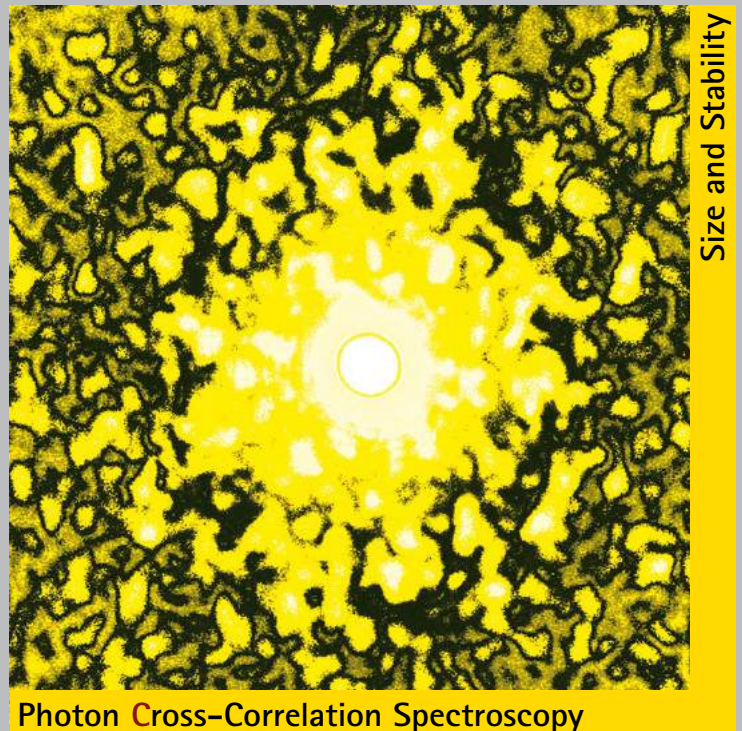
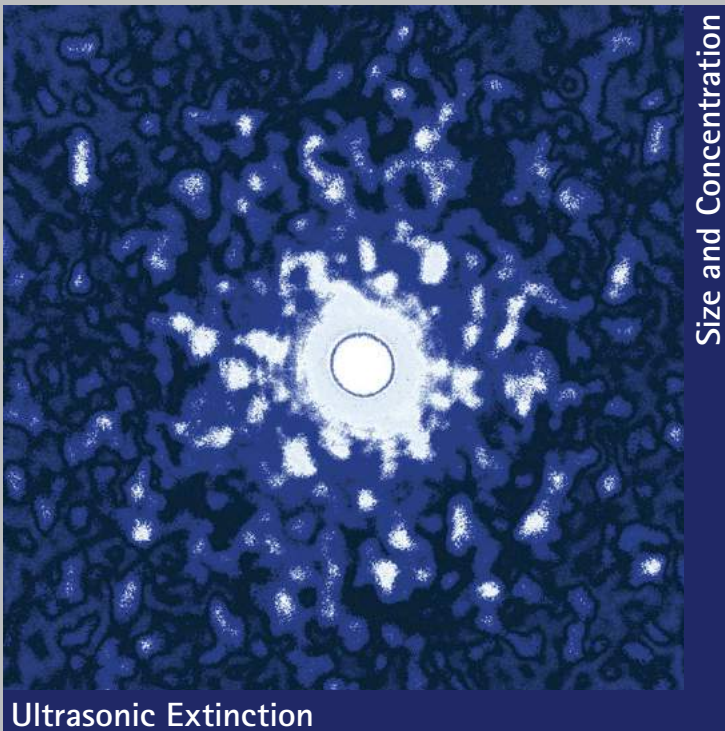
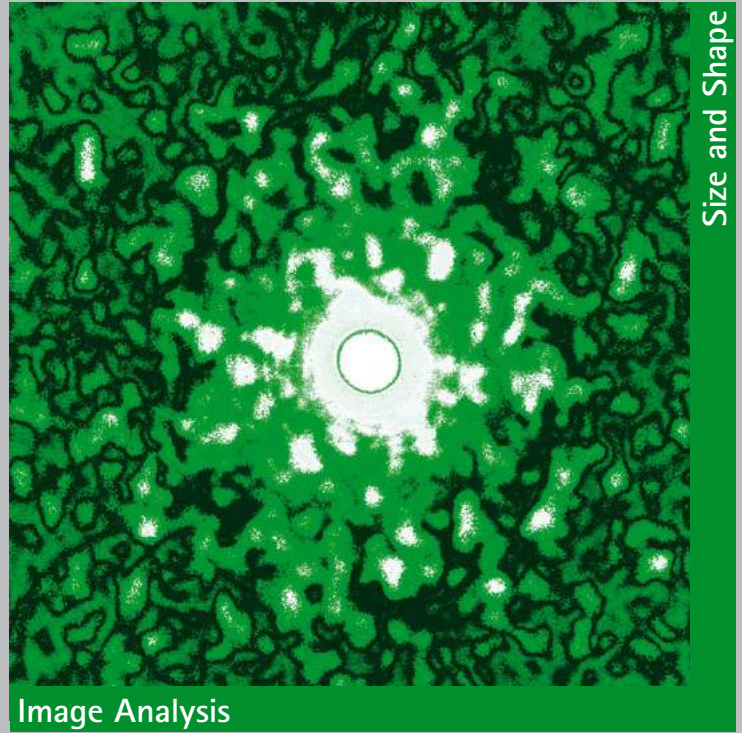
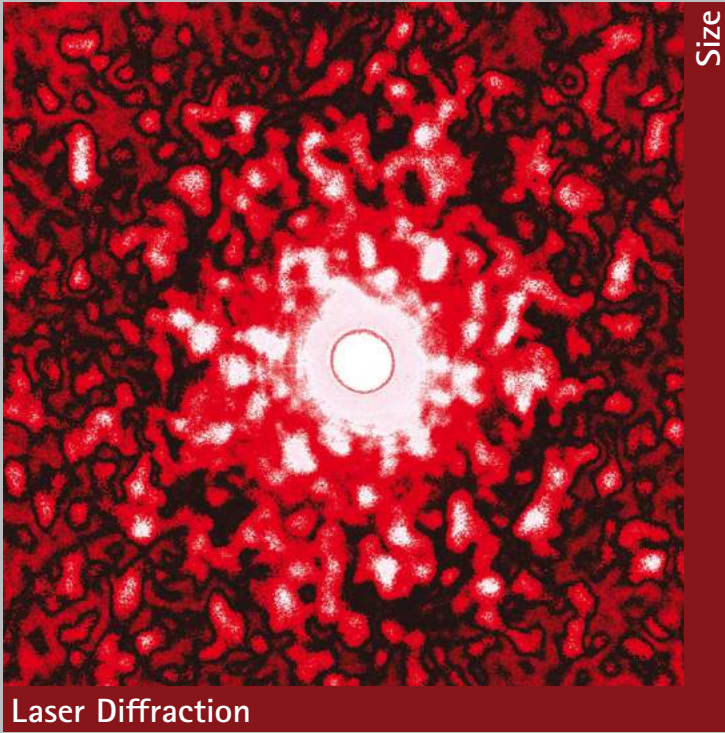


Classic Technologies



HELOS | RODOS & Co. | Laser Diffraction Particle Measurement | Laboratory Size and Distribution | $< 0.1 \mu\text{m}$ to $8,750 \mu\text{m}$

HELOS R-Series A Modular Classic with Innovative Dispersing Units

Laser diffraction is the established and most efficient light scattering method for particle size analysis covering a wide range from sub-micron to millimetre scale.

Sensor

The proven HELOS series – with its classical laser diffraction set-up deploying a parallel beam – offers a powerful technology for particle size analysis of powders, granules, suspensions, emulsions, sprays and numerous other disperse systems. The modular system design, together with a great variety of dispersing and dosing units, provides a flexible adaptation to the most diverse industrial and research applications.

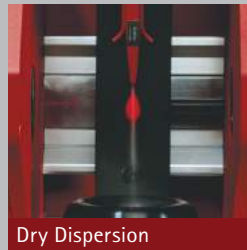
Dry Dispersion Breakthrough

In the early 1980s, Sympatec introduced a breakthrough innovation which was leading laser diffraction to another dimension: dry powder dispersion for even the finest, cohesive powders with RODOS. And with the R-series of laser diffraction sensor HELOS, new benchmarks regarding accuracy, repeatability, and system-to-system-comparability have been achieved. Great statistics based on large particle numbers are realized at shortest measuring times. Latest refinements comprise the enhanced application of parameter-free Fraunhofer evaluation down to the submicron regime (below $1 \mu\text{m}$), a great measuring signal frequency for best resolution with range combination technology and even more powerful evaluation modes for both, Fraunhofer and Mie.¹⁾

The modular sensor reveals its true superiority when operated with feeding and dispersing systems, that



DRYSUBMICRON



Dry Dispersion



GRADIS



HELOS & RODOS



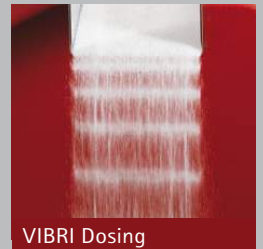
ASPIROS



HELOS Laser Diffraction



VIBRI



VIBRI Dosing



QUIXEL



SUCELL



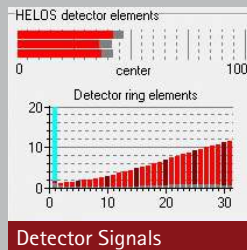
Suspension Diffraction



CUVETTE



INHALER



Detector Signals



SPRAYER



Spray Dispersion

guarantee for best adaptation to the product sample.

Dry Dispersion

RODOS provides synchronised operation for dosing and dispersing of dry products together with feeders VIBRI or ASPIROS. Efficient dispersion down to the primary particles is achieved for products ranging from $< 1 \mu\text{m}$ to $3,500 \mu\text{m}$, despite

strong cohesive forces. For coarser, fragile, free-flowing products gravity disperser GRADIS with a special fall shaft design is the best choice.

Wet dispersion

For analysis of suspensions and emulsions a variety of wet dispersing units such as SUCELL, QUIXEL and CUVETTE is available.²⁾ They provide optimum applications from a few

drops of suspension to a litre, with sonication, circulation and heating or cooling for best sample treatment.

Sprays

The open measuring zone of HELOS is most suitable for the analysis of extended sprays. SPRAYER and INHALER adapters can simply be modified for use with customer specific dispersion devices (e.g., MDIs, DPIs).

¹⁾ Applications and results are managed with a comprehensive control and evaluation platform. The software is realized building on a multi-user, multitasking database

infrastructure. It is the joint base for HELOS laser diffraction and all other Sympatec instruments.

²⁾ RODOS and SUCELL may be installed as united system OASIS, combining dry and wet applications.



QICPIC | RODOS & Co. | Image Analysis Particle Measurement | Laboratory Size and Shape | $< 1 \mu\text{m}$ to $34,000 \mu\text{m}$



QICPIC R-Series

Dynamic High-Performance Image Analysis with Proven Dispersing Units



QICPIC & RODOS

Determination of particle shape provides an important additional option in characterizing particulate matter. It reveals characteristic distribution attributes as collective property functions in addition to size.

For the acquisition of particle shapes, images of primary particles are required. Again, dispersion forms the main challenge. Evidently, the established and proven dispersion systems known from laser diffraction with HELOS were cross-bred with a new sensor principle.

Sensor

The modular image analysis sensor QICPIC combines size and shape characterization of disperse particle systems within a detection range of below $1 \mu\text{m}$ to $34,000 \mu\text{m}$. Flexible sensor adaptation for analysis of

powders, granules, fibres, suspensions and emulsions is provided by a wide range of dispersing and dosing units. Numerous implementations in pharmaceutical and chemical industry, food and beverage technology, and soil science just denote the array of applications in industry and research.

The most prominent feature is an exposure time within the sub-nano-seconds regime, achieving an image capturing frequency of up to 500 frames per second. This allows the use of proven dry disperser RODOS for the characterization of finest, cohesive powders. And based on a great number of measured particles, a high confidence level for measuring results is achieved. Our powerful evaluation software supports the simultaneous determination of all



QICPIC & GRADIS

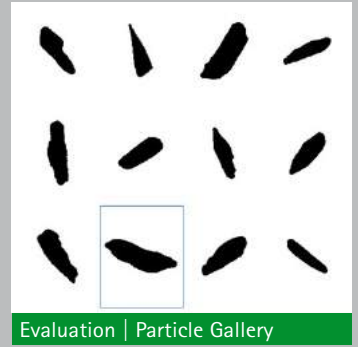


QICPIC & LIXELL & LIQXI

relevant size and shape characteristics. A particle gallery together with user-defined screening criteria facilitate the creation of specific and meaningful reports.

Dry Dispersion

RODOS is the choice for fine powders, fibres and granules from $5 \mu\text{m}$ to $4,000 \mu\text{m}$, if agglomerates need to be dispersed. A free aerosol jet of primary particles is introduced to the measuring zone. For smoothest dispersion of coarser, even fragile particles, the GRADIS free-fall shaft masters a range from a few microns to 30 millimetres and above. For the gentle and fast separation of assemblies of curly or even tangled fibres, FIBROS combines brush, nozzle and sieve. The fibres are carried to the measuring zone in a stream of air through GRADIS.



Evaluation | Particle Gallery



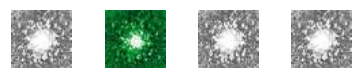
QICPIC & MIXCEL

Wet Dispersion

With an open and modular design, LIXELL is the most versatile wet dispersion unit. It provides numerous adaptations to diverse applications and size ranges with sample volumes starting at 20 ml. A large volume flow-through cuvette is realized with FLOWCELL. Even large particles in the millimetre range and sample volumes of 20 l/min and above are managed.

Dry and Wet Dispersion

A piggy-back mounted SUCELL on top of dry disperser RODOS provides the OASIS system, which allows to easily switch between dry and wet measurements. It impeccably operates a pumped suspension loop for liquid applications. Alternatively, the aerosol free jet known from RODOS is at hand for dry samples.





NANOPHOX | Photon Cross-Correlation Spectroscopy Analysis of Nanoparticles in a Unique Range of Concentrations



NANOPHOX

Dynamic Light Scattering (DLS) is commonly used for nanoparticle characterization. With Photon Correlation Spectroscopy (PCS), scattered light intensities of particles under thermal motion are auto-correlated in order to determine the particle size distribution of nanodispersions. However, this conventional technology requires extremely diluted samples in order to deliver meaningful results.

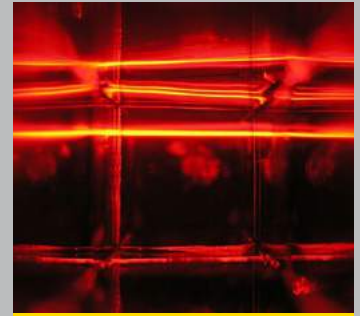
With NANOPHOX, Sympatec exclusively introduces Photon Cross-Correlation Spectroscopy (PCCS), which allows for nanoparticle size analysis in suspensions and emulsions at up to a hundred times higher solid contents. The outstanding technological feature of NANOPHOX is the acquisition of two separately induced scattered light intensities, which

then are cross-correlated. This allows for robust measurements in a wide range of concentrations. In addition to size, the aggregation or sedimentation behaviour of nanosuspensions (i.e. stability) may be analysed. Typical applications comprise e.g., polymer emulsions, colloidal silica, inks and research on nanodispersions in general.

Dilution Series | PCCS and PCS
Studies with DLS reference material (polystyrene latex, nominal particle size 100 nm) illustrate the performance of PCCS within a wide range of concentrations. Five different latex suspension samples ranging from the undiluted suspension with 1 % solids content by volume to a dilution ratio of 1:10,000. For measurements performed with NANOPHOX in PCCS mode, the

measured peak diameter ranges between 97 and 106 nm, respectively. Regardless of dilution, all measured hydrodynamic diameters show valid results that comply with the specifications. In contrast, the PCS mode shows results that are off-specification for concentrated samples with dilution ratios of 1:1,000 and above. At least $5 \cdot 10^3$ times dilution is required in order to obtain a correct particle size with PCS. There is no dilution required with PCCS.

Using PCCS will extend the range of sample concentrations that can be measured by DLS significantly. It avoids unnecessary sample dilution and opens new possibilities to study effects in high concentrated nanodispersions.



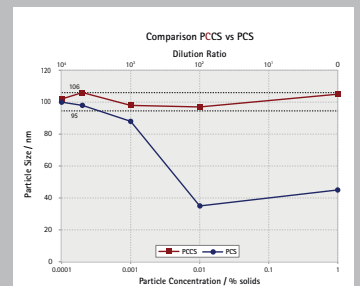
Positionable Measuring Volume



Cuvettes: Acrylic | Glass | Micro



Dilution Series



Dilution Series | PCCS versus PCS



OPUS
NIMBUS

PICTOS
PICTIS
PICCELL

MYTOS
MYTIS
TWISTER & Co.



Particle Size and Shape Analysis for the Production

in-line | on-line | at-line from $< 0.1 \mu\text{m}$ to $20,480 \mu\text{m}$



OPUS | Chemicals

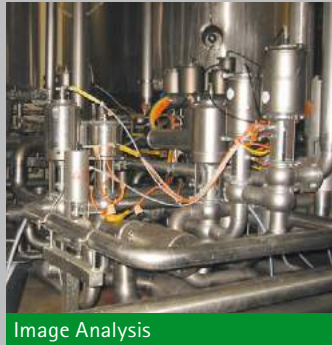


Image Analysis



MYTOS & TWISTER | Jet milling



MYTOS & TWISTER | Metal powder



OPUS | Gypsum



PICTOS & VIBRI | Coal



MYTOS & TWISTER | Cellulosis



MYTOS & TWISTER | Spray grits

in-line | Ultrasonic Extinction
 $< 0.1 \mu\text{m}$ to $3,000 \mu\text{m}$
Ultrasonic extinction provides an outstanding performance for in-line and on-line particle size analysis of suspensions and emulsions. One of the major benefits is the ability to operate in highly concentrated mediums, which typically come along with wet process stages. A solid content between 5 and 50 % by volume is a typical range of concentration. These are perfect conditions for OPUS, which even may be applied at concentrations up to 70 % by volume – typical for paste-like particulate systems.

Using sound waves instead of light waves, analysis of suspensions or emulsions is independent of transparency and may be conducted in

totally opaque disperse matter like water droplets in crude oil, mineral slurries or even carbon particles in liquid pitch. Paints, sugar paste or pharmaceutical suspensions also belong to the main field of application. Ultrasonic extinction allows for a rugged and robust probe design that resists typical process conditions such as high temperatures, pressures or aggressive media and abrasive materials.

in-line | Image Analysis
 $2 \mu\text{m}$ to $20,480 \mu\text{m}$
Process-related particle size and shape characterization is realized with integrated image analysis sensors PICTOS, PICTIS & PICCELL covering a size range from $2 \mu\text{m}$ to $20,480 \mu\text{m}$. PICTOS integrates QICPIC dynamic image analysis and RODOS dry dispersion technology in

a robust body, which was specifically developed for on-line applications. PICTIS combines image analysis and gentle gravitational disperser GRADIS, allowing at-line or on-line applications in process environments. And PICCELL with its flow-through cuvette finally transfers wet dispersion to on-line operations of image analysis. Feeding of PICTOS, PICTIS & PICCELL is realised either with dynamic and representative sampling system TWISTER, blending MIXER or static L-probes. Also, automatic or user-operated manual feeding is an option.

in-line | Laser Diffraction
 $0.25 \mu\text{m}$ to $3,500 \mu\text{m}$
MYTOS integrates the established core technologies of HELOS laser diffraction and RODOS dry dispersion in a single robust body: a process-

proven laser diffraction sensor for dry powders ranging from $0.25 \mu\text{m}$ to $3,500 \mu\text{m}$. In combination with continuously operating sampling system TWISTER a complete integration into the processing pipe is realised making it a true in-line solution delivering representative results. Alternatively, MYTOS may be operated on-line either with TWISTER, MIXER, L-probes or existing sampling solutions. Integrated at-line operation in automated lab environments is succeeded with vibratory feeder VIBRI. For instance, typical applications comprise milling operations or spray granulation. MYTIS is first choice for granules or fragile particles. It combines HELOS laser diffraction technology with gravitational disperser GRADIS in a robust industrial system for a size range from $0.5 \mu\text{m}$ to $3,500 \mu\text{m}$.



Innovation from Tradition



Pulverhaus view from tailings



Historic Pulverhäuschen



Welcome to Pulverhaus

In a picturesque environment, edged by ponds of the Harz Mountains, surrounded by forests of fir and pregnant alleys of maple trees, the headquarter of Sympatec GmbH is located on a plot of land, which has been moulded by the mining industry for centuries. It is home to the once richest mines of the Oberharz, "Dorothee" and "Caroline". Still today, cairn stones, which mark the border of the "Burgstätter Revier", and the operational air shaft of the Caroline mine make reference to the 17th century. Amidst this world cultural heritage, the protected historical monument "Pulverhäuschen", a storage for mining explosives, displays an early application of powder technology.

Just alongside, the new Pulverhaus has been established in 2004. Its

purpose is no longer the storage for explosives. It is home to design, manufacture and development of innovative particle sizing technology that is marketed and supported worldwide. Today, Sympatec instruments are highly appreciated for their unrivalled performance regarding the characterization of dry powders.

The signatures of Goethe, Heine, Schopenhauer as well as James Watt and Alfred Nobel in the visitor's book of the 18th and 19th century witness the early achievements of underground mining technology. Today's visitors may explore leading technology in particle size analysis above ground.

In the early 1980s, Sympatec introduced a breakthrough innovation

which was leading laser diffraction to another dimension: dry powder dispersion for even the finest, cohesive powders with RODOS. As a result, a broad range of leading instruments for particle size analysis of powders, suspensions, sprays, emulsions and aerosols was generated using ultrasonic extinction, dynamic image analysis and photon cross-correlation spectroscopy as physical principles.

The Pulverhaus pools the company's innovation strength to further develop product oriented instruments for most demanding laboratory applications including automated lab solutions. For process control in production lines, integrated applications of proven technologies have already been realized in combination with reliable sample coupling systems.

Pulverhaus is brand home to the Sympatec instruments, founded at a famous location with a fine tradition in innovation. It is known as one of the few centres of competence of powder technology, enjoying an excellent global reputation.



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