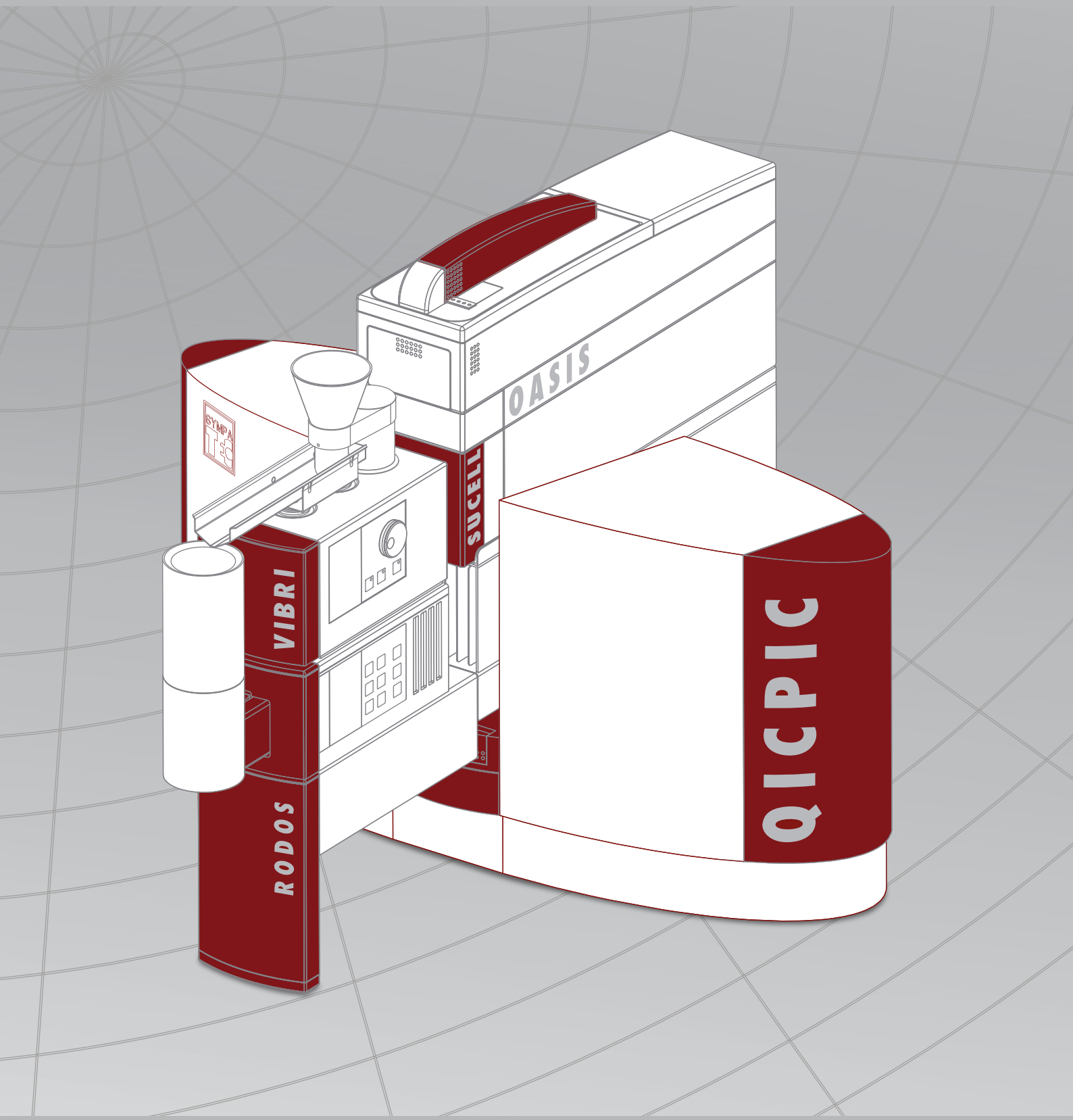
QICPIC | RODOS & Co. | Dynamic Image Analysis

Particle Measurement | Laboratory

Size and Shape | 0.55 µm to 33,792 µm

Technical Specifications



Sympatec develops, manufactures, sells, services and supports a range of best instruments for particle size and shape analysis in laboratory and process applications for customers worldwide. With continuous innovations Sympatec makes a prominent contribution to ❱ laser diffraction, ❱ dynamic image analysis, ❱ ultrasonic extinction and ❱ dynamic light scattering.

The Universal Shapefinder

Technical Specifications

High-Performance Image Analysis from Submicron to Centimeter on with up to 500 fps

Unrivalled Resolution | Greatest Accuracy | Highest Statistical Confidence

The modular image analysis sensor QICPIC has proven its superior capabilities in size and shape analysis of disperse particle systems within a variety of demanding applications in research and industry. With adaptable dispersing units and feeders, the sensor is flexibly adjusted to powders, granules, fibres, suspensions and emulsions, which are to be characterized.

QICPIC offers an overall detection range from 0.55 µm to 33,792 µm. Seven of the overlapping optical modules will seamlessly capture the entire range. And the great dynamic measuring range of each respective module allows for the characterisation of wide distributed disperse systems.

A precise capturing of particle outlines is realized by transmitting 8 bit greyscale images even at highest frame rates. Powerful algorithms evaluate the particle projections at rates of up to 500 frames per second (fps). The accuracy of particle size and particle shape analysis has therefore reached a new dimension of quality.

High-resolution and high-speed CMOS cameras allow for optimal horizontal and vertical windowing. Even very large particle numbers (up to 100 million particles per measurement) are captured and evaluated at shortest measuring times. For the measurement results, a unique level of statistical confidence is achieved.*

Regarding image capturing, two sensor models are available:

- QICPIC/L02
  resolution up to 4.2 MP,
  frame rate up to 225 fps and
  data rate 5 GBit/s (1 x USB 3.0)

- QICPIC/L06
  resolution up to 4.2 MP,
  frame rate up to 500 fps and
  data rate 10 GBit/s (2 x CXP-5)

The network-ready control and evaluation software PAQXOS serves as a powerful tool for real-time capturing, storing and evaluation of the measuring data.

After every measuring operation the complete raw data will be stored in the database automatically to enable a subsequent evaluation with alternative modes.

QICPIC emphasises latest and future-oriented standard interfaces (such as TCP/IP, CoaXPress (CXP) and USB 3.0) for device control and system integration into the existing IT environment. This ensures the systems' upgrade capabilities as well as a high degree of compatibility.

Naturally, the proven modular system design delivers the highest degree of application flexibility. For an optimal adaptation to a wide variety of products many dispersing units are applicable:

- dry | RODOS, GRADIS, FIBROS
- wet | LIXELL, FLOWCELL, SUCELL
- dry & wet | OASIS

Benefits at a glance

- **Reliable and fast determination of size, shape and quantity**
  Dynamic image analysis with up to 500 fps ensuring a high number of captured particles for statistically sound results in seconds to just a few minutes.
- **Flexible adaptation to a wide range of applications**
  Modular system design with a great selection of dispersing and dosing units for dry and wet applications. Best adaptation to your product(s).
- **Powerful dry dispersion with injection disperser RODOS**
  Controlled dispersion forces generate a free aerosol jet from dry, even cohesive powders. With a nanosecond exposure, accelerated and dispersed particles are captured as pin sharp images.
- **Wide measuring range | < 1 µm to 34 mm**
  A selection of four precision lenses covers the complete measuring range. Each optical module offers a unique dynamic range (1:2,000) for a perfect characterisation of even wider distributed samples.
- **Powerful evaluation modes | Meaningful results**
  Simultaneous determination of all relevant size and shape characteristics, including fibres. A particle gallery and user-defined screening criteria facilitate the creation of specific reports.
- **Adaptable, high resolution size and shape distributions**
  Raw data recording allows for finest gradation of distribution diagrams. Result presentation adapted to your needs.

QICPIC & RODOS & VIBRI

* Typical relative standard deviation for accuracy $\sigma(Q_3) < 1\,\%$ | for repeatability $\sigma(Q_3) < 0.1\,\%$.

QICPIC

High-Performance Image Analysis

Modular Image Analysis Sensor
for Particle Size and Shape Characterisation

Sensor		
Model	QICPIC/L02	QICPIC/L06
Detection range | µm	0.55 - 33,792	0.55 - 33,792
Measuring range modules	7	7
Maximum frame rate | fps	225 @ 1.5 MP	500 @ 1.5 MP

Measuring principle	
Dynamic image analysis	Particle illumination in transmission
	› Quasi-static image analysis by nanosecond exposure
	› Use of effective dry dispersion units that reliably separate particles
	› Double-telecentric optics for highest contrast of even transparent particles
	› Image size independent of object position
	› High confidence level by fastest image acquisition allowing for a high number of particles
	› In accordance with ISO 13322-1/2

Light source		
Model	QICPIC/L | LED	
Pulsed LED	λ =660 nm (red)	λ =450 nm (blue)
Pulse duration	In nanoseconds range	
Frequency	10 to 500 fps	

Measuring ranges and optics				
	Magnification	$x_{min, phys}$ | GSR[1]	-	$x_{max, ISO}$ | phys
Optical modules	M3 (10:1)*	.55 | 4.95	-	375 | 1,126 µm
L02 | L06	M4 (5:1)*	1.1 | 9.9	-	750 | 2,253 µm
	M5 (3:1)	1.8 | 16	-	1,252 | 3,755 µm
	M6 (2:1)**	2.8 | 25	-	1,877 | 5,632 µm
	M7 (1.3:1)	4.2 | 38	-	2,888 | 8,665 µm
	M8 (1:2)	11 | 99	-	7,510 | 22,528 µm
	M9 (1:3)	17 | 153	-	11,264 | 33,792 µm

* only for wet applications

** M6 dry only for models with one fixed measuring range

Discrete measuring ranges with highest precision and resolution. User-defined configuration of up to four precision lens modules per lens holding disk.[7]

Detector and data acquisition				
Camera performance	QICPIC/L02		QICPIC/L06	
Detector resolution | px	2,048 x 2,048		2,048 x 2,048	
Pixel size | µm²	5.5 x 5.5		5.5 x 5.5	
Frame rate | fps	225 @ 1.5 MP		500 @ 1.5 MP	
	170 @ 2.1 MP		355 @ 2.1 MP	
	85 @ 4.2 MP		175 @ 4.2 MP	
Data Rate	5 GBit/s		10 GBit/s	
Interface	1 x USB 3.0		2 x CXP-5	
Measuring performance	Duration[2]	Number of particles		Standard deviation[3]
Minimum	1 s	some hundred		5-10 %
Recommended	1 - 100 s	1 million		1 %
Maximum	100 - 1,000 s	> 30 millions		0.1 %

Evaluation modes	
Particle size	Equivalent sphere, equivalent perimeter,
	enclosing rectangle, Feret diameter, Chord length
Particle shape	Sphericity, aspect ratio, convexity, roundness
Fibre characterization	Fibre length, fibre diameter, volume-based fibre
	diameter, straightness, elongation
Volume models	Sphere, ellipsoid, cylinder
Class limits	Automatic generation depending on measuring range
	Intelligent, individual class limits generator
	ISO compliance by default

Quality of measuring results		
Accuracy	σ < 1 %	Mean relative standard deviation
		verified by standard target (USAF)
Repeatability[4]	σ < 0.2 %	Typical (narrow distribution)
	σ < 1 %	Typical (wide distribution)
Comparability[5]	σ < 2 %	Mean relative standard deviation
		of median (x_{50})
	|Δx|< 5 %	Maximum relative deviation[6]

FIBROS

GRADIS & VIBRI

1) The second value (GSR) indicates the lower range limit which yields a good shape recognition. 2) Dependent on product under observation and – if wet dispersion is applied – dependent on dispersing media. 3) Related to particle size distributions of three consecutive measurements. Depending on the measuring task other criteria may be crucial in order to assess the quality of measurement when applying image analysis. 4) Repeated measurement of a (riffled) sample with up to about 1 million particles with reference material SiC P600 (x_{50}-value). 5) System-to-system reproducibility. 6) Related to $x_{10}|x_{50}|x_{90}$-values. 7) Stated size ranges are application and system configuration dependent. 8) With particles, that are just a fraction compared to the size of the detector, an optical concentration of 0.1 % < c_{opt} < 0.3 % is aspirable with regard to reproducibility of the particle size distribu-

RODOS | SUCELL & Co.

Versatile Dry and Wet Dispersion

SYMPATEC

Adaptable Dispersing Units
for Powders, Granules, Fibres, Suspensions and Emulsions

Dispersing Units and Feeders[7]

Dry

	Dispersing range	Sample amount per analysis[8]
RODOS/L	1.8 - 4,000 µm*	< 1 - 1,000 g
Injection disperser for finest, even cohesive powders		
	* with fibres up to 6,000 µm	
GRADIS/L	1.8 - 18,000 µm**	10 - 1,000 g
Gravity disperser for coarser, even fragile dry particulate systems		
	** with straight fibres up to 34 mm; with curled fibres up to 100 mm	
VIBRI/L[9]	up to 15,000 µm	< 1 - 1,000 g
Vibratory feeder for precise dosing and feeding of dry particulate systems		
ASPIROS/L[9]	up to 500 µm	< 1 g
Micro dosing system for feeding small amounts of precious or toxic dry substances in encapsulated sample vials[10]		
FIBROS[11]		
Disperser for gentle separation and feeding of dry, even curly fibres	500 - 30,000 µm 1.8 - 5,000 µm	fibre length fibre diameter

Dry and wet

	Dispersing range	Sample amount per analysis[8]
OASIS/L		
Combined RODOS | dry[9] and SUCELL | wet[12, 13]	1.8 - 4,000 µm 0.55 - 2,000 µm	< 1 - 1,000 g (50) 500 ml

Wet

	Dispersing range	Analysis volume[8]
SUCELL/L[13]	0.55 - 2,000 µm	(50) 500 ml
Closed loop flow-through cell for suspensions and emulsions; built-in sonication (0-72 W); small volume adapter (SVA)[14]		
MULTISAMPLER | wet	up to 1,000 µm	39 ml vials
Sample handling system for automated feeding of wet samples in vials		70 vials per rack up to 140 vials with rack extension
LIXELL	0.55 - 2,000 µm	min. 20 ml
Flow-through cell for flexible application set-ups, adaptable cuvettes and application kits[14]		
LIQXI | for LIXELL	up to 500 µm	250 ml* or 400 ml**
Wet dosing system with stirrers, flow baffles and peristaltic pump for representative sample flow		* flow-optimized or ** standard glass beaker
FLOWCELL | Large volume flow-through cell		
10 mm	11 - 5,000 µm*	> 10 l/min
20 mm	17 - 10,000 µm*	> 20 l/min
	* with soft disperse matter (e.g., pulp) up to 8 mm and 16 mm, respectively	

RODOS & VIBRI

ASPIROS

SUCELL/L

LIXELL

tion. With bigger sized particles, whose projections fill the detector large-scale, higher optical concentrations may be accepted. 9) RODOS & GRADIS typically with dry feeding unit VIBRI. Feeding of RODOS with ASPIROS, alternatively. 10) When using hazardous or toxic substances, additional safety measures must be taken by the operator at the installation site. 11) Applicable for feeding of fibres in combination with GRADIS. 12) Closed-loop flow-through cell for suspensions and emulsions, with sonication (0-72 W), small volume adapter (SVA) optional. 13) Automated sample feeding with MULTISAMPLER | wet optional 14) optional

Systems for Particle Size and Shape Analysis

Sensor | Dispersers | Evaluation | Quality

Quality assurance system		
Certification	Standardised test procedure	
Reference material	SiC-F800	(x_{50} ≈ 9 µm)
	SiC-P600	(x_{50} ≈ 26 µm)
	SiC-F230	(x_{50} ≈ 66 µm)
	SiC-P80	(x_{50} ≈ 260 µm)
	SiC-P50	(x_{50} ≈ 430 µm)
	SiC-P16	(x_{50} ≈ 1,600 µm)
Validation	According to FDA regulations	

Software	
PAQXOS	PC or remote control of application in terms of sensor, dispersing units and sample feeding
Control and evaluation software for particle size and shape analysis	Evaluation[15, 16] › Particle size and size distribution, mean values and standard deviations › Particle shape and shape distribution, mean values and standard deviations › Fibre characterization › Formation of individually specified fractions
	Presentation of results based on user-defined reports and templates[16] › Diagrams (distribution curves, trend graphs) › Tables › Characteristic values › Shape descriptor diagrams | Scatter plots › Particle gallery | Particle movie
	Step-by-step wizard for quick and successful measurements
	Intuitive SOP management
	User-friendly, individual user interface

System specifications		
Dimensions (L/W/H)	763 / 301.5 / 383 mm	
Measuring zone	123 mm	
Weight	36 kg	
Supply voltages	90 - 250 V AC @ 50-60 Hz	
Power consumption	Standby	0.1 W
	In operation	38 W idle | 360 W max.
Compressed air[17]	Supply	min. 6 bar (Class 3)
	Consumption	max. 300 l/min
Extraction[18]	Application dependent industrial extraction unit	

Compliance	
ISO 13322	The ISO standard requirements concerning "Particle size analysis - Image analysis methods" are met or even partially exceeded.
FDA 21 CFR Part 11	The compliance to FDA rule standards concerning electronic records and electronic signatures is supported.

Computer specifications		
Operating system[19]	Microsoft® Windows® 10 Professional (64 Bit)	
	QICPIC/L02	QICPIC/L06
Hardware specifications[20]	Up-to-date desktop PC, e.g. Intel Core® i7, min. 2.9 GHz, 8 GB RAM, HD Graphics 630 (integrated), Sound and LAN onboard, DVD±RW	Up-to-date tower PC, Intel Xeon® W processor, min. 3.6 GHz, 32 GB RAM, NVIDIA® Quadro® P2000® 5 GB,
CPU	Intel Core® 6-Core	Xeon® 8-Core
Hard disk	SSD 512 GB SATA	SSD 512 GB SATA, HDD 1 TB SATA
Display	27" WQHD/QHD (2.560 x 1.440 px)	
Interfaces	1 x USB 3.0 (5 GBit/s)	2 x CXP-5 (10 GBit/s) PCIe®-Gen 2 | > 3.000 MByte/s

QICPIC & OASIS

15) A diversity of different size and shape factors is implemented. 16) Ex-post, recalculations and modifications of evaluation and presentation are possible. 17) In conjunction with injection disperser RODOS (resp. OASIS) and FIBROS. 18) In conjunction with dry dispersers RODOS (resp. OASIS), GRADIS and FIBROS. 19) Microsoft® Windows® 7 Professional (64 Bit) supported. 20) Sympatec reserves the right to supply equivalent or better specified personal computers.

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