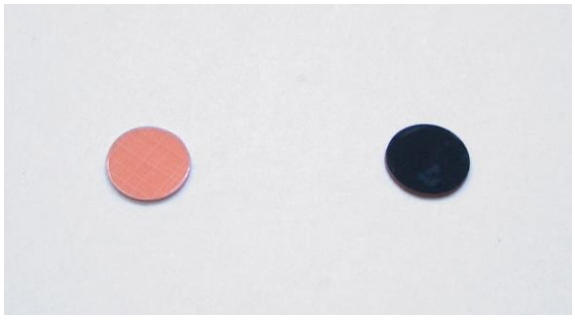

Fig. 7 Sensor spot back (red) and front (black)

4.2 Mounting the Sensor Spots in the Vessel

You can also watch our videos about integrating an oxygen sensor spot into different vessels on http://www.presens.de/support-services/videos.html.

The wall of the test vessel should be transparent or semi-transparent and not too thick. The adhesion surface of the vessel should be plane or only slightly arched; moreover the surface should be dry and clean, otherwise the sensor spot might partly detach from the vessel wall.

Place the sensor spot with its front side (black side) up on the desk; then pick it up by its front side with vacuum tweezers.

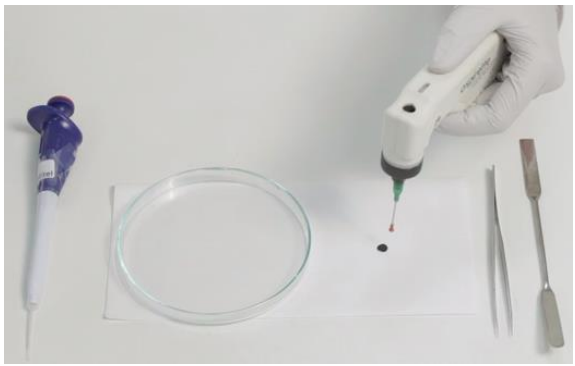

Fig. 8 Picking up an oxygen sensor spot with an aspirette by its front side

Holding the sensor spot with the vacuum tweezers apply approx. 4 µL (when using spots with common diameter of 5 mm; otherwise please consider) of silicone glue on the red side of the sensor spot using a dispenser pipette.

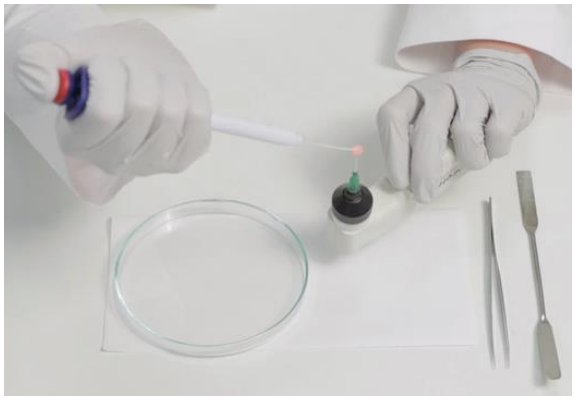

Fig. 9 Applying silicone glue to the sensor spot

Now carefully place the sensor spot on the inside vessel wall. Slightly press it onto the surface so that a small ring of silicone glue emerges around its edge.

Fig. 10 Carefully place the oxygen sensor spot in the vessel

! No air should be enclosed in the silicone glue between sensor spot and vessel wall. The glue should be spread evenly over the sensor spot surface to avoid detachment. Put the vessel in a dark place and let the silicone glue cure for at least 12 hours.

Then the vessel can be filled with your sample. Mount the respective accessory on the outer surface of the vessel right opposite the sensor spot and connect it via polymer optical fiber to the oxygen transmitter. Or, in order to do this manually, directly hold a polymer optical fiber to the outside vessel wall opposite the sensor spot.

Fig. 11 Polymer optical fiber held by hand opposite the sensor spot to read its response

4.3 Calibration

Oxygen sensor spots have to be calibrated before use. A conventional two-point calibration in oxygen-free environment (nitrogen or sodium sulfite), and air saturated (PSt3) or 1 – 2 % oxygen (PSt6) environment has to be performed.
The oxygen sensor requires no re-calibration up to 100,000 measurement points.

Please see the respective transmitter instruction manual for more detailed information about software settings and calibration procedure.

4.3.1 Calibration of a PSt3 Sensor Spot – Preparation of Calibration Standards

1st Calibration Point:

- Oxygen-free water
  To prepare oxygen-free water dissolve 1 g of sodium sulfite (Na_2SO_3) and 50 µL cobalt nitrate ($Co(NO_3)_2$) standard solution (ρ(Co) = 1000 mg/L; in nitric acid 0.5 mol/L) in 100 mL water. Use a suitable vessel with a tightly fitting screw top and label it **cal 0**. Make sure there is only little headspace in your vessel. Due to a chemical reaction of oxygen with the Na_2SO_3 the water becomes oxygen-free. Additional oxygen, diffusing from air into the water, is removed by surplus Na_2SO_3. Close the vessel with the screw top and shake it for approximately one minute to dissolve Na_2SO_3 and to ensure that the water is oxygen-free. To prepare oxygen-free water you also can use sodium dithionite ($Na_2S_2O_4$).

  Fill the calibration solution **cal 0** in the vessel you have mounted the sensor spot in. Make sure the sensor spot surface is covered completely with the liquid. To minimize the response time, slightly stir the solution. Then follow the instructions in the respective transmitter manual for calibration. After recording the first calibration point remove the calibration solution **cal 0**, fill the vessel with distilled water and stir it for 1 minute. Repeat this procedure at least 5 times to clean the sensor spot from sodium sulfite.

  For storing the calibration solution **cal 0** keep the vessel closed after calibration with a screw top to minimize oxygen contamination. The shelf life of **cal 0** is about 24 hours provided that the vessel has been closed with the screw top.

- Nitrogen-saturated atmosphere
  As an alternative you can use nitrogen-saturated atmosphere as calibration standard **cal 0**. Use a commercially available test gas N_2 (5.0) (suppliers are e. g. Air Liquide, Linde, Westfalen AG).

Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

2nd Calibration Point:

- Air-saturated water

  Add 100 mL water to a suitable vessel and label it **cal 100**. To obtain air-saturated water, blow air into the water using an air-pump with a glass-frit (air stone), creating a multitude of small air bubbles, while stirring the solution. After 20 minutes, switch of the air-pump and stir the solution for another 10 minutes to ensure that the water is not supersaturated.

  Fill the calibration solution **cal 100** in the vessel you have mounted the sensor spot in. Make sure the sensor spot surface is covered completely with the liquid. To minimize the response time, slightly stir the solution. Then follow the instructions in the respective transmitter manual for calibration.

- Water vapor-saturated air

  As an alternative you can use water-vapor saturated air as calibration standard **cal 100**. Place wet cotton wool in the vessel you have mounted the sensor spot in. Close the vessel with a fitting screw top or lid. (For inserting the temperature sensor into the vessel you might have to drill a hole in the lid.) Wait about 2 minutes to ensure that the air is water vapor-saturated.

  Then follow the instructions in the respective transmitter manual for calibration.

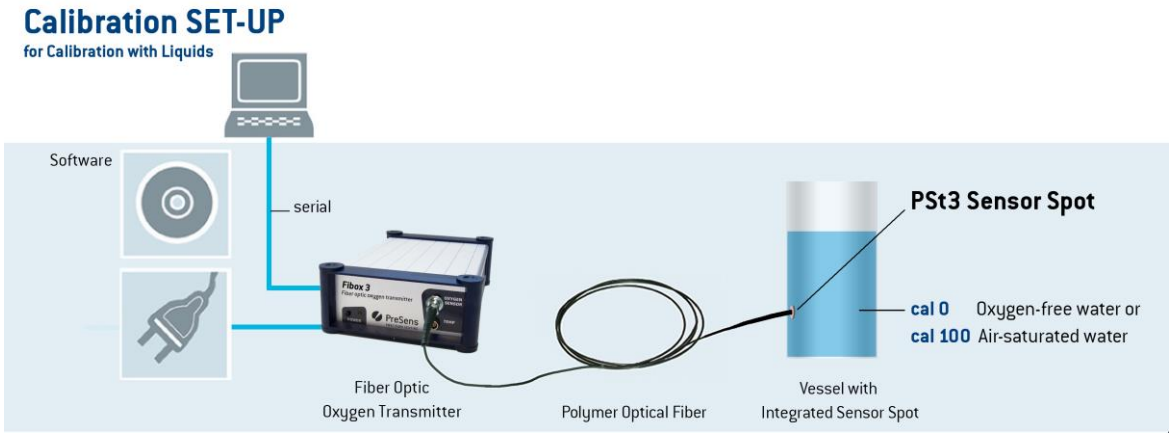

Fig. 12 Calibration set-up: Two-point calibration of a PSt3 sensor spot with liquid calibration standards

4.3.2 Calibration of a PSt6 Sensor Spot – Preparation of Calibration Standards

Calibration of PSt6 sensor spots is performed with certified gases (suppliers are e. g. Air Liquide, Linde, Westfalen AG).

1st Calibration Point:

- Nitrogen-saturated atmosphere
  Use nitrogen (N_2 5.0) as a first calibration standard **cal 0**.

  Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

2nd Calibration Point:

- 1 – 2 % O_2
  The second calibration value **cal 2nd** for a PSt6 sensor is ideally in the range between 5 and 10 % air sat. (ca. 1 – 2 % O_2 → % air sat. = % O_2 x 100/20.95). Use a commercially available test gas of 1 – 2 % O2 as a second calibration standard **cal 2nd**.

  Lead the gas into a vessel filled with distilled water before introducing it in the vessel with the sensor spot (see Fig. 13). Then follow the instructions in the respective transmitter manual for calibration.

If it is not possible to use gases or to build a suitable calibration chamber, a manual calibration can be performed, using calibration values obtained from the final inspection protocol delivered with the sensor spots. You can find more information about manual calibration in the instruction manual of the respective transmitter.

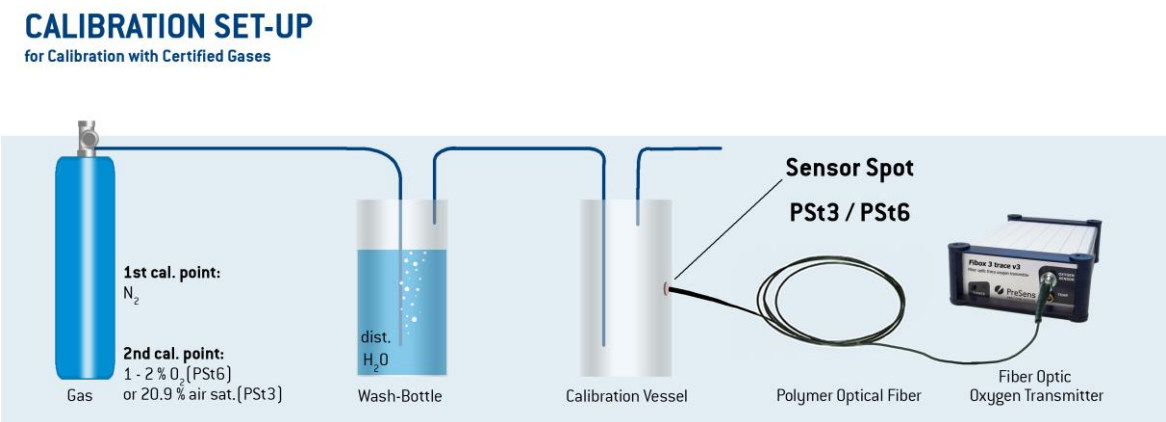

Fig. 13 Calibration set-up: Two-point calibration of PSt3 and PSt6 sensor spots with gases

5 Technical Data

	Sensor Type PSt3		Sensor Type PSt6	
Specifications	**Gaseous & Dissolved O_2**	**Dissolved O_2**	**Gaseous & Dissolved O_2**	**Dissolved O_2**
Measurement range	0 – 100 % O_2 0 – 1000 hPa	0 – 45 mg/L 0 – 1400 µmol/L	0 – 4.2 % O_2 0 – 41.4 hPa	0 – 1.8 mg/L 0 – 56.9 µmol/L
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/L at 2.83 µmol/L ±1.4 µmol/L at 283.1 µmol/L	± 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/L at 0.03 µmol/L ± 0.020 µmol/L at 2.8 µmol/L
Accuracy	± 0.4 % O_2 at 20.9 % O_2 ± 0.05 % O_2 at 0.2 % O_2		± 1ppb 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})	< 6 sec.	< 40 sec.	< 6 sec.	< 40 sec.
Properties				
Compatibility	Aqueous solutions, ethanol, methanol			
No cross-sensitivity with	pH 1 – 14 CO_2, H_2S, SO_2 Ionic species			
Cross-sensitivity to	Organic solvents, such as acetone, toluene, chloroform or methylene chloride Chlorine gas			
Sterilization procedure	Steam sterilization Ethylene oxide (EtO) Gamma irradiation			
Cleaning procedures	Cleaning in place (CIP, 5 % NaOH, 90 °C, 194 °F) 3 % H_2O_2 Acidic agents (HCl, H_2SO_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)			

6 Concluding Remarks

Dear Customer,

With this manual, we hope to provide you with an introduction to work with the oxygen sensor spots type PSt3 and PSt6.

This manual does not claim to be complete. We are endeavored to improve and supplement this version.

We are looking forward to your critical review and to any suggestions you may have.

You can find the latest version at www.PreSens.de.

With best regards,

Your PreSens Team

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