Chlorolab 3+

Liquid-phase oxygen electrode system for advanced photosynthesis & respiration studies

Hansatech Instruments

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- > PC operated USB Oxylab+ electrode control unit
- > DW3 advanced large volume electrode chamber with 2 optical ports and integral S1 oxygen electrode disc
- > LH36/2R LED light source (up to 900 µmols m^{-2} s^{-1}) with automated control via user-defined PFD light tables
- > Suitable for liquid-phase samples between 1 - 20ml (min. 15ml if illuminated) with 0 – 100% oxygen concentration
- > 24 bit high resolution measurement of oxygen signals
- > Integral systems for measurement of pH & other ion-selective electrode (ISE) signals with 16 bit resolution
- > Onboard LCD readings of oxygen, auxiliary & ISE signals
- > 2 channel capability via purchase of additional systems
- > Quantitherm PAR/Temp sensor for light source calibration
- > OxyTrace+ Windows® software for data acquisition, hardware control & data analysis
- > Real time 0 – 4.5v analogue output of oxygen signal

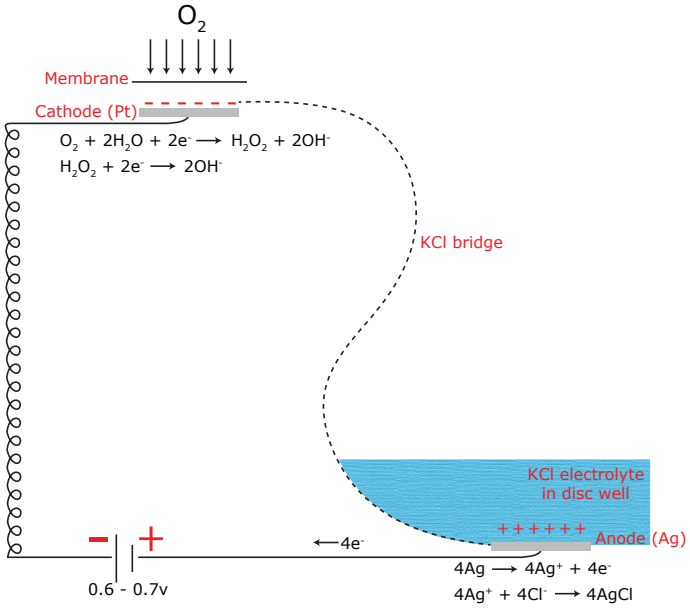
Oxylab+ electrode control unit

The next generation Oxylab+ oxygen electrode control unit combines striking aesthetics with enhanced features and functionality offering significant advances in flexibility and performance over previous generations of electrode control unit. As part of a complete system, Oxylab+ provides a convenient yet powerful tool for measurements of oxygen evolution or uptake across a broad range of liquid-phase samples from chloroplast extractions to mitochondrial suspensions with oxygen concentrations up to 100%.

Oxylab+ offers unrivalled price vs. performance combining simplicity of operation with an enviable feature set. The outstanding flexibility ensures Oxylab+ is equally useful in both a teaching and research capacity. 24 bit resolution allows detection of minute changes in oxygen tension without needing to apply instrument gain. This results in beautiful, noise free traces even when zoomed close in on areas of interest. Integral electronics provide control over an LED light source with automatic intensity changes handled by user-defined PFD light tables in software.

The system allows realtime graphing of signals from auxiliary inputs and ion-selective electrodes providing scope for comprehensive analysis of oxygen activity simultaneously with signals such as pH, TPP+, calcium, potassium and hydrogen ions. Signals from all inputs are additionally displayed on an LCD screen mounted within the front panel of the Oxylab+ control unit.

Up to 2 individual Oxylab+ control units may be linked to a single PC and operated simultaneously from OxyTrace+ software providing a powerful, multi-channel system.



Oxygen electrode disc

Since its original design in the early 1970's by Tom Delieu and David Walker, the S1 Clark Type Oxygen Electrode disc remains largely unchanged – a true testament to the quality and reliability of the sensor. The S1 consists of a platinum cathode and silver anode set into an epoxy resin disc and is prepared for use by trapping a layer of 50% saturated KCl solution beneath an oxygen permeable PTFE membrane. A paper spacer placed beneath the membrane acts as a wick to provide a uniform layer of electrolyte between anode and cathode.

When a small voltage is applied across these electrodes (with the platinum negative with respect to the silver), the current which flows is at first negligible and the platinum becomes polarised (i.e. it adopts the externally applied potential). As this potential is increased to 700 mV, oxygen is reduced at the platinum surface, initially to hydrogen peroxide H_2O_2 so that the polarity tends to discharge as electrons are donated to oxygen (which acts as an electron acceptor). The current which then flows is stoichiometrically related to the oxygen consumed at the cathode providing a fast, effective method of detecting small changes in oxygen tension in a liquid-phase sample.

DW3 electrode chamber

The DW3 large volume electrode chamber is particularly suited to oxygen evolution/uptake measurements of macroalgae in seawater samples of between 1 – 20ml (15-20ml if illumination is required).

The square section borosilicate glass reaction vessel with a prepared S1 electrode disc forming the floor of the vessel. A large quartz front optical port allows a large sample surface to be uniformly illuminated using the LH36/2R red LED light housing. Samples may either be in stirred suspension or in the case of laminar material, may be vertically supported and retained by the plunger such that they may be fully illuminated.

Precision temperature control of sample and sensor is delivered via a concentric water jacket with self-sealing ports for connection to a thermoregulated circulating water bath. The water jacket is constructed from black acetal which provides the ability for dark adaptation of samples or oxygen measurement in complete darkness. An additional optical port on the reverse of the chamber allows other items such as additional light sources, fibre optic light guides and detectors to be mounted on the DW3 enabling spectroscopic measurements to be made.

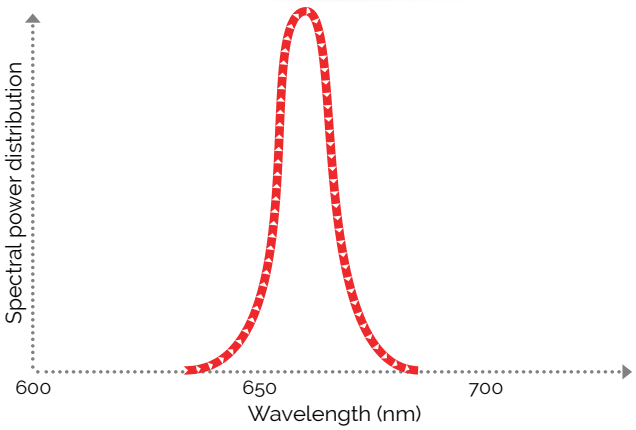
DW3 is fitted with a plunger with a precision central bore. The height of the plunger may be adjusted easily to suit liquid-phase sample volumes of between 1 - 20ml whilst the central bore easily accommodates Hamilton type syringes allowing additions/subtractions to/from the reaction vessel during an experiment.

LH36/2R light source

The LH36/2R light housing is designed specifically for use with the DW3 chamber. The light housing mounts directly on to the larger optical port of the DW3 and is held securely in place.

The large area LED array consists of 36 red LED's arranged in such a way to provide a high uniformity of illumination of laminar samples suspended in the square section chamber of the DW3.

LH36/2R connects directly to the rear of the Oxylab+ electrode control unit. Light intensity adjustments are made automatically based on user-defined PFD tables within OxyTrace+ software. PFD tables consist of up to 20 individual steps allowing complex light response assays to be configured for automatic execution during a measurement.



The LH36/2R has an integral cooling fan which automatically switches on to cool the housing when the light intensity reaches a certain point. This provides stability control of the light intensity when required at higher light intensity steps. Optical feedback controls within the light housing serves to enhance the stability of the LH36/2R performance across the entire range of intensity.

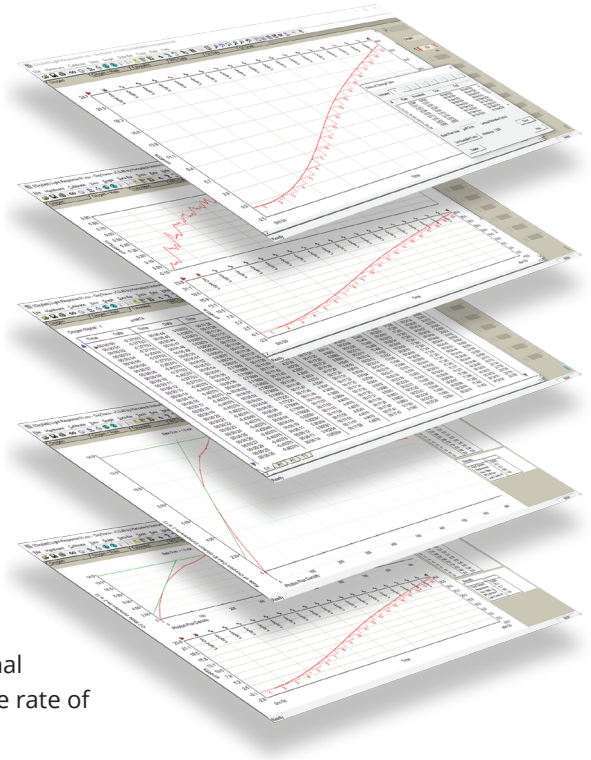
The LH36/2R has a peak wavelength centred at 660nm with a maximum intensity of 900 µmol m^{-2} s^{-1} in DW3.

Quantitherm PAR/temperature sensor

The QRT1 consists of a handheld display unit combined with the QTP1+ probe sensor. For use as a calibration tool for the LH36/2R light source, the QTP1+ probe connects directly to the rear of the Oxylab+ control unit allowing a 10 step multi-intensity calibration routine within the OxyTrace+ software to be performed.

QRT1 may also be operated as a standalone sensor across the range of normal measuring temperatures used for both photosynthesis and cellular respiration studies and offers maximum accuracy in the 10°C – 40°C region. For photosynthesis measurements, the PAR quantum sensor provides a displayed resolution of 1µmol m^{-2} s^{-1} throughout the 0 to 5,000 µmol m^{-2} s^{-1} range and up to a maximum of 50,000 µmol m^{-2} s^{-1} with a displayed resolution of 10 µmol m^{-2} s^{-1}.

OxyTrace+ software



OxyTrace+ is a multi-function Windows® program supplied with Chlorolab 3+ for system configuration, calibration, data acquisition and analysis. An automated 2 step calibration routine guides the user quickly and effectively through the system calibration process using electrode values measured from air-saturated and deoxygenated water.

OxyTrace+ allows simple configuration of comprehensive PFD tables consisting of up to 20 individual light steps. Light intensity adjustments are performed automatically during the measurement. OxyTrace+ also allows calibration of the LH36/2R light source from a simple software routine. This requires the QTP1 PAR/temperature sensor to be connected to the rear of the Oxylab+ control unit and placed into the reaction vessel prior to the addition of any liquids.

A tabbed interface allows a simple transition between the different data views including oxygen electrode (and if configured, auxiliary and external ion-selective electrode) real-time output, a split screen showing real-time rate of change above the oxygen signal and tabulated numerical data.

Post acquisition analysis tools allow automatic calculation of oxygen rates from user-defined rate intervals. Additional analysis tools automatically calculate rates of change for defined PFD light steps with a calculation of quantum yield presented at the end of a measurement. All files are saved as Comma Separated Values (CSV) data files opening effortlessly in external data processing packages such as MS Excel®.

OxyTrace+ will run on all supported Microsoft operating systems.

System components

Chlorolab 3+ systems are supplied with the following components:

- OXYL1+: Oxylab+ electrode control unit
- DW3: Oxygen electrode chamber
- S1: Oxygen electrode disc and SMB-SMB connection cable
- LH36/2R: LED light housing
- QRT1: Quantitherm PAR/temperature sensor
- A2: Membrane applicator to assist with smooth application of electrode membrane
- S2/PL: Pack of 5 magnetic followers
- S4: PTFE membrane (0.0125mm x 25mm x 33m)
- S10: Set of replacement o-rings for DW2/2 electrode chamber
- S16: Cleaning kit for the S1 electrode disc.

Technical specifications

Oxylab+ electrode control unit

Measuring range:	Oxygen: 0 - 100%, pH: 0 - 14pH, Aux: 0 - 4.096V
Signal inputs:	S1 O_2 electrode (SMB), pH/ISE (BNC), Aux (8 pin Mini Din), QTP1 PAR/Temp probe (6 pin Mini Din)
Resolution:	Oxygen: 0.0003% (24 bit), pH: 0.0006pH (16 bit), Aux: 62.5µV/bit (16 bit)
Polarising voltage:	700mV
Input sensitivity:	0 - 9000nA
Magnetic stirrer:	Software controlled 150 - 900rpm in % steps
Sampling rate:	0.1 - 10 readings/s
Electronics:	Microcontroller: 16 bit high performance CPU running at 32 MHz ADC: Dual, Low power, 16/24 Bit Sigma Delta
Display:	61 x 2 character blue LCD
Communications:	USB2.0
Analogue output:	0 - 4.5V O_2 signal
Dimensions (HWD):	250 x 125 x 65mm - 0.63 Kg
Power:	95 - 260V universal input mains supply. Output 12V DC 2.5A

DW3 electrode chamber

Suitability:	Liquid-phase photosynthesis/ respiration
Construction:	Black acetal
Sample chamber:	Square section borosilicate glass
Sample volume:	1-20ml (15ml min. for illumination)
Plunger:	Variable height, central bore
Temperature control:	Water jacket connected to circulating water bath
Optical ports:	Optical port (26mm dia), Quartz window (36mm dia)
Dimensions:	110 x 75 x 100mm - 400g

S1 oxygen electrode disc

Electrode type:	Clark type polarographic sensor
Electrode output:	Typically 1.6µA at 21% O_2
Residual current:	Typically 0.04µA in 0% O_2
Response time:	10 - 90% typically < 5 seconds
Oxygen consumption:	Typically <0.015µmol/hr^{-1}

LH36/2R light source

Light source:	36 red LED array
Control:	Via Oxylab+ & OxyTrace+ software
Wavelength:	660nm peak wavelength
Cooling:	Integral automatic cooling fan
Intensity:	max. 900 µmols m^{-2} s^{-1}
Dimensions:	74 x 52mm - 270g

QRT1 PAR/Temperature sensor

Measuring range:	0- 50000µmol m^{-2} s^{-1} (+/- 5%) in 2 ranges (0 - 5000 & 0 - 50000) in 400 - 700nm band
Resolution:	1µmol m^{-2} s^{-1} at 0 - 5000 10µmol m^{-2} s^{-1} at 5001 - 50000
PAR sensor:	Silicon photodiode & optical filter with white acetal diffuser
Temperature sensor:	RT curve matched bead thermistor. 0 - 50°C/32 - 122°F (0.02°C resolution)
Signal display:	Handheld display unit. 16 x 2 LCD display. 0 - 5V analogue output of PAR/ temperature values
Power requirements:	4 x 1.5V AA (LR6) cells Typically 100 hours battery life
Dimensions (display):	146 x 92 x 32mm - 300g
Dimensions (QTP1):	9.5 x 107mm - 50g

Hansatech Instruments is a British company that has been developing high quality scientific instrumentation for over 40 years. Our systems are used widely for teaching & research in cellular respiration & photosynthesis programs in more than 100 countries throughout the world. We have gained an enviable reputation for quality, reliability & excellent price/performance.

Our product range consists of a range of modular solutions for the measurement of oxygen using Clark type polarographic sensors. We also develop chlorophyll fluorescence measurement systems using both continuous excitation & pulse-modulated measurement techniques with further optical instrumentation for the measurement of sample chlorophyll content.

Purchasers of Hansatech Instruments products can be assured of ongoing support & prompt & efficient attention to enquiries at all times. Support is available both directly & from our global distributor network. Customers are encouraged to register their instruments on our website which allows access to our Support Ticketing System in addition to instruments manuals & software upgrades.

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