Particle size and shape characterization
by Dynamic Image Analysis

CAMSIZER X2

MICROTRAC MRB
PARTICLE CHARACTERIZATION

part of VERDER scientific

dual camera technology

Microtrac MRB – Particle Characterization at Its Best

Comprehensive analysis of granules, powders and suspensions

Microtrac MRB is your superior partner for the characterization of disperse systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovation and quality form the basis of our success.

Microtrac MRB offers three product lines with competence centers on three continents:

Scattered Light Analysis: Microtrac MRB is a leading supplier of laser diffraction systems (static light scattering), a versatile method for particle size determination. The portfolio also includes dynamic light scattering instruments perfectly suited for the characterization of nano particles. The development and production site for this product line is located in Pennsylvania, USA.

Image analysis: With the CAMSIZER series Microtrac MRB provides high-quality systems for the determination of particle size and particle shape based on imaging techniques. These image analyzers are developed and manufactured in our competence center in Haan, Germany.

Surface and porosity measurement: Specific surface, BET value and porosity of powders are determined by gas adsorption. The competence center for this product line is located in Osaka, Japan.

As part of the Verder Scientific Group we offer worldwide support through a network of subsidiaries and distributors.

CAMSIZER Series

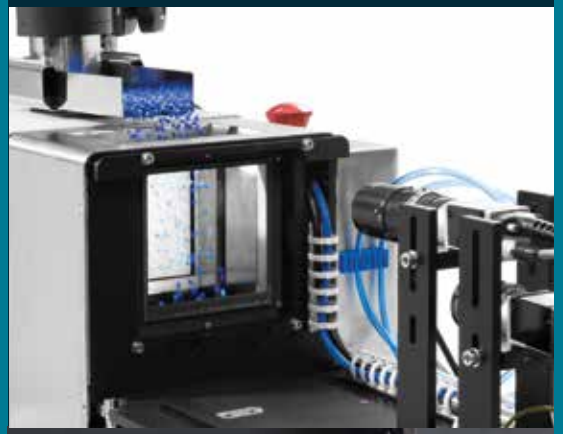
High-resolution image analysis of particle size and particle shape

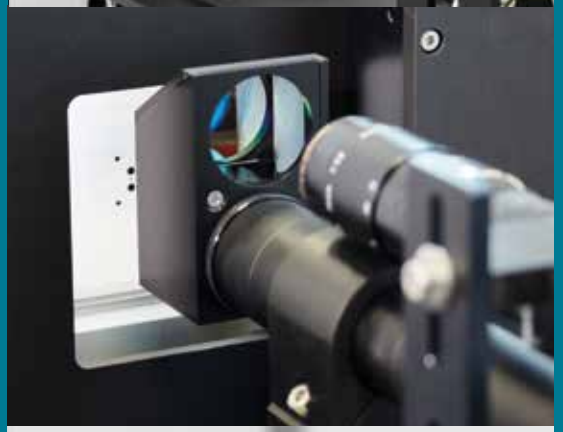
With the CAMSIZER X2 and CAMSIZER P4 Microtrac MRB sets standards in Dynamic Image Analysis. Thanks to the unique two-camera principle both instruments provide quick analyses with excellent accuracy and reproducibility over an extremely wide measuring range.

This makes the CAMSIZERs ideally suited for routine analysis as well as quality control applications. Thanks to a powerful evaluation software which provides a multitude of valuable information and measurement parameters, the analyzers are also suitable for usage in R&D applications.

The latest development, the CAMSIZER M1, measures particles based on static image analysis. This method is particularly suitable for the highly precise determination of the size and shape of very small particles in the low micron range.

- CAMSIZER X2: Dynamic Image Analysis of powders and suspensions
- CAMSIZER P4: Dynamic Image Analysis of free-flowing bulk materials
- CAMSIZER M1: Static image analysis of very fine materials





CAMSIZER X2

Flexible Size and Shape Analysis for Highest Requirements

The CAMSIZER X2 is a powerful, extremely versatile particle analyzer with a wide measuring range that combines state-of-the-art camera technology with flexible dispersion options. Based on the principle of Dynamic Image Analysis (ISO 13322-2), the CAMSIZER X2 provides precise particle size and shape information of powders, granules and suspensions in a measuring range from 0.8 µm to 8 mm.

The CAMSIZER X2 produces a particle flow which is characterized by an optical system with high resolution. An ultrabright LED stroboscopic light sources and two high-resolution digital cameras achieve a frame rate of more than 300 images per second which are evaluated in real time by a powerful software. Thus, the CAMSIZER X2 captures the images of hundreds of thousands to several millions of particles with highest accuracy within only 1 to 3 minutes. The CAMSIZER X2 provides a wide selection of particle information which allows for comprehensive and reliable characterization of the sample material. It is suitable for use in R&D as well as for routine tasks in quality control.

Particle Analyzer CAMSIZER X2

- Particle size and particle shape analysis from 0.8 µm to 8 mm with Dynamic Image Analysis (ISO 13322-2)
- Precise analysis of wide size distributions
- Excellent resolution for narrow or multimodal size distributions
- Detection of small amounts of oversized or undersized particles
- Fully comparable to sieve analysis and laser diffraction results
- A wealth of evaluation options (different size models, a variety of shape parameters, particle library, single frame evaluation, etc.)
- Outstanding reproducibility
- Measurement time 1 – 3 minutes, high sample throughput
- Modular „X-Change“ system for dry and wet measurement
- Ultra-strong LEDs and high-resolution cameras for the clearest results
- Easy operation, virtually maintenance-free

Extremely Wide Measuring Range due to Dual Camera Technology

Microtrac MRB's unique dual camera technology is a landmark in the development of Dynamic Image Analysis. By simultaneously employing two cameras with different magnifications, extremely wide dynamic measuring ranges are archieved. This is accomplished without hardware adjustments or modifications and without compromising accuracy. Each camera is specialized for one measuring range.

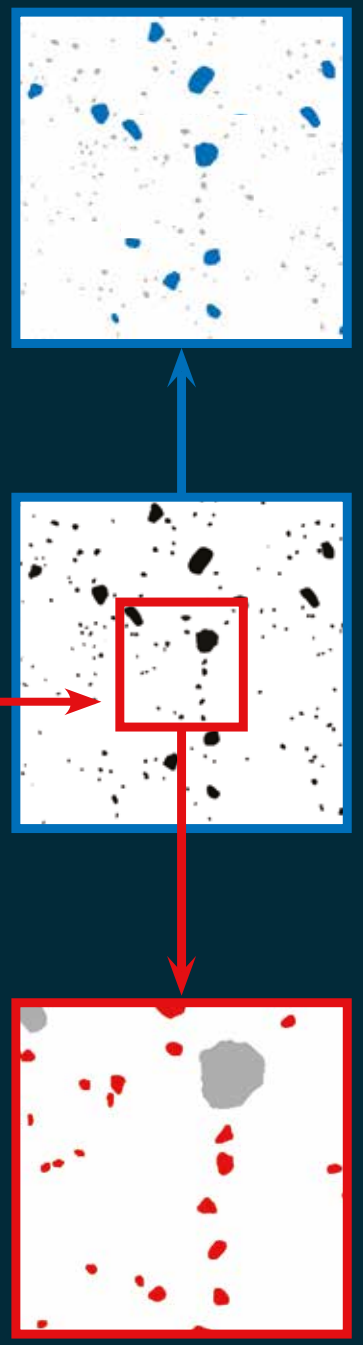
The ZOOM camera analyzes fine particles with highest precision whereas the BASIC camera detects the larger particles with excellent statistics. A special algorithm combines the information provided by both cameras and delivers the exact size distribution in a possible range of more than three decades!

This arrangement resolves a significant drawback of many image analysis systems that employ only one camera, e. g. microscopes. Such instruments either cannot correctly report the fine particles in wide size distributions, or the large particles are not captured due to the small field of view.

dual camera technology

Measurement Principle

Two cameras operate simultaneously during measurement: the BASIC camera (blue) analyzes the larger particles, the ZOOM camera (red) captures the small particles. This procedure ensures optimum measurement conditions for all particle sizes in a distribution.



Modular X-Change System for Maximum Flexibility

Correct sample preparation and dispersion of the particles before passing into the measurement field are as important as the actual analysis. Particularly for fine powders which tend to agglomerate, sufficient dispersion is crucial to the reliability of the measurement results. Therefore, various modes of sample feeding help to achieve separation of the agglomerates without destroying individual particles. The CAMSIZER X2 offers three dispersion options:

Dispersion by compressed air

The X-Jet module disperses the sample via a Venturi nozzle and is suitable for the effective analysis of powders. The actual measurement of the particles takes place in the air stream. Dispersion pressure may be set between 0 kPa and 460 kPa. This ensures optimum analysis conditions for all sample types.

Dispersion by gravity

The X-Fall module is used for non-destructive measurement of sensitive samples in free fall to minimize particle breakage. The sample can be recovered after the analysis.

Dispersion in liquids

CAMSIZER X2 also offers the option to analyze particles in liquids with the X-Flow module. The suspension flows in a closed circle through a glass cell where the cameras record the particle images. The integrated ultrasonic unit further aids in the dispersion process.

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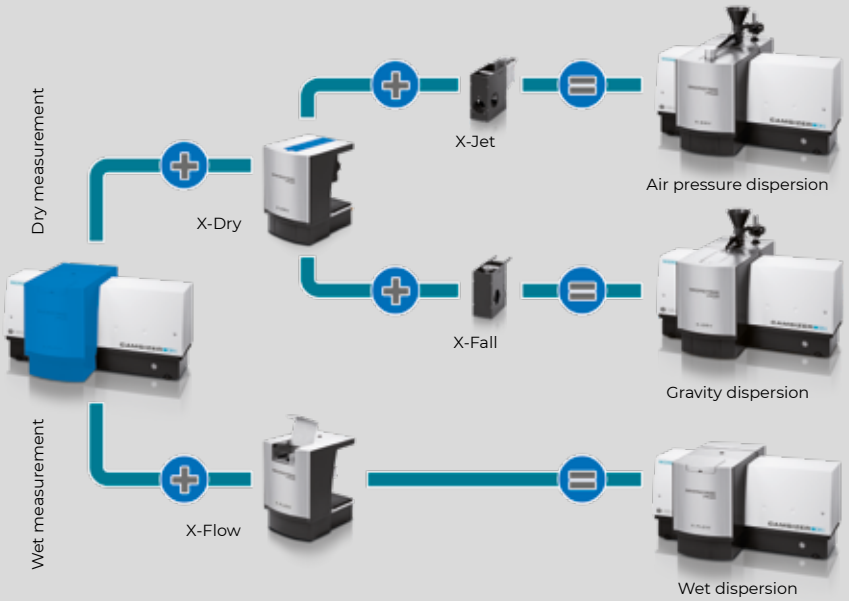
X-DRY

Modular Design for Maximum Flexibility

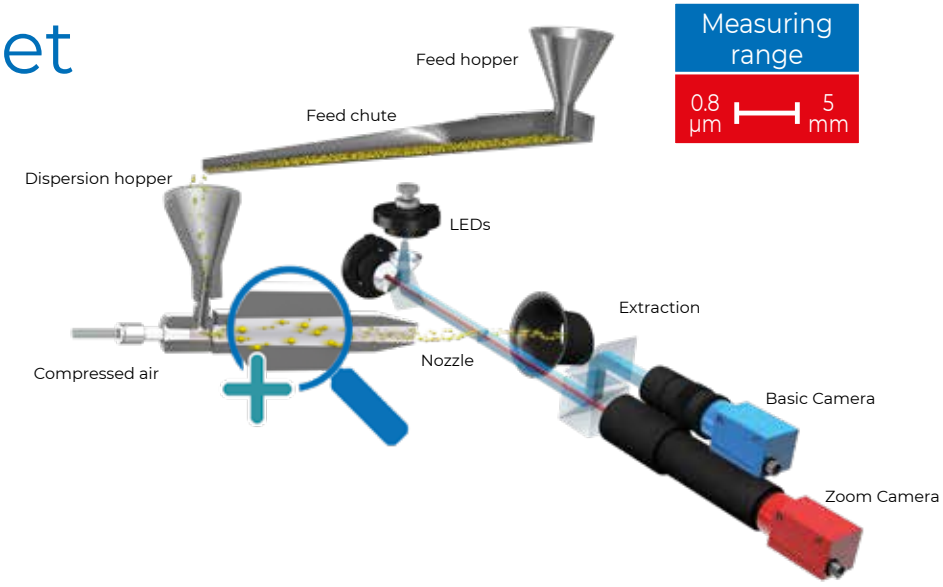
The CAMSIZER X2's modular **"X-Change"** system offers **three alternative dispersion options**, permitting the selection of the **optimum method** for each sample type. The user may choose between wet dispersion with **X-Flow** or dry measurement either in free fall with **X-Fall** or in an air flow with **X-Jet**. The modules and cartridges are quickly and easily exchanged which makes working with the CAMSIZER X2 convenient and safe.



Air Pressure Dispersion with X-Jet

Many materials tend to agglomerate due to surface forces. The X-Jet module effectively disperses the particles in an air flow while passing through a Venturi nozzle. The dispersion pressure can be set as required for individual particles. For sensitive granules, for example, reduced pressure ensures non-destructive measurement. After passing the measurement field, the sample is automatically removed from the analyzer by a vacuum cleaner.

- Pressure adjustable from 0 kPa to 450 kPa
- Effective dispersion, also for particles < 10 µm
- Gentle measurement of friable samples
- Quick analysis of large quantities
- Different nozzle diameters available for the control of dispersion energy



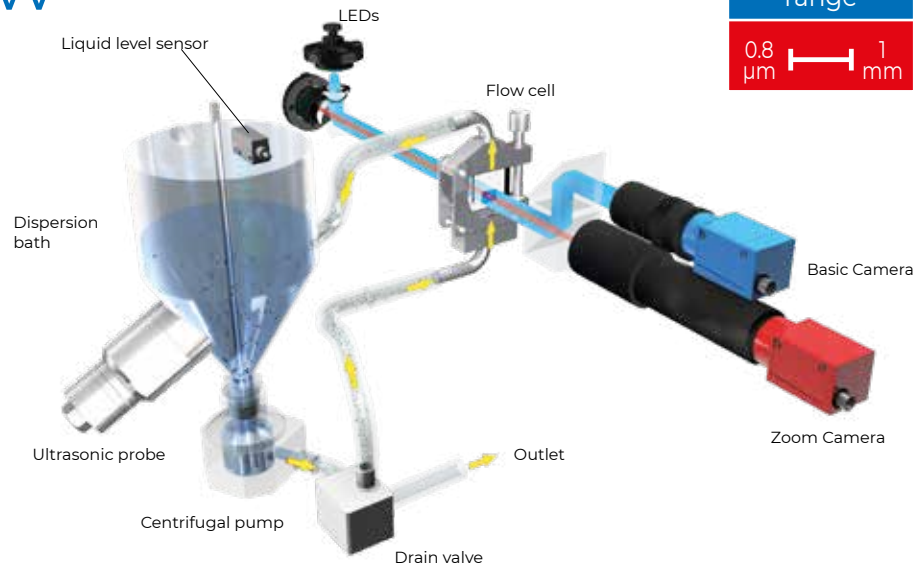
Wet Measurement with X-Flow

The wet module X-Flow analyzes suspensions in a size range from 0.8 µm to 1 mm. The sample moves within a closed loop from the dispersion bath to the flow cell where the camera system captures the particle images. X-Flow comes with an ultrasonic bath and strong centrifugal pump to ensure efficient dispersion. Suitable dispersion media are water, alcohol, and also nonpolar organic solvents.

- Analysis of suspensions
- Effective dispersion with ultrasound
- Resistant to organic solvents
- Various cells available

Measuring range

0.8 µm — 1 mm



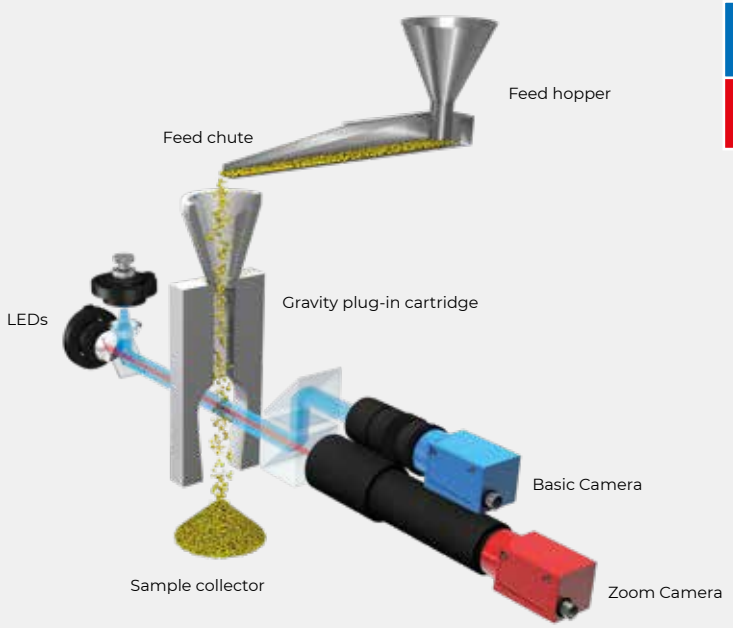
Gravity Dispersion with X-Fall

Flowable, unagglomerated samples can be analyzed by using the X-Fall module. The measurement is non-destructive because the particles directly fall from a chute through the field of view. X-Fall is suitable for particle sizes up to 8 mm; the detection sensitivity for over-sized grains is extremely high. In contrast to dispersion by air pressure, the sample can be recovered after the measurement with X-Fall.

- Gentle, contact-free measurement
- Analysis of particle sizes up to 8 mm
- Complete sample recovery

Measuring range

10 µm — 8 mm



A Wealth of Analysis and Evaluation Options

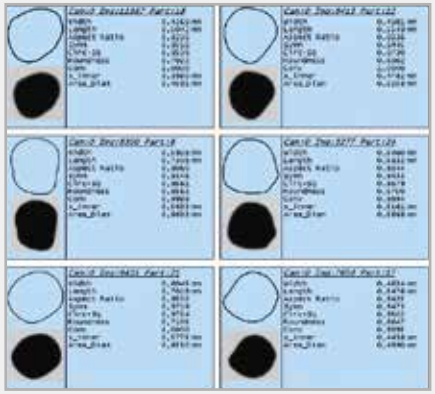
All parameters at a glance: Dynamic Image Analysis provides comprehensive information about the sample material to be analyzed. The high-performance CAMSIZER software measures dozens of parameters from every single particle and presents the results in a clearly structured, standard-compliant measurement report. Functions like the comprehensive export option and the generation of synoptical tables or trend analyses are routine procedures.

Storage and automatic monitoring of predetermined product specifications are also part of the software. Password protection prevents undesired modifications of measurement settings. Hence, analyses may also be carried out by non-technical staff.

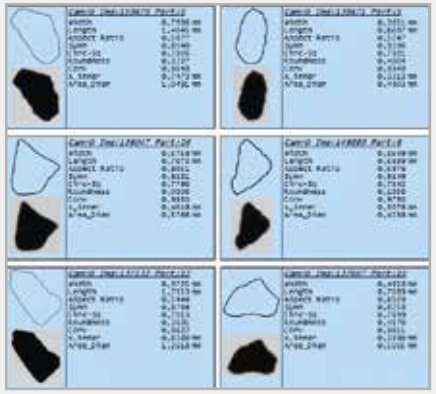
User interface of the CAMSIZER software

Detailed Evaluations with Particle X-Plorer

The strength of Dynamic Image Analysis is the evaluation of a vast number of particles in a very short period of time. The result after 1 to 3 minutes measuring time is usually based on hundreds of thousands to millions of single particles which guarantees a high statistical reliability. Moreover, the innovative software module Particle X-Plorer imports information on individual particles into a database, thus allowing the user to find particles with specific characteristics or combinations of characteristics. This facilitates application development, interpretation of measurement results and understanding of the sample material. Further options provided by Particle X-Plorer include the creation of 3D scatter diagrams or subsequent filtering and advanced evaluation of complete data sets.



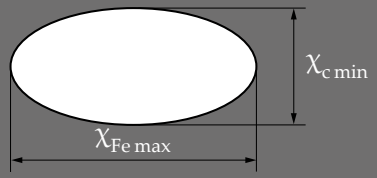
Sand sample with rounded grains



Sand sample with angular grains

ASPECT RATIO

$$\frac{\chi_{c\,min}}{\chi_{Fe\,max}}$$

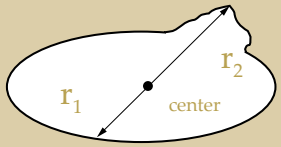


CIRCULARITY

$$\sqrt{\frac{4\,\pi\,A}{P^2}}$$

SYMMETRY

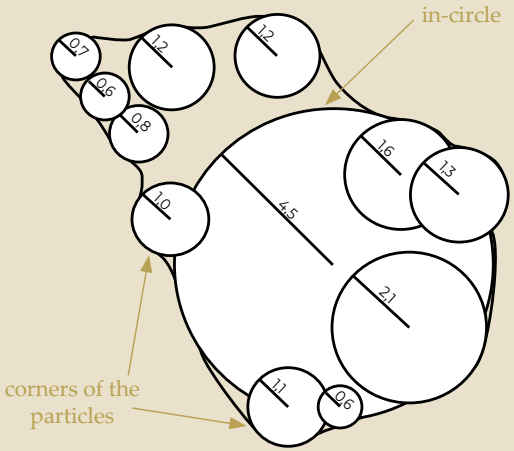
$$\frac{1}{2}\left[1+\min\left(\frac{r_1}{r_2}\right)\right]$$



CONVEXITY

$$\sqrt{\frac{A_{real}}{A_{convex}}}$$

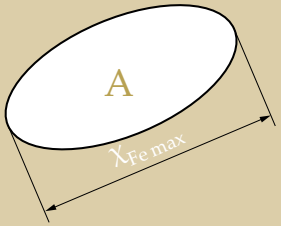
ROUNDNESS



$$= \frac{\text{Average radius of the corners}}{\text{Radius of the in-circle}}$$

COMPACTNESS

$$\sqrt{\frac{4\,A}{\pi}} \Big/ \chi_{Fe\,max}$$



$\chi_{c\,min}$ = Width
$\chi_{Fe\,max}$ = Length
A = Area
U = Perimeter

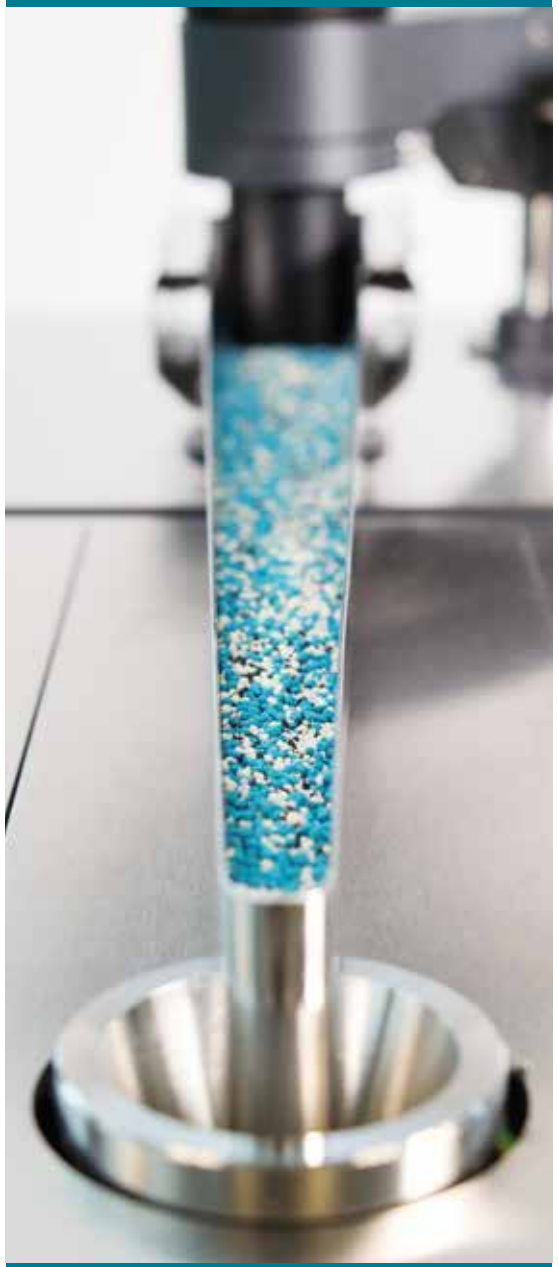
Only Image Analysis Provides Information on Particle Shape

Bulk material properties like density, flowability, compactibility, conveying characteristics and surface condition are influenced by particle shape. This makes these parameters a crucial process and quality indicator in many application areas.

Examples:

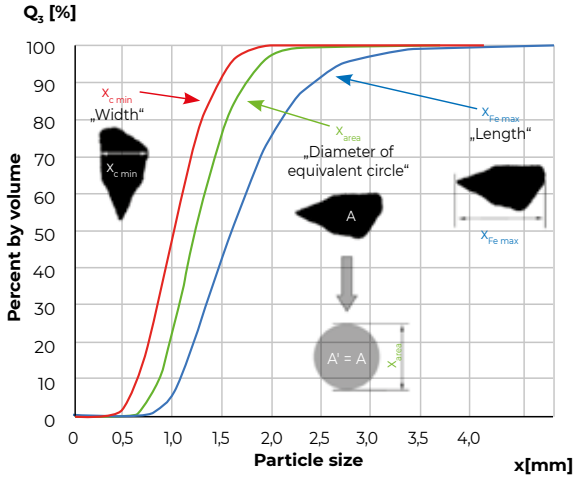
- Angularity of abrasives
- Analysis of broken fractions in granules
- Detection of agglomerates in glass beads
- Analysis of the roundness of plastic or metal powder particles for Additive Manufacturing (direct influence on flowability and packing density)
- Length and diameter of needle-shaped crystals
- Analysis of the roundness of sand particles to evaluate the usability as construction material or proppant, or for geological examinations

Various parameters are available for shape quantification (see illustration on the left). These include width/length ratio (aspect ratio), circularity (calculated from area-to-perimeter ratio), symmetry, convexity, and compactness. Roundness is calculated from the curvature of the particles' corners.



Comparability to Sieve Analysis and Laser Diffraction

„Size“ is only defined unambiguously for spherical particles: the diameter is identical in all directions and orientations. For non-spherical particles, however, the dimensions can vary strongly, depending on the orientation and direction of measurement. Traditional sieve analysis, for example, separates particles on a wire mesh sieve stack with different aperture sizes into fractions.



DIA may use different size definitions

The smallest possible sieve aperture that a particle can pass is defined by the particle’s smallest projection area. Hence, sieve analysis measures particles in a preferential orientation and provides information which is mostly based on the width of the particle. Particle size analysis with laser diffraction relates all measuring data to the diameter of a spherical particle model. Only image analysis offers different size definitions which can be ascertained simultaneously. This makes the results comparable to those obtained with other techniques.

The outstanding strength of DIA is the possibility to measure width and length of a particle and to provide a size distribution based on these parameters. The particle width (red curve) can easily be compared to sieve analysis results.

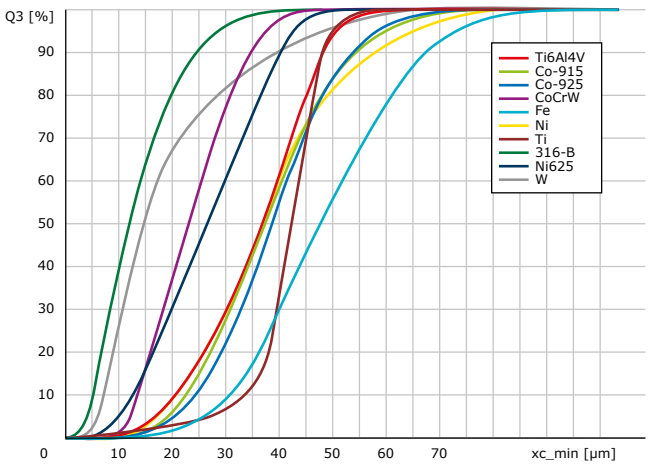
Sieve Analysis, Laser Diffraction, Static or Dynamic Image Analysis?

A comparison of measurement techniques

PERFORMANCE FEATURE	Dynamic Image Analysis	Sieve Analysis (RETSCH)	Laser Diffraction	Static Image Analysis
Wide dynamic measurement range	+++	++	+++	−
Reproducibility and repeatability	+++	++	+++	−
High resolution for narrow distributions	+++	−	−	+++
Particle shape analysis	+++	−	−	+++
Direct measurement technique	+++	+++	−	+++
Compatibility of results with other techniques	++	−	−	−
Reliable detection of oversized grains	++	+++	−	−
Robust hardware, easy operation for routine analysis	+++	+++	+++	−
Analysis of individual particles	++	−	−	+++
High measurement speed, short measurement times	+++	−	+++	−
Measuring range	0.8 µm – 135 mm	10 µm – 125 mm	10 nm – 5 mm	0.5 µm – 1.5 mm

Powder Metallurgy

The different techniques used in powder metallurgy require different material properties. For Additive Manufacturing (AM), for example selective laser sintering, a homogeneous particle size distribution and spherical particle shape are crucial. The example shows a range of CAMSIZER X2 analyses of various metal powders which are reliably characterized for their suitability to be used in powder metallurgical processes. Non-spherical, fused or broken particles are reliably detected and quantified. Analysis of metal powders with a mean particle size < 10 µm, which are utilized for Metal Injection Moulding (MIM), is also possible with the CAMSIZER X2.



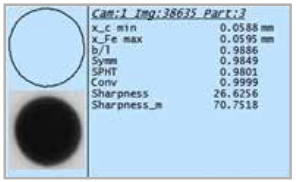
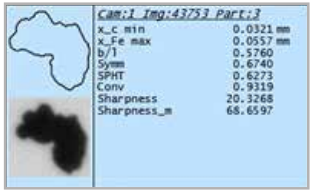


Image of a spherical metal powder particle

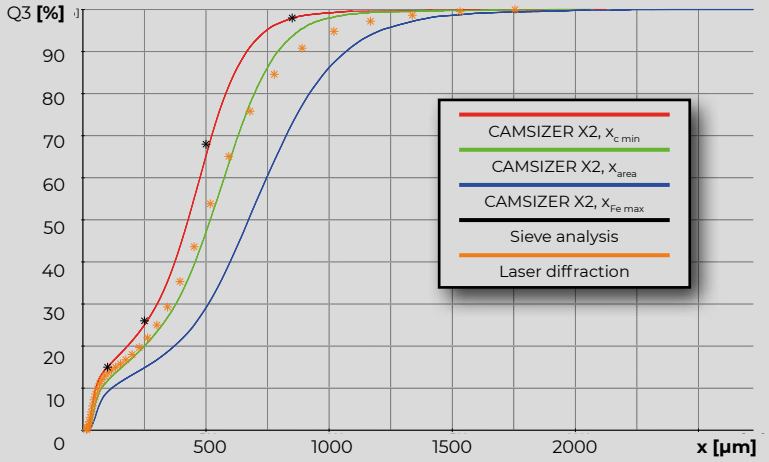


Irregular particles are reliably detected

Coffee powder

Comparability to sieve analysis and laser diffraction

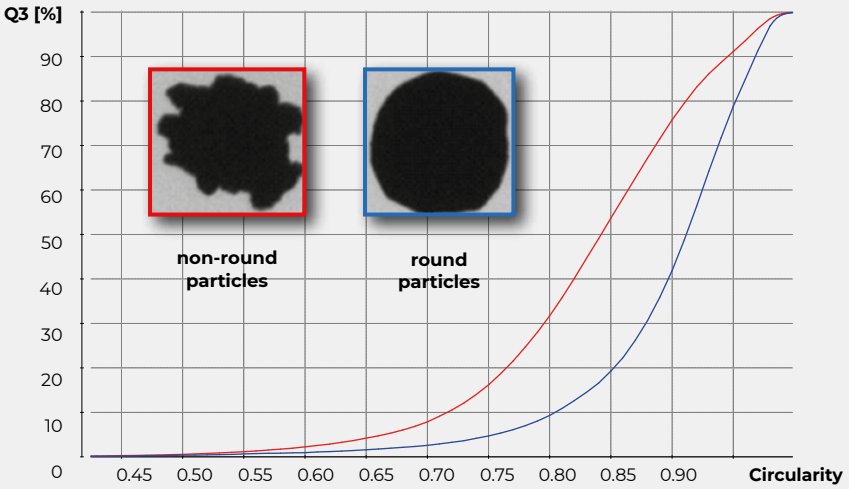
The particle size distribution of coffee powder determines the extraction properties and thus influences the taste. Different types of coffee production (filtered coffee, espresso, etc.) require different degrees of fineness. The size distribution of coffee powder may reach up to 1 mm, with a significant fine fraction. The CAMSIZER X2 analyzes this size range quickly and reliably. The CAMSIZER X2 delivers results which are fully comparable to alternative measurement techniques by consideration of the suitable size definition. The results of sieve analysis correspond to the size definition xc_min. Laser diffraction relates all measuring data to the diameter of an ideal spherical particle. Hence, the results best match the size definition x_area.



Pharmaceuticals & Food

Analysis of granules, active ingredients and excipients

The CAMSIZER X2 is ideally suited for particle size and particle shape analysis of a huge variety of pharmaceutical products. A typical application is the analysis of all kinds of pellets and spheres which are quickly and thoroughly measured in dry mode by using the X-Fall or X-Jet module. Thanks to the flexible dispersion options, fine crystalline or micronized active ingredients and excipients (like cellulose or citric acid) are easily and efficiently characterized. The software package “AuditTrailManager“ is available for the CAMSIZER X2 and is required to comply with the regulations of 21CFR part 11. The example shows the results of measuring two granules with similar size but completely different shape.

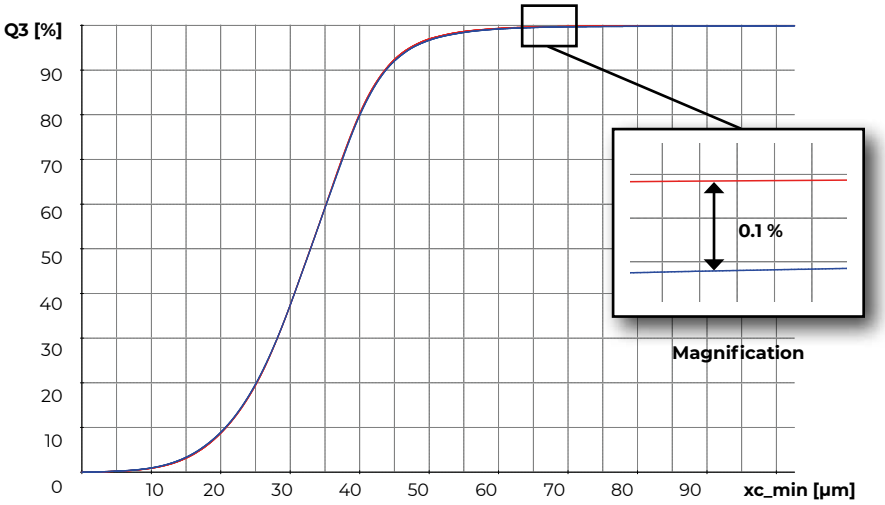


Minerals & Construction Materials

Reliable detection of oversized grains

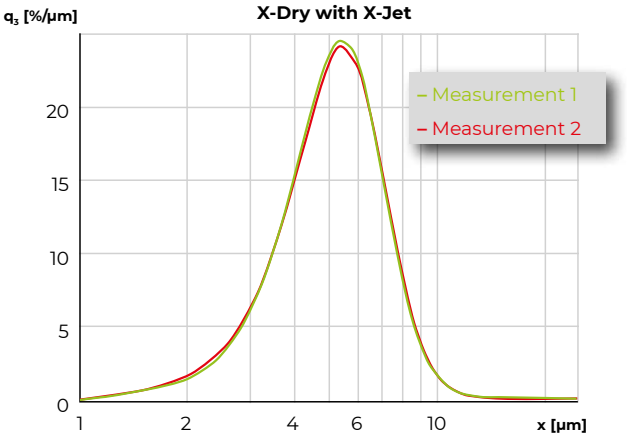
The CAMSIZER X2 is suitable for measuring a variety of minerals and ceramic materials. High sample throughput, highest precision and sensitivity to the slightest variations in product quality make the CAMSIZER X2 the ideal instrument for quality control.

For many applications, reliable detection of small amounts of oversized particles is crucial. In this application example, a gypsum sample consisting of particles <100 µm was mixed with a few coarse particles (0.1 wt. %). These are detected by the CAMSIZER X2 with a high degree of accuracy.



Dry Measurement of Small Particles

The X-Jet cartridge is the perfect choice for measuring fine powders precisely and reproducibly. The example shows a SiC micro-abrasive sample at the lower end of the CAMSIZER X2 measuring range. The size distribution lies between 1 µm and 12 µm. Thanks to the high depth of field, pulsed, ultra-strong light sources and short exposure times, these rapidly moving, micrometer-sized particles are reliably detected. The precisely defined fineness of the abrasive guarantees the optimum combination of abrasion and surface roughness.



Accessories and Options

Optimum configuration for each application

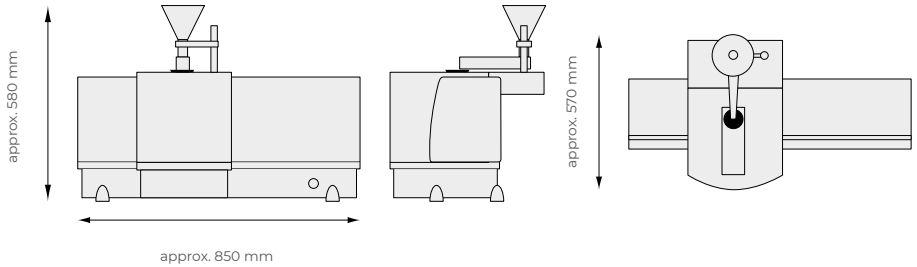
Microtrac MRB offers a variety of hoppers and chutes (1) for special applications. Dispersion nozzles and cuvettes are available in different aperture sizes to ensure optimum conditions for each measurement (2). Calibration of the CAMSIZER X2 only takes one minute and can be carried out by using a high-precision reference reticle (3). A range of sample dividers produces representative subsamples or aliquotes of powders, granulates and all kinds of bulk materials (4).

CAMSIZER X2 at a glance

Technical Data

CAMSIZER® X2		
Measurement ranges	Module „X-Dry“ with „X-Fall“	10 µm to 8 mm
	Module „X-Dry“ with „X-Jet“	0.8 µm to 5 mm
	Module „X-Flow“	0.8 µm to 1 mm
Measurement principle	Dynamic Image Analysis (ISO 13322-2)	
Measurement time	approx. 1 to 3 min. (depends on the required measurement statistics)	
Number of cameras	2	
Sample volume	<20 mg – 500 g (depends on sample type and measurement mode)	
Measurement speed	>300 images/sec.	
Size of detection analysis area	approx. 20 x 20 mm	
Resolution	0.8 µm per Pixel	
Measurement parameters	Particle size	Smallest diameter, length, mean diameter etc.
	Particle shape	Aspect ratio (breadth to length), symmetry, sphericity, convexity etc. (ISO 9276-6)
Instrument data	Dimensions (H x W x D)	approx. 580 x 850 x 570 mm
	Weight (without PC)	approx. 50 kg
	Compressed air supply	approx. 6 bar
	Compressed air consumption	approx. 25 - 140 l/min (depending on dispersion pressure selected)

The CAMSIZER X2 is CE-certified and complies with the relevant regulations and standards.
The vacuum cleaner is included in the delivery of the X-Dry module.



CAMSIZER P4

The CAMSIZER P4 is another powerful particle analyzer by Microtrac MRB which is designed for measuring dry, flowable bulk materials. Just like the X2 model, the CAMSIZER P4 is based on the proven Dual Camera Technology. The P4 model analyzes all samples in free ffall (similar to X-Fall); with a measuring range from 20 µm to 30 mm it is particularly suitable for replacing time-consuming and error-prone sieve analyses. Robust hardware and application-oriented software allow for high sample throughput with minimum maintenance and a high degree of automation. The CAMSIZER P4 can be equipped with automated sample feeding for highly efficient process analysis.

For more information please visit
www.microtrac.com/camsizerP4

dual camera technology

MICROTRAC MRB

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