



Epsilon 4

Building materials



Trust your elemental analysis

Analyze next to the production line

Improve your process efficiency through high quality, low cost elemental analysis.

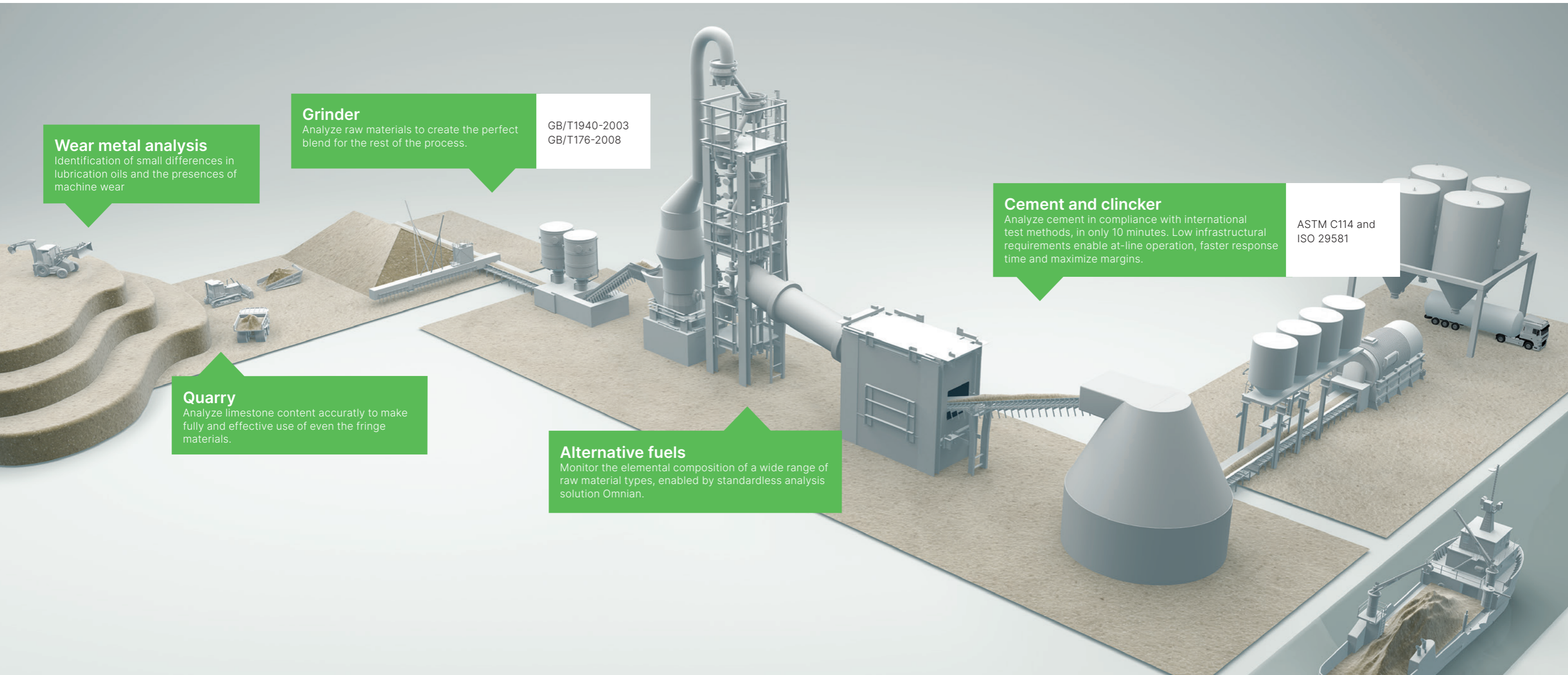
Continuing Malvern Panalytical's successful and established line of benchtop spectrometers, Epsilon 4 provides state-of-the-art energy dispersive X-ray fluorescence (EDXRF) analysis. Like its predecessors, it is safe, reliable and easy to use. However, the latest advances in excitation and detection technology have further improved the analytical capabilities of the spectrometer.

The outstanding analytical performance of Epsilon 4 approaches that of floor-standing XRF instruments, with a much lower cost of ownership.

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's value for the cement industry

- Full process and quality control of cement, clinker and raw materials
- Complying with international test methods like ASTM C114 and ISO 29581-2
- Wide fusion-based reference standards (WROXI-cement extension) when no CRMs are available
- Automatable
- Low cost of ownership & low infrastructural requirements
- Suitable for a wide variety of samples
- Accurate and highly reproducible data
- Low cost of calibration maintenance



ASTM C114 compliant cement analysis in only 10 min

X-ray fluorescence spectroscopy (XRF) has an important and well-established analytical role within the cement industry. In combination with the Eagon 2 fully automatic fusion system, Epsilon 4 complies with the latest cement testing methods of both ASTM C114-15 and ISO 29581-2 in only 10 minutes. Calibration graphs for Fe_2O_3 and Na_2O , are shown in Figures 1 and 2, respectively.

ASTM C114-15 gives recommendations concerning the maximum deviation of analytical results for a selection of important compounds in cement. In brief, the norm suggests that the analyses be made in duplicate and that they must be made on different days using eight

international NIST Portland SRM cement reference materials. Two criteria apply, one for the differences between duplicates measured on different days and one for the differences between the averages of the duplicates and the certified values.

The measured concentration differences for all the compounds in all eight SRM standards were smaller than the permitted differences of the norm (see Figures 3 and 4). Therefore, the Epsilon 4 meets ASTM C114-15 requirements for SiO_2 , Al_2O_3 , Fe_2O_3 , CaO , MgO , SO_3 , K_2O , Na_2O , TiO_2 , P_2O_5 , ZnO and Mn_2O_3 in cement samples prepared as fused beads.

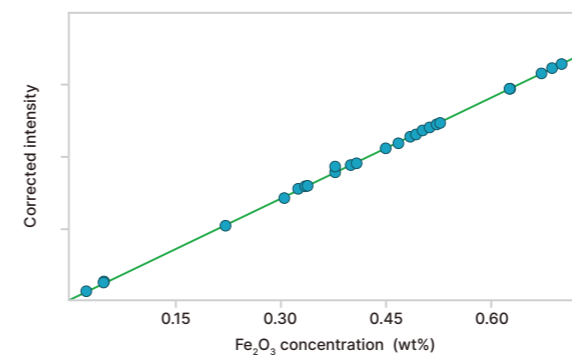


Figure 1. Calibration graph of Fe_2O_3 in cement certified standards, prepared as fused beads

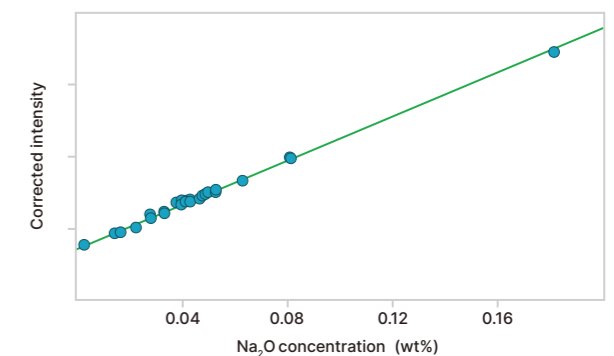


Figure 2. Calibration graph of Na_2O in cement certified standards, prepared as fused beads

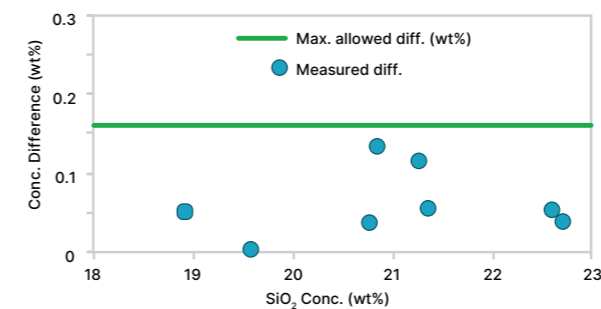


Figure 3. Summary of the duplicate test obtained for eight NIST SRM cement samples compared to ASTM C114-15 limit for SiO_2

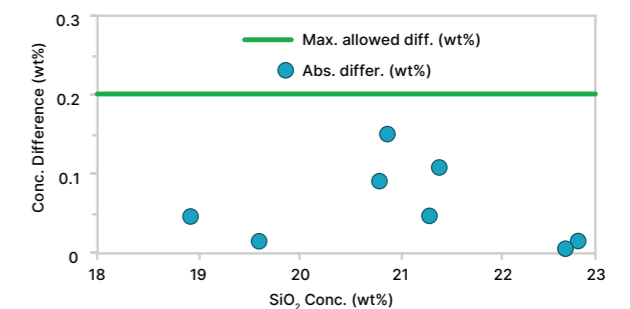


Figure 4. Summary of the accuracy test obtained for eight NIST SRM cement samples compared to ASTM C114-15 limit for SiO_2

The power of benchtop XRF systems

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 with improved and extended light element capabilities (C - Am)
- 15-watt version - used for higher sample throughput in challenging environments (F - Am)

																		Z	Possible to analyze with Epsilon 4																																			
																		Z	Not possible to analyze with Epsilon 4																																			
																		Z	Possible with Epsilon 4 and optional detector																																			
H																	He	B	C	N	O	F	Ne																															
Li	Be															Al	Si	P	S	Cl	Ar																																	
Na	Mg															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																																					
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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

Our unique, high-performance, metal-ceramic X-ray tube, specifically designed and manufactured for Epsilon 4, 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

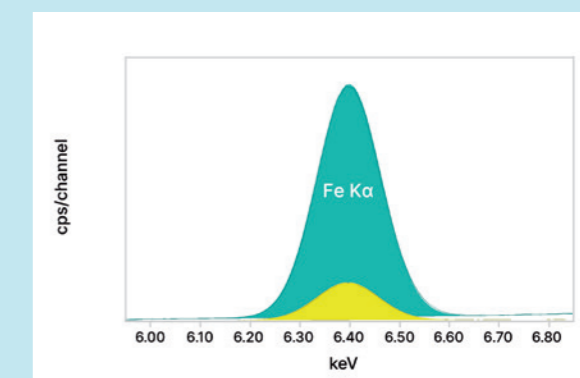
The unique combination of a 10-position removable sample changer with spinner enables the automatic processing of sample batches without the need for operator attention. Continuous rotation of the sample during measurement minimizes any errors caused by non-homogeneity or surface irregularities within 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.



Six times higher intensities for iron obtained with Epsilon 4, in comparison with its predecessor Epsilon 3^{XLE}

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.

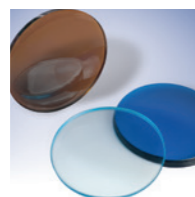
Epsilon 4 spectrometers can handle a large variety of sample types weighing from a few milligrams to larger bulk samples. Samples can be measured as:

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

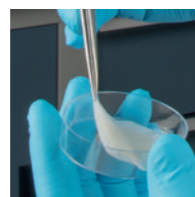
Liquids



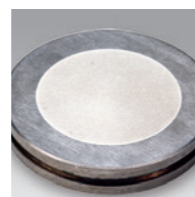
Solids



Air filters



Powders



Tailored solutions through expertise

Experienced Malvern Panalytical staff work in close cooperation with you to provide not only training but also tailored analytical programs and procedures, balancing throughput and accuracy while minimizing set-up and running costs.



Access to the right calibration samples is the key to accurate XRF analysis. 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.

Malvern Panalytical 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 cement making process

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



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 like alternative fuels, 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.



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

Wear metal analysis **Oil-trace**



Oil-Trace is an innovative solution to the challenges often faced in the analysis of oil and petrochemicals. Oil-Trace offers a universal solution for a range of elements in a wide variety of 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.

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.



Why choose us?

When you make the invisible visible, the impossible is possible.

Our analytical systems and services help our customers to create a better world. Through chemical, physical and structural analysis of materials, they improve everything from the energies that power us and the materials we build with, to the medicines that cure us and the foods we enjoy.

We partner with many of the world's biggest companies, universities and research organizations. They value us not only for the power of our solutions, but also for the depth of our expertise, collaboration and integrity.

With over 2200 employees, we serve the world, and we are part of Spectris plc, the world-leading precision measurements group.

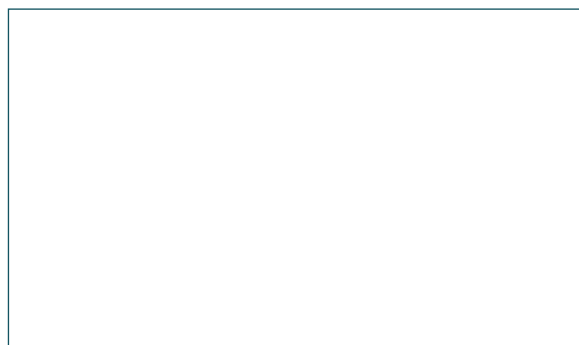
Malvern Panalytical. We're BIG on small™

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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