



**Malvern
Panalytical**
a spectris company

XRF solutions for automotive catalyst recycling

Fast, accurate determination of precious metal content



Easily analyze your converter's precious metals

Get a fair value for your recycling contribution

Catalytic converters – designed to remove toxic gases and pollutants from car exhausts – contain the precious metals platinum (Pt), palladium (Pd), and rhodium (Rh). When a car reaches the end of its life, its catalytic converter is scrapped and the precious metals are recovered, extracted, and refined.

From scrap merchants to toll refineries, several stakeholders are involved in this 'recycling chain'.

To ensure that all of them are compensated fairly for their contribution, it's essential to grade the converter's high-value precious metal content accurately.

At Malvern Panalytical, we've created a fast, easy, transparent way to do this – all while meeting the highest safety standards.

Value for every recycling-chain player



Better accuracy, more confidence

Our Epsilon spectrometers use the latest energy-dispersive X-ray fluorescence (ED-XRF) technology. Combined with our advanced data models, this ensures precise measurement – every time. These world-class benchtop solutions can be used by every participant in the automotive catalyst recycling chain.

As well as determining the precious metal content in used automotive catalysts, XRF also provides the total elemental composition of the material, so you can address other operational challenges at the same time.



Quick, easy measurements

XRF is a simple technique. So you don't have to be a skilled operator with a chemistry background, or worry about extensive sample preparation.

With our solution, all you need to do is mill your sample to a fine powder, put it in the spectrometer, and click 'measure'. Easy!

Even better, XRF is quicker than fire-assay or inductively-coupled plasma (ICP) analysis and there's no need for any complicated sample preparation.



Guaranteed maximum safety

All Malvern Panalytical X-ray solutions are designed according to the strict regulations of regulatory bodies.

The Epsilon 1 and Epsilon 4 table top systems shield their users against X-rays during analysis. You'll have peace of mind in the lab, thanks to a unique internal interlocked enclosure providing complete radiation protection, deserving its Vollschutz classification.

No need to worry about safety as the system is fully enclosed and completely safe.



Epsilon 1

Small, economical, powerful XRF

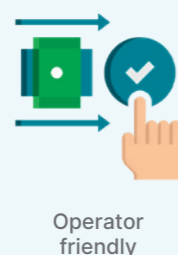
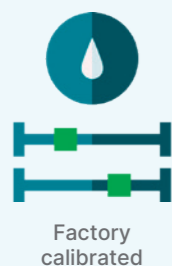
Want to get better accuracy and precision from your handheld XRF spectrometer, while keeping your workflow as simple as possible? Our Epsilon 1 ED-XRF spectrometer is here for you.

Epsilon 1 produces precise, accurate data – quickly, cost-effectively, and with minimal operator involvement or sample preparation. It's set up for Pd, Pt, and Rh

analysis directly from the factory, so you can get started straight away. And the spectrometer is designed for ultra-safe operations and reproducible sample positioning. Plus, with its compact, robust design, all you need is a regular main connection!

This easy operation makes Epsilon 1 the ideal choice for high-quality, on-site XRF analysis.

Results you can trust at the touch of a button



Benefit from:

- Trusted Pd, Pt, Rh analysis for determination of true market value
- Analysis throughout the periodic table (Na –Am), from ppm – 100 wt-%
- Identification of fraudulent elements like Tungsten and Molybdenum
- No running costs besides electricity
- Analysis of other sample types, i.e. polymers, solutions, solids

Loose powders

For easy sample preparation and fast screening

The Epsilon 1 is designed to measure loose powders directly – with accurate results in just a few simple steps:

- Collect a representative sample
- Grind the sample to a homogeneous powder
- Put a few grams of powder in the sample cup



How is Epsilon 1 calibrated?

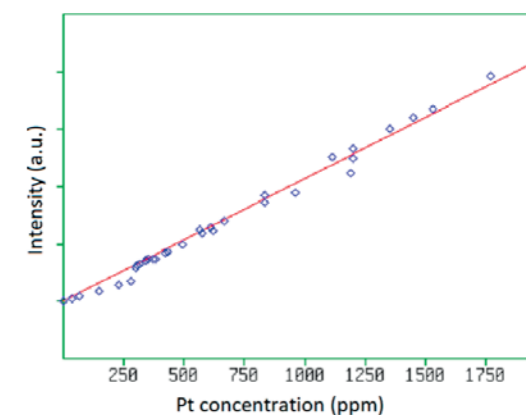
Epsilon 1's factory calibration is based on over 30 car catalytic converter samples. The precious metal content of these samples was referenced using alternative technologies such as fire-assay and ICP analysis. As well as Pd, Pt, and Rh, the calibration also includes other elements commonly found in used catalytic converters.

Measuring the total matrix improves the flexibility of the method and makes it applicable for different catalytic converter materials. Detailed calibration results for the precious metals are listed in table 1.

Table 1. Calibration details of the factory setup.

Compounds	Concentration range (ppm)	RMS (ppm)*	Correlation Coefficient
Pt	0 – 1992	52.5	0.9968
Rh	0 – 585	10.6	0.9959
Pd	0 – 8776	92.6	0.9991

** The RMS (Root Mean Square) value is equivalent to 1 sigma standard deviation.



Accurate and precise

The method's accuracy and instrument precision were tested by measuring three official **certified reference materials (CRMs)** consecutively.

The CRMs' certified and average measured concentrations, RMS, and relative RMS values (Table 2) demonstrate excellent accuracy and precision.

Table 2. Result of validation measurements with commercially available used automotive catalyst CRMs. The samples were measured as loose powders.

Sample name (repeats)	Compounds	Certified conc. (ppm)	Average conc. (mg/kg)	RMS* (ppm)	Rel. RMS (%)
NIST 2556 (20x)	Pt	697.4 +/- 6.3	695.6	7.2	1.1
	Rh	51.2 +/- 0.5	53.9	2.0	3.7
	Pd	326 +/- 1.6	322.8	7.	2.2
NIST 2557 (20x)	Pt	1131 +/- 11	1189.6	13.2	1.1
	Rh	135.1 +/- 1.9	141.6	2.2	1.6
	Pd	233.2 +/- 1.9	236.9	3.6	1.5
ERM-EB504a (5x)	Pt	1414 +/- 9.0	1424.8	5.1	0.4
	Rh	210 +/- 2.2	216.2	2.3	1.1
	Pd	1596 +/- 11	1675.1	18.3	1.1

Epsilon 4

Fast, accurate elemental analysis

Epsilon 4 is a multi-functional benchtop XRF analyzer for elemental analysis of fluorine (F) to americium (Am), and from R&D through to process control. It can operate as the ideal main elemental analyzer for laboratories throughout the recycling chain, from collectors to refineries.

Combining the latest excitation and detection technologies with mature software and smart design, Epsilon 4's performance is close to that of a floor-standing XRF spectrometer.

You can measure your samples directly as loose powders or as pressed pellets and receive results comparable to fire-assay or ICP analysis. All without the extensive sample preparation and chemical waste, and with much quicker turnaround times!



Central laboratory performance



Operator friendly



Versatile solution



Highest Accuracy



Benefits from:

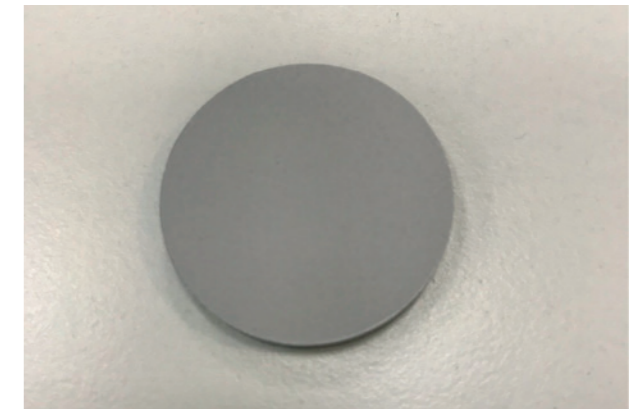
- Sensitivity throughout the periodic table (F – Am)
- High throughput: load 10 samples at once
- Sample spinner for homogenization
- Flexible operation, from spent catalysts to recovered concentrated solutions
- Reduced need for more complex methods

Pressed pellets

For even deeper insights

For high-quality analysis of catalytic converter samples, it's best to make a pressed pellet. Although this means a bit more work to prepare your sample, it's relatively straightforward and will benefit your analysis. Here's how it works:

- Collect a representative sample
- Grind the sample to a homogeneous powder
- Put a few grams of powder in the sample press and apply pressure
- Load the pellet in the instrument



Accurate and precise

Epsilon 4's accuracy and precision using pressed pellets were tested by measuring three official certified reference materials (CRMs) consecutively.

The CRMs' certified and average measured concentrations, RMS, and relative RMS values (Table 3) demonstrate excellent accuracy and precision.

Table 3. Result of validation measurement with commercially available spent automotive catalysts certified reference materials. The samples were measured at pressed pellets.

Sample name (repeats)	Compounds	Certified conc. (ppm)	Average conc. (ppm)	RMS* (ppm)	Rel. RMS (%)
NIST 2556 (20x)	Pt	697.4 +/- 6.3	692.8	1.3	0.2
	Rh	51.2 +/- 0.5	52.5	0.7	1.3
	Pd	326 +/- 1.6	322.6	2.8	0.9
NIST 2557 (20x)	Pt	1131 +/- 11	1152.2	2.4	0.2
	Rh	135.1 +/- 1.9	143.5	1.4	1.0
	Pd	233.2 +/- 1.9	225.6	1.3	0.6
ERM-EB504a (5x)	Pt	1414 +/- 9.0	1392.0	2.6	0.2
	Rh	210 +/- 2.2	207.8	2.5	1.2
	Pd	1596 +/- 11	1640.9	13.4	0.8

Enjoy more in-depth insights

Besides precious metal content, Epsilon 4 can also give you deeper insight into your sample. It lets you measure its full elemental composition – so you can find the most efficient processing strategy and detect any rogue elements.

Table 4. Result of validation measurement with a car catalytic converter sample prepared as a pressed pellet. The sample was measured 20 times consecutively.

Compound	Unit	Concentration	RMS	Relative STD (%)	Compound	Unit	Concentration	RMS	Relative STD (%)
MgO	wt-%	9.67	0.04	0.4	Rh	ppm	143.5	1.4	1.0
Al ₂ O ₃	wt-%	45.78	0.04	0.1	Pd	ppm	225.6	1.5	0.7
SiO ₂	wt-%	34.34	0.05	0.1	Pt	ppm	1152.2	2.4	0.2
TiO ₂	wt-%	0.6	0.001	0.2	BaO	wt-%	0.344	0.001	0.3
Fe ₂ O ₃	wt-%	1.969	0.003	0.2	La ₂ O ₃	wt-%	0.093	0.002	2.2
NiO	wt-%	0.924	0.001	0.1	CeO ₂	wt-%	1.694	0.003	0.2
ZnO	wt-%	0.217	0.0005	0.2	PbO	wt-%	1.864	0.002	0.1

Be flexible

Omnian

Sometimes, it's just not possible or worthwhile to calibrate all your sample types. Perhaps there are no standards, or those that are available are too expensive.

But you can still use a generic method to analyze the elemental composition of a single sample. Even better – this method is available on both our Epsilon 1 and Epsilon 4 XRF benchtops.

How does this work? By using our standardless Omnian software! Combining twenty generic samples with the power of physics, Omnian can quantify elemental composition for a wide variety of sample types – including polymers and liquids. All with one easy method!

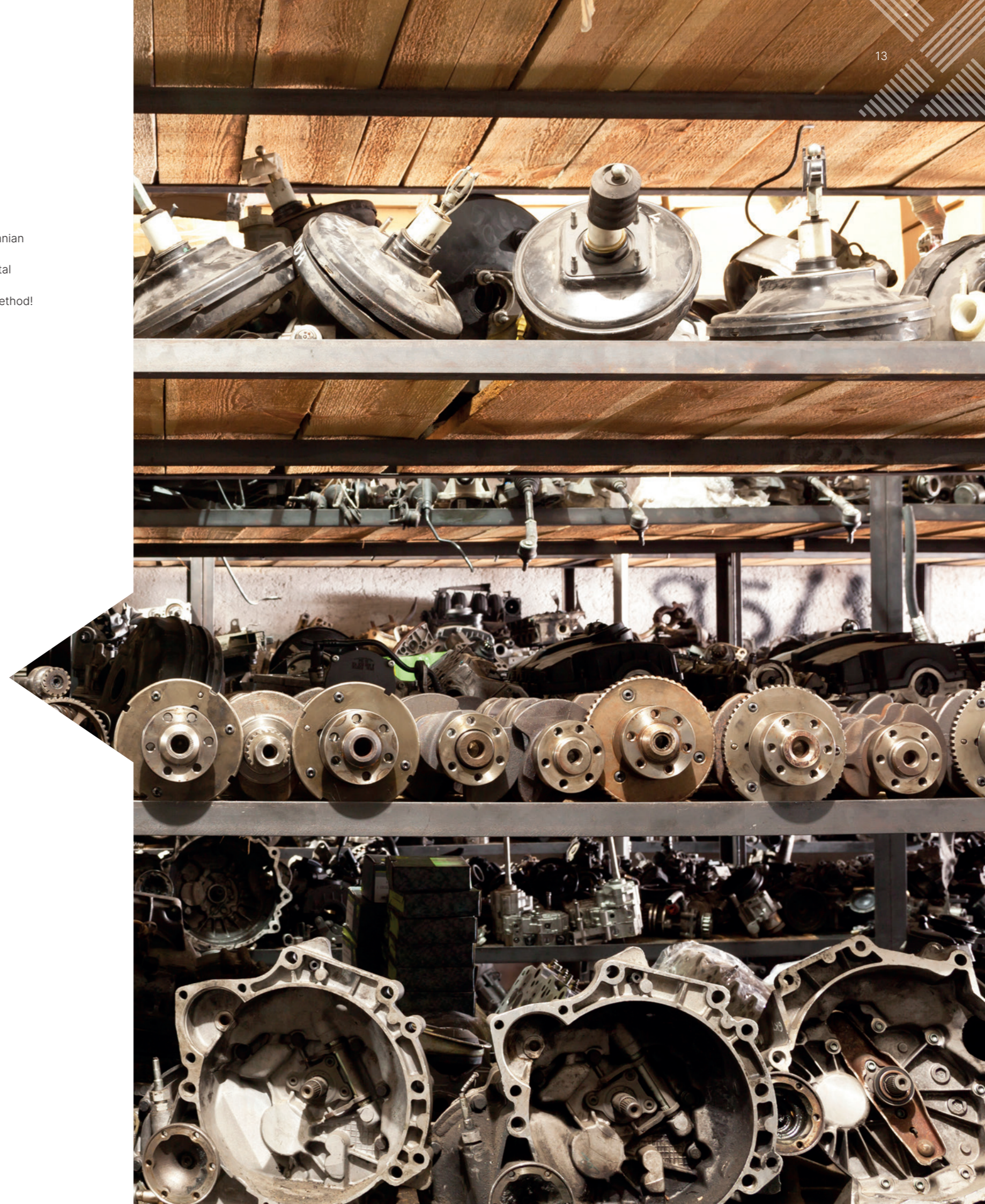
A case in point: Analyzing an alloy steel sample

To demonstrate Omnian's performance with metals, we analyzed a low-alloy steel standard (BAS SS404/1) (Table 5). The only sample preparation needed was cleaning of the surface with fine sandpaper.

Table 5. Omnian results compared to certified values of a low alloy steel standard.

Low alloy steel	Measured concentration (wt-%)	Certified concentration (wt-%)
Si	0.73	0.87
P	0.034	0.057
S	0.027	0.024
V	0.11	0.11
Cr	0.53	0.48
Mn	0.35	0.31
Fe	97.22	N.A.
Ni	0.42	0.40
Cu	0.32	0.34
Mo	0.26	0.31

Measure any material of interest during your daily operations



Be fast

Fingerprint

Fingerprint is our positive material identification (PMI) solution for Epsilon spectrometers. With fingerprint you can set the criteria for a quick PASS/FAIL result.

Be traceable

Enhanced Data Security

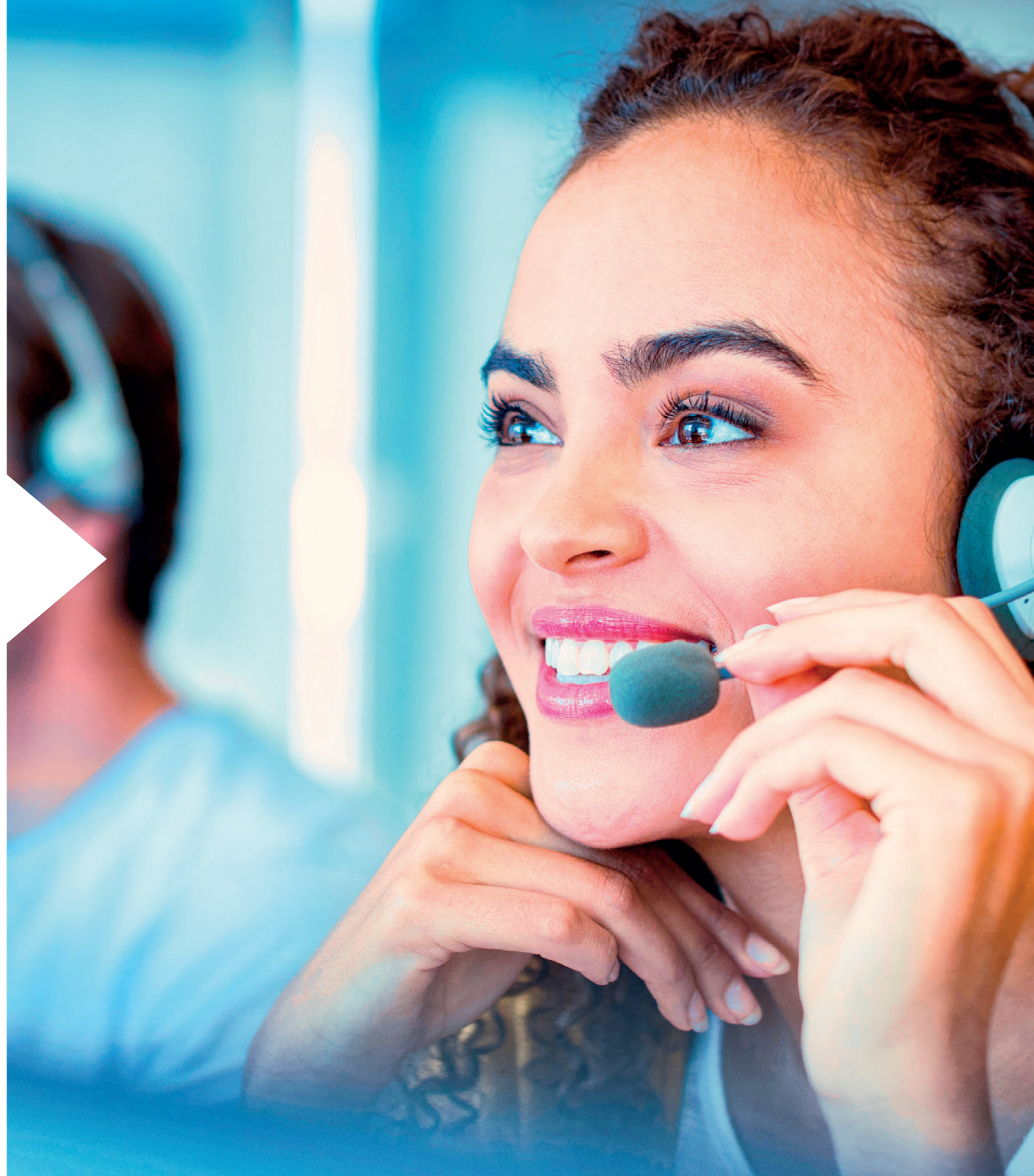
Used automotive catalytic converters are highly valuable. With our Enhanced Data Security audit trail, you can be confident that your data is secure.

Enhanced Data Security will log all your measurements and application updates, giving you a complete overview of your precious-metal grading over time.

What are you waiting for?

Our XRF spectrometers are built for you, offer total versatility, and deliver the right data just when you need it – so you can get full value from your catalyst recycling operations. Want to know your return on investment?

Talk to us today!





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.

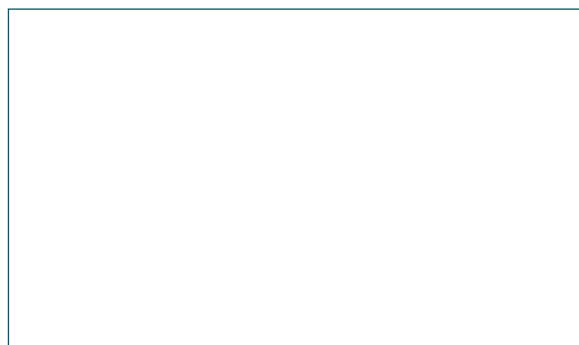
Malvern Panalytical. We're BIG on small™

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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