Malvern Panalytical
a spectris company

POWDER METALLURGY AND ADDITIVE MANUFACTURING

Material characterization solutions

SHAPING THE FUTURE

Powder metallurgy is an umbrella term that covers a range of processes for manufacturing metallic components from metal powders usually by first forming a dimensionally stable compact and then sintering it. The main processes include;

- Press and Sinter
- Metal injection molding
- Hot/Cold Isostatic pressing
- Additive manufacturing

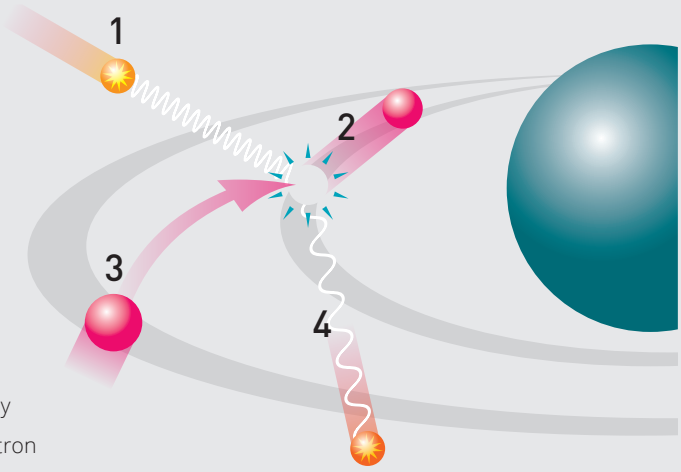
Traditional powder metallurgy processes such as press and sinter have been used to produce metallic components since the 1920s while processes such as Hot Isostatic Pressing (HIP) and Metal Injection Molding (MIM) have been employed since the 1960s and 70s respectively.

Additive Manufacturing is a relatively new technique that permits local fusing of metal powders using a laser, electron beam, or by post-sintering adhesive bonded powders.

There are a number of reasons for using a powder metallurgy process instead of a traditional process such as machining. These include one or more of the following:

- Significant cost savings
- High dimensional accuracy
- Minimal post processing
- Good part to part reproducibility
- Greater dimensional freedom and compositional complexity
- Reduced waste

Powder metallurgy refers to the production and working of metals as fine powders which can be pressed and sintered to form objects.



1. Incident X-ray
2. Ejected electron
3. Electron from outer orbital takes it's place
4. Fluorescent X-ray

X-ray fluorescence

In an XRF experiment, a sample is irradiated by X-ray radiation which causes constituent atoms to become ionized. In response the sample emits fluorescent X-ray radiation with discrete energies and intensities that are characteristic of the elements present and their quantities.

METAL POWDER **MANUFACTURE**

Metal powders are common to all powder metallurgy processes hence the powder manufacturing process and resultant powder properties are critically important and intrinsically linked.

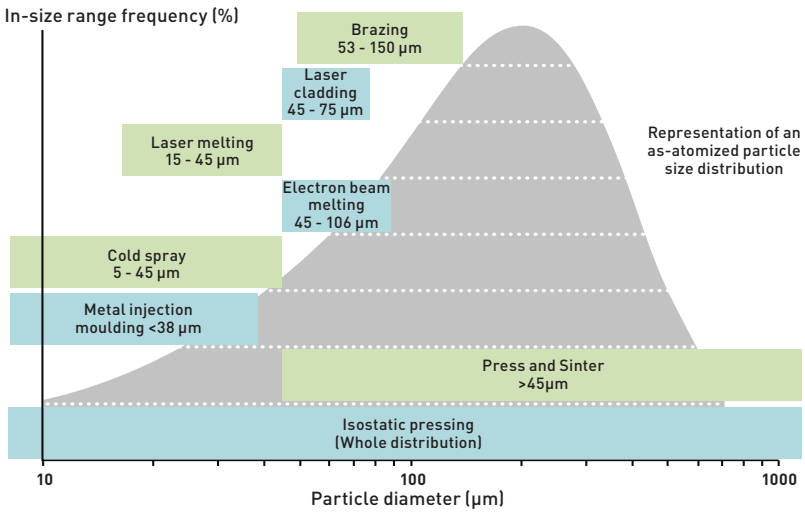
The main routes for manufacturing metal powders are:

- Comminution of solid metal
- Precipitation of a salt from solution
- Thermal decomposition of metal carbonyl (Carbonyl process)
- Solid state reduction of metal oxide
- Electrodeposition
- Atomization of molten metal

The choice of powder manufacturing route depends on the metal / alloy, the powder metallurgy process, and the powder properties required for that process.

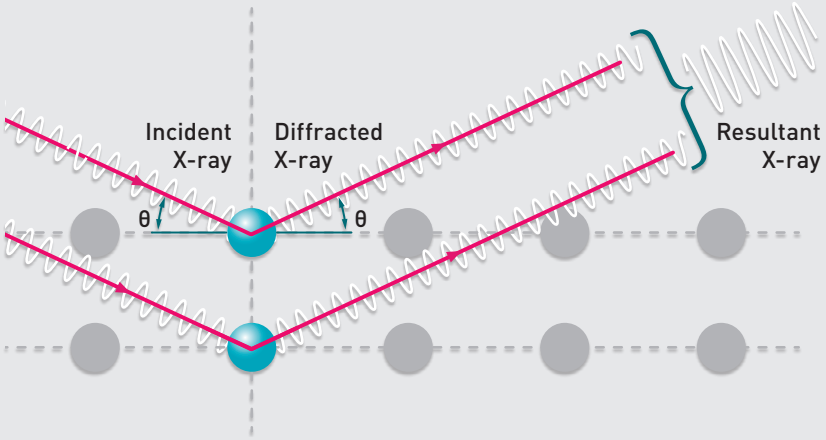
Key powder characteristics are:

- Particle size distribution
- Particle shape
- Micro-structure
- Surface condition
- Elemental composition



X-ray diffraction

X-ray diffraction is a non-destructive analytical technique in which incident X-rays are scattered by the atoms of a crystal to produce an interference effect and resultant diffraction pattern. The scattering pattern provides information about the identity, distribution and size of crystalline phases present in the material.



PRESS AND SINTER

Powder characteristics are important for press and sinter, as for other powder metallurgy processes, with particle packing and apparent density of the powder blend critical.

A lower apparent density gives greater compaction and cold-welding of particles on pressing, resulting in a stronger green body. Interparticle friction is also important and facilitates contact, deformation and densification of the structure during pressing.

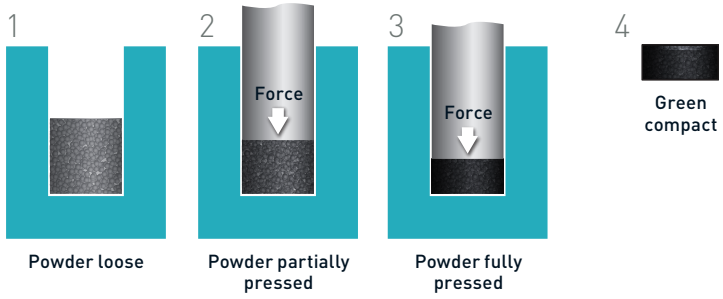
Metal powder hardness also affects pressing performance and can depend on phase composition and grain size.

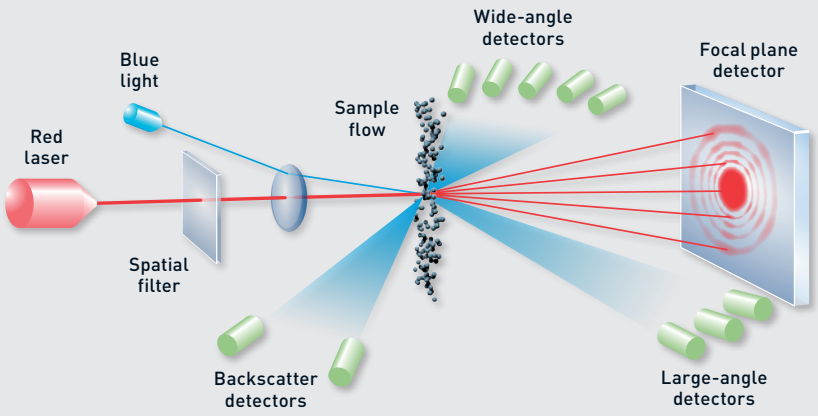
Malvern Panalytical's characterization solutions for Press and Sinter can be used to:

- Predict and control powder packing to give the required volume reduction and degree of cold-welding
- Ensure optimum contact between particles for more efficient sintering
- Measure and control batch-to-batch variability in the metallic powder
- Ensure optimum flowability and packing in the die to prevent defects in the sintered component
- Ensure alloys have the correct elemental composition and phase structure
- Determine residual stress, strain and texture of sintered parts

Press and sinter is the most conventional manufacturing method associated with powder metallurgy and involves three basic steps

1. Powder blending - metal powder is mixed with a suitable lubricant
2. Die compaction - the powder blend is pressed in a die to form a compact 'green body'
3. Sintering – the 'green body' is heated to below its melting point to form the sintered component





Laser diffraction

In a laser diffraction measurement a laser beam passes through a dispersed particulate sample and the angular variation in intensity of the scattered light is measured. Large particles scatter light at small angles relative to the laser beam and small particles scatter light at large angles.

The angular scattering intensity data is then analyzed to calculate the size of the particles that created the scattering pattern using the Mie theory of light scattering.

ADDITIVE MANUFACTURING

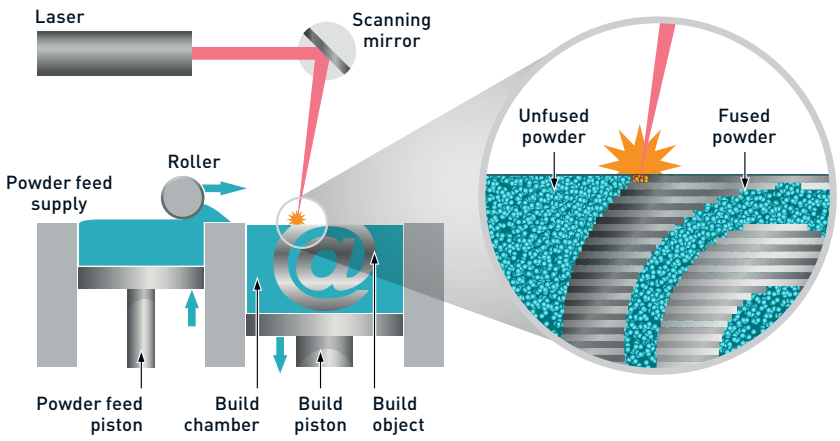
In powder bed fusion processes a metal powder layer is applied to a building platform and a laser or electron beam is used to selectively melt or fuse the powder. After melting the platform is then lowered and the process repeated continually until the build is complete. The unfused powder is removed and either reused or recycled depending on its condition.

The efficiency of powder bed additive manufacturing processes and the quality of finished components is largely dependent on the flow behavior and packing density of the powders.

The particle size directly influences these properties and is a key specification for this process, with the optimum particle size being in the range 15-45 µm for SLM and 45-106 µm for EBM for example.

Malvern Panalytical's characterization solutions for Additive Manufacturing can be used to:

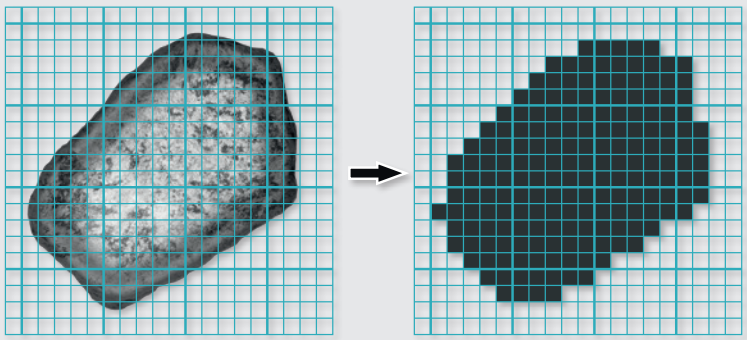
- Ensure a consistent powder supply and prevent variations in product quality
- Identify suitable powders for machines with different spreader or rake designs
- Optimize atomization conditions to achieve desired powder properties
- Predict and optimize powder packing density and flow characteristics
- Ensure powders have the correct elemental composition and phase structure
- Determine residual stress, strain and texture of manufactured components



Automated imaging

Automated imaging techniques use a digital camera to capture 2D images of a dispersed particulate sample. Individual particle images are identified using digital thresholding techniques, and then analyzed to determine their size, shape and other physical properties such as transparency.

Automated imaging instruments typically measure tens to hundreds of thousands of particles in the same amount of time needed to measure a very small number by manual microscopy.



METAL INJECTION MOLDING

The rheological properties of the feed-stock are of major importance for MIM applications since they influence the homogeneity of the molten feedstock, how well it flows through the die into the mold cavity, and the mechanical properties of the green part on cooling.

Rheological properties are influenced by a number of factors including; binder molecular weight and structure; solids loading; particle size and shape; temperature and flow rate.

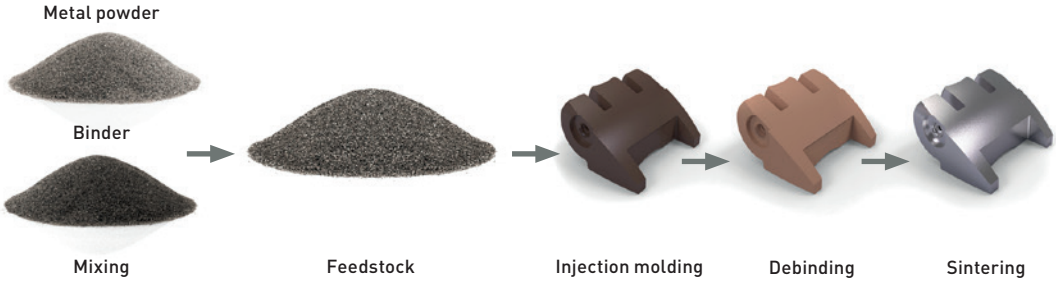
Most metals can be used in MIM if they have the correct powder properties, including particle size and shape.

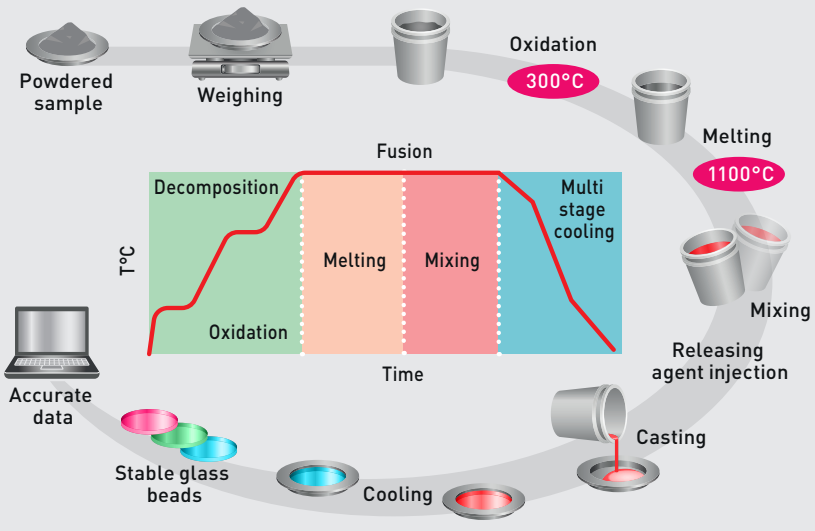
High packing densities are required, so spherical particles with the correct size distribution are preferable, as are smaller particles (< 38µm) that sinter more readily.

Slight particle irregularity can be beneficial to give mechanical strength to green and brown parts.

Malvern Panalytical's characterization solutions for Metal Injection Molding can be used to:

- Optimize particle loading to minimize part shrinkage and void formation
- Ensure appropriate feedstock rheology during molding, and dimensional stability post-extrusion
- Optimize binder properties including molecular weight and structure for flow behavior and debinding performance
- Ensure consistent metal powder supply with correct particle size, elemental composition and phase structure





Sample preparation by fusion

Fusion is a sample preparation method developed in the mid 50s. It involves dissolving a fully oxidized sample (at high temperature) in a solvent (a flux) in a crucible. The melted mixture is agitated and poured into a mold to create a glass disk for XRF analysis. It can also be poured into a beaker to create a solution for AA or ICP analysis. One of the main advantages of using fusion in the preparation of metals is that the technique is not affected by mineralogical or particle size effects, thus enhancing the precision and accuracy of XRF results.

ISOSTATIC PRESSING

Isostatic pressing is a forming process where pressure is applied uniformly (using gas or liquid) to a hermetically sealed container filled with compacted metal powder. The benefits of isostatic pressing over press and sinter are equal compaction in all directions and more uniform density in the final component.

Isostatic pressing can be performed at elevated temperatures (Hot Isostatic Pressing (HIP)) or at ambient temperature (Cold Isostatic Pressing (CIP)).

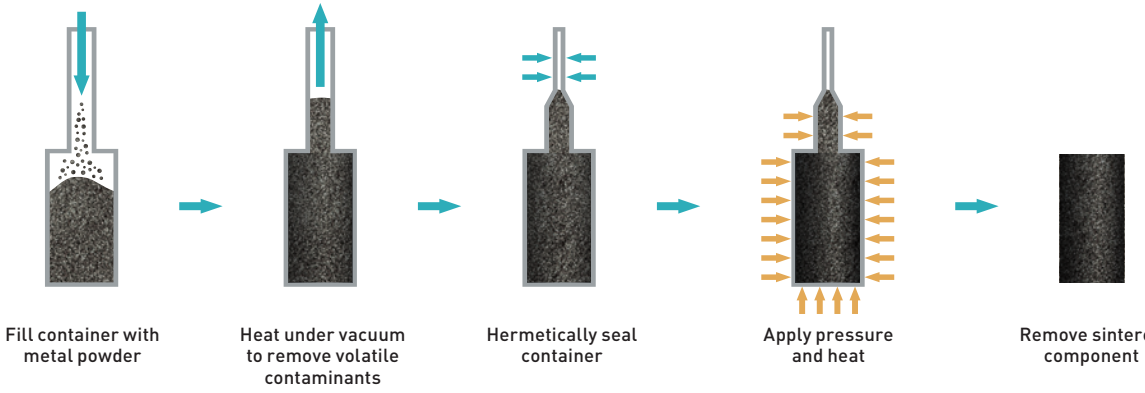
Although HIP is a direct manufacturing route for metal components it can also be used for densifying parts from other powder metallurgy processes.

Spherical powders with a relatively wide but consistent particle size distribution are preferred for HIP as they give higher fill densities. For CIP, some particle irregularity may help increase cold-welding, ideally without compromising powder flow and packing.

Phase composition and crystallite size are also important since these can affect powder hardness and melt properties which impact pressing efficiency and sintering behavior.

Malvern Panalytical's characterization solutions for Isostatic Pressing can be used to:

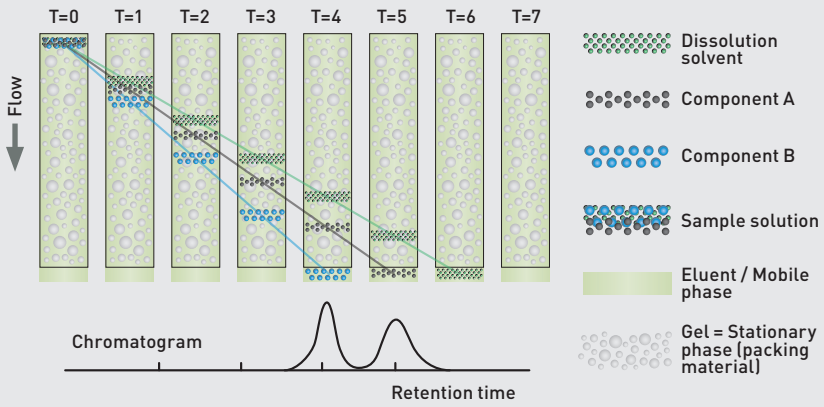
- Predict and control packing density and minimize void formation in the sintered part
- Specify and control metal powder quality
- Optimize powder flow in the mold and maintain process efficiency
- Ensure powders have the appropriate phase structure and elemental composition



Gel Permeation Chromatography

Gel Permeation Chromatography (GPC) is an analytical technique that separates dissolved maro-molecules by size based on their elution from columns filled with a porous gel.

When GPC is coupled with light scattering, viscometer and concentration detectors (known as triple detection), it can measure absolute molecular weight, molecular size and intrinsic viscosity, and generate information on macromolecular structure, conformation, aggregation and branching of polymers and waxes.



WHAT DO YOUR CUSTOMERS SAY?

Wall Colmonoy invest in Morphologi 4 to improve their metal powder products and manufacturing processes

Wall Colmonoy is a leading global materials engineering group of companies engaged in the manufacturing of Colmonoy® and Wallex® surfacing and Nicrobraz® brazing products, precision castings, coatings, and engineered components across aerospace, automotive, oil & gas, mining, energy and other industrial sectors. Headquartered in Madison Heights, Michigan, Wall Colmonoy have been an established name in metallurgy since 1938, with several sites in the US and European headquarters in Swansea, UK.

Wall Colmonoy manufactures over 500 different metal powder products at their Pontardawe facility in Swansea and have a comprehensive suite of analytical equipment for characterizing their powders: including laser diffraction, chemical analysis, rheometry, optical microscopy and electron microscopy. With a recent move into Additive Layer Manufacturing, where powder properties such as particle size and shape are often more critical, there was a need to expand their analytical capabilities. “We know that particle shape directly influences Additive Layer Manufacturing performance and our customers expect a high-quality product with the correct size distribution and a spherical morphology” said Tom Roblin, Process Engineering Manager. “We have manual microscopy and electron microscopy which allow us to qualitatively check the products we manufacture but we also needed a technique that could provide quantitative data on a statistically representative sample.”

The technical team recognized that an automated optical imaging platform capable of analyzing a large number of particles was required. They also needed image analysis capabilities that could automatically quantify the size and shape distribution of those particles. “We identified three platforms that we thought could meet our requirements. This included two Dynamic Imaging systems and the Morphologi 4 Static Imaging system from Malvern Panalytical” said Roblin. “While Dynamic Imaging was able to analyze a larger sample volume, the superior image clarity provided by the Morphologi 4 was of greater importance to us and also gave more consistent results”.

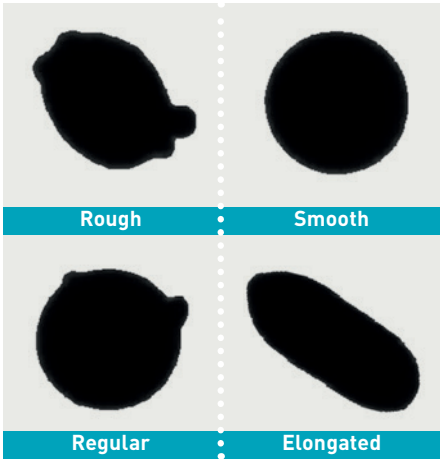
The Morphologi 4 has found multiple applications within the laboratory, not just for Additive Layer Manufacturing powders, but for many of their other products also. “Morphologi 4 is used to quantitatively measure the particle shape of our atomized alloy powders. By investing in this measurement equipment, we can benchmark and improve our current processes and products.” said Roblin. “It will also aid in the development of a new range of Wall Colmonoy powders for Additive Layer Manufacturing. For us, it is a valuable tool that provides clear images, quantitative analysis and consistent results.”

MORPHOLOGI 4

Direct measurement of metal powder size and shape

The Morphologi 4 is an advanced yet easy-to-use, particle characterization tool for measuring particle size and shape from 0.5 microns to several millimeters. The instrument offers the flexibility required for R&D and troubleshooting applications, as well as the user-independent results and validation required for automated QC analysis.

For many powder metallurgy applications particle shape can be just as important as particle size. The Morphologi 4 reports shape information using parameters such as elongation, circularity, convexity to quantify particle irregularity and surface roughness. More efficient than manual microscopy and electron microscopy, automated imaging provides statistics on tens of thousands of particles.



"Morphologi 4 is frequently used for optimising atomisation conditions and evaluating the impact of process changes on powder properties. It is a valuable tool that provides clear images and consistent results."

Tom Roblin
Wall Colmonoy

Features	Benefits
Particle size range from 0.5 µm to 1000 µm	Make size measurements of powders for all powder metallurgy applications
Measurement of non-spherical particles in terms of their length and width	Provides a more relevant size measurement of irregular particles
Automated image analysis that reports a range of shape parameters	Quantify particles in terms of the degree of irregularity or surface roughness
Automation of manual methods such as microscopy	Perform microscopy measurements faster and less subjectively, while freeing up resource
Integrated dry powder dispersion unit	Easy, reproducible sample dispersion which is critical to achieving meaningful results
Optimized microscope optics and high signal to noise CMOS camera	Generation of high quality particle images and image analysis data
Automated SOP control from sample dispersion to results analysis	Simple, intuitive operation and robust, repeatable measurement protocols

MASTERSIZER 3000

Accurate particle size with minimum effort

The Mastersizer 3000 is the latest generation of the world's most widespread particle sizing instrument, used by many thousands of companies and research institutes across a wide range of industries.

Malvern Panalytical's considerable experience and applications know-how has gone into every stage of the design of the Mastersizer 3000 instrument, from fundamental particle sizing performance right through to user ergonomics and method advice.

Many of the disadvantages of traditional sieve analysis are addressed by the Mastersizer 3000:

- Faster and simpler analysis
- Increased measurement range including very fine particles
- Better measurement resolution for improved product quality
- Trouble free maintenance

"We've been using the Mastersizer 3000 for almost a year and our throughput has increased more than we could have imagined. The repeatability is such that multiple analyses overlaid appear as one distribution, and the software is extremely robust."

Justin Hoover
Metals and Additives LLC

Features	Benefits
Measure particles in the size range 0.01 µm – 3.5 mm	Enable accurate measurement of almost any metal powder fineness and formulation
High accuracy, repeatability and reproducibility (< 1% variation)	Verifiable instrument-to-instrument performance that you can rely on
Easy sample loading and cleaning	Reproducible dispersion with minimal sample to-sample contamination
Rapid measurements (<20 sec)	Increased throughput/productivity and more efficient process control
TCP/IP or Autolab driver remote control via Malvern Link™ II	Feed results directly to the plant process control system
Modern and intuitive software interface	Streamlined method development and built-in expert advice
Meets all the recommendations for ISO13320	Guarantees quality and compliance

OMNISEC

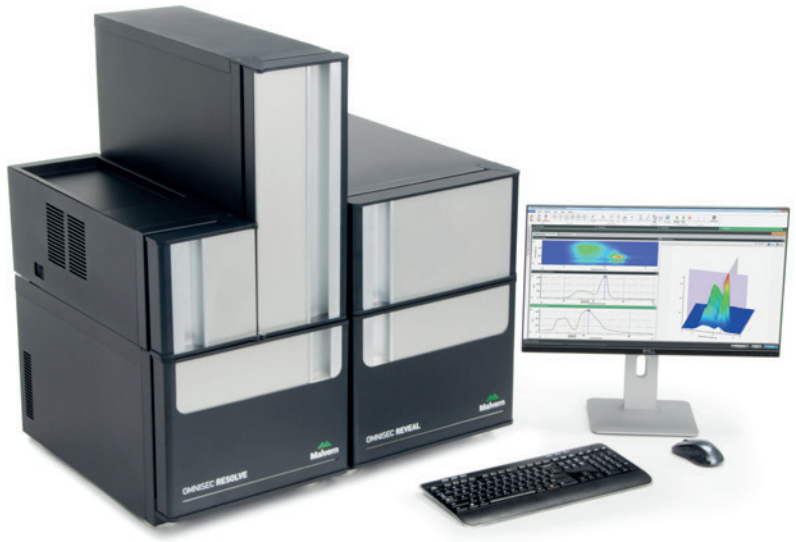
The most advanced multi-detector GPC/SEC system

OMNISEC is a Gel Permeation Chromatography (GPC) / Size Exclusion Chromatography (SEC) system for the measurement of absolute molecular weight, molecular size, intrinsic viscosity, branching and other parameters.

The system includes OMNISEC RESOLVE, the integrated GPC/SEC module, OMNISEC REVEAL, the integrated multi-detector module and OMNISEC software, for the characterization of synthetic and natural polymers.

OMNISEC can accurately measure the most important characterization parameters, including:

- Absolute molecular weight and molecular weight distribution
- Intrinsic viscosity and molecular structure



'Since we purchased OMNISEC, we're able to deliver more sensitive GPC data, so our ability to support decisions around different suppliers and troubleshooting has been directly enhanced.'

Dr Kirt Durand
Syngenta

Features	Benefits
Highly sensitive light scattering (LS) detector	Measure molecular weights of polymers, oligomers and waxes down to 200 g/mol
Integrated differential viscometer	Measure intrinsic viscosity (IV) to investigate molecular structure and branching
Temperature controlled detectors	Achieve better baseline stability for improved accuracy and sensitivity
Workflow oriented software	Makes GPC/SEC measurements and analysis as easy and intuitive as possible
Integrated column oven	Improve separation quality and resolution
Refractive Index (RI) detector	Measure the concentration of almost any solute
Triple detection (RI, IV and LS)	Combine data to determine as hydrodynamic radius (Rh), radius of gyration (Rg) and Mark-Houwink parameters

EPSILON

Benchtop XRF spectrometers for simple elemental analysis

X-ray fluorescence (XRF) is routinely used by metal powder producers and component manufacturers for determining the elemental composition of metal alloys and for detecting the presence of contaminants. Elemental composition is particularly important for alloys since small variations in the concentration of alloying elements can affect its chemical and physical properties, including strength, hardness, fatigue life and chemical resistance.

The Epsilon range of Energy Dispersive X-ray fluorescence (EDXRF) analyzers are capable of simple element identification and quantification from sodium (Na) to americium (Am). They are easy to operate, compact and X-ray safe instruments without the need for additional chemicals. Considerable savings in time and cost are two of the many benefits EDXRF can bring compared to alternative analytical techniques such as ICP.

"Very easy to use. Reproducible analysis. Very user-friendly."

SelectScience® TRUSTED REVIEWS ★★★★★

Ivan Boninsegna
Aquafil S.p.a.

Features	Benefits
Analysis with/without reference standards	Can be calibrated with reference materials for most accurate data or without for samples with unknown composition
Versatile sample presentation	Can analyze sample types including liquids and slurries, pressed powders, loose powders, fused beads and irregularly shaped objects
Both systems have compact design with Epsilon 1 having a built-in computer and touchscreen.	Requires less bench space and allows for easy and direct instrument operation in the lab or at-line
Epsilon 4 has optional SDD^{Ultra} detector for ultra light element analysis	Analysis of ultra light elements such as carbon, nitrogen and oxygen down to 1 wt%
Epsilon 4 has a 10-position removable sample changer with spinner	Automatic processing of sample batches and minimal errors caused by non-homogeneity of sample
Epsilon 1 has optional small spot capability (1 mm spot size) with camera for easy positioning	Quantify inclusions and contaminants to determine their origin

ZETIUM

Floor-standing XRF for elemental excellence

Designed to meet the most demanding process control and R&D applications, the Zetium spectrometer leads the market in high-quality design and innovative features for quantitative analysis of elements ranging from beryllium (Be) to americum (Am), and is the preferred choice when light element analysis and analytical precision is important. The modular design also allows for various task-oriented enhancements to meet specific application requirements.

Zetium uses SumXcore technology which brings together the benefits of WDXRF (Wavelength Dispersive) and EDXRF (Energy Dispersive) XRF with unique advantages for the analysis of metals, including:

- reduction in analysis time and improved precision
- identification of unexpected elements in samples

For inclusion or contaminant detection, small spot mapping and elemental distribution analysis can be performed.

"Calibrates well to levels we look at. Software is very intuitive and product support is great from their diverse application specialists."

SelectScience® TRUSTED REVIEWS ★★★★★

Riley Perkins
Freeport McMoran

Features	Benefits
Analysis with/without reference standards	Can be calibrated with reference materials for most accurate data or without for samples with unknown composition
Versatile sample presentation	Can handle sample types including pressed powders, loose powders, fused beads and irregularly shaped objects
High-capacity sample changer	High-throughput analysis of up to 240 samples per 8-hour shift
System enhancement packages	Can be easily adapted and upgraded to meet future testing requirement
SuperQ software with Virtual Analyst	Simple and intuitive task-oriented workflow with expert guidance for ease-of-use
Small spot analysis with elemental mapping	Determine spatial distribution of elements and presence of inclusions or contaminants
SumXcore - Combined WD/ED XRF	Reduced measurement times with improved precision and sensitivity

EMPYREAN

The multi-purpose X-ray diffractometer

Empyrean is a multipurpose X-ray diffractometer for determining the micro-structural characteristics of metal powders and their fabricated components, including;

- phase composition
- crystallite size
- texture (crystallite orientation)
- residual stress/strain

These characteristics can affect properties such as hardness, strength and fatigue life, and are influenced by thermal and mechanical processes such as atomization, laser melting and powder pressing.

Empyrean features a MultiCore Optics system that enables a large variety of different measurements to be performed automatically without manual intervention.

Empyrean has the unique ability to measure a variety of sample types including powders, thin films, nanomaterials and solid objects, over a wide range of temperatures.

It has an unrivaled collection of sample stages and optical components, including a tensile stage for sample analysis under stress, that can be easily interchanged to allow a wide range of diffraction, scattering and imaging applications, including computed tomography, to be performed.

"Very reliable and modular system! I love that I can quickly change the system from one mode to the other to provide support to a number of different ongoing research projects."

SelectScience® TRUSTED REVIEWS ★★★★★

David Tavakoli
Georgia Tech

Features	Benefits
MultiCore optics (iCore and dCore)	Automates measurements including multiple measurement geometries to maximize instrument utilization and obtain a more complete understanding of your materials
Pre-aligned fast interchangeable X-ray modules (PreFIX)	Enables the diffractometer to be reconfigured in a few minutes without module re-alignment, saving time and effort
Wide range of sample types	Can measure all sample types - from powders to thin films, from nanomaterials to solid objects - even during tensile testing
Full suite of configurable modules and measurements including a tensile stage	Provides access to a wide range of diffraction, scattering and imaging applications on a single platform
A range of non-ambient chambers for analysis at temperatures ranging from -260°C to 2000°C and under different atmospheric conditions	Study the effect of temperature, pressure, gas atmosphere and mechanical stress on phase transformation, chemical reactions, recrystallization, etc.
HighScore/HighScore Plus Software	Provides comprehensive phase identification, profile fitting, Rietveld, crystallographic and extended cluster analysis

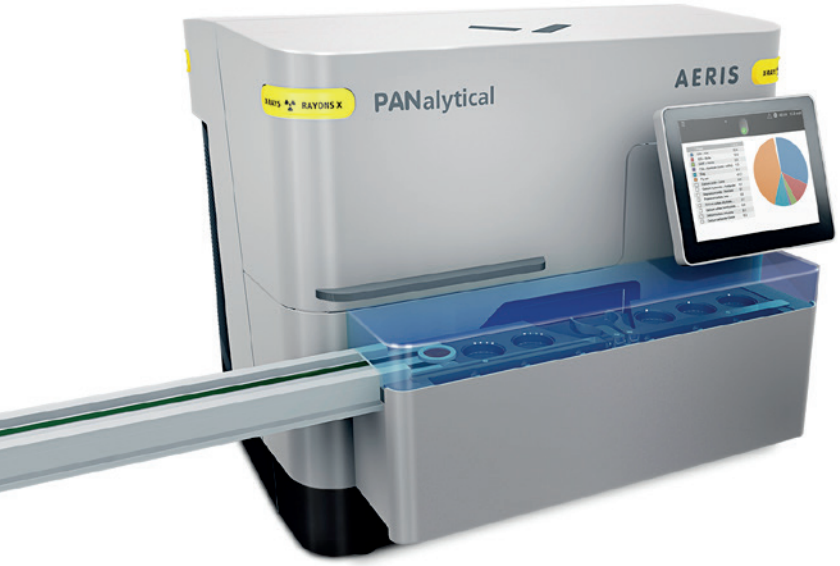
AERIS

Phase analysis made simple

Aeris is a user-friendly bench-top X-ray diffractometer that provides fast, reliable and accurate phase identification and quantification of your metal powders. Aeris makes X-ray diffraction simple and accessible to everyone. Aeris is also the first X-ray diffractometer to be fully automatable and can be easily incorporated into a relevant process. The unique touch screen user interface lets you proceed effortlessly through the measurement process and results can also be analyzed in the HighScore software to provide a wealth of crystallographic information.

Aeris' low cost of ownership delivers maximum return on investment since it has limited infrastructure requirements. For example, it has a small footprint and does not require compressed air or water cooling. It also has a much lower power consumption compared to floor standing systems and its X-ray tube has a virtually unlimited lifetime.

Aeris is also the first benchtop to be fully automatable and can be easily incorporated into a relevant process.



"Great machine that produces accurate, high-resolution and reproducible results in a short amount of time."

SelectScience® TRUSTED REVIEWS ★★★★★

Charles Liu
SEMx Incorporated

Features	Benefits
Simple touch-screen user interface	Intuitive operation that make measurements quick and easy even for the novice
Minimal infrastructure requirements	No cooling water, no chiller, no compressed air - the only thing you need is a single-phase power socket
HighScore/HighScore Plus Software	Provides comprehensive phase identification, profile fitting, Rietveld, crystallographic and extended cluster analysis
Powerful search-match algorithm for multiple reference databases	Optimizes search criteria across a wide range of reference databases making it easier to identify minor phases in the diffractogram
Automatable bench-top that can connect to a belt	Automate a process or perform high-throughput analysis

SAMPLE PREPARATION EQUIPMENT

What is fusion and why should I use it in my laboratory?

Fusion is a sample preparation method developed in the mid 50s. It involves dissolving a fully oxidized sample (at high temperature) in a suitable solvent (a flux) in a platinum, zirconium or graphite crucible. The melted mixture is agitated and poured into a mold to create a glass disk for XRF analysis. It can also be poured into a beaker to create a solution for AA or ICP analysis.

This universal technique has numerous benefits when you compare it with other sample preparation methods such as pressed pellets or acid digestion. One of the main advantages of using fusion in the preparation of metals is that the technique is not affected by mineralogical or particle size effects, thus enhancing the precision and accuracy of XRF results.

Why should I use fusion in my lab?

This universal technique has numerous benefits when you compare it with other sample preparation methods such as pressed pellets or acid digestion

	Fusion	Pressed pellets
Affected by mineralogy	No	Yes
Affected by particle size	No	Yes
Desirable size of powder (microns)	50 - 100 (Easy)	5 - 30 (Difficult)
Accuracy	≤1%	≤10%
Easy clibration with synthetic standards	Yes	No
Application of matrix correction	Yes	No

LeNeo fusion instrument prepares glass disks for XRF analysis as well as borate and peroxide solutions for AA and ICP analysis. This automatic electric instrument has one fusion position and is easy to use. It guarantees safety for the operator as well as superior analytical performances in the laboratory.

TheOx Advanced fusion instrument has been designed by our experts to suit our customers' ever-changing needs. This instrument is powered by electricity and has six fusion positions. It is used to prepare glass disks for XRF analysis as well as borate and peroxide solutions for AA and ICP analysis. Its extra features enhance analytical performance and safety, benefiting users at all levels.

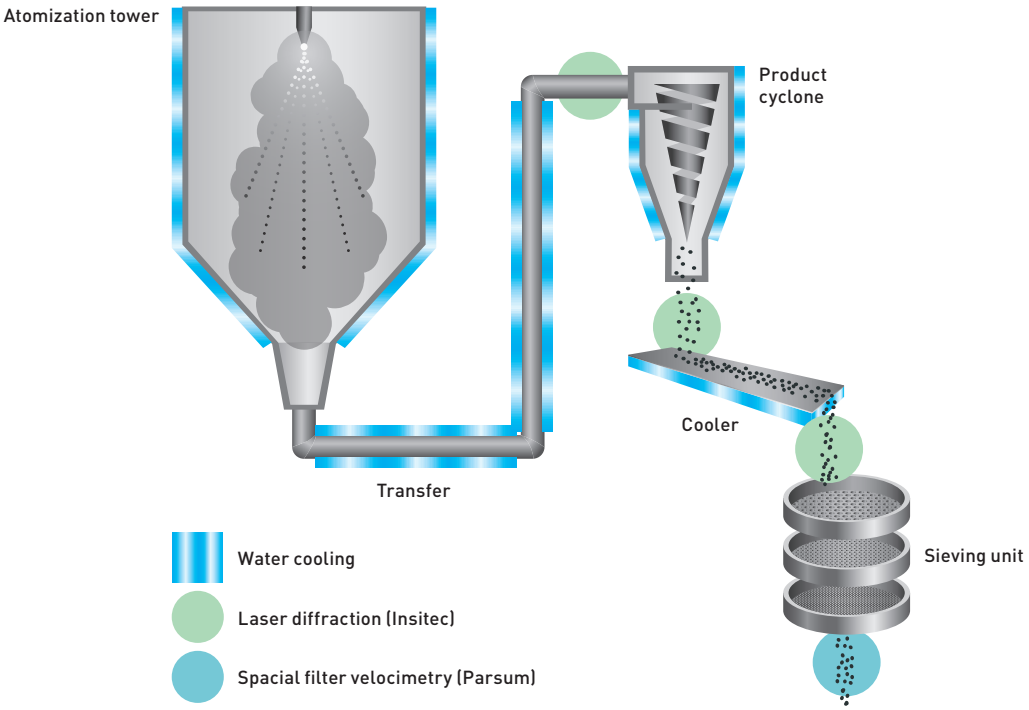
The Eagon 2 is a fully automatic fusion instrument that prepares glass disks for XRF analysis. Its innovative patented design ensures performance, operator safety and ease of use. The Eagon 2 instrument makes fusion and the consequent benefits for accurate XRF analysis easily achievable.

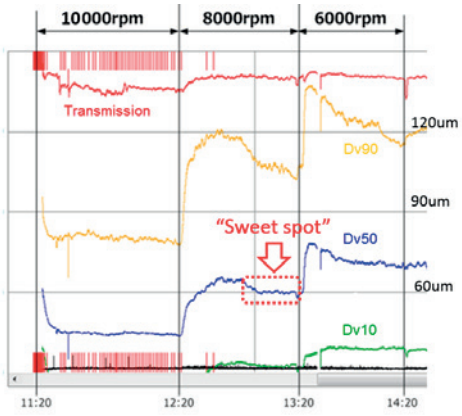
REAL-TIME PARTICLE SIZING

A watchful eye to optimize your process

Manufacturing high quality metal powders economically demands exemplary process control. Established in-line and on-line particle sizing technologies provide continuous process monitoring and a data stream that supports complete process automation. Such technology therefore makes it easier to make highly consistent products to a tight particle size specification at the lowest possible variable cost.

At the same time, continuous particle sizing has a role to play in managing the re-use of high-value AM powders, a critical issue for economic viability. With a proven track record and strong reliability, in-line and on-line particle sizing technology holds considerable value for metal powder manufacturers establishing robust supply chains for the PM industry, and for AM users looking to optimize their powder management processes.





Real-time measurement system makes it possible to instantly observe the effect of decreasing the speed of rotation of the atomizing disk and the time taken for the process to re-establish a steady state. (Green Dv10, blue Dv50, orange Dv90, red is transmission).

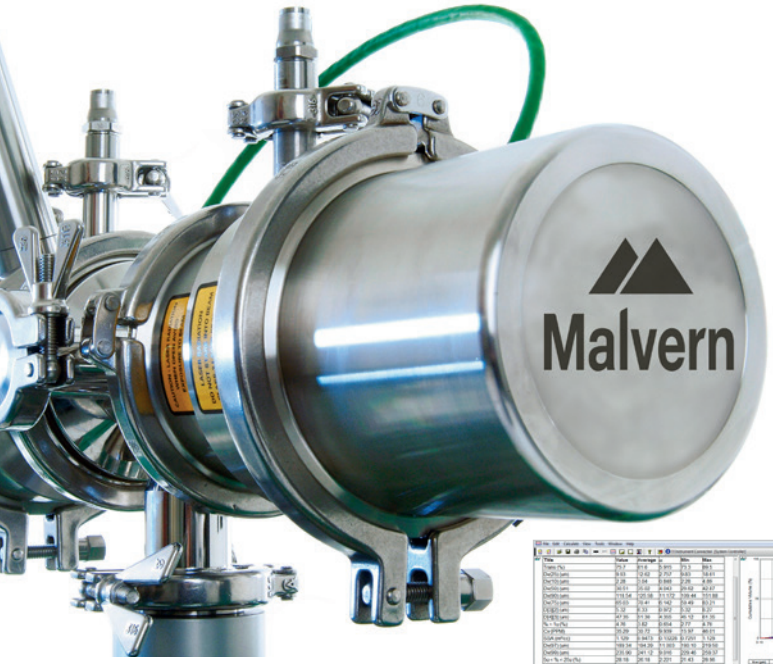
INSITEC

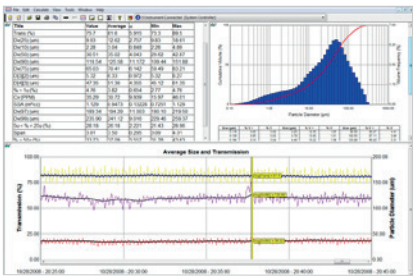
Robust, reliable, real-time particle sizing for process control

Insitec analyzers are on-line laser diffraction systems that provide continuous particle size analysis, for efficient, cost-effective monitoring and control of industrial process streams including dry powders, slurries and sprays in the size range 0.1 µm to 2.5 mm.

Insitec provides real-time particle size distribution for automatic 'closed loop' process control, enabling the operator to optimize and control processes such as spray drying, atomization, milling and screening, and react in real-time to production fluctuations.

Malvern Link™ II software interface, enables full integration with your plant control system and unlocks the potential value of timely particle size measurement. The dedicated analysis software, automation and data reporting can be customized to meet individual requirements.





"For us, the Insitec is an essential tool for optimizing the performance of the finishing mills and it is of great value to the production teams. It provides continuous particle size data for the material exiting the mills, so that the operators can react quickly and confidently when making control decisions."

Michel Berger
Holcim

Features	Benefits
Measure particles in the size range 0.1 µm – 2500 µm.	Enable accurate measurement of metal powder from a range of processes
Optical head and sample path certified to Pressure Shock Resistance of 11bar(a) (PSR11)	Withstands extreme conditions of metal powder production
Ceramic linings protect critical, high-velocity areas of the sample pathway and purging protects windows from dust	Maintenance requirements are minimal
Provides continuous particle size data	Operators can react quickly and confidently when making control decisions
Meets all the recommendations for ISO13320	Guarantees quality and compliance
Measures representative sample volume	Statistical reliability for process control
Control system integration options – OPC, Modbus, Profibus, wired IO	Ease of reporting
Integrated software interface for plant automation	Deliver results in real-time to your control room and allow automation of routine tasks such as cleaning, maintenance and background checks

PARSUM

Real-time size measurements for screening applications

The Parsum probe measures particle size distributions and velocities of solid particles in gas streams using a patented spatial filtering velocimetry technique. It has a size range of 50 µm to 6 mm and is widely used for monitoring and optimization of screening operations. Real-time particle distribution data enables the user to reduce variability during processing and detect screen breakages by monitoring for oversized particles.

The probe contains an array of light sensitive detectors which are illuminated by a laser. This array can detect single particles as they pass through the laser beam within the probe measurement zone. The shadow produced by each particle can be used to calculate the particle velocity and its chord length (particle size).

The detector signals are sampled very rapidly (up to 10,000 particles per second) and particle size distribution data is continuously updated during operation to produce a real time particle size trend. This provides direct insight into the performance of the process without the need for sample extraction.

Features	Benefits
Real-time measurement of particles in the size range 50 µm to 6 mm during processing	Continuous and uninterrupted monitoring of processes such as sieving, pneumatic transport and mixing
Measure up to 20,000 particles in real-time	Fast and statistically representative data for confident decision making and optimum process control
Wide range of accessories, such as inline dispersers and cleaning cells	Provides a so-called “process interface” for adapting the measurement probe to different conditions within the process.
Range of different probes for various processes and environments	Make real-time measurements inside mixing vessels, under sieve-decks and during conveying, even in ATEX zones
IPP measuring software	Flexible and adaptable system of programmes and interfaces that can control 4 probes simultaneously and gives real-time updates of particle size distributions and sieve fractions/throughputs

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WHY CHOOSE **MALVERN PANALYTICAL**?

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