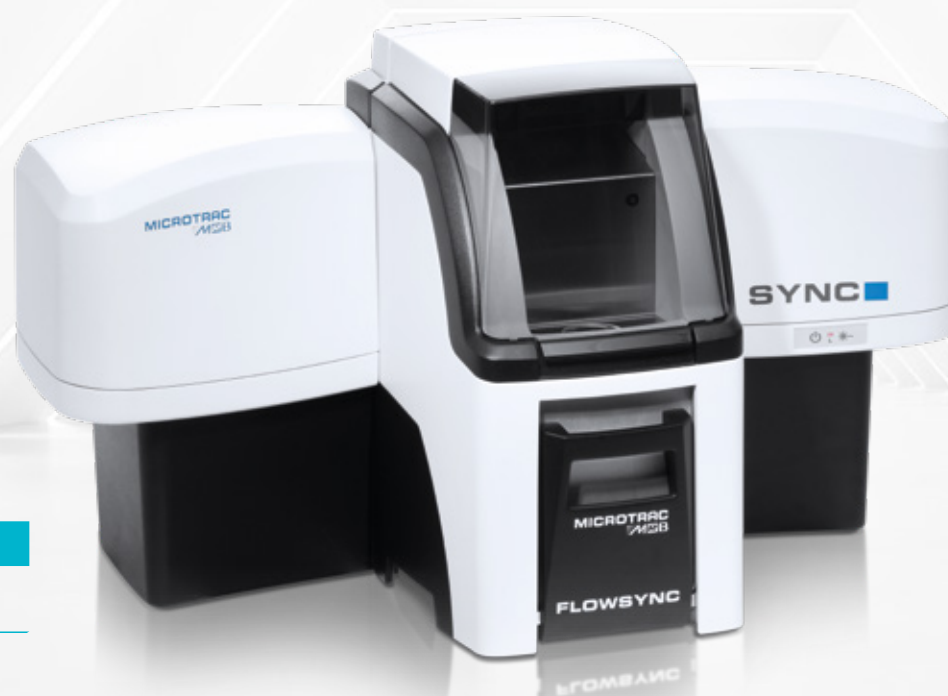


SYNC



PARTICLE SIZE & SHAPE ANALYZER

**COMBINING LASER DIFFRACTION AND
DYNAMIC IMAGE ANALYSIS IN ONE INSTRUMENT**

MICROTRAC MRB

PARTICLE CHARACTERIZATION AT ITS BEST



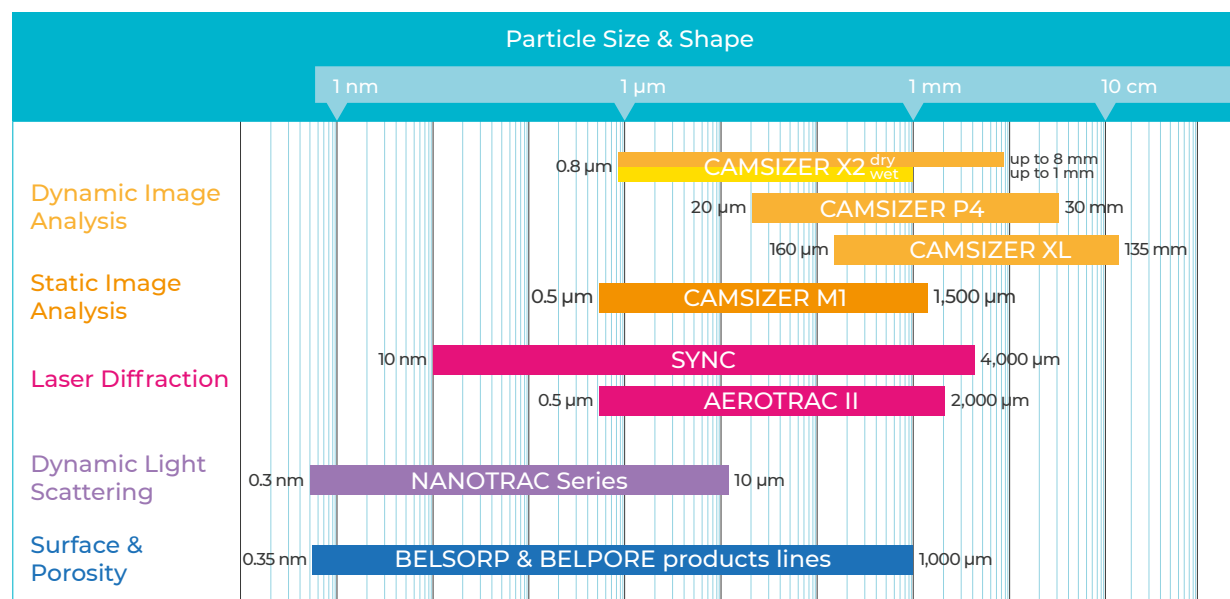
Microtrac MRB is your preferred partner for the comprehensive characterization of particulate systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovation and quality form the basis of our business.

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



MICROTRAC MRB

THREE PILLARS OF EXCELLENCE



Microtrac MRB offers three product lines with centers of excellence 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 which are perfectly suited for the characterization of nanoparticles. 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 measurement of particle size and particle shape based on both static and dynamic imaging. These instruments are developed and built in our production site in Haan, Germany.

| Surface & Porosity

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

The **SYNC analyzer** uniquely combines the strengths of laser diffraction with those of image analysis in a single instrument, opening completely new possibilities in particle characterization.

A NEW DIMENSION IN PARTICLE ANALYSIS

SYNC

With the SYNC analyzer, Microtrac MRB integrates its highly accurate tri-laser diffraction technology with its versatile image analysis capability to provide particle characterization practitioners with a unique measuring experience. The patented synchronous measurement technology allows users to make both a laser diffraction measurement and an image analysis measurement on a single sample, in the same sample cell at the same time:

- | One sample
- | One optical bench
- | One flow path
- | One sample cell
- | One analysis

This makes the SYNC ideally suited for routine QC applications. It also provides valuable information to researchers as they develop new materials and processes. The powerful software interface provides both particle size distribution information as well as a multitude of morphological parameters. The patented BLEND routine allows users to examine materials over a wide range of sizes from 0.01 microns to 4000 microns.

The SYNC logo is displayed on the white front panel of the analyzer. It consists of the word "SYNC" in a bold, dark grey sans-serif font, followed by a solid blue square.

Particle Size & Shape Analyzer

SYNC

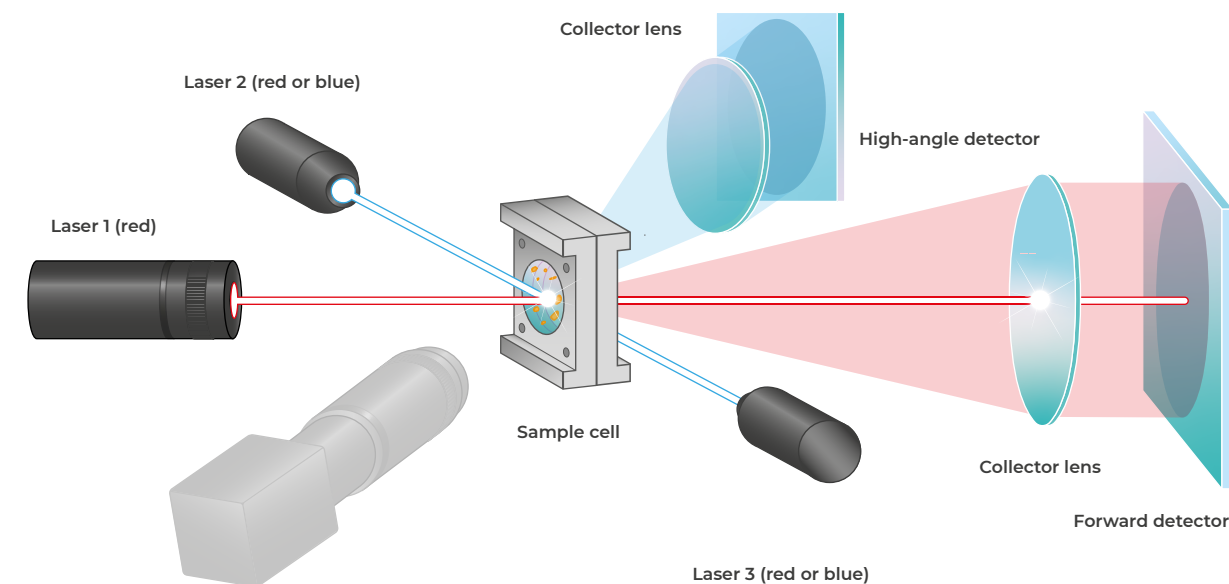
- ▶ Particle size and shape analysis from 0.01 to 4000 microns using laser diffraction (ISO 13320:2020) and dynamic image analysis (ISO 13322-2)
- ▶ Excellent sub-micron detection using blue laser technology. Ability to resolve narrow and multi-modal distributions in the sub-micron range
- ▶ Detection of small amounts of oversized or undersized fractions in the size distribution
- ▶ Patented synchronous measurement technology and BLEND distribution analysis. One analysis yields a particle size distribution and over 30 morphological parameters
- ▶ Fast measurement time – typically 30 seconds
- ▶ Fast and easy switch between wet and dry measurement modules. Change from wet to dry mode in less than 15 seconds
- ▶ Full IQ / OQ validation package compliant with FDA 21 CFR Part 11 guidelines



ADVANCED LASER DIFFRACTION ANALYSIS

PATENTED TRI-LASER SYSTEM

Particle size measurement by Laser Diffraction (LD) has become the most used technology in research and industry and is the de-facto standard for incoming and outgoing product quality control. During the measurement, a laser beam illuminates a well dispersed particle sample and the size distribution is calculated from the scattered light pattern. In Microtrac MRB's technology, this scattered light is measured at various angles from 0.02 to 163 degrees. This is achieved by using two detector arrays and three lasers that illuminate the sample from different angles. The SYNC



can be equipped with all red lasers or a combination of red and blue lasers.

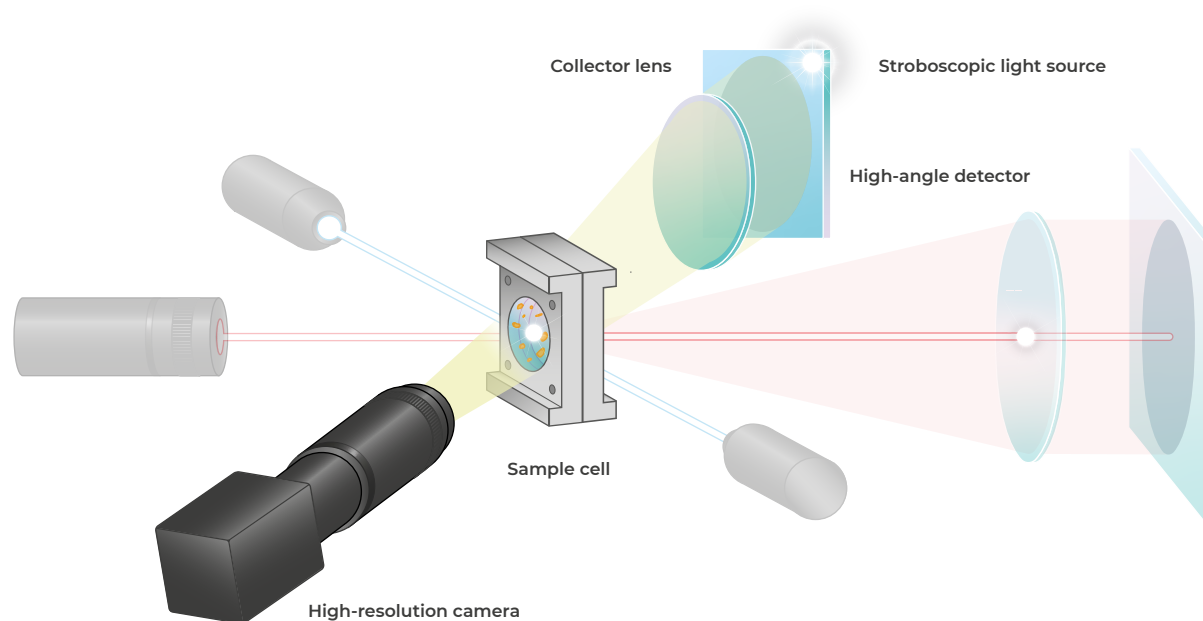
Small particles scatter light at large angles while large particles scatter light at small angles. The scattered light intensity is collected continuously throughout the measurement. The evaluation is done using Microtrac MRB's innovative modified Mie scattering theory. This algorithm produces accurate particle size distributions for both spherical and non-spherical particles as well as for both transparent and absorbing materials.

Features

- Configurations:
 - 3 red lasers
 - 1 red laser + 2 blue lasers
 - 2 red lasers
- Patented Tri-Laser design
- Fixed optics with solid state lasers diodes provide long lasting ruggedness and reliability
- Zero stabilization time
- Fourier optical system delivers the optimal pattern of light by assuring that the angle of incidence is constant

NEW OPPORTUNITIES

INTEGRATED DYNAMIC IMAGE ANALYSIS



The characterization of particulate systems, once dominated strictly by size analysis, is evolving. Dynamic Image Analysis (DIA), which measures important parameters related to particle morphology, provides detailed information regarding the physical properties of materials. These key properties and the resulting manufactured product can change drastically with no significant differences reported in the LD size distribution. Image analysis can rapidly identify problems and significantly reduce troubleshooting time. Particles in a flowing stream, backlit by a high-speed strobe

light, are photographed by a high-resolution digital camera to create a video file of images for the flowing particles. More than 30 size and shape parameters are acquired for every particle. Although the measurement technology of DIA is straightforward, the data analysis used to identify and solve problems is very powerful. The software includes filter functions to search, display, and evaluate particles with specific properties or a combination of properties. Data can also be presented in scatter plots, in which each data point represents a single particle image.

Features

- ▶ Integrated, synchronized Dynamic Image Analysis (ISO 13322-2)
- ▶ Powerful strobe light for excellent image quality
- ▶ 5.2 Megapixel camera
- ▶ Up to 60 frames per second
- ▶ Live view and video file
- ▶ More than 30 morphological parameters from every particle: width, length, aspect ratio, sphericity, circularity, roundness, solidity, transparency, and many more

OUR CONCEPT OF

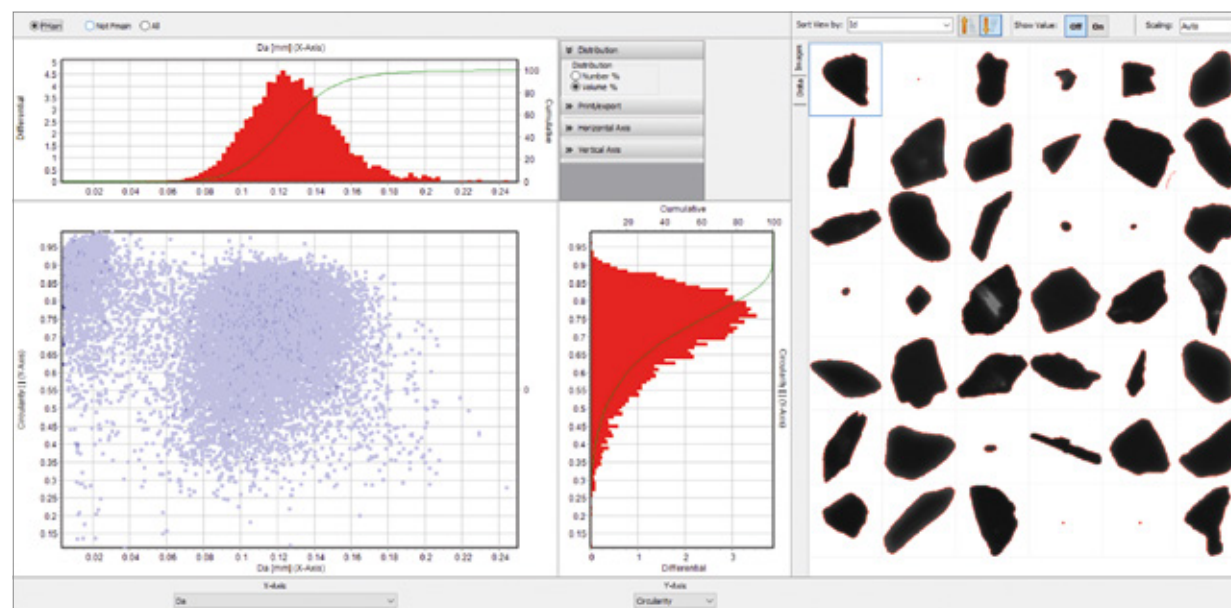
COMBINING LASER DIFFRACTION WITH DYNAMIC IMAGE ANALYSIS

The SYNC particle analyzer by Microtrac MRB provides traditional users of laser diffraction technology with exciting new capabilities to characterize their materials. The proven Tri-Laser technology provides accurate and repeatable laser diffraction results from light collected over 163 degrees of angular scatter. When combined with state of art camera technology capturing images of the particle stream at the same time, the SYNC offers not only size data but significantly more information about the shape of the materials and the quality of the dispersion.

Material is either dispersed in a carrier fluid for wet measurements in the FLOWSYNC or dispersed in air for dry powder measurements in the TURBOSYNC. As the sample stream passes through a single measurement cell in the optical module, it is interrogated by the lasers. The sample stream is simultaneously illuminated by stroboscopic LED to allow the high-speed camera to take images of the same sample. This allows users the flexibility to determine particle size distributions from an ensemble sample dispersion as well as the ability to examine single particles or groups

of particles from the hundreds of thousands of images captured by the camera. The user ultimately has the ability to look individually at a laser diffraction analysis or an image analysis, or at a combination analysis using the patented BLEND feature.

This combination analysis provides QC users the ability to qualify their data using two methodologies at the same time and provides R&D users with a powerful tool to characterize new materials.





SYNC

MAXIMUM PERFORMANCE BY DESIGN

- | Patented Tri-Laser design
(red & blue lasers are available)
- | Detector array covering 0.02 - 163 degrees
- | Stroboscopic light source and integrated camera for dynamic image analysis
- | Same bench & dispersion system for diffraction & image analysis
- | Wet and dry analysis, easy change
- | Small footprint



CONNECTIVITY & MODULARITY

CHANGE BETWEEN DRY & WET MODULES

No other particle analyzer allows more rapid change from wet to dry and vice versa. The modules can be removed from the analyzer with a single movement and reinstalled just as easily. All necessary cables and hoses are permanently connected to the back of the analyzer. This means that no changes to the measuring instrument or modules are required during the actual changeover. Removal of measuring cells or tedious plugging and un-plugging of mechanical and electrical connections is no longer necessary. This makes the process a real plug-and-play operation.



FLOWSYNC

DISPERSION MODULE FOR WET MEASUREMENTS

The FLOWSYNC's automated filling, de-aerating, pre-circulating and circulating operation means that each sample is handled with a consistency that improves the repeatability of particle size distribution and imaging data.

Consistency: An in-line ultrasonic probe with variable power disperses agglomerated materials to ensure consistent sample dispersion during measurements.

Versatility: Users can program, save and

recall unlimited SOP routines for fill, disperse, measure, rinse and run commands.

Connectivity: An integrated fill pump allows the user to connect any water or solvent source. The recirculator fills, de-aerates and dilutes automatically.

Auto-Dispersion: The FLOWSYNC's fluid dynamics feature a built-in turbulence to ensure that all particles are moving constantly within the system, negating the need for an external stirrer.



Resistiveness: The FLOWSYNC can be operated with a wide variety of carrier fluids. In addition to water and alcohol, this includes organic solvents like hexane or toluene.

Self-Cleaning: The wash feature ensures that the walls of the sample vessel are thoroughly cleaned during the rinse cycle. This eliminates cross contamination from one sample to the next.

TURBOSYNC

DISPERSION MODULE FOR DRY MEASUREMENTS



The TURBOSYNC delivers a properly dispersed sample to the measuring cell, allowing for consistent and repeatable particle size analysis. A moving sample tray introduces the powder into the measurement system.

Flexibility: Compressed air and flow condition settings up to 50 psi (345 kPa) allow the operator to achieve optimal dispersion, even for highly agglomerated materials. Dispersion conditions can be fine-tuned for measurement of even the most fragile materials.

Small Sample Volumes: Sample volumes can be as small 0.1 cm³. This is ideal for applications where the sample is expensive or produced in small volumes.

Large sample volumes: The removable sample tray can hold larger quantities of powder. If required, multiple trays can be processed and combined into one measurement record.

Automatic sampling: The Microtrac MRB FLEX software facilitates the automation of measurement cycles. Simply place the sample



in the tray and press RUN. All data is saved on the system PC or can be exported to user networks.

Rapid Measurements: Measurement time is usually 10 - 40 seconds, depending on the properties of the sample material.

Repeatability: Consistent control of aspiration settings deliver excellent sample-to-sample and instrument-to-instrument repeatability.

MICROTRAC MRB

APPLICATIONS

Versatility is a great strength of laser diffraction analysis. This makes the method suitable for a variety of applications in both research and industry. Microtrac MRB laser diffraction analyzers are characterized by particularly convenient, easy-to-learn operation. Thanks to their robust design, the instruments are practically maintenance-free and fit for 24/7 operation. The high sample throughput and the extremely wide particle size range from nanometers to millimeters the reasons for the method's popularity in so many laboratories.

However, drawbacks of laser diffraction are poor resolution for large particles, limited sensitivity for oversize and the inability to measure particle shape. These downsides of laser diffraction, however are the strengths of image analysis. Thanks to the unique combination of both techniques, the SYNC provides information which is not available from laser diffraction alone and improves the overall accuracy of size measurement.

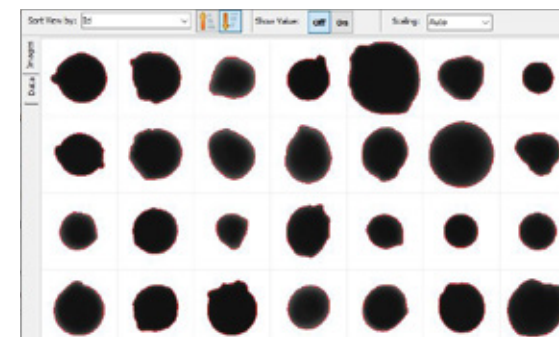
TYPICAL FIELDS OF APPLICATION

- ▶ INDUSTRIAL MINERALS
- ▶ CERAMICS
- ▶ PHARMACEUTICALS
- ▶ CHEMICALS
- ▶ PAINTS & PIGMENTS
- ▶ METAL POWDERS
- ▶ CONSTRUCTION MATERIALS
- ▶ GLASS BEADS
- ▶ COATINGS
- ▶ 3D PRINTING
- ▶ FOODSTUFF
- ▶ COSMETICS
- ▶ BATTERY MATERIALS
- ▶ POLYMERS
- ▶ EMULSIONS

SIZE & SHAPE ANALYSIS – ADDITIVE MANUFACTURING

Particle size distribution has long been an important characterization metric used to quantify materials. Size and shape are extremely important parameters that can drastically impact material performance in additive manufacturing. Raw powders must be broad in their size distribution, as well as round in shape. It is important to detect oversized particles to assure uniformity in the size distribution and detect deviations from spherical particles so

that the packing density and flowability can be controlled. These size and shape characteristics can lead to imperfections / defects in printed parts. With the SYNC, size and shape information can be obtained simultaneously on the same sample through the addition of dynamic image analysis to a laser diffraction instrument. Reliable oversize detection and detailed shape information are possible with a single measurement.

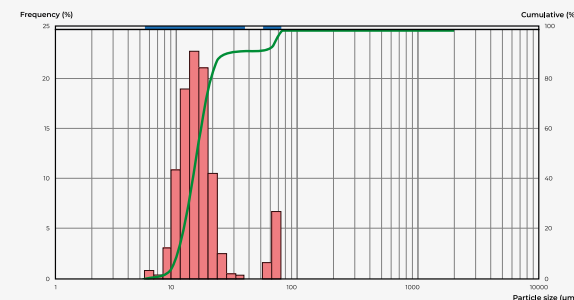


Particle images of metal powder which are used for Additive Manufacturing: Some particles have satellites, i. e. small particles fused to large ones.

OVERSIZED PARTICLE DETECTION – ABRASIVES

Reliable oversized particle detection is often a challenge for laser diffraction. Many industries manufacture materials whose usage and effectiveness can be greatly hindered by the presence of even a few oversized particles. In particular, the performance of abrasives is tied directly to the size distribution. There are a wide variety of uses for abrasives that each require a specific size and size distribution to maximize efficacy. Some applications are in-

credibly susceptible to large particles reducing the effectiveness of the grinding media or producing an unacceptable surface. In addition to size, shape parameters such as roundness and angularity are important in predicting the performance of the material. The incorporation of dynamic image analysis as a complementary technique allows for all the advantages of laser diffraction, as well as the added benefits of reliable oversize detection.

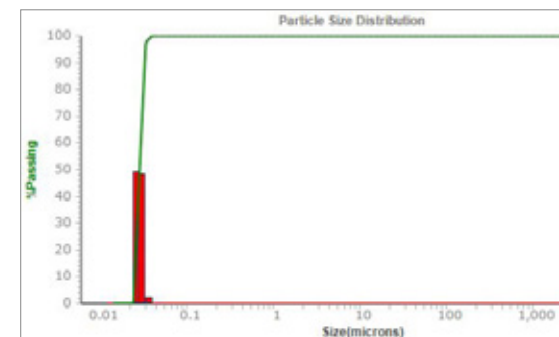


Accurate detection of oversize particles in an abrasive sample with the BLEND algorithm.

MODIFIED MIE ANALYSIS – SUBMICRON MATERIALS

Mie scattering theory is widely used in laser diffraction. However, Mie theory was originally developed using transparent, spherical particles. Compensation must be made to adapt Mie theory to non-spherical particles. Microtrac MRB's proprietary modified-Mie analysis was developed to do just that. This analysis is chosen by simply selecting irregular for the particle shape. No imaginary RI, no absorption or extinction coefficients are required. At sizes

below 30 microns, spherical particles have a strong resonance feature in the scattering pattern. Irregularly shaped particles, on the other hand, have significantly reduced intensity of this resonance. Modified Mie calculations easily and accurately account for the reduction in scattering and will not result in an over or under reporting of fines dependent on the input parameters. All Microtrac MRB laser diffractors include Modified Mie calculations.

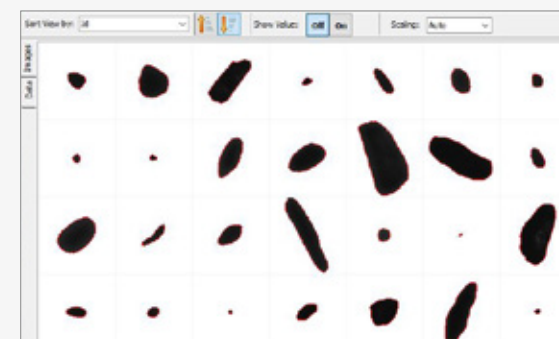


Accurate reporting of 26 nm polystyrene spheres.

DRY POWDER MEASUREMENTS – ACTIVE PHARMACEUTICAL INGREDIENTS (API)

Dry measurements are becoming increasingly popular in particle size analysis, due in part to larger sample volumes being easily measured. Difficult samples such as soluble, fragile, or agglomerated materials can be properly dispersed and measured without being damaged using the TURBOSYNC module. Active pharmaceutical ingredients (API) are often soluble in many carrier fluids, are very cohesive, and need to be handled with care. Without the

need for exotic organic carrier fluids, dry measurements reduce cost, eliminate time consuming sample prep, and increase safety. Determining the correct particle size is important for assessing drug efficacy and bioavailability. Typically, API can contain a wide variety of shapes and sizes in a single sample portion, both of which are measurable with the SYNC. FLEX software has password protected security and is FDA 21 CFR Part 11 compliant.



Particle images of an API measured with the TURBOSYNC.

TECHNICAL DETAILS

SPECIFICATIONS AT A GLANCE

Measuring range	0.01 to 4000 microns
Precision	Spherical glass beads, D50 = 642 microns, Precision as CV = 0.7% Spherical glass beads, D50 = 57 microns, Precision as CV = 1.0% Spherical latex beads, D50=0.4 microns, Precision as CV = 0.6%
Laser class	Red 780 nm, blue 405 nm – class 1 laser product per 21 CFR 1040.10 & IEC60825-1
Laser power	Red laser 0.35 to 2 mW nominal; blue lasers 10 mW nominal
Detection system	Two fixed photo-electric detectors with logarithmically spaced segments are placed at correct angles for optimal scattered light detection from 0.02° to 165° using 151 detector segments
Data handling	Data integrity ensured using FDA 21 CFR Part 11 compliant security features including password protection, electronic signatures and assignable permissions.
Typical analysis time	10 to 30 seconds
Electrical	AC input: 90 - 264 VAC, 50/60 Hz, single phase
Power consumption	Approx. 30 VA maximum, depending on options installed
Environmental	Temperature: 5°C to 40°C (41°F to 104°F) Humidity: 90% RH, non-condensing maximum Storage temperature: -10°C to 50°C (14°F to 122°F) (dry only) Pollution: Degree 2
Compliance	ISO 13320 Laser Diffraction ISO 13322 Dynamic Image Analysis
Image analysis	5.2 megapixels (2560 x 2048 px), up to 60 fps at maximum resolution
Wet operation	Volume: 200 ml nominal Flow rate: 0 to 65 ml/s maximum with water Inlet pressure: 50 psig (345 kPa) maximum
Dry operation	50 psi (345 kPa) maximum pressure 3 CFM (0.0014 m ³ /h) at 50 psi (345 kPa) minimum flow rate Free of dry contaminants, moisture and oil
Vacuum	Vacuum must meet or exceed 80 CFM (38 l/s)
Physical specifications	Case material: Impact resistant plastic Exterior surfaces: Finished with solvent-, stain-, and corrosion-resistant paint or plating Chemically compatible with a wide choice of organic and inorganic dispersants
Dimensions (H x W x D)	18 x 31 x 12 in (457 x 787 x 305 mm)
Weight	53 lbs (24 kg)

ADDITIONAL SOLUTIONS

FURTHER LASER DIFFRACTORS // ACCESSORIES FOR S3500 & BLUEWAVE



S3500 & BLUEWAVE

S3500 and BLUEWAVE are laser diffraction analyzers that also feature the proven Tri-Laser arrangement. The S3500 uses three red lasers, while the BLUEWAVE uses one red and two blue lasers. Both instruments can be equipped with accessories for wet analysis (SDC) or dry measurements (TURBOTRAC). Thanks to their robust design, excellent ease of use, and a large variety of additional modules, both devices have become established as standard instruments in many industries.



AEROTRAC II

The AEROTRAC II is an analyzer for particle size distribution & concentration ratio analysis for suspended particulates in air such as atomized droplets, powders, spray particles, mist etc. It is suitable for a wide range of applications including nebulizers and spray cans. Measurement modes are available to support various applications. The short measuring time intervals (0.02 ms) allow for measuring the size distribution directly after spraying and the analysis of the size distribution over time.

Features

- ▶ S3500 measurement range:
20 nm – 2800 μm
(wet & dry samples)
- ▶ BLUEWAVE measurement range:
10 nm – 2800 μm
(wet & dry samples)
- ▶ AEROTRAC II measurement range:
0.5 μm – 2000 μm (different lenses
required) for sprays, nebulas,
aerosols, etc.
- ▶ Small footprint, robust design



MS30 AUTOSAMPLER

| The MS30 allows for the automatic measurement of up to 30 samples one after the other. The sample containers can hold up to 2.5 ml of material.



S3500 SI

| The SI accessory features a camera and light source to acquire and evaluate particles by dynamic image analysis.



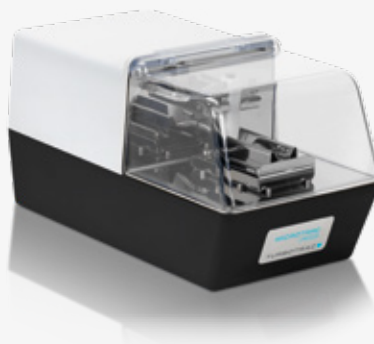
USVR (Ultra Small Volume Recirculator)

| The Ultra Small Volume Recirculator (USVR) allows analyses of small liquid volumes from 35 to 50 µl.



SDC

| The Sample Delivery Controller (SDC) is designed to quickly and accurately deliver well-dispersed liquid samples.



TURBOTRAC

| The TURBOTRAC delivers properly dispersed samples to the measuring cell, allowing for consistent and repeatable particle size analyses of dry powders.



LVR (Large Volume Recirculator)

| Allows analyses of up to 4 litres of sample volume. The flow rate is up to two liters per minute.

Microtrac Inc.

215 Keystone Drive
PA-18936 Montgomeryville
USA

Phone: +1 888 643 5880
marketing@microtrac.com
www.microtrac.com

MicrotracBEL Corp.

8-2-52 Nanko Higashi, Suminoe-ku
Osaka 559-0031
Japan

Phone: +81 6 6655 0360
info@microtrac-bel.com
www.microtrac.com

Microtrac Retsch GmbH

Retsch-Allee 1-5
42781 Haan
Germany

Phone: +49 2104 2333 300
info@microtrac.com
www.microtrac.com

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**SCIENCE
FOR SOLIDS**

Verder Scientific is a business field belonging to the Verder Group and sets standards in the development, manufacture and sale of laboratory and analytics devices. Used in quality control, research and development for test-piece preparation and the analysis of solids.

For several decades our companies have supplied production plants and research institutes, laboratories for quality testing and analytics, all kinds of technical specialists and scientists with modern, reliable devices to solve the many and varied challenges they face.

