

MEASURING QUALITY. SINCE 1796



## MODIFIED ATMOSPHERE TESTERS

GAS ANALYSERS FOR CONTROLLING PROTECTIVE GAS PACKAGING



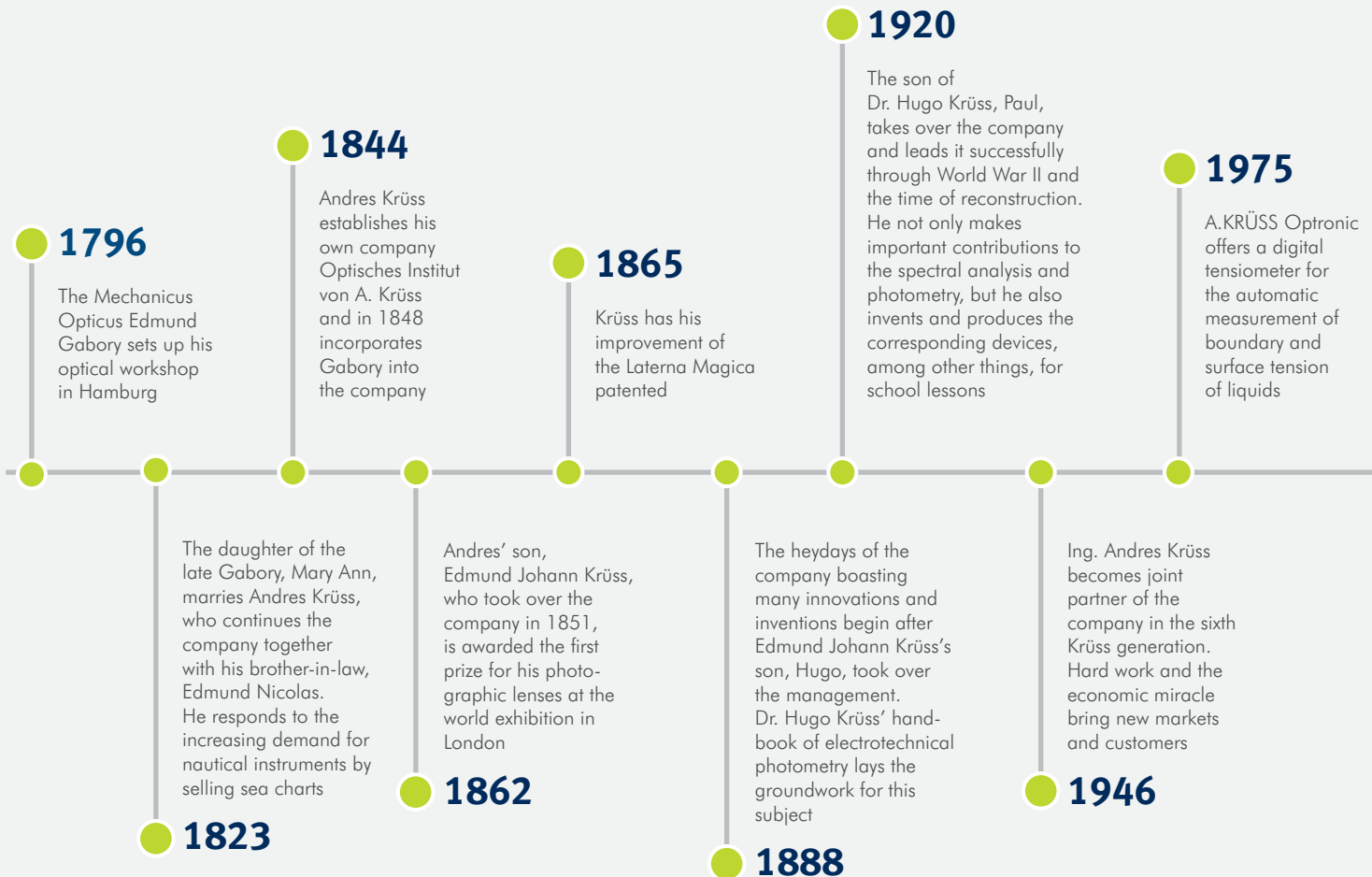
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# A.KRÜSS OPTRONIC – CUTTING-EDGE TECHNOLOGY, MADE IN GERMANY

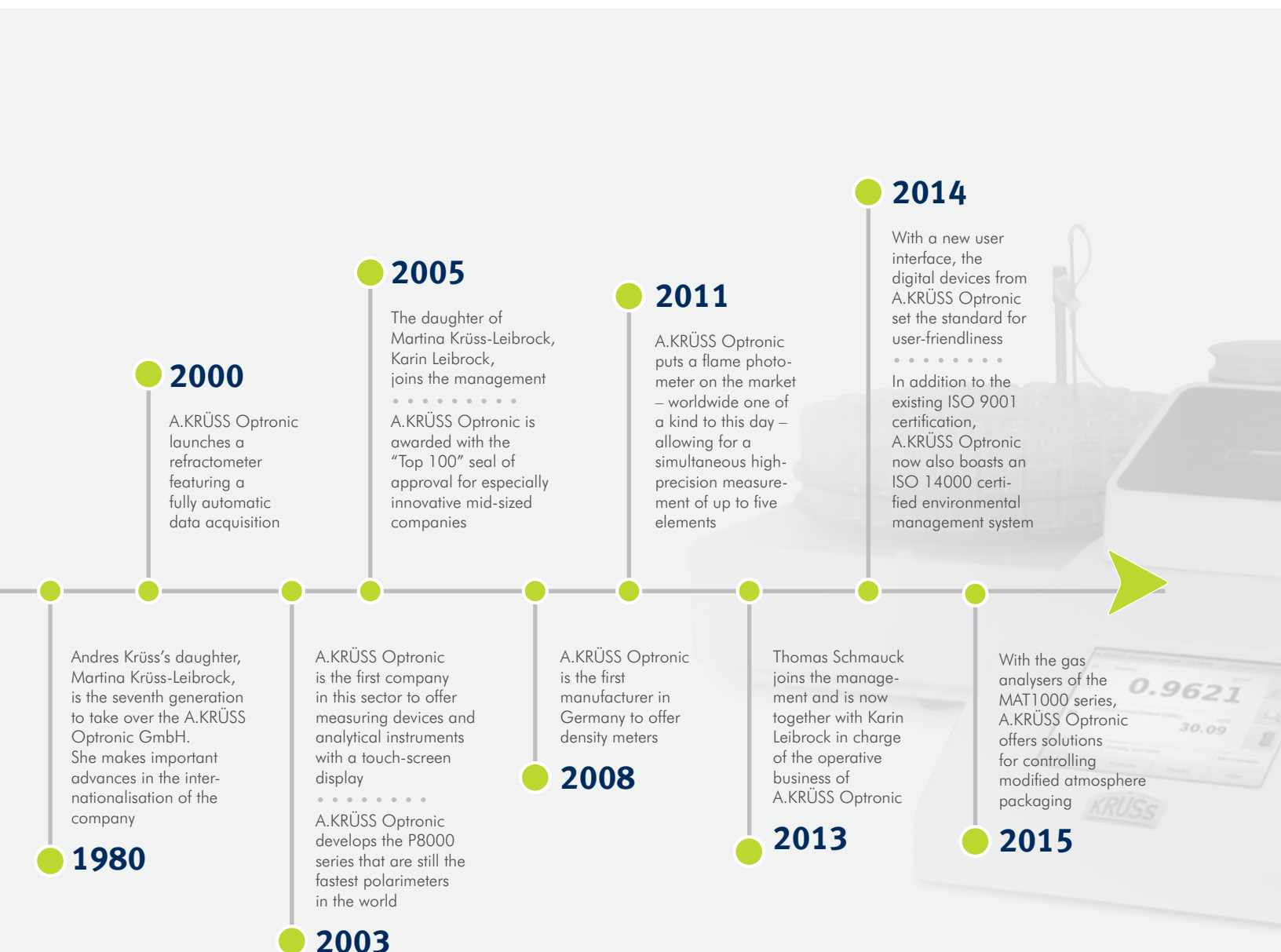
A.KRÜSS Optronic is a leading manufacturer of high-precision optoelectronic measuring devices and analytical instruments. The family enterprise founded in 1796 offers an extensive range of products and customised solutions for quality assurance in the pharmaceutical, chemical, petrochemical, food and beverage industry as well as for research and science. We also offer a wide variety of products for professional gemology. Whether it is a refractometer, polarimeter, density meter, gas analyser,

flame photometer, melting point meter or microscope – our instruments meet the highest requirements in terms of speed, accuracy and reliability. Thanks to our strong R&D capacities, we are a driving force in the technology market setting the standards for functional scope and user-friendliness. A dense network of sales partners and certified service partners allows us to provide individual consultation as well as optimised service and support for our customers around the globe.

## OVER 200 YEARS OF PIONEERING SPIRIT AND SUCCESS



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## MODIFIED ATMOSPHERE PACKAGING

In order to be successful on the market, manufacturers of sensitive or perishable products must be able to guarantee first-class quality over a long period of time. This applies, in particular, to the food industry but also the electronics, pharmaceutical or cosmetics industry.

Modified Atmosphere Packaging (MAP) plays a decisive role in this. Typical protective gases are nitrogen ( $N_2$ ), carbon dioxide ( $CO_2$ ) and oxygen ( $O_2$ ) as well as a mixture of these gases. These are natural components of the ambient air but in modified concentrations that need to be checked. In most food packages, the oxygen concentration is reduced while the carbon dioxide concentration is increased in order to inhibit the growth

of aerobic microorganisms. That also allows you to slow down oxidation processes that change the ingredients and thus the taste and colour of the products. Other food-stuff, however, requires a certain oxygen content inside the packaging so it can stay fresh or keep its colour.

But protective gases are not only used in the food industry. Electronic components are also packaged under nitrogen in order to prevent oxidation and corrosion processes.

The same applies to pharmaceutical or cosmetic products, for example, in vials or blister packages. In addition, the modified atmosphere stabilises the packaging providing the product with a mechanical protection.

### ANALYSIS OF HEADSPACE VOLUME

In order to check the mixture ratio of the protective gases inside a package, a self-adhesive septum is applied to a sampling point. The suction needle of the gas analyser is then inserted through the septum into the headspace of the package. A simple touch on the touch-screen of the device will ensure that the required sample is automatically drawn in. Within a very short time, the oxygen and carbon dioxide content is measured, the nitrogen content calculated, and the results are shown on the display.



*Taking a protective gas mixture sample from a food package*

### PROTECTIVE GASES

N N

O C O

O O

#### NITROGEN ( $N_2$ )

Nitrogen is an inert gas and does not react with surrounding substances. For manufacturing reasons, it has a high purity of up to 99.99%, it is colourless, odourless and tasteless and diffuses only very slowly through plastic film. That is why it is used in MAP to displace oxygen, to adjust a gas mixture or to function as a filling gas that prevents the collapse of the packaging. A 100% nitrogen atmosphere is used for snack products to prevent oxidation and thus rancidity.

#### CARBON DIOXIDE ( $CO_2$ )

Carbon dioxide – colourless, odourless and tasteless just like nitrogen – inhibits oxidation processes and the growth of most aerobic bacteria and moulds. It is therefore often used to increase the storage life of packaged foodstuff. Generally, the following applies: the higher the  $CO_2$  content, the longer the storage life. However, some food will change its taste if the  $CO_2$  content is high. In addition, the gas might be absorbed by the product or escape from the packaging making it collapse.

#### OXYGEN ( $O_2$ )

If food comes into contact with oxygen, it will usually oxidise and go bad. Oxygen also allows for the growth of aerobic microorganisms. This is the reason why protective gas packaging often does not contain any oxygen or only very little. Fresh produce, however, requires oxygen since it still “breathes” after the harvest. A high  $O_2$  content of 70% in the packaging is even beneficial in case of raw red meat: It prevents the product from becoming “pale” as well as its colonisation by anaerobic microorganisms.

## THE GAS ANALYSERS OF THE MAT1000 SERIES

Quality assurance and ever increasing consumer requirements make it necessary to control modified atmosphere packaging on a regular basis. Gas analysers must deliver fast, reliable measurement results and be easily integrated into the work process – just like our devices from the MAT1000 series. They are used by many companies for the quality inspection in the lab but also at the production

line if sensitive or perishable products are filled or packaged. Our Modified Atmosphere Testers (MAT) are suitable for both the random sampling and the permanent monitoring of the gas mixture used on packaging machines. Their solid metal housing with an interchangeable protective cover offers protection against impact and dirt from the outside.



Gas analysers of the MAT1000 series

### EASY OPERATION AND HIGH SAFETY STANDARD

As a user of our gas analysers, you enjoy many benefits:

- Easy and intuitively to use via touch-screen – even by untrained personnel
- Methods and scales that can be configured by the user for many different applications
- Freely definable formulas and parameters for complex conversions
- Shortcut keys for the most important functions
- Optional user administration with two authorisation levels
- Easy-to-understand, menu-guided adjustment
- Only a small sample volume required
- High accuracy even with small sample volumes
- Short measurement period
- Customised layout of the result reports
- Compliance with global standards such as GMP/GLP and 21 CFR Part 11 (Audit Trail)
- Validation possible
- High safety standard thanks to the traceability and reproducibility of all measured data
- Integrated interfaces for the convenient transfer of measured values (USB, Ethernet, RS-232)
- Compact design in robust cast aluminium housing
- IQ/OQ/PQ by A.KRÜSS Optronic or certified service partners
- Service, maintenance, calibration and adjustment on site

## INDIVIDUAL SOLUTIONS FOR ANY MODIFIED ATMOSPHERE

In order to meet the different requirements on the quality control of protective gas packaging, we offer four types of gas analysers that are fitted with different sensors and measuring cells.

### MAT1100

#### THE REASONABLY PRICED ENTRY-LEVEL MODEL FOR SAMPLE CHECKS

The MAT1100 is the right choice whenever you only need to be concerned with the oxygen concentration or whenever only nitrogen is used. Its electrochemical oxygen cell (EC) measures within the range of 0.5 and 35 volume per cent and with an accuracy of  $\pm 0.2$  volume per cent. Unlike our other models, the MAT1100 requires very little time to heat up and can therefore be quickly used for occasional measurement or in case of frequent "changes of location".

### MAT1200

#### THE ECONOMICAL SOLUTION FOR O<sub>2</sub> AND CO<sub>2</sub> MEASUREMENTS

If you need to measure the concentrations of oxygen and carbon dioxide, then the MAT1200 will be the appropriate model. In addition to an electrochemical oxygen cell, it features a non-dispersive infrared sensor (NDIR) for the CO<sub>2</sub> measurement over the measuring range of 0 and 100 volume per cent and with a high accuracy of  $\pm 0.5$  volume per cent. The MAT1200 hence covers most carbon dioxide applications in modified atmosphere packaging – at a very attractive price.

### MAT1400

#### THE SPECIALIST FOR FAST, HIGH-PRECISION OXYGEN MEASUREMENTS

The zirconium dioxide sensor (ZrO<sub>2</sub>) of the MAT1400 measures the oxygen concentration over the entire measurement range between 0 and 100 volume per cent. Especially in case of a very low concentration, it will achieve an excellent accuracy of  $\pm 0.001$  volume per cent. The MAT1400 is therefore suitable for the inspection of oxygen-free as well as oxygen-rich modified atmospheres. It can also be used in the cold storage room from ambient temperatures of 10 °C.

### MAT1500

#### THE ALL-ROUNDER FOR HIGHEST STANDARDS

Fitted with a zirconium dioxide sensor and a non-dispersive infrared sensor, the MAT1500 combines the advantages of the MAT1200 and MAT1400 and is our number one when it comes to the range of application, performance and precision. The measurements are completed within only approx. ten seconds. As is the case with the MAT1400, highly precise results can be achieved with single measurements of oxygen concentrations thanks to the min/max detection even if only a small sample volume is available.

## NEEDS-BASED MEASUREMENT PROCEDURES

### MANUAL MEASUREMENT

In case of a manual measurement, the user can individually set the measurement period and therefore adjust it to the available headspace volume. This will prevent a vacuum from forming in flexible packages that would allow the product to enter and clog the needle.

### AUTOMATIC MEASUREMENT

When an automatic measurement is performed, the measurement will be automatically ended as soon as the measured value stays within a variance that the user can freely set. This saves significant time and improves the reproducibility of the measurement results.



## MIN/MAX DETECTION

In case of single measurements of oxygen concentrations, our models MAT1400 and MAT1500 will achieve highly precise results even if only a small sample volume is available. This is ensured by their short measurement period, the

so-called  $t_{90}$  time, in combination with the min/max detection, where in each case only the lowest or highest measured value is evaluated. Therefore, the additional taking in of ambient air after the sample volume has been consumed does not pose a problem. 7

## OVERVIEW OF OUR GAS ANALYSERS AND SENSORS

|                        | MAT1100                              | MAT1200   | MAT1400  | MAT1500  |
|------------------------|--------------------------------------|---|--|--|
| AREA OF APPLICATION    | Sporadic O <sub>2</sub> sample check | Combined O <sub>2</sub> and CO <sub>2</sub> measurement | High sample throughput                                       | High sample throughput                                       |
|                        |                                      |   | High O <sub>2</sub> concentration                            | High O <sub>2</sub> concentration                            |
|                        |                                      |   |  | Combined O <sub>2</sub> and CO <sub>2</sub> measurement      |
| ADVANTAGES             | Cost-effective option                | Cost-effective option                                   | Long service life  | Long service life  |
|                        | Fast operational readiness           |   | Fast measurement   | Fast measurement   |
|                        |                                      |   | High precision with the lowest O <sub>2</sub> concentrations | High precision with the lowest O <sub>2</sub> concentrations |
|                        |                                      |   | Wide measurement range                                       | Wide measurement range                                       |
|                        | Low drift                            | Low drift   | Drift-free   | ZrO <sub>2</sub> : drift-free, NDIR: low drift               |
|                        |                                      | Environmentally compensated CO <sub>2</sub> measurement |  | Environmentally compensated CO <sub>2</sub> measurement      |
| O <sub>2</sub> SENSOR  | EC                                   | EC  | ZrO <sub>2</sub>   | ZrO <sub>2</sub>   |
| CO <sub>2</sub> SENSOR |                                      | NDIR  |  | NDIR   |
| N <sub>2</sub>         |                                      | Arithmetic determination                                |  | Arithmetic determination                                     |

### ELECTROCHEMICAL OXYGEN CELL (EC)

The measurement range of the electrochemical oxygen cell between 0.5 and 35 volume per cent O<sub>2</sub> makes it especially interesting for products such as fresh fruit, raw, low-fat fish or sea food, which are packaged neither under an oxygen-free nor particularly oxygen-rich modified atmosphere. Since this low-cost measuring cell is quickly ready for use, it is recommended for sporadic sample checks or if only a few samples are measured every day. The low-drift long-life cell in our MAT1100 and MAT1200 devices boasts an above-average service life of up to six years. Unlike conventional alkaline cells, it uses an acidic electrolyte (formic acid), which is why its cross-sensitivity toward acidic gas components such as carbon dioxide is low (< 0.002 volume per cent O<sub>2</sub> with a load of 100 volume per cent CO<sub>2</sub>), and a measured value correction as a function of the CO<sub>2</sub> concentration is not required. The carbon monoxide in coffee packages or flammable gas components such as alcohol also do not influence the specified accuracy.

### ZIRCONIUM DIOXIDE SENSOR (ZrO<sub>2</sub>)

Because of its excellent accuracy of  $\pm 0.001$  volume per cent with the lowest O<sub>2</sub> concentrations, the zirconium dioxide sensor is primarily used to test oxygen-free modified atmospheres for sterilised finished products or electronic, pharmaceutical or cosmetic products. Thanks to its wide measurement range between 0 and 100 volume per cent, it can also be used for high oxygen concentrations as required for red fresh meat. The investment in the zirconium dioxide sensor of the MAT1400 and MAT1500 devices will quickly pay off if many samples are measured every day due to the long service life of up to 15 years. Thanks to the fast response time of 0.3 seconds, only very little sample gas is required – an advantage especially in case of a small headspace volume as it is common with sachets and cosmetics products. The cross-sensitivity of the sensor toward humidity and temperature is low. A regular adjustment is not necessary because it is free of drift. We simply recommend an occasional calibration with synthetic air.

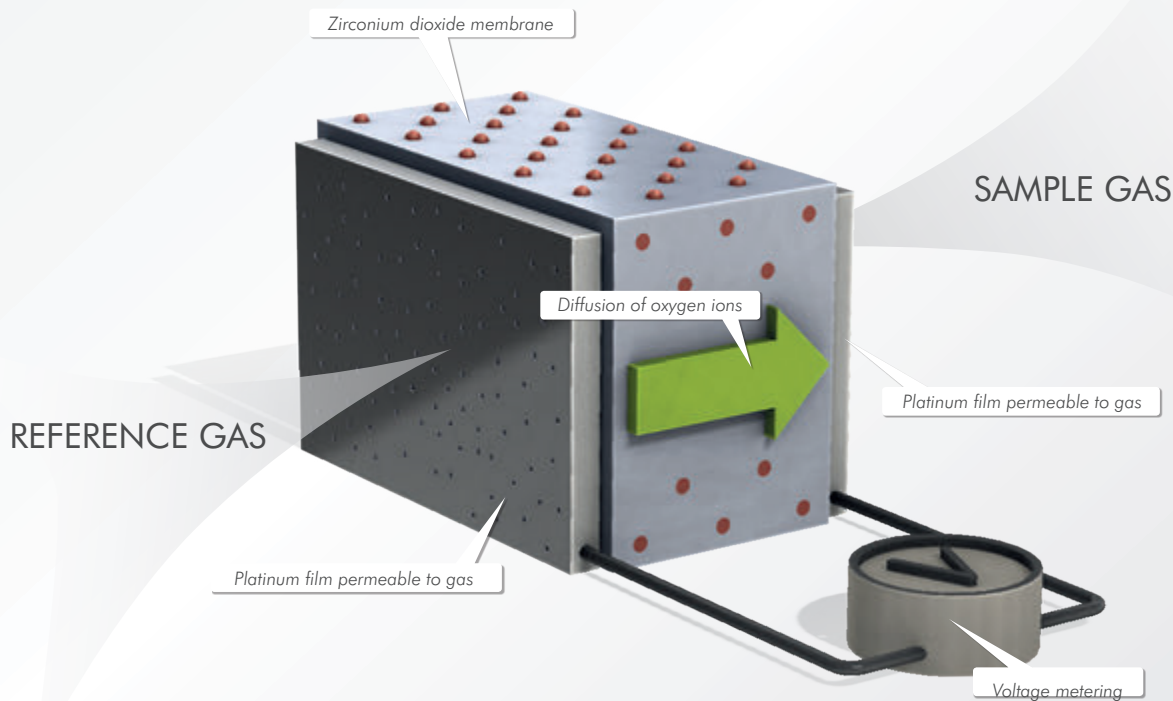


## NON-DISPERSIVE INFRARED SENSOR (NDIR)

From poultry with skin to cut cheese to cake and pastries – the non-dispersive infrared sensor with its wide measurement range between 0 and 100 volume per cent is suitable for most applications of carbon dioxide in modified atmospheres. Its high accuracy of  $\pm 0.5$  volume per cent always ensures precise measurement results. The NDIR sensor operates according to a patented process that uses two wavelengths of the infrared spectrum in order to automatically compensate for temperature, humidity and other environmental influences. Since it does not have any moving parts, it is very reliable, and no additional maintenance work is required. The NDIR sensor of the MAT1200 and MAT1500 models can be very easily adjusted via the intuitive user interface, but thanks to the low drift this is rarely necessary.

## FLOW RATE MONITORING AND TEMPERATURE CONTROL

In support of the sensor technology, our gas analysers measure further values in order to ensure the absolute reliability of the measured values related to the protective gases. For example, the flow rate of the sample is determined so that optimum measurement results are always guaranteed regardless of tube length, contaminations in the filter and similar application conditions. If the additional automatic monitoring of the gas flow is activated, a warning will appear if the flow rate does not reach the value set by the user. The temperature of the zirconium dioxide sensor of the MAT1400 and MAT1500 models is kept at 750 °C regardless of the sample temperature as it operates most efficiently by this means.



## DESIGN AND FUNCTIONALITY OF THE ZIRCONIUM DIOXIDE SENSOR

Inside the sensor, a ZrO<sub>2</sub> membrane heated to 750 °C separates the sample gas from the ambient air. Due to the Yttrium oxide stabilisation of the membrane, oxygen ions diffuse in the direction of the lower oxygen partial pressure and hence to the lower oxygen concentration. Both sides of

the membrane are coated with a platinum film permeable to gas. These electrodes allow you to measure an electrical potential difference between the sides of the membrane from which the oxygen concentration of the sample gas can be calculated.

## EASY, INTUITIVE OPERATION FOR MAXIMUM EFFICIENCY

The gas analysers of the MAT1000 series feature a self-explanatory, well-arranged user interface. A state-of-the-art TFT display ensures a clear, bright visual representation of all the information. The integrated touch-screen allows even non-expert personnel to intuitively and thus quickly operate the device. Once the measurement is started, the sample is drawn in, and the display shows the measured

values for oxygen, carbon dioxide and nitrogen as well as the air pressure, the gas flow and – depending on the model – the temperature of the measuring cell. Only a small sample volume is required, and stable measured values are already available after an average of five to ten seconds.

### THE MAIN SCREEN: EVERYTHING RELEVANT AT A GLANCE

- Freely assignable shortcut keys for the most important functions
- Measured values can be viewed at a glance
- Optional secondary and tertiary scale to display up to three measured values
- Method selection with only two clicks

### CREATE YOUR OWN METHODS

- Create any number of methods so that the respective desired parameters can be used for each sample
- Available method parameters: scales, measurement procedures, limit values, comment and much more
- Selectable measurement modes: single or continuous
- Several single measurement procedures: manual, automatic, min/max detection

### HIGH OPERATING COMFORT

- Easy, menu-guided adjustment
- Standardised operating of all A.KRÜSS laboratory devices
- Can be connected to a barcode scanner
- Printer configuration with numerous options
- A selection of six languages (de, en, fr, es, it, pt)





## INTELLIGENT USER ADMINISTRATION

- Two authorisation levels
- Can be activated or deactivated depending on the requirements
- Optional setup of user profiles
- Differentiations with the help of user-defined colour schemes
- Customised settings for different users or work groups

## COMPLETE DOCUMENTATION OF MEASURED VALUES

- Integrated measured data storage: complete recording of all measured data as well as system or method settings
- Consecutive numbering of the measurements
- Documentation of all measured values of the last 999 measurements

## CUSTOMISE YOUR RESULT REPORTS

- Customisable result table using the column configuration
- Selection of the results with filters
- Ascending or descending sorting of the datasets according to number

## INTEGRATED INTERFACES, FLEXIBLE DATA EXPORT

- Print-out on serial ASCII printer at RS-232 interface
- Print-out on network printer in PDF or GS format
- Print-out as PDF on USB flash drive or to network share
- Export of the measurement results in HTML or CSV format on USB flash drive or to network share
- Easy integration into existing networks (DHCP client) or a LIMS

## EXTENSIVE RANGE OF SERVICES



### YOUR BENEFITS AS AN A.KRÜSS CUSTOMER

- Service, maintenance, calibration and adjustment on site
- IQ/OQ/PQ by A.KRÜSS Optronic or certified service partners
- Calibration and adjustment with certified test gases
- Training and application consulting on site
- Spare parts and accessories directly from the manufacturer
- Customer-specific customisation of devices
- Efficient support thanks to a fast confirmability of the customer's situation based on extensive reports

### CALIBRATION AND ADJUSTMENT OF OUR GAS ANALYSERS

We recommend to have our gas analysers of the MAT1000 series calibrated and adjusted once a year exclusively by A.KRÜSS Optronic or by one of our certified service partners.

Our calibration protocols and certificates are GMP-/GLP-compliant and thus one component that ensures a GMP-/GLP-compliant work. For the calibration and adjustment of our gas analysers, we use certified test gases that are also calibrated on a regular basis. A calibration and adjustment is usually completed within a very short period of time so that any interference with the operational processes of our customers is minimised.

### MAINTENANCE OF OUR GAS ANALYSERS



Our maintenance contracts include the following services:

- Response time of no more than 48 hours and phone support during office hours, e.g. technical support in case of faults
- Maintenance of the devices named in the maintenance contract including functional check and safety inspection, cleaning of all components important for the proper function as well as calibration with certified test gases and, if necessary, adjustment
- Provision of the required certified test gases as well as measuring, control and special tools
- Firmware updates if they are required for the functionality of the devices
- Should repairs be required within the scope of maintenance work, we will charge for the required spare parts separately. We will grant a one year warranty on replacement and spare parts
- Provision of rental equipment to bridge the time required for maintenance, calibrations, adjustments and repairs. Maintenance customers will have preferential rights on rental equipment
- Preparation of GMP-/GLP-compliant maintenance and calibration protocols
- Warranty extension from 24 to 36 months when registered at [www.kruess.com](http://www.kruess.com) within three months after purchase

## OVERVIEW OF MODELS, ACCESSORIES AND CONSUMABLES

| ORDER NUMBER | MAT1000 SERIES   |
|--------------|--|
| MAT1100      | Gas analyser with electrochemical oxygen cell  |
| MAT1200      | Gas analyser with electrochemical oxygen cell and NDIR sensor for carbon dioxide         |
| MAT1400      | Gas analyser with zirconium dioxide sensor for oxygen                                    |
| MAT1500      | Gas analyser with zirconium dioxide sensor for oxygen and NDIR sensor for carbon dioxide |

| ORDER NUMBER | OPTIONAL ACCESSORIES AND CONSUMABLES  |
|--------------|---|
| MAT1001      | Suction filter, 10 pieces   |
| MAT1002      | Needle, stainless steel (0.8 mm x 40 mm), 12 pieces   |
| MAT1003      | Needle, stainless steel (0.45 mm x 18 mm), 12 pieces  |
| MAT1004      | Tygon tube, 80 cm   |
| MAT1005      | Suction unit (set), consisting of:<br>Handle<br>Handle adapter<br>Tygon tube (80 cm)<br>Suction filter, 10 pieces<br>Needle made of stainless steel (0.8 mm x 40 mm), 12 pieces |
| MAT1010      | Septa, white, self-adhesive, roll of 1000 in cardboard dispenser  |
| BC876        | Barcode scanner   |
| PC761        | Protective cover  |
| CBM910       | 24-character plain paper printer  |
| CBM910P      | Plain paper roll for printer CBM910   |
| CBM916       | Interface cable for printer CBM910  |
| CBM910F      | Ink ribbon for printer CBM910   |

| MANUFACTURER  | TEST GASES IN DISPOSABLE BOTTLES (filling volume in gas [litres]: 34 l, 58 l, 110 l)  |
|---|---|
|  | Zero gas – 100% nitrogen (N <sub>2</sub> )  |
|   | Reference gas – 50% carbon dioxide (CO <sub>2</sub> ), 50% nitrogen (N <sub>2</sub> )   |
|   | Test gas – 1% oxygen (O <sub>2</sub> ), 99% nitrogen (N <sub>2</sub> )  |
|   | Synthetic air   |
|   | For all 3 bottle sizes,<br>suitable flow valves can be supplied   |
|  | Customer service<br>Air Products PLC<br>2 Millennium Gate, Westmere Drive<br>Crewe CW1 6AP, United Kingdom<br>Phone: +44 1270 612708<br>E-mail: apukinfo@airproducts.com<br>www.airproducts.co.uk |

## FEATURES AND TECHNICAL DATA

### FEATURES

- Easy and intuitively to use via touch-screen – even by untrained personnel
- Low-drift electrochemical oxygen cell (EC)
- Low-drift non-dispersive infrared sensor (NDIR)
- Low-drift zirconium dioxide sensor (ZrO<sub>2</sub>)
- Only a small sample volume required
- Short measurement period
- Easy, menu-guided adjustment
- Compact design in cast aluminium housing
- Built-in air pressure sensor
- Integrated flow rate monitoring
- Interface package for convenient transfer of measured values (USB, Ethernet, RS-232)
- Any number of measurement methods for the monitoring of the measurement process according to method, batch, product and/or production line incl. limit value monitoring
- User administration (optional password protection with different usage rights)
- Measured data storage (saves the last 999 measurements)
- Numerous flexible filter functions
- Selectable measurement modes: single or continuous measurement
- Measurement procedures: manual, automatic, min/max detection

### COMPLIANCE WITH GLOBAL STANDARDS

- GMP/GLP
- 21 CFR Part 11 (Audit Trail)
- Pharmacopoeia, OIML, ASTM
- Validation possible

|  |                          |
|--|--------------------------|
| SCALES                                   |                          |
| OXYGEN (O <sub>2</sub> )                 | MEASUREMENT RANGE        |
|  | ACCURACY                 |
|  | RESOLUTION               |
| CARBON DIOXIDE (CO <sub>2</sub> )        | MEASUREMENT RANGE        |
|  | ACCURACY                 |
|  | RESOLUTION               |
| NITROGEN (N <sub>2</sub> )               | ARITHMETIC DETERMINATION |
| O <sub>2</sub> SENSOR                    | TYPE                     |
|  | SERVICE LIFE             |
|  | CROSS-SENSITIVITY        |
|  | DRIFT                    |
| CO <sub>2</sub> SENSOR                   | TYPE                     |
|  | SERVICE LIFE             |
|  | CROSS-SENSITIVITY        |
|  | DRIFT                    |
| AVERAGE MEASUREMENT PERIOD <sup>1)</sup> |                          |
| MINIMAL HEADSPACE VOLUME <sup>2)</sup>   |                          |
| HEATING TIME                             |                          |
| AMBIENT TEMPERATURE                      |                          |
| HUMIDITY OF THE SAMPLE GAS               |                          |
| OPERATING VOLTAGE                        |                          |
| POWER CONSUMPTION                        |                          |
| ADJUSTMENT                               |                          |
| CONTROL                                  |                          |
| INTERFACES                               |                          |
| DIMENSIONS (WxHxD)                       |                          |
| WEIGHT                                   |                          |

Picture credits:

P. 7: © Monty Rakusen/Getty Images

P. 12: © gstockstudio/www.fotalia.de

<sup>1)</sup> after heating-up time

<sup>2)</sup> after pre-rising with N<sub>2</sub>

**MAT1100****MAT1200****MAT1400****MAT1500**

| Oxygen<br>Any number of user-defined scales                              | Oxygen<br>Carbon dioxide<br>Nitrogen<br>Any number of user-defined scales | Oxygen<br>Any number of user-defined scales   | Oxygen<br>Carbon dioxide<br>Nitrogen<br>Any number of user-defined scales                         |
|--|---|---|---|
| 0.5–35 vol%  | 0.5–35 vol%   | 0–100 vol%  | 0–100 vol%  |
| ±0.2 vol%  | ±0.2 vol%   | ±0.001 vol% (< 1 vol%)<br>±0.01 vol% (< 6 vol%)<br>±0.1 vol% (< 35 vol%)<br>±0.4 vol% (> 35 vol%) | ±0.001 vol% (< 1 vol%)<br>±0.01 vol% (< 6 vol%)<br>±0.1 vol% (< 35 vol%)<br>±0.4 vol% (> 35 vol%) |
| 0.1 vol%   | 0.1 vol%  | 0.001 vol%  | 0.001 vol%  |
| N/a  | 0–100 vol%  | N/a   | 0–100 vol%  |
|  | ±0.5 vol%   |   | ±0.5 vol%   |
|  | 0.1 vol%  |   | 0.1 vol%  |
| N/a  | Residual content of the gas mixture                                       | N/a   | Residual content of the gas mixture   |
| Electrochemical cell (EC)  | Electrochemical cell (EC)   | Zirconium dioxide sensor (ZrO <sub>2</sub> )  | Zirconium dioxide sensor (ZrO <sub>2</sub> )  |
| Up to 6 years (by 20 vol% O <sub>2</sub> )                               | Up to 6 years (by 20 vol% O <sub>2</sub> )                                | Unlimited   | Unlimited   |
| No CO <sub>2</sub> cross-sensitivity                                     | No CO <sub>2</sub> cross-sensitivity                                      | toward inflammable gases  | toward inflammable gases  |
| Low drift, < 3%/month  | Low drift, < 3%/month   | Drift-free  | Drift-free  |
| N/a  | Two-channel NDIR sensor   | N/a   | Two-channel NDIR sensor   |
|  | Unlimited   |   | Unlimited   |
|  | Not affected by moisture  |   | Not affected by moisture  |
|  | Low drift < 1%/month  |   | Low drift < 1%/month  |
| 7 s  | 10 s  | 5 s   | 10 s  |
| 10 ml  | 10 ml   | 7 ml  | 7 ml  |
| < 10 s   | 5 min   | 10 min  | 10 min  |
| 10–50 °C   |   |   |   |
| < 90% r. H.  |   |   |   |
| 100–250 V, 50/60 Hz  |   |   |   |
| Max. 60 W  |   |   |   |
| Automatic (menu-guided)  |   |   |   |
| 7.0" - capacitive touch-screen, 800 x 480 Pixel                          |   |   |   |
| USB (USB flash drive, barcode scanner, keyboard, mouse); Ethernet RS-232 |   |   |   |
| 200 mm x 150 mm x 350 mm   |   |   |   |
| 4.6 kg   |   |   |   |

A.KRÜSS Optronic GmbH  
Alsterdorfer Straße 276–278  
22297 Hamburg | Germany

Tel. +49 40 514317-0  
Fax +49 40 514317-60

E-Mail [info@kruess.com](mailto:info@kruess.com)  
Web [www.kruess.com](http://www.kruess.com)

