

# *Hansatech* Instruments

Serving the Sciences for over 45 Years



Short Form Catalogue

# Prof. David A. Walker FRS



**1928 - 2012**

David Walker was both a dear friend and trusted colleague who played an enormous role in the early development of Hansatech Instruments Ltd. David was an important and influential figure - both professionally and personally - to all who were fortunate enough to know him. Through his life's work, David contributed tirelessly towards furthering photosynthesis research and disseminating the understanding of photosynthesis to a wider, general audience.

Throughout his career, David authored over 200 publications including several books for both the scientific community and for children. He was made a Fellow of the Royal Society in 1976 and in 2004 received the International Society of Photosynthesis Research Communications Award "to acknowledge his outstanding efforts to communicate photosynthesis to the general public".

David is sorely missed and this brochure is dedicated to his memory.

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Welcome to our Short Form brochure! The information in this product guide is intended as an overview of the main items in the Hansatech Instruments Ltd product range. For more detailed information, please contact your local distributor. Contact details for Distributors may be found on our website at [www.hansatech-instruments.com/distributors/](http://www.hansatech-instruments.com/distributors/).

Alternatively, please visit our website at [www.hansatech-instruments.com](http://www.hansatech-instruments.com) where individual system information sheets are available for download.

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## A Brief History of Hansatech Instruments

The name 'Hansatech' is derived from the Hanseatic League, a trading alliance of towns and cities of Northern Europe which flourished in the 13th to 15th centuries. The town of King's Lynn, where Hansatech Instruments is located, was a key trading post between England and continental Europe.

The original Hansatech Limited was founded in 1972 as a sub-contracting electronic assembly company. Shortly afterwards, contact was made between Hansatech and Prof. David A. Walker who was at that time Professor of Biology at Sheffield University. Prof. Walker had been using prototype Clark-type oxygen electrodes which he had designed and developed with Tom Delieu.

Further collaboration ensued and in 1974 Hansatech Ltd launched the DW1, a commercial Clark-type polarographic oxygen electrode with an accompanying chamber and control unit. The aim of this instrument was to further the use of oxygen measurements in the teaching and research of plant physiology. The DW1 is in use in laboratories worldwide and still sells strongly.

Contact with customers acted as a further springboard for developments, and by 1989, the scientific side of the business had grown sufficiently to allow the foundation of a new company, Hansatech Instruments Ltd, which is housed in an attractive old farmhouse in a rural location on the outskirts of King's Lynn.

A specialist team of skilled employees ensures that our ever-broadening range of high quality scientific instrumentation has been designed for optimum performance and reliability. We collaborate with experienced and renowned academics and scientific bodies to ensure that the design of our instrument range meets the needs of established and developing trends in scientific research and teaching programmes.

Our products are now in use in scientific programs in more than one hundred countries throughout the world and have gained an enviable reputation for quality, reliability and excellent price / performance.







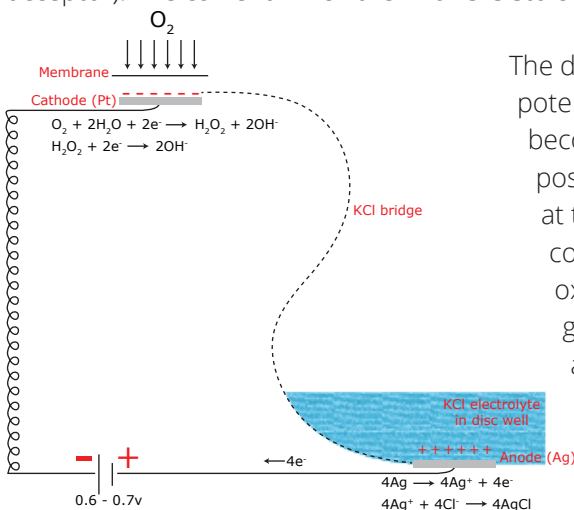
# Clark-Type Oxygen Electrode Measurement Principles

The following text and image are based on the chapter "The Principle of Oxygen Measurement" from the book "The Use of the Oxygen Electrode & Fluorescence Probes in Simple Measurements of Photosynthesis" by Prof. David A. Walker (Oxygraphics Ltd. 1987).

Hansatech Instruments oxygen electrode systems for photosynthesis and respiration measurements take one of 2 forms, liquid or gas-phase. The measurement techniques for each form are quite different, however, the underlying principles of the measurement of oxygen remain the same. Oxygen dissolved in the reaction vessel of liquid-phase systems or that which accumulates in the sample chamber of gas-phase systems is detected polarographically by either the S1 or S1/MINI (in Oxytherm oxygen measurement systems) Clark-type electrodes (Clark, 1956).

Both oxygen electrode discs comprise a relatively large (2mm diameter) platinum cathode and a concentric silver anode immersed in, and linked by, an electrolyte solution. Both electrodes are set in an epoxy resin disc; the cathode at the centre of a dome and the silver anode in a circular groove named the well or electrolyte reservoir, surrounding the dome. The electrodes are protected by a thin PTFE (Teflon) membrane which is permeable to oxygen and the purpose of the dome is to stretch the membrane smoothly over the surface of the platinum cathode and to allow it to be secured in position by an O-ring. The membrane also traps a thin layer of electrolyte (a solution, which usually contains potassium chloride) over the surface of the electrodes. A paper spacer is placed beneath the membrane in order to provide a uniform layer of electrolyte between anode and cathode.

When a small voltage is applied across these electrodes, so that the platinum is made 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.



The diagram opposite represents the oxygen electrode reactions. When a potentiating voltage is applied across the two electrodes, the platinum (Pt) becomes negative (i.e. becomes the cathode), and the silver (Ag) becomes positive (the anode). Oxygen diffuses through the membrane and is reduced at the cathode surface so that a current flows through the circuit (which is completed by a thin layer of KCl solution or other electrolyte). The silver is oxidised and silver chloride deposited on the anode. The current which is generated bears a direct, stoichiometric, relationship to the oxygen reduced and is converted to a digital signal and recorded by an electrode control unit.

# Complete Oxygen Measurement Systems

## Oxyview 1 System

### Liquid-phase oxygen electrode teaching system

The Oxyview 1 liquid-phase oxygen electrode teaching system has been designed in response to the ever-increasing demand for a low-cost system for teaching photosynthesis and respiration measurements using oxygen electrode techniques. The system is designed to be used in a busy teaching environment but is equally at home in a modern research facility.

- > Convenient, low cost system for teaching of photosynthesis research & cellular respiration measurements using the oxygen electrode
- > Oxyview electrode control unit with integral magnetic stirrer
- > DW1/AD electrode chamber with base mounted S1 electrode disc
- > Oxygen content of sample displayed as digital or percentage value
- > User-friendly configuration via a responsive 4 button control panel and a series of comprehensive menu screens
- > Analogue output for connection to a chart recorder or other external recording device.



## Oxygraph+ System

### Liquid-phase photosynthesis & respiration measurement

The Oxygraph+ oxygen electrode system provides PC control of oxygen uptake or evolution measurements across a broad range of applications from studies of mitochondria and cellular respiration to measurements of isolated chloroplast suspensions in photosynthesis research applications with up to 100% oxygen concentration.

- > PC operated oxygen electrode control unit with USB2.0 connectivity
- > Suitable for liquid & gas-phase samples with 0 – 100% oxygen concentration
- > Clear cast acrylic DW1/AD oxygen electrode chamber with integral Clark-type polarographic oxygen electrode
- > Integral systems for measurement of pH & other ion- selective electrode signals with 16-bit resolution
- > 24-bit high-resolution measurement of oxygen signals
- > System expansion to 8 channels via purchase of additional components
- > Windows® software for data acquisition, hardware control & data analysis
- > Real time 0 – 4.5v analogue output of oxygen electrode signal.



# Oxytherm+ System

Liquid-phase photosynthesis & respiration measurement with solid-state temperature control



The next generation Oxytherm+ 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 a complete system, Oxytherm+ 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%. Available in two versions: Respiration and Photosynthesis.

- > PC operated electrode control unit with USB connectivity
- > Advanced electronic electrode chamber with solid-state Peltier temperature control between 3 - 40°C
- > Oxytherm+ Photosynthesis version fitted with automated white LED light source up to 4,000  $\mu\text{mol m}^{-2} \text{s}^{-1}$
- > 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 signal, auxiliary & ISE signals & chamber temperature
- > 8 channel capability via purchase of additional systems
- > OxyTrace+ Windows® software for data acquisition, hardware control & data analysis
- > Real time 0 - 4.5v analogue output of oxygen signal

# Chloroview 1 System

Entry-level system for the study of photosynthesis & respiration in liquid-phase samples under illumination

Chloroview 1 is an entry level system for studies of photosynthesis & respiration from liquid-phase suspension samples under actinic illumination. The system is ideally suited to teaching environments for under & post-grad plant biology studies of the photosynthetic processes but is equally at home in research facilities where demands on equipment performance are high.

- > Oxygen electrode control and signal acquisition via Oxyview electrode control unit
- > DW1 oxygen electrode unit with integral oxygen electrode
- > Oxygen signal output from Oxyview to recording device via 0 - 5V analogue output
- > Illumination via LS2 high-intensity halogen white light source
- > Quantitherm light/temperature sensor for light source calibration.



# Chlorolab 2+ System

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

Chlorolab 2+ is an advanced system for the study of respiration and photosynthesis from liquid samples under automated illumination from a white, red or blue LED light source (colour selected at point of purchase). The system automates the acquisition of oxygen evolution/uptake rates over user-defined light intensities to determine the apparent quantum yield.

- > PC operated USB Oxylab+ electrode control unit
- > DW2/2 advanced electrode chamber with 4 optical ports and integral S1 oxygen electrode disc
- > LED1/W white LED light source (up to  $2,000 \mu\text{mol m}^{-2} \text{s}^{-1}$ ) with automated control via user-defined PFD light tables
- > Suitable for liquid-phase samples between 0.2 - 2.5ml (min. 1.5ml 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
- > QTP1 PAR/Temp sensor for light source calibration
- > OxyTrace+ Windows® software for data acquisition, hardware control & data analysis



# Chlorolab 3+ System

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

Chlorolab 3+ provides a sophisticated system for the advanced study of respiration and photosynthesis from larger liquid-phase sample volumes up to 20ml. The system is ideally suited to busy research facilities where demands on equipment performance are high but is equally at home in teaching environments for under & post-grad plant biology studies of the photosynthetic processes.

- > 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  $900 \mu\text{mol m}^{-2} \text{s}^{-1}$ ) with automated control via user-defined PFD light tables
- > 24-bit high-resolution measurement of oxygen signals
- > Suitable for liquid-phase samples between 1 - 20ml (min. 15ml if illuminated) with 0 - 100% oxygen concentration
- > 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
- > QTP1 PAR/Temp sensor for light source calibration
- > OxyTrace+ Windows® software for data acquisition, hardware control & data analysis





# Leafview 1 System

Entry level system for the study of photosynthesis & respiration in gas-phase samples under illumination

Leafview 1 is an entry level system for studies of photosynthesis & respiration from gas-phase, solid-state samples under actinic illumination. The system is ideally suited to teaching environments for under & post-grad plant biology studies of the photosynthetic processes but is equally at home in research facilities where demands on equipment performance are high.

- > Oxygen electrode control & signal acquisition via Oxyview control unit
- > LD1/2 electrode unit suitable for leaf discs up to 10cm<sup>2</sup> cut from whole leaves, algae or moss etc
- > LS2 intensity adjustable by insertion of neutral density filters
- > Oxygen signal output from Oxyview to recording device via 0 – 5V analogue output
- > Upper optical port allows illumination from LS2 high-intensity white light source.



# Leaflab 2+ System

Research grade system for the study of photosynthesis & respiration in gas-phase samples under illumination

Leaflab 2 facilitates advanced studies of photosynthesis and respiration from solid-state samples. The system is ideally suited to busy research facilities where demands on equipment performance are high but is equally at home in teaching environments for under & post-grad plant biology studies of the photosynthetic processes.

- > PC operated USB Oxylab+ electrode control unit
- > LD2/3 gas-phase electrode chamber with dual water jacket for effective sample/sensor temperature control
- > LH36/2R LED light source (up to 750  $\mu\text{mol s}^{-1}$ ) with automated control via user-defined PFD light tables
- > Suitable for gas-phase measurements from leaf disc samples of 10cm<sup>2</sup>
- > 24-bit high-resolution measurement of oxygen signals
- > Integral systems for measurement of auxiliary signals with 16-bit resolution
- > Onboard LCD readings of oxygen & auxiliary signals
- > 2 channel capability via purchase of additional systems
- > QSRED 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





# Continuous Excitation Chlorophyll Fluorescence

A continuous excitation fluorimeter is designed to measure the Kautsky Induction or Fast Chlorophyll Fluorescence Induction (Kautsky and Hirsch, 1931\*). It uses focussed, high-intensity light from red LED's to induce a fast chlorophyll fluorescence response from a dark adapted sample. Continuous systems require the use of a special leafclip system. This is a multi-purpose tool which provides dark adaptation for the sample (required for the measurement of maximum photochemical efficiency), defines the measurement area on the sample and prevents ambient light leakage into the highly sensitive photodiode used by the instrument for chlorophyll fluorescence detection.

Hansatech Instruments produce 3 types of continuous excitation fluorimeter, Handy PEA+, Pocket PEA and the M-PEA Multi-Function Plant Efficiency Analyser. All of these systems utilise a fast data acquisition system capable of recording every 10  $\mu$ seconds.

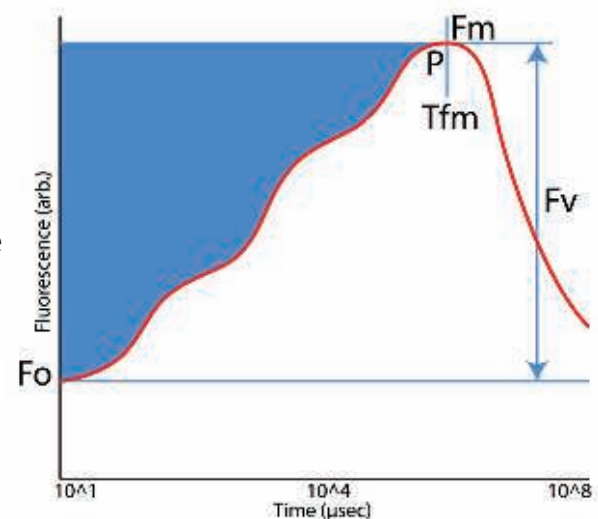
## The Kautsky Fluorescence Induction.

If a sample is dark adapted the PSII electron acceptor pool is gradually re-oxidised to a point where all of the PSII reaction centres are capable of undertaking photochemistry. If that sample is then suddenly illuminated with a high-intensity light source, a rapid (approx. 1 s) polyphasic rise in chlorophyll fluorescence may be observed which is subsequently followed by a slow (approx. 2 minute) decline in fluorescence intensity to a steady-state level of fluorescence. This induction phenomena is often referred to as the Kautsky Induction (Kautsky and Hirsch, 1931\*).

Kautsky Induction curves must be plotted on a logarithmic axis in order to observe the polyphasic rise to the maximum chlorophyll fluorescence value. This is due to the reactions causing the different kinetics which occur typically in the first 300 msecs of illumination.

Chlorophyll fluorescence measurements are not absolute. The fluorescence emitted depends upon the excitation light intensity and the response of the plant to the new light conditions. Many of the commonly used comparative fluorescence parameters are ratios. It is therefore important that measurements are made in truly comparable circumstances if data is to be used for comparison.

\* Kautsky, H. and A. Hirsch (1931). Chlorophyllfluoreszenz und Kohlensäureassimilation. *Naturwissenschaften*, 19, 964.



# Pocket PEA System

## Ultra-portable, rapid screening chlorophyll fluorimeter

The Pocket PEA chlorophyll fluorimeter is suitable for teaching, research and a wide variety of commercial applications where rapid screening of samples is required.

The robust yet compact hand-held design provides ease of use and reliable operation.

Bluetooth wireless transfer conveniently allows records to be transferred in the field from the Pocket PEA chlorophyll fluorimeter to a suitable PC for detailed review and analysis using custom Windows® Mobile and Windows PC software.

- > Rapid screening capability with single button operation & storage of up to 200 full data sets
- > Automatic calculation of parameters including Fv/Fm & OJIP analysis
- > Robust enclosure with sealed, high intensity optics
- > 100kHz sampling frequency with 16-bit resolution
- > Bluetooth wireless data transfer as standard
- > Powerful Windows® data transfer & analysis software included.



# Handy PEA+ System

## Ultra-portable, rapid screening chlorophyll fluorimeter

The Handy PEA+ chlorophyll fluorimeter consists of a compact, light-weight control unit encapsulating sophisticated electronics providing the high time resolution essential in performing measurements of fast chlorophyll fluorescence induction kinetics. Simple to configure and operate, the system allows up to 5 user-defined protocols to be created in-software and transferred to the Handy PEA+ for different field applications. A maximum of 1000 recordings of between 0.1 – 300 seconds may be saved in the memory of Handy PEA+ before being transferred to the PEA Plus software via USB communications.

- > Compact (170 x 85 x 40mm), lightweight (565g)
- > Large-scale screening capacity up to 1000 full trace data files
- > High time resolution detection for discrimination of fast chlorophyll fluorescence induction kinetics
- > Saturating high-intensity focused LED array for accurate determination of Fm
- > Upload user-defined, repeatable protocols for automatic field execution
- > Interchangeable sensor unit cables with lengths of up to 20 metres
- > Optional HPEA/LPA2 liquid-phase measurement accessory
- > Powerful Windows® data transfer & analysis software included.



# M-PEA+ System

## Multi-function plant efficiency analyser

The M-PEA++ (Multi-Function Plant Efficiency Analyser) combines high quality fast (prompt) fluorescence kinetic and P700+ absorbance studies with ground-breaking Delayed Fluorescence measurements providing one of the most comprehensive systems for the investigation of plant photosynthetic efficiency available.

The system is controlled from a comprehensive Windows® software package (M-PEA+) which allows complex experiments to be designed, uploaded and executed by the M-PEA+ hardware. Recorded data is quickly downloaded to the software via a USB2.0 connection.

P700 is the term used to describe the chlorophyll within the reaction centre of PSI as this is the wavelength of light to which the photosystem is most reactive. Upon illumination using a strong light source, the photosynthetic electron transport chain is almost entirely reduced. The electrons from this reduction in turn activate the enzyme ferredoxin-NADP+ reductase which leads eventually to NADP reduction and CO<sub>2</sub> fixation. This initial reduction process is represented by the O-J-I-P steps of the Kautsky induction curve during prompt fluorescence measurements. The oxidation of P700 causes an increase in absorbance at wavelengths falling in the 800 - 850nm band.

Delayed fluorescence (DF) has much in common with prompt fluorescence (PF) as it originates from the same chlorophyll molecules of the Photosystem II antenna complexes. DF is essentially light that is emitted from green plants, algae and photosynthesising bacteria for a short time after they have been exposed to light, but after the prompt fluorescence emission has decayed. Although DF occurs in the same red-infra-red region of the spectrum as PF, the intensity of the DF emission is lower than that of PF by at least two orders of magnitude therefore requiring extremely high-sensitivity apparatus to measure the signal.

Like PF, the properties of the DF emission are highly sensitive to the functional state of Photosystem II and the photosynthetic reaction chain as a whole. The DF emission, natural to all green plants, has been known to scientists for over fifty years. It was first discovered by Strehler and Arnold (1951) when attempting to use firefly luminescence for the measurement of the light-induced accumulation of ATP in the green alga *Chlorella*. They found that even without the addition of luciferase and luciferin, there was a long-lived glow from algal cells and chloroplasts in darkness following illumination.

The observed DF was characteristic of different photosynthesising samples used—leaves (Strehler and Arnold 1951), chloroplasts and photosynthesising bacteria (Arnold and Thompson 1956). Strehler and Arnold postulated that it was in fact chemiluminescence of the chlorophyll, caused by reversal of the photosynthetic reactions. The close relationship between DF and the photosynthetic reactions was confirmed undoubtedly in many studies and sometimes DF was found even more sensitive than PF (Kramer and Crofts, 1996).

- > Advanced lab-based system for investigation of plant photosynthetic efficiency
- > M-PEA-1 variant for prompt fluorescence & P700+ modulated absorbance measurements
- > M-PEA-2 variant as M-PEA-1 with additional measurements of Delayed Fluorescence (DF) & leaf absorptivity
- > Sophisticated sensor unit with all optical emitters & detectors in a robust, enclosed housing
- > USB connection to a Windows® PC
- > Comprehensive Windows® experimental design, data transfer & analysis software.
- > Integral battery providing field measurement capability



# Pulse Modulated Chlorophyll Fluorescence

The FMS 2+ field-portable, pulse modulated chlorophyll fluorescence measurement system was developed in line with an increasing requirement for high sensitivity modulated instruments in front line photosynthesis research.

During measurement the tissue sample is exposed to a pulsed amber (or optional blue) LED light source (the modulating beam) which induces a pulsed fluorescence signal from the sample under conditions where ambient light is excluded. When ambient light is applied, the optical filtering of the system allows three types of light signal to reach the detector - ambient light of fluorescence wavelengths, non-pulsed fluorescence signal induced by the ambient light and pulsed fluorescence signal induced by the modulating beam. Application of ambient light changes the physiology of the sample, altering the proportion of energy that is re-emitted as fluorescence. Thus the magnitude of the peaks of the pulsed fluorescence signal that are induced by the modulating beam will reflect changes in sample physiology. It is these signals that the rapid pulse peak tracking electronics amplify and measure; ambient and non-pulsed fluorescence signal are discarded.

## Principles of modulated fluorimeters

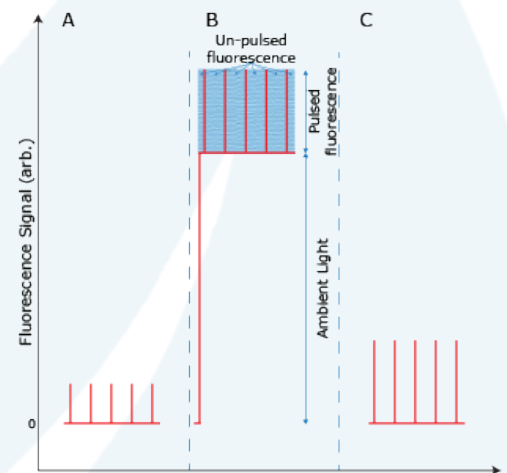
The diagram opposite shows the fluorescence signal detected by the FMS 2+ modulated chlorophyll fluorimeter under modulating beam only conditions (A), under actinic light plus modulating beam before (B) and after (C) the rapid pulse peak tracking electronics. The pulsed fluorescence that is induced by the modulation beam is effectively used to probe the efficiency of light-use for Photosystem II photochemistry. Clearly it is important that the measuring technique itself does not induce changes in the physiology of the sample under investigation.

Exposure of a sample to a powerful pulsed light source may be expected to introduce a significant artefact into the measurement. However, Hansatech Instruments modulated chlorophyll fluorimeters have been specifically designed to avoid such problems by using a modulating beam of very short duration pulses (1.8  $\mu\text{sec}$ ) with long off period between pulses. The net result is that the integrated amount of radiation incident upon the sample from the modulating beam is very small (approximately  $<0.05 \mu\text{mol m}^{-2} \text{s}^{-1}$ ), too small to induce significant physiological change in the sample (Schreiber et al. 1986), yet powerful enough to provide a reliable signal for fluorescence analysis.

The interpretation of fluorescence signals has developed considerably since the early experiments of Kautsky and Hirsch (1931) with several techniques employed to determine information about the photosynthetic performance of PSII (Baker 1991). FMS 2+ systems have been designed to incorporate these techniques into simple routines which store appropriate chlorophyll fluorescence measurements and automatically calculate key parameters.

A modulated chlorophyll fluorimeter uses sophisticated electronics to separate chlorophyll fluorescence from ambient light. The systems achieve this using a rapid pulsing excitation light in order to induce a corresponding pulsed fluorescence emission. The fluorimeter uses a highly sensitive photodiode to detect and record the pulsed fluorescence signal and to ignore any non-pulsed signal.

At physiological temperatures peak fluorescence emission occurs in the red region of the spectrum (685 nm) and extends into the infrared region to around 800 nm (Krause and Weiss 1984). Accurate determination of fluorescence requires a detection system which is sensitive to fluorescence wavelengths yet blind to the actinic (or excitation) light which drives photochemistry. In continuous excitation instruments, signal discrimination is achieved using a 650nm actinic light source to drive photochemistry with optical filtering of the detector to prevent detection of non-fluorescence wavelengths of light. Unfortunately such systems must be shielded from ambient light during use, otherwise the red/far-red component of day-light will be super-imposed on the fluorescence signal. The pulse modulation technique ensures that fluorescence readings may be taken under ambient conditions remaining unaffected by the conflicting red/far-red wavelengths.





# FMS 2+ System

## Field portable pulse modulated chlorophyll fluorimeter

The FMS 2+ is a field portable version of the FMS 1+ pulse modulated chlorophyll fluorimeter. The control unit contains all of the electronics, optics and light sources necessary to derive most common chlorophyll fluorescence parameters including  $F_v/F_m$ ,  $\Phi_{PSII}$ ,  $qP$ ,  $qNP$ ,  $NPQ$  and  $ETR$ .

FMS 2+ is supplied with a custom leafclip (FMS/PTL) which connects electrically to the control unit and provides measurements of ambient temperature and PAR - an essential component of the  $ETR$  (Electron Transport Rate) calculation.

The FMS 2+ chlorophyll fluorimeter is powered by a 2.0 Ahr rechargeable lead-acid battery (2 supplied), capable of >8 hours of continuous measurement in the field.

- > Upgraded model with LED light sources replacing older halogen bulbs
- > USB connectivity replacing older RS232 communications
- > Pulse-modulated system with compact, field-portable Design
- > Integral LED light sources for modulation beam, actinic & saturating pulses
- > Leafclip with integral PAR/temperature sensor
- > Field-swappable batteries
- > Temperature compensated electronics for stable  $F_o$  measurement
- > Programmable by user-friendly iconised script editor
- > Windows® data acquisition & data analysis software



## Other Instrumentation

### CL-01

#### Chlorophyll content meter

Chlorophyll content is an indicator of photosynthetic activity relating to nitrogen content. This is particularly significant in plant growth programs where affects of the addition of nitrogen to a crop may be closely monitored.



- > User-friendly, low cost chlorophyll content meter
- > Field portable, light-weight, robust design
- > Dual wavelength optical absorbance (620 and 940nm)
- > Chlorophyll content range : 0-2000 units
- > Simple 2 button keypad operation
- > Auto calibration and temperature compensation
- > 60 measurement memory capacity
- > No PC required.

# HPEA/LPA2

Liquid-phase chlorophyll fluorescence adapter for Handy PEA+



Convenient Plug & Play design allows direct connection to Handy PEA+ in place of standard sensor head to facilitate chlorophyll fluorescence measurements from liquid-phase samples (requires Handy PEA+ system – sold separately).

- > Records OJIP parameters from liquid samples in 2ml vials
- > Range of amplification settings from x0.25 – x4.0 in addition to x10 gain in Handy PEA+ (effective max. gain of x40)
- > High intensity (up to  $3500 \mu\text{mol m}^{-2} \text{s}^{-1}$ ) 637nm red LED
- > Auto-zero function
- > Integral lithium polymer battery recharged via Handy PEA+ charger

# OXY/ECU

Oxygen electrode conditioning unit



Accessory for oxygen electrode systems allowing user selectable polarising voltages for measurement of other analytes with a built in automated electrode disc plating process for Hydrogen measurements.

- > Connects directly to Oxyview, Oxygraph, Oxygraph+, Oxytherm, Oxytherm+, OxyLab and OxyLab+ control units
- > User selectable polarising voltages over the range -1200mV to +1200mV in 100mV steps
- > Fully automated disc plating procedure to convert an S1 oxygen electrode for Hydrogen measurements.

# Distributors

Hansatech Instruments rely on a series of International Support Centres located in more than 30 countries around the world for sales and support of Hansatech Instruments products.

If you require technical assistance or wish to make a sales enquiry, please visit the Distributors page on our website at [www.hansatech-instruments.com/distributors/](http://www.hansatech-instruments.com/distributors/) and check to see if a local representative exists in your country in the first instance. If no local representative is present in your country, please contact Hansatech Instruments directly.

We currently have representation in the following countries:

- > Argentina
- > Australia
- > Austria
- > Belgium
- > Botswana
- > Brazil
- > Chile
- > China
- > Denmark
- > France
- > Germany
- > Greece
- > Hong Kong
- > India
- > Indonesia
- > Iran
- > Italy
- > Japan
- > Malaysia
- > Norway
- > Philippines
- > Poland
- > Portugal
- > Romania
- > Russia
- > Saudi Arabia
- > Singapore
- > South Africa
- > South Korea
- > Spain
- > Switzerland
- > Taiwan
- > Thailand
- > The Netherlands
- > Turkey
- > United Kingdom
- > USA
- > Vietnam





# Development & Warranty Information

## Development Policy

A policy of continuous development ensures that our range keeps abreast of current research needs. Recent advances in electronics technology have allowed rapid development of new generations of instruments providing flexibility & scope for multiple applications from single instruments. In the interests of updating & improving our equipment, we reserve the right to alter specifications without prior notice.

## Warranty & Customer Support

Purchase from Hansatech Instruments does not, however, stop there. Customers, both new & old, are assured of ongoing support & prompt & efficient attention to enquiries at all times. A large number of technical support issues may be dealt with quickly & efficiently by email & with the use of the support tools available from our web site. All software is available to registered users of Hansatech Instruments equipment for download from the Support section of our web site.

All equipment supplied by Hansatech Instruments is guaranteed for 12 months from the time of despatch against manufacturing faults or defective materials. The guarantee does not cover damage caused by misuse or unauthorised attempts to repair. If difficulties are experienced with the equipment, please contact Hansatech Instruments for advice. If necessary, equipment may be returned for repair/replacement during the warranty period. No charge will be made for parts/labour under warranty but we reserve the right to charge for customs clearance and return carriage if appropriate.

For repairs outside of the warranty period, please contact us for an estimate of cost & instructions regarding the return of equipment. If the product was purchased via a Hansatech Instruments distributor, please contact them for advice.

We also have a Registered Users Ticketing System on our website where users are encouraged to raise support questions. To register your instrument, you will require the product type and serial number.

Please go to [www.hansatech-instruments.com/register](http://www.hansatech-instruments.com/register) to register your system.



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.