



**Malvern
Panalytical**
a spectris company

EPSILON 4

Fast and powerful



ELEMENTAL ANALYSIS

Faster decisions by faster results

Improve your process efficiency, product quality and research activity through high-quality elemental analysis.

The latest advances in excitation and detection technology have further improved the analytical capabilities of Malvern Panalytical energy dispersive X-ray fluorescence (EDXRF) benchtop spectrometers. The Epsilon 4 demonstrates outstanding analytical performance comparable to floor-standing XRF instruments, together with a much lower cost of ownership. Your benefits are obtaining fast results and low detection limits through the whole analytical range.

This opens possibilities for tackling new and challenging applications that are traditionally performed by ICP and AAS. Discover the possibilities of XRF analysis and reduce your feedback time from hours to minutes by placing the XRF spectrometer next to the production line.

Epsilon 4 spectrometers are highly flexible analytical tools suitable for a wide range of dedicated applications which will pay off in no time.

Epsilon 4's value to elemental analysis

- Low cost of ownership, low infrastructural requirements, small footprint
- Minimum downtime and maintenance
- XRF's unmatched analytical precision and flexibility compared to other analytical techniques
- Non-destructive analysis
- Ready for many sample types: powders, solids, liquids
- Simple, fast and safe sample preparation
- Elemental screening of unknown samples



Norm-compliant performance

To protect the environment, norms like EPA I.O 3.3 (air filters analysis) and EPA Tier 3 (automotive fuels) are used to monitor emissions. Epsilon 4's high performance and stability over longer time enables norm and test method compliant results.

Ready for any sample type

Epsilon 4 is capable of measuring all different types of samples, like powders, liquids and solids. Apply elemental analysis to check composition of different types of goods, from cement up to fabric. If no standards are available, or the variety of samples is large, Malvern Panalytical's standardless analysis solution is the way to go.

Ensure product quality

Elemental analysis is used in many industries to guarantee product quality. From raw materials up to final products, the composition should be consistent to ensure the final quality. Epsilon 4 is useful and ready for quality control of a wide range of products, from ceramic vases up to the latest generation of electronic devices.

Unmatched sensitivity

Epsilon 4 can analyze hazardous and toxic elements in all kinds of product types. Guarantee the safety of toys, food products and pharmaceuticals using the Epsilon 4.

Faster results = Faster decision

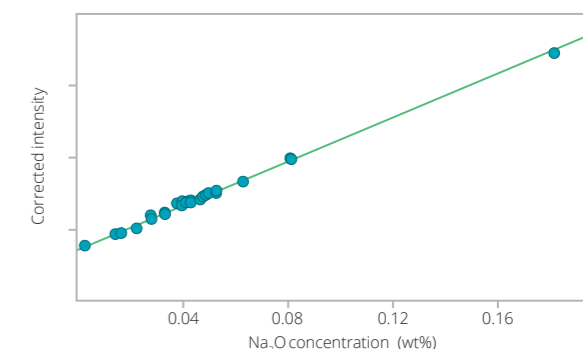
Epsilon 4's low utility requirements and small footprint enable at-line elemental analysis. The spectrometer can be placed close to the production facilities, without much installation effort. Shorten your feedback loop and enable active adaptation of your process parameters.

READY FOR DEDICATED CALIBRATIONS AND STANDARDLESS ANALYSIS

Accurate and precise analysis with dedicated calibrations

Epsilon 4 can be calibrated using reference materials that match the composition of the routine samples. These dedicated calibrations result in highly accurate data. Epsilon 4 can be calibrated for a wide variety of industry applications, like cement, cosmetics, environmental, food, forensics, metals, coatings, minerals, petrochemicals, pharmaceuticals, polymers, to name a few.

Malvern Analytical can also offer calibration solutions for several key applications, like toxic elements and additives in polymers, elemental impurities in pharmaceuticals, major and minor oxides in building materials and mining related samples, sulfur in fuels, and additives in lubricating oils.



Calibration graph of Na₂O in cement certified standards, prepared as fused beads

Screening of any sample using standardless analysis

For characterization and analysis of unknown samples, or in situations where certified standards that match specific sample characteristics are not available, Omnia is the solution of choice. Important applications include sample identification, screening, failure analysis, as well as the comparison of different materials.

The flexibility of Omnia with the ease of use of Epsilon 4 forms a powerful combination. Omnia is designed to provide fast and reliable quantification in its default 'black box' mode. However, the data collected is fully accessible and can be reviewed more extensively to allow troubleshooting and comparative analysis.

Omnia results compared to certified values of a lubricating oil standard from VHG Inc. Measuring time was only 3 minutes.

Lubricating oil	Measured concentration (wt%)	Certified concentration (wt%)
Mg	0.062	0.069
Si	0.021	0.025
S	0.925	0.987
Cl	0.002	0.001
Ca	0.413	0.395
Zn	0.014	0.012
Mo	0.000	0.000
Ba	0.031	0.026
CH ₂	98.53	N.A.

Omnia results compared to certified values of a stream sediment standard, prepared as a pressed powder sample. Measuring time was only 3 minutes.

Stream sediment	Measured concentration (wt%)	Certified concentration (wt%)
Na ₂ O	0.46	0.46
MgO	0.56	0.62
Al ₂ O ₃	11.73	10.37
SiO ₂	75.40	76.25
P ₂ O ₅	0.016	0.026
SO ₃	0.230	0.043
Cl	0.037	0.029
K ₂ O	3.37	3.28
CaO	0.35	0.47
Ti	0.175	0.210
V	0.003	0.005
Cr	0.003	0.004
Mn	0.216	0.249
Fe ₂ O ₃	4.20	4.39
Cu	0.007	0.008
Zn	0.032	0.037
As	0.015	0.019
Rb	0.039	0.041
Sr	0.003	0.003
Y	0.004	0.004
Zr	0.014	0.015
Nb	0.002	0.003
Sn	0.048	0.037
Ba	0.023	0.026
W	0.009	0.013
Pb	0.060	0.064
Bi	0.005	0.005
Th	0.002	0.002
H ₂ O/CO ₂	3.00	N.A.

THE POWER OF EPSILON 4

Combining the latest excitation and detection technology and smart design, the analytical performance of Epsilon 4 approaches that of more powerful and floor-standing spectrometers. Selective excitation and careful matching of the X-ray tube output to the capabilities of the detection system underlie the system's outstanding performance.



Epsilon 4 - Highly flexible analytical tools suitable for a wide range of applications:

- 10-watt version - used for elemental analysis (F - Am) in areas from R&D through to process control
- 15-watt version - used for higher sample throughput in challenging environments (F - Am)
- 15-watt version - used for higher sample throughput with improved and extended light element capabilities (C - Am)

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	L	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	A															
		L	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		A	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Z Possible to analyze with Epsilon 4
Z Not possible to analyze with Epsilon 4
Z Possible with Epsilon 4 and optional detector

Reduce helium consumption

The high performance of Epsilon 4 enables many applications to be operated in air atmosphere, without longer overhead time and costs involved for helium or maintenance of vacuum system. When measuring in air, low-energy X-ray photons characteristic of sodium, magnesium and aluminium, are sensitive to variations in air-pressure and temperature. Built-in temperature and air-pressure sensors compensate for these environmental variations, ensuring excellent results whatever the weather.

Calibrated for years

A low-drift X-ray tube and an automatic drift correction system give compliant results for years without the need for re-calibration. This results in a more efficient use of the system and less cost of calibration maintenance.

Online remote support

In the unlikely event of the Epsilon 4 needing specialist attention, an online diagnostic facility is available in the local service centers. Problems can be diagnosed, and in many instances corrected, directly online. This significantly reduces system downtime and cuts maintenance costs to a minimum.

Accurate results

The unique high-performance, metal-ceramic X-ray tube, specifically designed and manufactured by Malvern Panalytical, ensures high quality and reliable results. Flexible voltage settings from 4.0 to 50 kV and a maximum current setting up to 3.0 mA can be used to define application-specific excitation conditions that optimize the performance across the periodic table.

Ultimate light-elemental performance

With the optional SDD^{Ultra} detector, Epsilon 4 enables ultra-light element analysis of even carbon, nitrogen and oxygen.

Quality results through mature software

Accurate and precise results are obtained through advanced spectrum processing and state-of-the-art correction and quantification algorithms.

Safety guaranteed

Epsilon 4 complies with the latest Machinery Directive, CSA, IEC, EMC, Vollschutz norms and standards for protection and radiation safety to guarantee a safe instrument for the operator.

Unattended operation

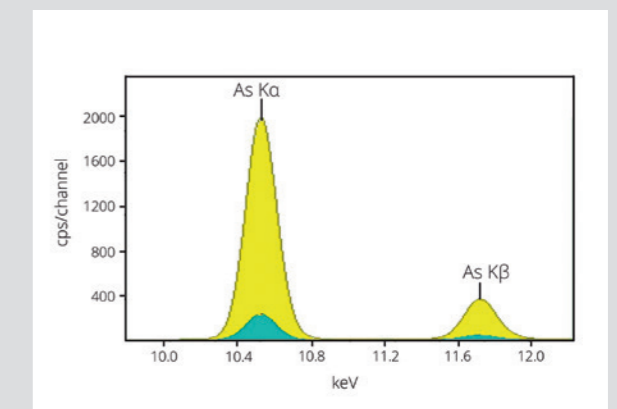
The unique combination of a 10-position removable sample changer with spinner enables the automatic processing of sample batches without the need for operator attention. Continuous rotation of the sample during measurement minimizes any errors caused by non-homogeneity or surface irregularities within individual samples and provides more accurate results. Automatic transfer of data to a central location gives you access to the latest results.

Fast and sensitive

Fast measurements are achieved by using the latest silicon drift detector technology that produces significantly higher intensities.

Unique detector electronics enable a linear count rate capacity to over **1,500,000 cps** (at 50% deadtime) and a count rate independent resolution typically better than 135 eV for better separation of analytical lines in the spectrum.

This allows the Epsilon 4 spectrometer to run at full power and therefore realizes a much higher sample throughput compared to traditional EDXRF benchtop instruments.



Ten times higher intensities for arsenic obtained with Epsilon 4, in comparison with its predecessor Epsilon 3^{XL}E

FAST, REPRODUCIBLE ANALYTICAL METHOD

Compared to other analytical techniques XRF requires little or no sample preparation

XRF is an ideal means of determining the chemical composition of all kinds of materials. Measurements in Epsilon 4 are carried out directly on the solid material (or liquid) with little to no sample preparation. There is no need for any dilution or digestion and therefore no disposal of chemical waste.

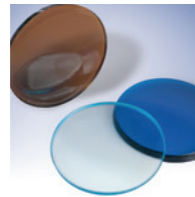
Epsilon 4 spectrometers can handle a large variety of sample types weighing from a few milligrams to larger bulk samples. Samples can be measured as:

- Solids
- Pressed powders
- Loose powders
- Liquids
- Fused beads
- Slurries
- Granules
- Filters
- Films and coatings

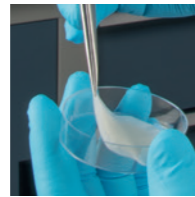
LIQUIDS



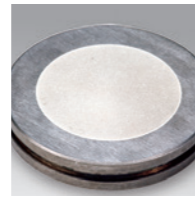
SOLIDS



AIR FILTERS



POWDERS



TAILORED SOLUTIONS THROUGH EXPERTISE

Experienced Malvern Panalytical staff will work in close cooperation with you to provide training and a wide range of consultancy services, including tailored analytical programs and procedures (SOP), balancing throughput and accuracy while minimizing setup and running costs, and specialist analysis.

Access to the right calibration samples is key in XRF. Malvern Panalytical helps in obtaining or creating the standards you need. We provide total solutions including standards for several key applications. We can also generate suites of in-house standards by certifying your materials through our ISO 17025 certified laboratory.

Sample preparation, although typically straightforward for XRF, is an important factor in the overall analytical precision and accuracy. Sample preparation needs to be quick, robust and reproducible, and the choice of sample preparation technique starts with your requirements and materials.

Combine XRF with the analytical solutions Malvern Panalytical offers, like near-infrared spectroscopy, particle size analysis and X-ray diffraction. Our experts can advise you which approach suits best given your material types and analytical requirements.

Tap into our knowledge network through our global Expertise Centers to optimize your complete analytical process, including sample preparation methods and equipment.



Our aim is to make Epsilon 4 an essential part of your value generation process analysis

The added value for you is what drives us:

- The largest support network in the industry
- Training programs customized to your needs
- Reference materials
 - *Certified reference materials (CRMs)*
 - *Synthetic reference materials tailored to your requirements*
- Analytical services
 - *Certify your samples through our ISO 17025 certified laboratory*
- Consultancy
 - *Norm compliance*
 - *Laboratory information management*
 - *Process automation*
 - *Standard operating procedures*
 - *Interlaboratory standardization*

MEASURE IT IN YOUR OWN LANGUAGE

1. Load your sample
2. Select required method
3. Enter relevant sample information
4. Just click Measure
 - 測量
 - 測定
 - Mesurer
 - Messung
 - Mesure
 - Zmierzyć
 - Medida
 - Измерить
 - Médir

ENHANCE YOUR ANALYSIS THROUGH SOFTWARE OPTIONS

Five industry software options are available to further enhance the capabilities of Epsilon 4: Omnian, Stratos, Oil-Trace, Enhanced Data Security and FingerPrint.

These dedicated options add new functional dimensions to benchtop spectrometry and take the hard work out of regulatory compliance.

Elemental screening OMNIAN



Our powerful Omnian software is ideal when there is no conventional calibration established for materials that require analysis. When faced with non-routine samples or materials for which there are no certified reference materials, Omnian provides excellent insight into the elemental composition. Designed to provide fast and reliable quantification, Omnian's advanced fundamental parameters (FP) algorithm automatically deals with the analytical challenges posed by samples of widely differing types.



Pass/Fail analysis FINGERPRINT



FingerPrint is a material type confirmation routine that uses a rapid statistical analysis of the spectrum for a simple PASS/FAIL answer. Spectra used for the FingerPrint routine can also be used for conventional compositional determination for a more complete diagnostic analysis.

Multi-layer analysis STRATOS



Stratos features an algorithm which enables simultaneous determination of chemical composition and thickness of layered materials. The software provides a rapid, simple and non-destructive means of analyzing coatings, surface layers and multi-layered structures. Accurate results are achieved by using conventional bulk standards, or reference samples whose composition and layer structure differ from those of the unknowns.

Enhanced data security AUDIT TRAIL SOFTWARE



The enhanced data security software option is designed for GMP and GLP environments, and enables the user to comply with FDA 21 CFR Part 11. The software includes every feature required to satisfy the strict environmental protocols, like multiple security levels, log in with user identification, reporting of date and time, results storing, extensive audit trails and LIMS integration.

One calibration for oils and fuels OIL-TRACE



Oil-Trace is an innovative solution to the challenges often faced in the analysis of oil and petrochemicals with variable light-matrix compositions. Oil-Trace offers a universal solution for a range of elements in a wide variety of applications, including fuel-biofuel mixtures and lubricating oils. Analysts benefit from a simplification of application maintenance and analytical procedure, and from cost savings through the use of simple and relatively inexpensive standards.



WHY CHOOSE MALVERN PANALYTICAL?

We are global leaders in materials characterization, creating superior, customer-focused solutions and services which supply tangible economic impact through chemical, physical and structural analysis.

Our aim is to help you develop better quality products and get them to market faster. Our solutions support excellence in research, and help maximize productivity and process efficiency.

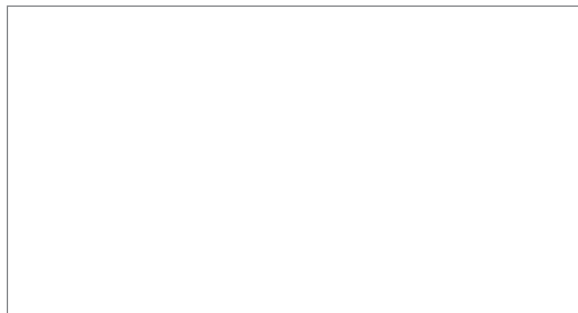
Malvern Panalytical is part of Spectris, the productivity-enhancing instruments and controls company.
www.spectris.com

SERVICE & SUPPORT

Malvern Panalytical provides the global training, service and support you need to continuously drive your analytical processes at the highest level. We help you increase the return on your investment with us, and ensure that as your laboratory and analytical needs grow, we are there to support you.

Our worldwide team of specialists adds value to your business processes by ensuring applications expertise, rapid response and maximum instrument uptime.

- Local and remote support
- Full and flexible range of support agreements
- Compliance and validation support
- Onsite or classroom-based training courses
- e-Learning training courses and web seminars
- Sample and application consultancy



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