

Industrial Products Resulting from Research of O. S. Wolfbeis and coworkers

(version of Nov. 2020)

(1) Diagnostic Instrumentation

1.1. Blood Gas Monitoring Systems during Cardiopulmonary Bypass Using Planar Fluorescent Sensors

For determination of extracorporeal pH values, oxygen, K^+ , pCO_2 and other parameters (CDI series 400 and higher; Manufactured by *Terumo Inc.*). Used in almost 70% of all critical care operations (such as in heart surgery) in the US. Based on respective fluorescent sensors as described in the paper list.

Web: <http://www.terumo-cvs.com/products/ProductDetail.aspx?groupId=3&familyID=906&country=1>



1.2. CO₂ Sensor-Based Fluorometric Quantitation of Pathogenic Bacteria in Blood

The *Becton Dickinson* instruments for the detection of pathogenic bacteria in whole blood (<https://www.bd.com/en-us/offerings/capabilities/microbiology-solutions/blood-culture/blood-culture-instrumentation/bd-bactec-fx-blood-culture-system>). Uses one of the CO₂ sensors described in the list of papers. Manufactured by *Becton-Dickinson*. Video on the FX40 systems: <https://www.bd.com/en-us/company/video-gallery?video=4543798550001>;



Left: Detection bottle with the fluorescent CO₂ sensor on the bottom. *Bottom:* a moderately sized instrument for low throughput screening for bacteria in blood. *Right:* An array of instruments for high-throughput screening for bacteria in blood.



1.3. Oxygen Sensor-Based Fluorometric Detection of *Microbacillus tuberculosis*

Enables instrumental detection of mycobacteria in pulmonary specimens (MGIT series; manufactured by *Becton-Dickinson*). <https://www.bd.com/en-uk/products/diagnostics-systems/identification-and-susceptibility-systems/bactec-mgit> The instrument has a maximum capacity of 960 MGIT tubes (7 mL), or with a 42-day detection protocol, approximately 8000 specimens per year. The test tube contains modified Middlebrook broth base, and OADC enrichment and an antibiotic mixture. An oxygen sensor film containing a ruthenium(II) based luminescent oxygen probe is used to measure the decrease oxygen partial pressure over time.



1.4. The **Mycobacteria Growth Indicator Tube**

For *visual* (instrumentation-less) detection of *M. tuberculosis*.

https://en.wikipedia.org/wiki/Mycobacteria_growth_indicator_tube

Manufactured by *Becton-Dickinson*. Contains a fluorescent sensor on the bottom of the tube; increase in red fluorescence indicates a positive test. For use in less industrialized countries. A microMGIT fluorescence reader is also available. Same sensor as in 1.3.

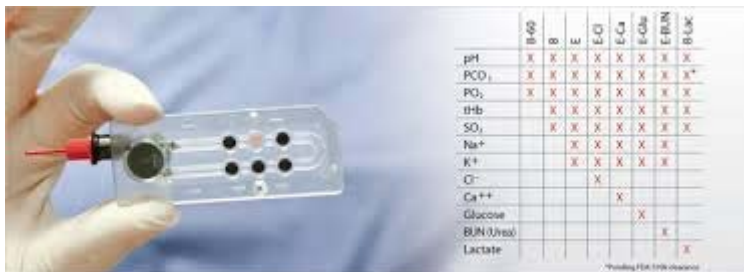


1.5. OPTI® CCA Portable and Fast Microfluidic **Blood Analyzers**

for pH, pO₂, pCO₂, tHb, SO₂; Na⁺, K⁺, Ca²⁺, Cl⁻, glucose, BUN, lactate. See

<https://www.optimedical.com/products-services/products-services.html>. Manufactured by *OptiMedical*.

Various systems available (OPTI® CCA; OPTI® CCA TS2, OPTI® LION). This unique technology does not use electrodes or contact points, which eliminates the need for costly electrode maintenance. The pictures show the disposable microfluidic cassette (with colored sensor spots) and the instrument. The cassette is placed under the lid of the reader, and the blood sample is inserted via a syringe as shown on the right. Fluorescent sensor spots are used. Their red or black color results from the use of optical isolations.



1.6. Animal **Electrolyte and Blood Gas Analyzer**

Used in veterinary medicine. (<https://www.idexx.com/en/veterinary/analyzers/vetstat-electrolyte-blood-gas-analyzer/>). Contains sensors for Na⁺, K⁺, Ca²⁺, Cl⁻, pH, pCO₂, pO₂, hemoglobin, oxygen saturation, transcutaneous CO₂, HCO₃⁻, base excess, anion gap. Manufactured by *Iidexx*. Similar to 1.5. but for veterinary uses.

(2) Planar Sensor Foils, Fiber Optic Sensors, Imagers

2.1. Planar **Sensor Foils**

For fluorometric sensing and imaging of oxygen, pH values, CO₂; for use in food sciences (brewing), marine sciences, biotechnology and pharmaceutical plants, and to test the tightness of bottles. Manufactured by *Presens GmbH* (www.presens.de). Includes oxygen sensors for use in testing the tightness of plastic bottles (oxygen ingress). The pictures show the size of typical sensor spots (left), and a self-adhesive oxygen sensor spot (for integration into transparent vessels and tubes).



2.2. Fiber Optic **Microsensors**

For fluorometric sensing of oxygen, pH values, CO₂; tip diameter 20 μm; for use in biology and marine sciences, fish farming, profiling of sediments, microbial mats or biofilms. Manufactured by *Presens GmbH* (www.presens.de/O2/products). The widely used oxygen sensors have a detection limit of 0.03 % oxygen.



2.3. Hand-Held Fluorescence **Imagers** for Imaging of Oxygen, pH Values and CO₂

Uses sensor foils. See

<https://www.presens.de/products/imaging>

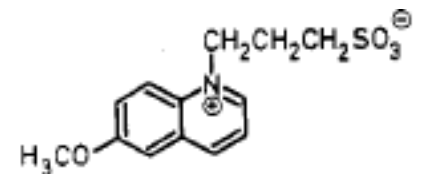
A sensor layer is placed on the subject of interest (such as wounded or tumorous skin) or a leaf. Fluorescence is imaged and data are processed to give a pseudo-colored presentation. Manufactured by *Presens GmbH*.



3. Optical Assays and Tests

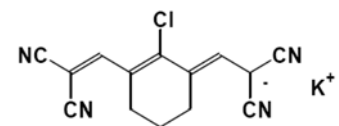
3.1. Fluorescent **Chloride Probes** such as Sulfopropylquinolinium (SPQ)

Now widely used for sensing and imaging of chloride in cells and in ion transport or to diagnose *Mucoviscidosis* (Cystic fibrosis). Fluorescence is strongly quenched by chloride, also by bromide and iodide. Available from *Thermofisher*, *Biotium*, *Sigma Aldrich*, *Genecopoeia*, *PromoCell*, *Biomol (Caymen)*, and others.



3.2. Test Kit for Detection of Borderline **Micro-Albuminuria**

Uses the optical probe *Albumin Blue*. Detects albumin (which is increased in case of kidney malfunction) in urine. Available from *ActiveMotif* (<https://www.activemotif.com/catalog/104/albumin-blue-fluorescent-assay-kit>), *Progen* (www.progen.com), and others.



Albumin Blue 580

3.3. Optical Total Organic Carbon (**TOC**) test

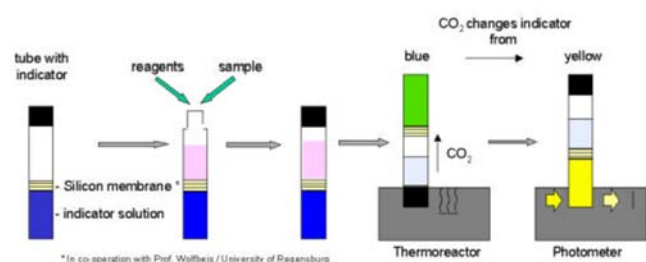
For rapid optical and visual determination of TOC. See <https://www.merckmillipore.com/> Manufactured by *Merck*. The decrease in the absorption of the blue pH indicator dye at 640 nm (as determined by photometry) is a parameter for the TOC level.

TOC Determination

MERCK

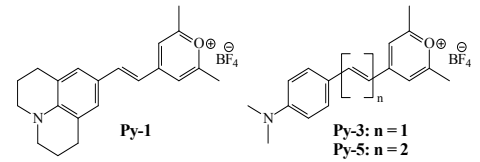
TOC Determination

- Remove inorganic carbon by stirring the sample on a stirrer vigorously.
- Add stirred sample and the digestion reagent into the TOC tube



3.4. Fluorescent Labels for Proteins and DNA

Reacts with primary amino groups. Mainly used to label antibodies and in immuno kits. Known as Chromeo™ dyes. The labels are blue but if conjugated to a primary amino group in a protein, a DNA or on a modified surface, they turn to red and become fluorescent. Typical chemical structures of Chromeo pyrylium dyes (such as Chromeo-P503 and Chromeo-P546) are shown on the right. Manufactured by *Activemotif* (<https://www.activemotif.com/catalog/6/fluorescence>). Also available from Sigma-Aldrich and Santa Cruz Biotechnology.



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3. Other Technology Transfer Activities

3.1. Member (1996 – 1998) of the Planning Committee of the Biotechnology Cluster *BioRegio Regensburg* and of *Biopark GmbH*

Following two years of planning within the BioRegio initiative of the German federal government, Biopark Regensburg (<https://www.biopark-regensburg.de/de/>) was established in 1998. It has become a major establishment for technology transfer from Regensburg University to regional industry and to start-up companies.



3.2. Founder and first CEO of *Chromeon GmbH* (2001 – 2007)

Manufacturer of fluorescent dyes and labels including chameleon labels such as Chromeo™ P540. Company has been acquired by Active Motif Inc. (Carlsbad; CA). For specific probes, see: <https://www.activemotif.com/catalog/108/fluorescent-chromeo-dyes> and see the Sigma-Aldrich catalog.



3.3. Initiator of the *Fraunhofer Group on Sensor Materials*

Founded in Regensburg in 2010; now part of the Fraunhofer EMFT in Munich. The group mainly works on stimulus-responsive (optical) materials for industrial sensing (<https://www.emft.fraunhofer.de/>)

