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The O2k-Fluorescence LED2-Module

http://www.bioblast.at/index.php/O2k-Fluorescence_LED2-Module

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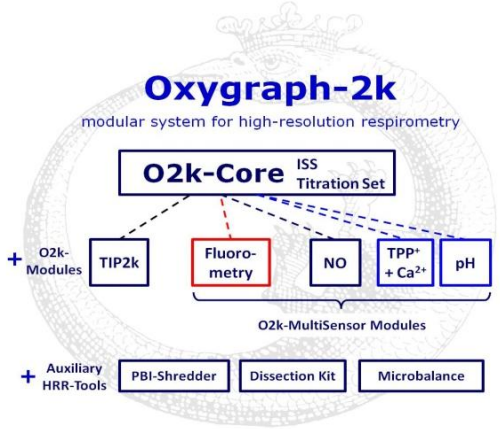


The O2k-Fluorescence LED2-Module is a modular extension of the O2k-Core (Series D-F). A growing number of fluorescence markers enables determination of diverse mitochondrial processes in addition to oxygen consumption, including generation of H_2O_2, ATP production, mitochondrial membrane potential and Ca^{2+}, extendable by user-specific applications.

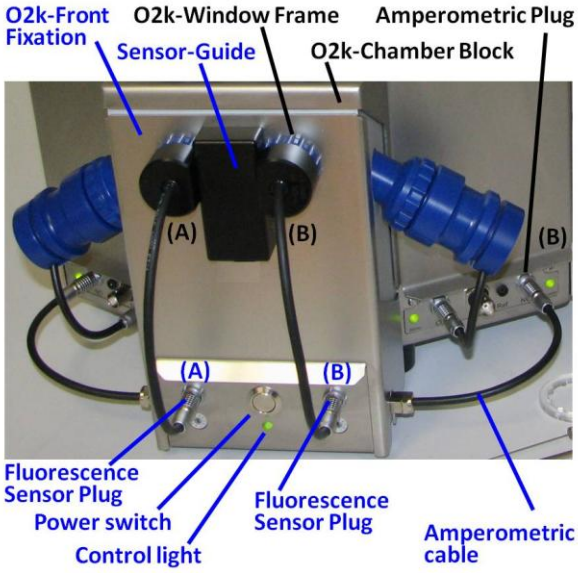
1. Components of the O2k-Fluorescence LED2-Module

The O2k-Fluorescence LED2-Module includes two pairs of sensors. Each of the four 'Fluo-Sensors' has a light-emitting diode (LED), a photodiode, a Filter-Cap, and three filter sets which can be exchanged for applications of various fluorophores. The Fluo-Control Unit is mounted to the O2k-Core with the O2k-Front Fixation and can be easily attached or removed. If connected to the amperometric O2k-MultiSensor channels, the signals and corresponding fluxes are recorded by DatLab simultaneously with O_2 concentration and O_2 flux.

2. Setup of the O2k-Fluorescence LED2-Module

1. Switch off the O2k with the power switch at the rear side of the O2k.

2. Remove both blue O2k-Window Frames by placing the O2k-Window Tool around the outer rim of the window frame and unscrewing counter clockwise.
3. Pull the Sensor-Guide ('nose') from the O2k-Front Fixation of the Fluo-Control Unit.
4. Align the Fluo-Control Unit with the O2k-Chamber Block so that the Fluo-Power cables are placed in the middle below the O2k-Main Unit from front to rear. Attach the Fluo-Control Unit to the O2k-Chamber Block with the O2k-Window Frames and fix them tightly with the O2k-Window Tool.



5. Reattach the Sensor-Guide to the O2k-Front-Fixation.
6. Unplug the O2k-Power cable at the rear of the O2k and connect it to the female plug of the Fluo-Control Unit. Insert the male plug of the Fluo-Control Unit into the main socket at the rear of the O2k.

7. Connect the cables from the side of the Fluo-Control Unit to the 'Amp' plugs (labeled "NO" in Series D-E) on the O2k-Main Unit. In this configuration, the O2k can be used for high-resolution respirometry and fluorometry. It is not necessary to dismount the Fluo-Control Unit for basic HRR when no fluorescence signal is recorded.

3. The Fluorescence-Sensors

Standard configuration:

Two Fluorescence-Sensors Green: 525 nm, Filter-Cap for H_2O_2 measurement with Amplex® UltraRed.

Two Fluorescence-Sensors Blue: 465 nm, Filter-Cap for measurement of mt-membrane potential with safranin. A different filter is used for measurement with Magnesium green® or Calcium green®.

Filter-Caps: The Filter-Cap can be exchanged for each Fluo-Sensor for applications with different fluorescent dyes.

Dismounting: Pull the Filter-Cap straight from the Fluo-Sensor. The Filter-Cap Guide prevents rotational movements.

Replacing filters: Remove the two filters and store them in the filter box labeled for this filter set. Insert the filters from the selected filter set: The round filters fit to the round window of the filter cap and cover the LED, the rectangular filters fit into the rectangular window of the filter cap and cover the photodiode.

Mounting: Hold the Fluo-Sensor and Filter-Cap in a vertical position. Align the Filter-Cap with the Filter-Cap Guide, the small steel rod protruding from the sensor. Press the Filter-Cap onto the sensor without any rotational movements.

Connect the Fluo-Sensors to the O2k: Insert the Fluo-Sensor into the window of the O2k-chamber as far as possible, aligning the Sensor-Guide Sector with the Sensor-Guide of the O2k-Front Fixation. Connect the cable of the Fluo-Sensor to the Fluo-Sensor Plug of the Fluo-Control Unit.

Removing the Fluo-Sensors: Remove the Sensor-Guide and rotate the Fluo-Sensor while pulling it out. Never pull on the cable. Replace the Sensor-Guide.

4. Stoppers

Use only black stoppers in conjunction with optical measurements. Black PEEK stoppers are now used for all HRR applications in general. See MiPNet12.06 for calibration of the O2k-Chamber volume, which is identical for black PEEK or white PVDF stoppers. During optical measurements, place black Cover-Slips on top of the O2k-Stoppers to prevent any light from penetrating into the O2k-Chamber through the injection ports.

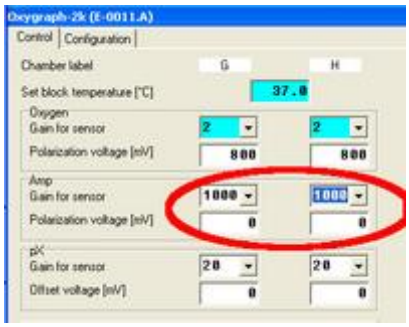
5. Electronic and DatLab Settings

1. Switch on the power of the O2k-Main Unit (rear).

2. Press the power switch on the front panel of the Fluo-Control Unit. Check that the control lights are on.

3. Start DatLab and select the DatLab menu [O2k-MultiSensor]/[O2k-Control]. Open the Configuration window and define the sensor for documentation.

Control of LED-intensity: The light intensity of the LED of each Fluo-Sensor (O2k-Chamber A and B) is controlled in the DatLab Control window in the field "Amp Polarisation voltage [mV]" (0 to 2000). Click Connect to Oxygraph-2k or Send to Oxygraph to apply the new settings.



For Fluo-Module Series A, use Position 9 (Variable) on both sides of the Fluo-Control Unit.

If the Polarization voltage is >0 and the Fluo-Control Unit is switched on, the indicator light on the Fluo-Control Unit is green. If the current is zero (the LED is not used), but the Fluo-Control Unit is switched on, the indicator light is red. Vary the light intensity while the Fluo-Sensors are placed outside the chamber to observe the change in light intensity. Do not look directly into the LED to protect your eyes.

Amplification: The gain for the amperometric (Amp) channel is set in the DatLab Control window in the field "Amp Gain for sensor" (1, 10, 100, or 1000). The gain amplifies the Amp raw signal [V] which can be recorded in the range -10 to +10 V.

Application-specific settings

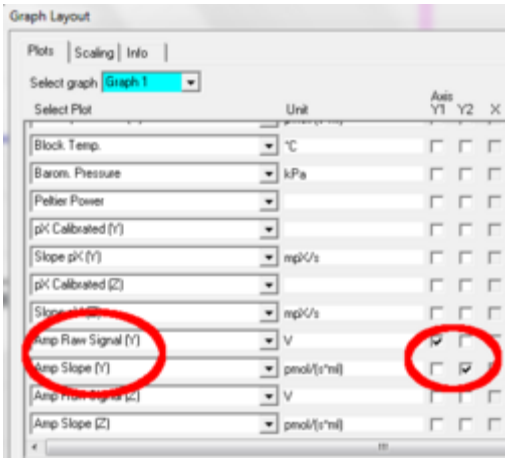
Application	Sensor	Filter set	Light intensity Amp voltage	Gain
Amplex® UltraRed	Fluorescence-Sensor Green	AmR	100 - 500	1000 (at light intensity = 100)
Safranin	Fluorescence-Sensor Blue	Saf	200 for >2 µM; 500 or higher for <2 µM safranin	1000
Magnesium green	Fluorescence-Sensor Blue	MgG / CaG	300	#
Calcium green	Fluorescence-Sensor Blue	MgG / CaG		#

#The optimum amplification for Magnesium green® and Calcium green® depends on the concentration of the fluorophore, which may vary widely in different applications. Therefore, no recommendation for the gain is given.

4. Insert the Fluo-Sensors into the windows of the O2k-Chambers.
5. Switch off the internal light [F10].
6. Close the O2k-Chamber by fully inserting the stoppers without trapping any gas bubble. A gas phase disturbs the optical signal by reflections.
7. Place black Cover-Slips on top of the O2k-Stoppers.
8. Select a graph layout to observe the change in the Amp signal when changing the light intensity (Amp voltage) or amplification (Gain).

DatLab templates for fluorescence applications can be downloaded from the OROBOROS homepage. See MiPNet12.07 for importing DatLab Template files.

Graph layout / Select Plot: Three plots are available in DatLab based on the recorded signal: Amp Raw Signal, Amp Calibrated, and Amp Slope. These plots can be selected from the drop-down lines and displayed with their check boxes either on the Y1 or the Y2 axis [Graph layout / Select Plots].



Amp Raw Signal displays the raw voltage (including amplification) as recorded by the O2k at a given gain setting.

Amp Calibrated is the signal after calibration with the parameters set in the Calibration window of the Amp channel.

Amp Slope is the time derivative of the calibrated signal, multiplied by 1000, in units [m(conc. Unit during calibration)/s], so if the signal was calibrated in µM (nmol/ml), the unit of the slope will be nM/s [pmol·ml^{-1}·s^{-1}]. To display the

slope calculated from the raw signal instead, check the appropriate box in the calibration window.

9. Define the *Y*-axis of the DatLab graph if an appropriate Graph layout is not available: Open the calibration window ([F5] or double click on the [Amp Calib] button) and enter the name in the field "Name for Amp-channel". Avoid long names. Enter the unit for the calibrated signal from the drop down menu beside "Unit". Default: "µM".
   Choose the factor for slope calculation from the drop down menu beside "Slope factor". Default: 1000. The correct unit for the slope is set by DatLab depending on (i) the unit selected for the calibrated signal and (ii) the factor for slope calculation. After changing the slope factor, all values for the slope plot are automatically recalculated.

10. Select the Gain setting to obtain a maximum voltage below 10 V. If the maximum observed raw signal is 9 V in an initial experiment, then the gain should be reduced to avoid "off scale" (>9.99 V). If the maximum recorded raw signal is lower than 1 V (e.g. 0.2 V), the gain should be increased to avoid limitation of resolution by digital noise.

6. Calibration during an experiment

11. During air calibration of the OroboPOS in the absence of a biological sample, the stoppers are partially inserted in the 'open' position and a gas phase is in the chamber above the stirred medium. The time for gaining a stable oxygen signal can be used to thermally equilibrate the Fluo-Sensors. In the open position, the optical signal is disturbed by the gas phase. Remove the Fluo-Sensors whenever a visual check of the O2k-chamber is necessary, but for a short period of time only.

12. Start an experiment as usual for HRR. Before an optical calibration is made, the biological sample must be added and the chambers must be closed.

13. Switch off the O2k-chamber light. [F10]

14. Add black Cover-Slips on top of the stoppers, and remove them only briefly during titrations.

Different fluorescence applications require specific calibration procedures (e.g. safranin versus H_2O_2). Note that for some applications (H_2O_2 production), the slope of the fluorescence signal is the relevant parameter, not the signal itself.

7. Further information and trouble shooting

For further information and updated versions see:

www.bioblast.at - OROBOROS Catalogue in Bioblast:
» http://www.bioblast.at/index.php/O2k-Fluorescence_LED2-Module

www.oroboros.at - O2k-Manual updates:
» http://www.oroboros.at/?O2k-FluorescenceLED2-Module

8. References

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www.oroboros.at/?MitoCom-Tyrol

Author contributions
Fasching M, Gradl P and Gnaiger E were responsible for the project and instrumental development. Eigentler A and Fontana-Ayoub M performed test experiments. Fasching M and Gnaiger E prepared the manuscript.
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