



*CLASSIFICATION, ANALYSIS, and COUNTING
of PARTICLE MIXTURES in biological,
industrial, and environmental liquids*

*powered by patented
SINGLE PARTICLE EXTINCTION
& SCATTERING SPES TECHNOLOGY*

CLASSIZER™ ONE

MULTIPARAMETRIC SINGLE PARTICLE ANALYSER



Early R&D

- Formulation QbD & SbD
- Heterogeneous Samples
- Complex-But-Real Particles



Formulation

- Classify particle mixtures
- Formulation behaviour
- In target complex liquids



Product QC

- Continuous Flow Analysis
- Process QC/PCA
- Impurities Identification

About EOS

*"If you cannot measure it,
you cannot improve it"*
Lord Kelvin 1824 – 1907

EOS S.r.l. (Effective Optical Systems) has been founded in 2014 in Milano (Italy). Since the beginning, EOS develops and offers **novel scientific devices and technological solutions for the analysis, design, and formulation of particles in biological, industrial, and environmental heterogeneous fluids.**

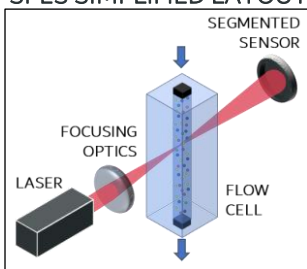
EOS patented solutions are the game-changers for improving R&D, formulation, and process quality control of products based on particles and particle mixes in markets as **delivery systems, cosmetics, pigments, inks, specialty chemicals, abrasives, beverages, and life and environmental sciences.**

The legal and business headquarters of EOS are located in Milano, Italy (EOS S.r.l. – Viale Ortles 22/4 – I-20139 Milano – Italy)

SPES

SPES (Single Particle Extinction and Scattering) is a patented light scattering technology highly suitable for the classification and characterisation of mixtures of particles and complex samples. Exploiting the unique optical properties of each particle measured, SPES classifies, analyses, and counts the particle populations in a heterogeneous fluids.

SPES SIMPLIFIED LAYOUT



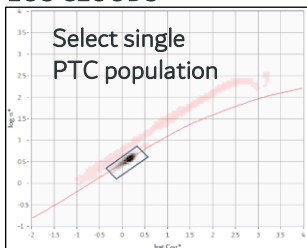
How CLASSIZER™ ONE /SPES works. A sample is dispersed and diluted in a liquid, which is flowed through a scattering cell where a laser beam is properly shaped and focused. As a single particle crosses the laser beam, the interference pattern between the transmitted beam and the forward scattered light is recorded on a sensor. The interference pattern presents fringes delivering the unique optical properties of the single particle illuminated.

SPES FRINGES



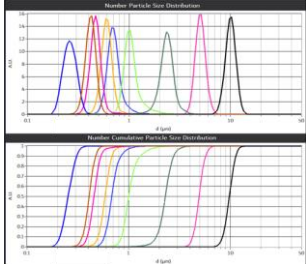
Extinction Cross Section C_{ext}^* and Polarizability α^* are thus retrieved for each single detected, validated, and counted particle thanks to a robust Pulse Shape Analysis scheme and proprietary algorithms. Tens of thousands of particles are measured & classified based on optical properties in few minutes. Artifact signals are rejected increasing data robustness.

EOS CLOUDS



CLASSIZER™ ONE creates the unique EOS CLOUDS histogram which is the optical fingerprint of the sample. Mixes of optically different particles produce simultaneously different clouds for each particle population, which can be individually selected, analysed, and compared. Particle size distribution, numerical concentration, and other insights are retrieved accordingly to selections, to whole sample, or for a time frame of the acquisition.

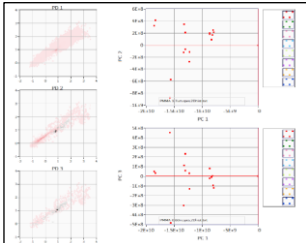
PTC SIZE DISTRIBUTIONS



Added-value information is provided thanks to SPES and EOS unique data libraries:

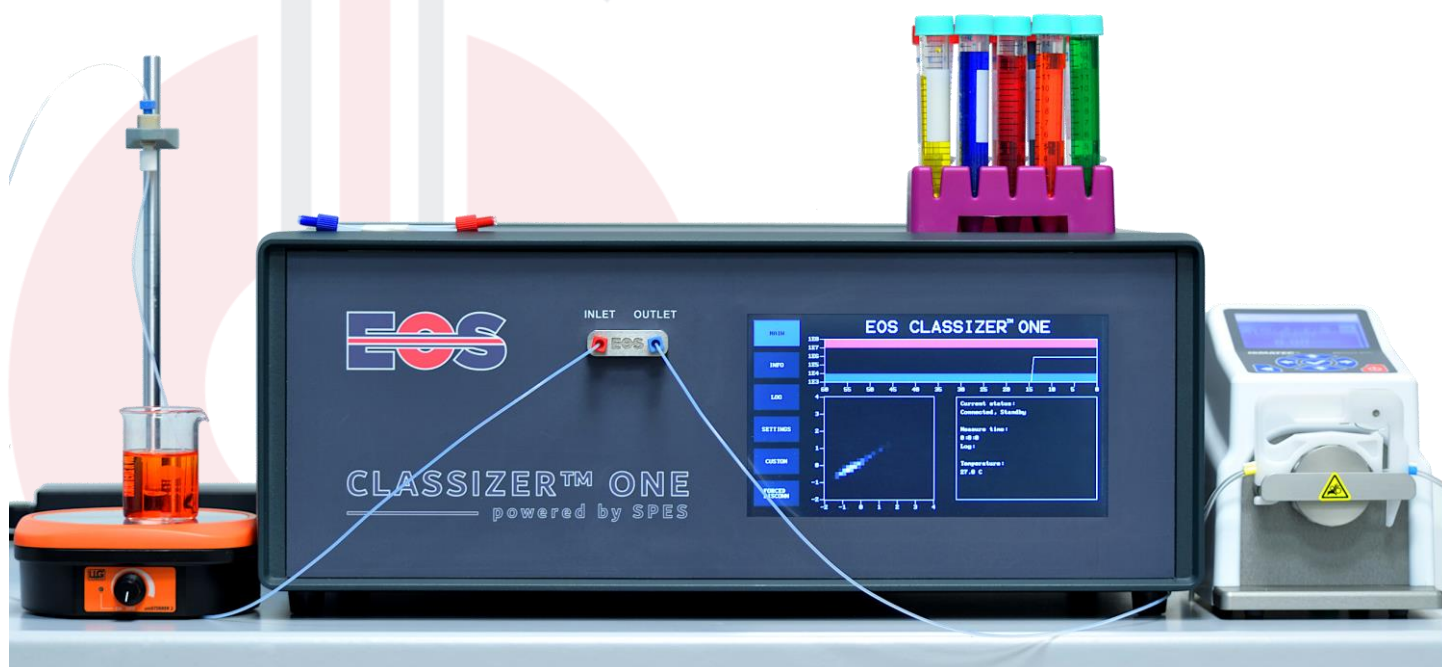
- Optical Classification, Absolute Particle Size Distribution, and Numerical Concentration of each single particle populations irrespectively of polydispersity and particle mixtures.
- Quality Control of optical particle structures as porosity, wetting, aspect ratio, payload, impurities, and shelf-life without intermediate steps (e.g., purification/filtration).
- Measurement of the particle behavior and the particle formulation stability directly in heterogeneous non-filtered target biological, industrial, or environmental fluids.
- Hi-Resolution Continuous Flow Analysis of particles, ready to couple to other analytical devices and systems, as cFFF separators, small chemical reactors, and pilot lines.
- Statistical approaches as Oversize Measure and PCA for Hi-Quality Batch-2-Batch analysis and out-of-specifics identifications in product formulation and production.

STATISTICAL ANALYSES



CLASSIZER™ ONE

CLASSIZER™ ONE delivers accurate, robust, reliable data based on patented **Single Particle Extinction and Scattering (SPES)** method for the **analysis, classification, and counting** of simple and mixtures of submicron and micrometric particulate systems in liquids. CLASSIZER™ ONE enables critical decision-making throughout research and development, particles formulation, and quality control in manufacturing processes driven decisions in delivery systems, cosmetics, cosmeceuticals, pigments, inks, specialty chemicals, food, beverage, nanoplastics, abrasives, life and environmental sciences.



Unique Patented Optical Layout – Industrial-grade – Touchscreen – Accessories

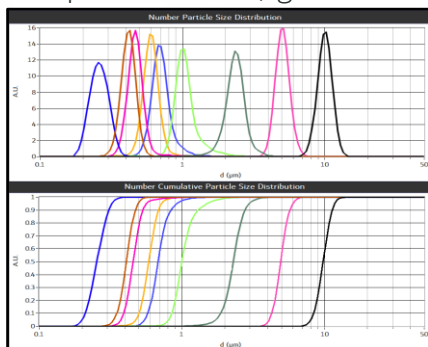


Quartz, Borosilicate Glass, PTFE, FEP, FKM, and Stainless Steel wetted surfaces ensure high chemical compatibility. CLASSIZER™ ONE measures samples at laminar constant flows of 0.2, 0.5, 1.0, 2.0, 4.0 mL/min and viscosity up to 30cS.

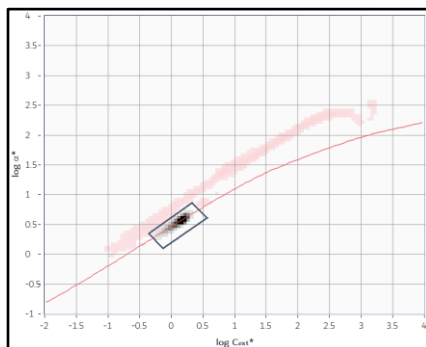
CLASSIZER™ ONE works with standard syringe pumps for standard manual usage. EOS offers liquid sample managers and autosampler to deliver highest measurement throughput and reliability in particle analysis and batch-2-batch QC.

Tailored hardware and software solutions are available and can be developed on the basis on the single user needs.

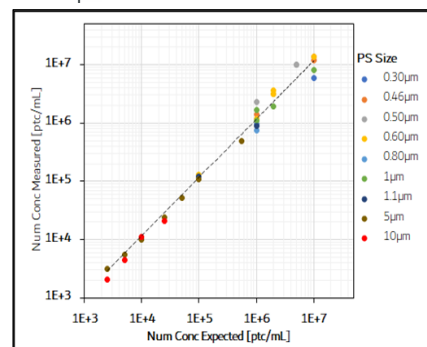
Particle Size Resolution¹
from 0.20µm up to 20µm
PS spheres in milliQ-grade water



Particle Classification¹
classification of a mixture of PS
and silicon oil emulsion in water



Particle Concentration¹
accuracy on num conc of several
PS spheres at different dilutions



CLASSIZER™ ONE – Tech Data model CSONE-ST

SPES size range¹

Dielectric Spheres	200nm – 20 µm
Absorbing Spheres	100nm – 10 µm

Particle Concentration¹ 10⁴ - 10⁷ particles / mL (10⁶ ptc / mL ideal)

Theory

Single Particle Extinction and Scattering SPES patented

Laser Unit¹

Red light diode (λ@640nm, <150mW) [customizable]

System Alignment

Semiautomatic (fabs preset, tuned on installation / maintenance, automatic alignment of the sensors)

Measuring Time¹

10 min, Acquisition Rate up to 10,000 events/min

Weight/Dimension¹

30kg, 52cm x 52cm x 30cm (WxDxH)

Wetted Surfaces¹

Quartz, Borosilicate Glass, PTFE, FEP, PEEK, FKM, FFKM, Stainless Steel

Environment

Temperature: 18–27 °C; RH: 35% – 75% RH @25°C

Software

GUI for system management, standard data analysis. Advanced features via AddON as **Continuous Flow Analysis CFA** and batch-2-batch analysis via **Principal Component Analysis PCA**. Tailored SOP available.

PC Requirements

Intel® Core™ i5 – min 4 cores @2GHz or similar, 40 GB available on SSD, 4GB RAM, Windows 10/11 (current service pack), x2 USB 3.0 (or higher), 1080p monitor

Sample Flow¹

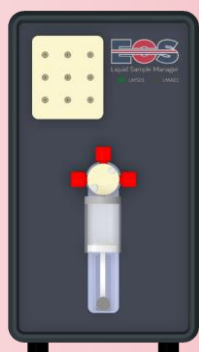
Stable typ. 0.2, 0.5, 1, 2, 4 ccm; viscosity up to 30 cS

Accessories¹

Compatible with standard syringe pumps. Available on request: EOS liquid standard sample manager **LMS01™**, EOS liquid advanced sample manager **LMA01™**, and EOS autosampler **LAS01™**. Consumables available.

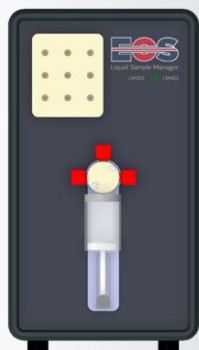
¹Dependent on sample, sample preparation, and model/configuration of CLASSIZER™ in use.

ACCESSORIES



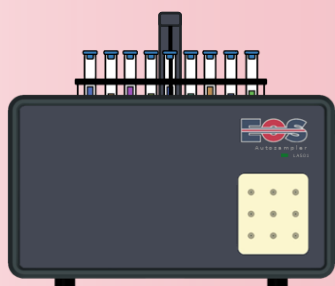
LMS™ Standard Liquid Sample Manager

EOS LMS™ standard sample manager enables Classizer™ ONE to operate in stable and repeatable conditions. It drastically reduces operator-dependent issues respect using a standard external pump; it occupies only a small space on the table. LMS™ relies on a robust syringe pump, PTFE and borosilicate syringe, plus a four-way valve for sample, simple cleaning, and waste management. LMS™ is designed to speed-up and standardize operations, to measure samples which are mostly already diluted, and for customers that do not want to lose time and energy in a search for compatible external pump.



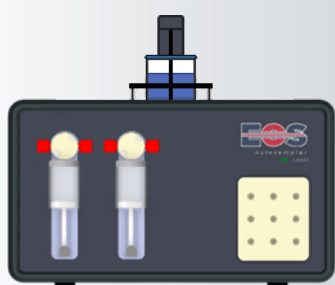
LMA™ Advanced Liquid Sample Manager

EOS LMA™ advanced sample manager is designed to bring all the benefits of the standard LMS™ sample manager with the additional value to perform repeatable automatic dilutions and cleaning protocols. LMA™ relies on a robust syringe pump, PTFE and borosilicate syringe, plus integrates up to 6 valves and a mixing chamber to manage the samples and create custom operative procedures of sample analysis, dilution ramps up to 100 times, and advanced standard and custom cleaning protocols.



LAS™ Liquid Autosampler

LAS™ is an autosampler compatible with Classizer™ ONE and liquid sample managers LMS™/LMA™. Compatible with up to 20 test tubes and vials of 20mL. Settings, operative procedures, and the washing can be started and operated through the Classizer™ ONE software. Each sample may be stirred via a magnetic stirrer to prevent particle settling before the sampling. Via LMS™ / LMA™ internal washing is performed in order to prevent the cross contaminations between samples. Tested sample can be recovered for new analyses.



LAD™ Liquid Autosampler

LAD™ is a single point autosampler compatible with Classizer™ ONE and liquid sample managers LMS™/LMA™. LAD™ samples small aliquots at fixed times from a selected point in a vial or a bottle containing a solution in order to study the particle stability, aging, and settling over time. LAD™ integrates a dilution system to manage and dilute concentrated aliquots and a cleaning system.



CONSUMABLES

Flanged Tubing and Connectors ready to use

EOS delivers an broad selection of standard and custom fluidic consumables for Classizer™ ONE as standard and custom tubing of different lengths, external diameter 1/8" and 1/16", and different materials as PTFE, PEEK, PFA, FKM, etc to ensure the best chemical compatibility.

Stainless steel and/or PEEK couplings and connectors are available, depending on the user experimental layout and needs.

Standard Material for Research and System Validation

EOS offer an extremely broad selection of organic and inorganic particles and polymer standards. The particles can be used for many applications in scientific research and device qualification. Examples of standards are:

- Polystyrene Particles
- PMMA Particles
- MF Particles
- SiO₂ Particles
- CeO₂ Particles
- Mineral Particles

... and many more!

Custom Cables, Vials, Syringes, Cleaning Solutions, and more!

Standard and custom cables for communications, vials of many materials and volumes, syringes, bottles, cleaning solution, and more are available to provide the best user experience and complete support for any particle analysis need..

Contact EOS technical customer support (support@eosinstruments.com) for more information.

EOS SOFTWARE

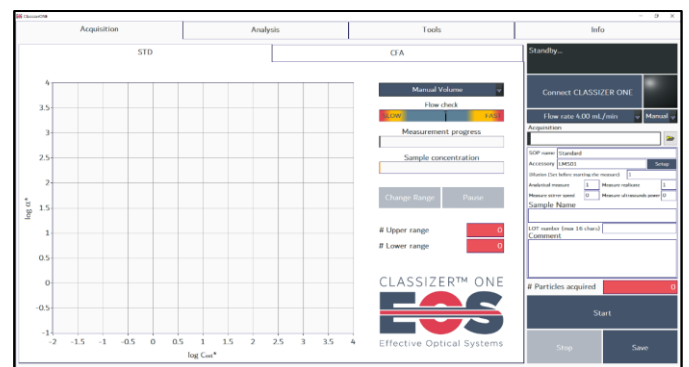
USER FRIENDLY CONTROL & EVALUATION PLATFORM

All-in-one software platform with dedicated tabs for acquisition and analysis offers intuitive solutions for easy-to-use and reliable measurements. Standard operations and add-ons for advanced data acquisition and analysis are available and ready to use. Tailored Operative Procedures can be developed in the software to fit user needs.

Internal checks are performed continuously. Warnings and expert advices are provided to the user in real time to guarantee the highest data quality, accuracy, and repeatability.

Acquisition and analysis tabs provide a continuously increasing number of tailored customizations of acquiring, classifying, and interpreting the multiparametric SPES data.

Comments and operator observations can be added to data during acquisition and analysis. Data are saved continuously limiting the risk of data loss and unintentional file overwriting.

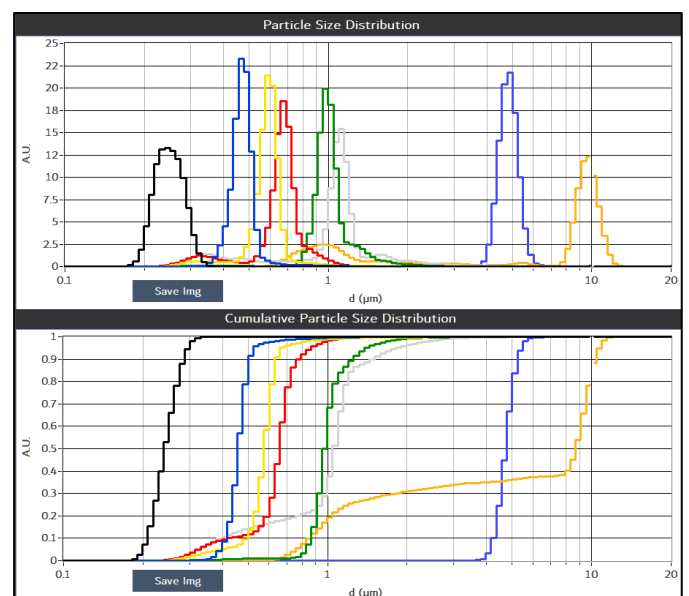
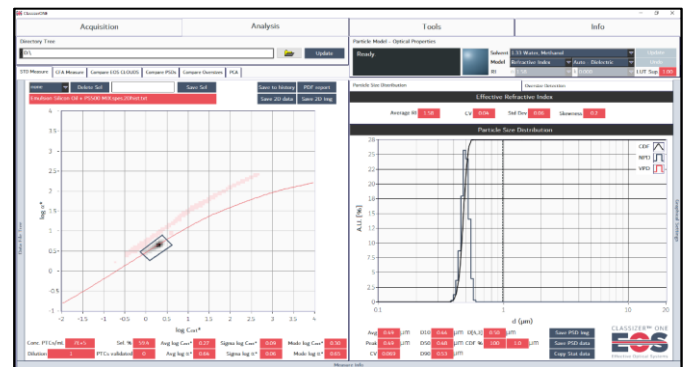


- Easy to use / Easy to clean
- Dedicated SOPs available
- No calibrations needed
- Robust Internal checks
- Real-time / In-Line / On-Line

Thanks to the unique EOS CLOUDS and SPES data, the user can **easily select any single particle population** detected in the fluid and represented in the 2D histogram. Numerical particle size distribution, statistical parameters, and concentration are retrieved accordingly to the selection and/or to the whole sample. Advanced feature as aggregation state, estimate payload, and aspect ratio are provided via tailored add-on.

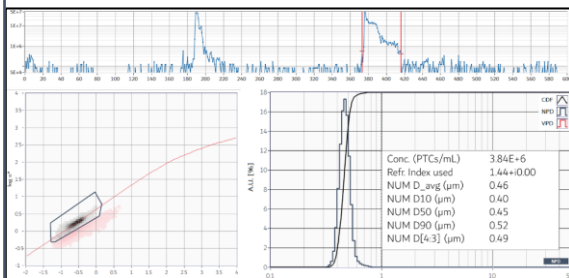
Advanced algorithms as Principal Component Analysis PCA and Continuous Flow Analysis CFA are available to compare and correlate the behaviour of the single components in heterogeneous products and for batch-to-batch and raw material and production batch-2-batch Quality Controls.

Traditional methods assumes particles as standard dielectric spherical particles. **Benefits from CLASSIZER™ ONE** for the unprecedented analysis and interpretation of particles and particle mixes in heterogeneous liquids.



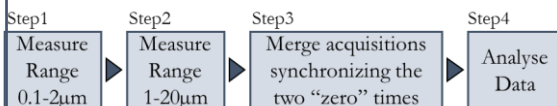
EOS add-on

CFA-SPES Add-On is the perfect solution for **Continuous Flow Analysis CFA** and real-time monitor of particles in for continuous flow applications. **SPES data** are retrieved with a time resolution of one second. Precise time laps can be selected for in detailed offline classification and analysis of particles and concentration transitions of single population.



Online/InLine monitoring of particles during continuous flow processes lasting hours or for measuring samples injected using an external commercial autosampler. **CLASSIZER™ ONE** may start/stop acquisitions via an external communication protocols as RS485, square volt, or tailored com protocols developed to fit user needs.

CLASSIZER™ ONE measures particles either in the size range 0.1-2µm or 1-20µm, depending on settings. Two ergodic runs on the two ranges can be synchronised, merged, and analysed as a single acquisition.

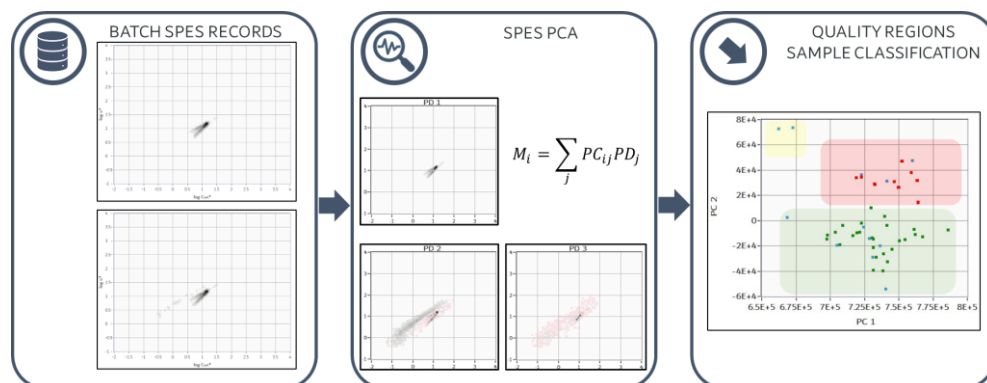


CLASSIZER™ ONE allows a high value and unique analysis of each single particle population classifying and extracting temporal resolved data of the single particle population in heterogeneous mix of particles in function of the single particle optical properties. The particle populations are detected and thus may be analysed separately by making a further selection in the EOS CLOUDS.

CLASSIZER™ ONE classifies the single populations in a particle mixture monitoring particle time transient and behaviour.

PCA-SPES Add-On provides an easy to use and effective **Principal Component Analysis PCA** tool for the statistical classification and batch-to-batch Quality Control of samples based on multiparametric **EOS CLOUDS** data.

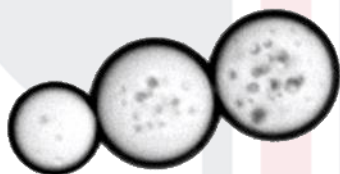
PCA-SPES classifies the EOS CLOUDS. Samples are clustered on the basis of secondary populations, difference in the shape of the main population, or changes in the absolute or relative numerical particle concentrations.



Supervised Machine Learning and K-nearest neighbour method available to classify batches using discrete labels as True/False, Yes/No, OK/Not OK, or Good/Bad to evaluate new data against library of previously measured batches.

APPLICATIONS

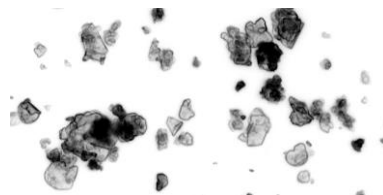
POLYMERIC / EMULSIONS



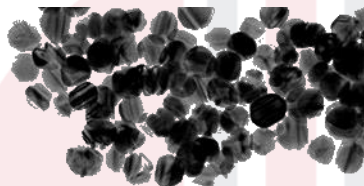
BIOFLUIDS / DELIVERY SYSTEMS



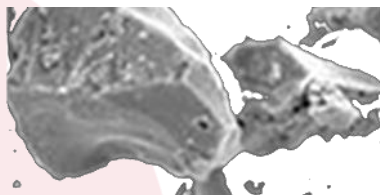
PIGMENTS / INKS



METALLICS / CARBONACEOUS



ABRASIVES / OXIDES



ENVIRONMENT / MINERALS



Presentation of Single Particle Extinction and Scattering (SPES) - Mixtures of polymeric particles and powders

AN001-2021 Analysis of Polymeric Particle Mixes via SPES Technology – an introduction to SPES method
AN006-2021 Multiparametric Classification of Particles as a Pathway to Oversize Analysis in Complex Fluids via SPES
Potenza MAC et al., «Measuring the complex field scattered by single submicron particles », AIP Advances 5 (2015)

Example of CFA application of SPES technology

AN002-2022 Continuous SPES Flow Analysis CFA-SPES

Example of PCA application of SPES technology

AN005-2022 Batch-To-Batch Consistency via Multiparametric SPES Principal Component Analysis PCA

Classizer™ ONE + Sample Managers & Autosampler

AN008-2022 Automatic Liquid Sample Management and System Cleaning with EOS LMS01™ and LMA01™
AN009-2022 Standardize SPES Operative Procedure and improve throughput of Liquid Samples via EOS LAS01™
Potenza MAC et al., «Single-Particle Extinction and Scattering Method ...», ACS Earth Space Chem 15 (2017)

Example of SPES application to aggregates

AN003-2021 Addressing the Issue of Wetting and Clustering by Means of SPES Technology
Potenza MAC *et al.*, «Single-Particle Extinction and Scattering Method ...», ACS Earth Space Chem 15 (2017)

SPES application to non-spherical particles

AN004-2021 Addressing the Classification of Non-Spherical Particles by Mean of the SPES Technology
Simonsen MF et al., «Particle shape accounts for instrumental discrepancy in ...», Clim. Past 14 (2018)

SPES application to emulsions, emulsion mixtures, blends
AN015-2022 Classification of Oil and Oil Mixes Emulsions

Examples of SPES application to particle analysis and behaviour characterization in biotech applications

AN011-2021 Quantitative Classification of Particles in Biological Liquids via SPES Technology
AN016-2021 Multiparametric Determination of Yeast Cell Viability via SPES Technology
AN017-2022_SPES Classification of Probiotic Formulations
Sanvito T et al., «Single particle extinction and scattering optical method unveils in real...», Nanomedicine 13 (2017)

Examples of SPES application to inks, pigments, coatings

AN018-2022 Classification of Inks and Pigments via SPES Technology
AN019-2022 SPES Classification of Vinyl Glues

Example of SPES application to oxide particles, abrasives, and industrial slurries w/o impurities and w/o emulsions

AN013-2022 Analysis of Abrasives via SPES Technology
Potenza MAC et al., «Optical characterization of particles for industries», KONA Powder and Particle 33 (2016)

Example of SPES application to particle degradation in target food environmental liquids and ecotoxicity analysis

AN012-2021 Monitoring the Fate of a Lipid/ZnO Emulsion in Environmental Waters
AN020-2023 Quantify Particle Release from Food Packaging
Maiorana S et al., «Phytotoxicity of wear debris from traditional and innovative brake pads», Env Int., 123 (2019)

DISCOVER THE APPLICATION NOTES
AVAILABLE ON WWW.EOSINSTRUMENTS.COM



CLASSIZER™ ONE
powered by SPES



The EOS CLASSIZER™ family

CSONE-ST	CLASSIZER ONE – benchtop unit based on SPES for particle analysis in the size range 0.1-20µm @ 0.2-4mL/min
CSONE-HF	CLASSIZER ONE HF – benchtop unit based on SPES for particle analysis in the size range 0.1-20µm @ 20-200mL/min
CSPAT-S	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 0.1-2.0µm @ 20-200mL/min – computer integrated
CSPAT-M	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 0.5-5.0µm @ 20-200mL/min – computer integrated
CSPAT-L	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 1.0-20.0µm @ 20-200mL/min – computer integrated
CSENV-S	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 0.1-2.0µm – pump integrated
CSENV-M	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 0.5-5.0µm – pump integrated
CSENV-L	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 1.0-20.0µm – pump integrated
CSAIR-S	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airborne particles in the size range 0.1-2.0µm @ 1-10L/min – computer integrated
CSAIR-M	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airborne particles in the size range 0.5-5.0µm @ 1-10L/min – computer integrated
CSAIR-L	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airborne particles in the size range 1.0-20.0µm @ 1-10L/min – computer integrated
SW v 1.5	Standard software platform for the management of EOS devices
L M S	Liquid Manager for standard sample management and basic system cleaning
L M A	Liquid Manager for advanced sample management, dilution, system cleaning
L A S	Liquid AutoSampler up to 24 vials of 20mL, coupling with LMS01/LMA01
L A S	Liquid AutoSampler for evaluation of particle aging and settling over time in a vial, coupling with LMS01/LMA01, dilution and cleaning
A M S	Aerosol Standard Manager – automatic aerosol management
A D C	Aerosol Dilution Chamber for the analysis of high concentrate aerosol with AMS

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