Non-invasive Online CO2 Measurement with Chemical optical CO2 Sensors

Chemical optical CO2 sensors provide a versatile tool for online monitoring of dissolved CO2 in various scale and designs

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Accurate CO_2 measurement in the liquid phase has been a challenge for decades. Although off-gas measurement by means of IR-spectroscopy is a proven technology, the correlation of CO_2-levels in gas and liquid phase in biological systems is difficult.

Fig. 1 pCO_2 mini fiber optic CO_2 transmitter

The pCO_2 mini transmitter is a precise fiber optic CO_2 transmitter. It is used with CO_2 sensors based on a 2 mm optical fiber. A PC is connected to run the easy-to-use software. pCO_2 mini is additionally equipped with an analogue out and a trigger input. The device is also equipped with a PT 1000 temperature sensor for online temperature measurement and compensation of the measured signal.

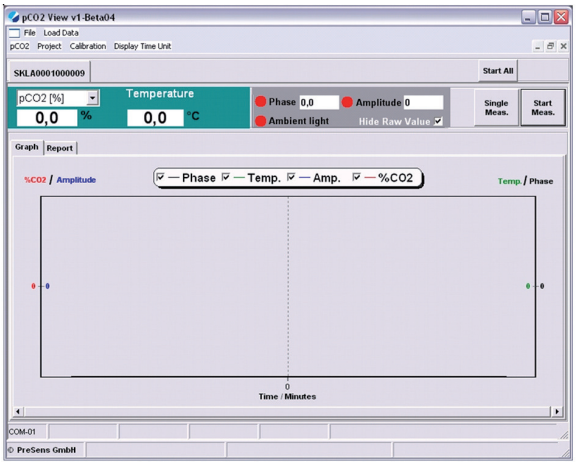

Fig. 2 pCO2 view v1 measurement control software for data acquisition, display and storage

The pCO_2 view software is used for controlling the operation of the pCO_2 mini transmitter. The data sent from the device are shown in digital display and graphically in a trace chart. The software includes menus for customer specific calibration of sensors as well as the possibility to operate with predefined calibration values. Data can be stored any time within a measurement and exported to MS Excel or plain ASCII-files. The upload of stored measurements is also possible for later evaluation.

CO2 sensor performance

The CO_2 sensors are optimized for physiological solutions. They are calibrated with gas mixtures of defined CO_2 concentration levels and delivered with a final inspection protocol. The customer can use either the factory data for calibration of the pCO_2 mini transmitter or perform his / her own calibration. The dynamic range of the CO_2 sensor is 1 % to 25 % CO_2 in order to fit to typical CO_2 levels within cell culture or other biotechnology applications. Sensors can be delivered beta-irradiated or untreated. Autoclavable sensors are also available.

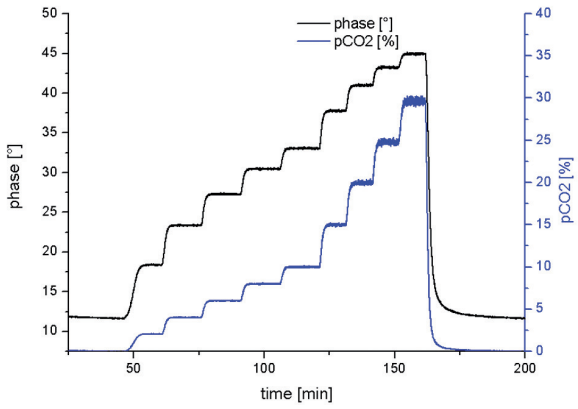

Fig. 3 Time trace of sensor reading at 20 °C upon exposure to atmospheres with defined levels of up to 30 % CO_2 in the mixture.

Measurement principle

The chemical optical carbon dioxide sensor is based on our patented DLR measurement principle[1]. The light of the blue LED excites the sensor to emit luminescence. 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 CO_2 sensitive indicator can be suppressed by CO_2 (see [2] in Fig. 4). The measurement signal correlates to the partial pressure of carbon dioxide. This internal referencing compensates intensity fluctuation caused e. g. by changes in excitation intensity.

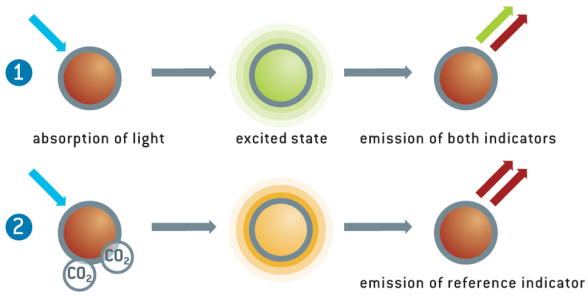

Fig. 4 Measurement principle of CO_2 sensors: (1) signal in absence of CO_2, (2) signal of sensor in CO_2 containing environment

PreSens CO2 sensors as an alternative to off-line sampling [2]

PreSens CO_2 sensors were evaluated for monitoring the cultivation cells in a 3-L bioreactor. As shown in Fig. 5, 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 0.4 x 10^6 cells/ml. The readings of the PreSens CO_2 sensor were also in good correlation to off-line CO_2 measurements. Additionally, the PreSens CO_2 sensor offers the possibility to continously monitor the CO_2 concentration between two off-line measurements.

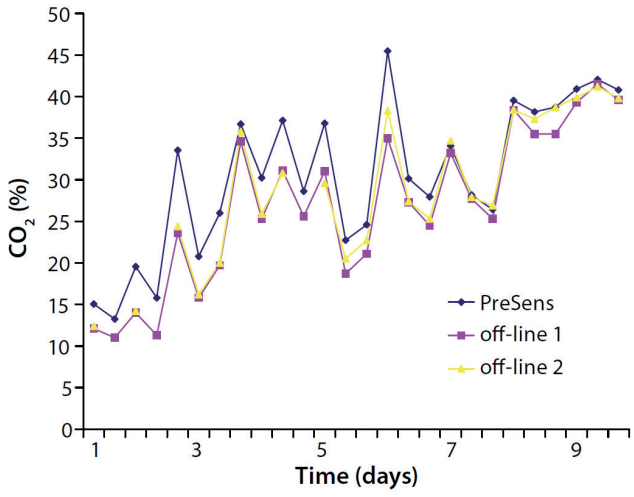

Fig. 5 Comparison of on-line (PreSens CO_2 sensor) and off-line measurement of CO_2 in a 3-L bioreactor

References:

[1] Patent DLR Nr. EP 1000345 (B1) and Nr. US 6602716 (B1)

[2] Baggio, et al. Physical-Chemical Sensors: Application to Bioreactor Monitoring and Control. ESACT 2009, Dublin, Ireland

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