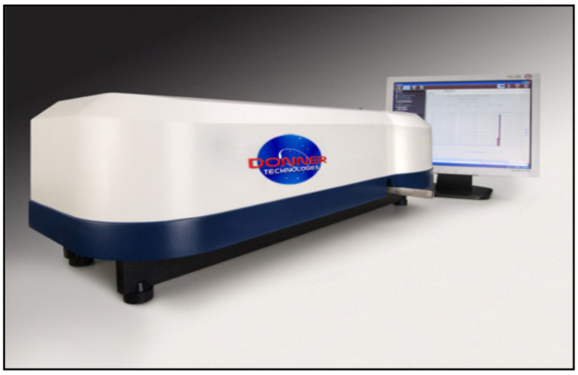
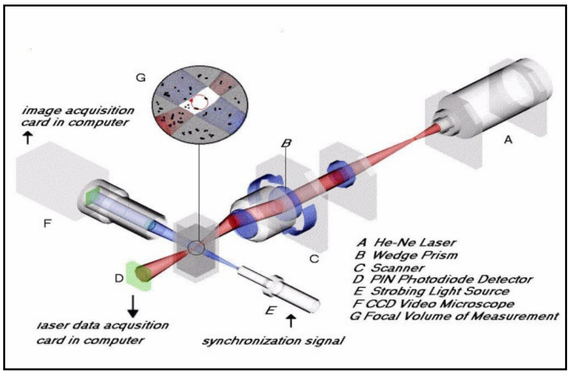
DIPA 2000 Particle Analyzer - Overview





The DIPA 2000 is a Computerized Inspection System for Particle Size Analysis (PSA) in the range of 0.1-3600 µm and Dynamic Shape Characterization (DSC) in the range 1.0-5000 µm. It consists of laser and video measurement channels respectively, providing information required for analysis and characterization any kind of particles, with high resolution, accuracy and repeatability.

This modular system offers versatile cells and accessories for Wet, Dry, Emulsion and Fiber measurements, for a large variety of materials, applications and industries. Interchangeable cell modules allow optimal flexibility in sample preparation and measurement phase. Automatic alignment test and no calibration test requirements completes the user friendly feature of this device.

The Laser Channel uses the unique Laser Obscuration Time (LOT) principle for measuring the diameter of particles in dynamic flow. As particles passes through the analyzer it temporarily blocks the rotating laser beam. A detector measures the obscuration time of the individual particles in the laser beam.
As data are being collected on single particles basis, high resolution results are obtained. Another advantage of the LOT measurement principle is that the obscuration time is not influenced by optical or physical properties. In other words, the particle size is independent of refractive index, absorption, surface texture, porosity, electrical conductivity or any other kind of the sample pre-knowledge.

The Video Channel analyzes the shape of the particles in dynamic flow. This channel is equipped with a CCD microscope video camera. Illumination is provided by a synchronized strobe light, and the acquired images are displayed and analysed. By means of image analysis software, the images are automatically processed and analysed, and a series of size and shape parameters are evaluated. In this way thousands of sampled images can be collected during a measurement cycle.
User friendly software provides fully automatic features such as rejection of out-of-focus particles, separation of touching frames particles, automatic light correction and contrast enhancement that assist in optimising sample measurement. Software algorithms enable automatic, programmed calculation of over than 40 different parameters, including Ferret diameter, area, perimeter,

circularity and aspect ratio. The software also offers powerful shape filters that allow the measurement of specific particles within a complex mixture of different particles. All measurement results can be presented in multiple types of graphs and tables, and sample images can be stored for analysis at a later time.
Object data base is available for a particle by particle visualisation and parameter validation
A glance to some enhanced features:

- *Easy set-up and measurement using software wizard*
- *Advanced pre-processing algorithms*
- *Size and shape grouping*
- *Automated report generator*
- *Storage of real data (un processed mages)*
- *Re processing of raw data*
- *Calibration and verification tools available*
- *Interface for 3rd party hardware (microscopes)*
- *Concentration measurements including calibration*
- *FDA 21 CFR Part 11 S/W security compliant*

DIPA 2000 CELL MODULES

The DIPA 2000 can be fitted with nine easily interchangeable measurement cells that permit dynamic measurement of wet, dry, surface, heated, and airborne particles. This wide range of measurement cells ensures that samples do not need to be adapted to the analyser, but the analyser is technically adjusted to the requirements of the sample specifications.

Each Cell Module is designed to optimize the conditions of analysis for a particular material. Based on the nature of the material, the user can choose to analyze the sample in any of the following forms: as dry powder/granule, in liquid medium or as an aerosol.

Magnetic Stirring Cell: *DCM-101*

The DCM-101 Magnetic Stirrer Cell Module is used for general analysis of liquid-borne particulates. Sample volumes from 1.5 ml to 3.5 ml are used. Only milligram quantities of a sample are required. Standard disposable plastic, or glass cuvettes are used, with a special magnetic stirrer situated at the bottom of the cuvette.
Particle concentrations from 1,000 to 100 million particles/ml may be measured; however, this Cell Module may not be appropriate for measurement of very dense or large particles (settles rapidly) or magnetic particles (attracted to the magnetic stirrer).

Mechanical Stirring Cell: *DCM-102*

The DCM-102 Mechanical Stirring Cell Module uses the same cuvette as the DCM-101, but incorporates a propeller inserted from the top of the cuvette for stirring the mixture. This Cell Module is recommended for measuring magnetic particles.

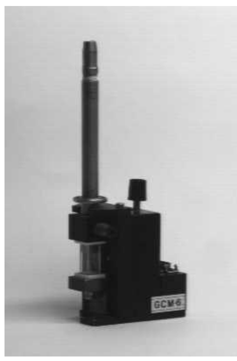
Liquid Flow Cell: *DCM-104*

The DCM-104 Liquid Flow Cell Module facilitates analysis of liquid borne particles which are propelled through the cell by an external flow pump. Large volumes of liquids can be pumped through the cell, or circulated through open flow systems (recommended when a large amount of material is necessary, to obtain a representative sample).
The type of pump used is determined by the material to be analyzed, and the nature of the liquid medium used. The DCM-104 is useful in on-line applications, for monitoring the particulate content of continuous flow processes as well as for the measurement of heavy or dense particles, which can be maintained in uniform suspension by the flow of a pump. The DCM-104 may not be appropriate for liquid volumes of less than 20ml, or for mixtures of particles with high tendency to aggregate and clog to the tubing material.

Fiber Flow Cell: *DCM-104L*

The DCM-104L Fiber Flow Cell Module is dedicated to fibers analysis using the video channel. The fibrous sample is dispersed in a liquid and flows through the Fiber Cell from top to bottom using the LFC-101 Liquid Flow Controller. The elongated cell section above the measurement zone causes the fibers to orient in the laminar flow direction. Hence, overlapping fibers are minimized improving both accuracy and analysis time of fiber dimension and shape analysis.

Aerosol Flow Cell: *DCM-106*



The DCM-106 Aerosol Flow Cell facilitates analysis of airborne solids or liquids found in a particular environment. It may be used in natural or industrial dusty environments to measure the particle size distribution and concentration of aerosols.
The DCM-106 Aerosol Flow Cell is used in combination with the Aerosol Controller Unit Aero-C. Under suction provided by the Aero-C, particles flow downward through the cell. This air flow creates an “air sheath” within the flow cell, which prevents particles from adhering to the walls of the cuvette, allowing clear and open surface for the optical measurement area.

Micro Flow Cell: *DCM-108*

The DCM-108 Micro-Flow Cell analyzes particles in liquids through a narrow flow cell. The liquid is propelled by an external pump through a narrow cell of 0.5, 1.0, 2.0 mm narrow-path. Thus particles suspended in heavy or dense media (opaque or near-opaque liquids) can be analyzed.

This cell provides capability to analyze opaque or near-opaque dispersions when even only a small portion of the laser light reaches the detector. Signal amplification is optimized by dedicated calibration knob.

Thin Layer (“Slide”) Cell: *DCM-110*

The DCM-110 Microscope Slide Cell accommodates particles to be analyzed on a standard microscope slide. The cell motor shifts the slide vertically and horizontally, scanning the sample affixed to the slide.

The DCM-110 Allows a thin application of material as ink or emulations or as dry state applications such as fine powders (using PD-10 uniformly powder dispersing system) on a slide, analyzed thousands of particles by using the DCM-110 motor that shifts the microscope slide vertically and horizontally across the laser or video path. The mechanical motion is designed, so that no area is measured more than once.

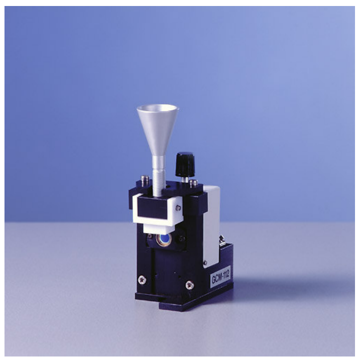
Heated Cell: *DCM-111*

The DCM-111 Heating Cell allows the analysis of heated materials such as wax, cream, liquids or solids that become liquid when are heated. Controlled temperature chamber surrounds the cuvette and its sample inside. A special magnetic stirrer is being rotated inside the cuvette by using speed controlled magnetic motor embedded in the cell, allowing sufficient blend for the sampled particles.

Free Fall Cell: *DCM-112*

The DCM-112 Free Fall Cell accommodates analysis of free falling dry samples. A regulated flow of dry particles or granules passes through the cell module. Particle Size and Shape analysis with both laser and video channels can be performed whilst the particles falls through the system.

The feeding frequency of the particles/granules is controlled with a dedicated Dry Powder Feeder. The analyzed particles can be draw back by using vacuum pump or manually collected into a dedicated container underneath the measurement area, so the lost of the mate.



DIPA Analytical Parameters

In the DIPA results List section, all measurement data can be displayed. The DIPA 2000 allows automated report generation of standard and custom reports and display of many graphs, tables and statistical information. Below are definition/explanations of the parameters and statistics that are available throughout the results list section.

Solids
Solids displays the percentage of solid particles in the sample.
Note that the accuracy of the results depends on how spherical the particles are.
The following formulas are used to derive the mean diameters presented in the statistical summary; the significant ones must be determined, based upon the particular application and the material analyzed.

Concentration
Concentration indicates the total number of particles per ml in the measurement cell.

Specific Area
The Specific Area indicates the area per gram.
Dividing the expression by the material density determines the original Specific Area.
In the Laser Channel the Specific Area is defined as
Specific Area = 6 / D [3,2]

Mean Diameters
The Mean Diameter is the diameter which represents the average diameter in a given population. The algebraic sum of the deviations of a set of numbers from their arithmetic mean is zero.

D[1,0] Number, Length
The following Number formula applies:

$$(\overline{X}_{NL}) = \frac{\sum dL}{\sum dN} = \frac{\sum xdN}{\sum dN}$$

D[2,0] Number, Area
The following Number Area formula applies:

$$(\overline{X}_{NA}) = \sqrt{\frac{\sum dA}{\sum dN}} = \sqrt{\frac{\sum x^2 dn}{\sum dn}}$$

D[3,0] Number, Volume

The following Number Volume formula applies:

$$(\overline{X}_{NV}) = \sqrt[3]{\frac{\sum dV}{\sum dN}} = \sqrt[3]{\frac{\sum x^3\ dN}{\sum dN}}$$

D[2, 1] Length, Area

The following Length Area formula applies:

$$(\overline{X}_{LA}) = \frac{\sum dA}{\sum dL} = \frac{\sum x^2\ dN}{\sum xdN}$$

D[3,1] Length, Volume

The following Length Volume formula applies:

$$(\overline{X}_{LV}) = \frac{\sum dV}{\sum dL} = \frac{\sum x^3\ dN}{\sum xdN}$$

D[3,2] Area, Volume

The following Area Volume formula applies:

$$(\overline{X}_{AV}) = \frac{\sum dV}{\sum dA} = \frac{\sum x^3\ dN}{\sum x^2\ dN}$$

D[4,3] Volume, Moment

The following Volume Moment formula applies:

$$(\overline{X}_{VM}) = \frac{\sum dM}{\sum dV} = \frac{\sum x^4\ dN}{\sum x^3\ dN}$$

Statistical Parameters

Standard Deviation

The Standard Deviation is the positive square root of the expected value of the square of the difference between a random variable and its mean.

D10, D50 and D90 Diameters

D10 diameter is a value, which is larger or equals the value of 10% of the tested population (i.e., it is smaller than the value of 90% of the tested population).
Similarly, D50 diameter is smaller than the value of 50% of the tested population, and D90 diameter is smaller than the value of 10% of the tested population.

Mode

The Mode is the value or item occurring most frequently in a series of observations or a given statistical population. The Mode of a set of numbers is that value which occurs with the greatest frequency, meaning it is the most common value.

Confidence

The Confidence statistic indicates the level of confidence requested (in %), and the graph upon which it is based (A = Area, N = Number, V = Volume); if collection is by Sample Size, "NONE" appears.

Number

This category stands for the **Number Distribution** factor. You will find the appropriate factor for Median Diameter, and Confidence.

Area

This category stands for the **Area Distribution** factor. You will find the appropriate factor for Median Diameter, Mode and Confidence.

Volume

This category stands for the **Volume Distribution** factor. You will find the appropriate factor for Median Diameter, Mode and Confidence.

Particle Shape Parameters

Object Index

Each object in the analysis is numbered with the **Object Index**.

Area

This select parameters option provides the calibrated **Area** in Analysis.

Pixel Count

This gives the number of pixels within an analyzed object.

Equivalent Diameter
This gives the diameter of a circle of equal area to the object.

$$\sqrt{\frac{\text{area}}{\Pi}}$$

X (Center of Gravity)
The x pixel value of the center of Gravity of the object.

Y (Center of Gravity)
The y pixel value of the center of gravity of the object.

Perimeter
Perimeter gives the object perimeter including the internal perimeter if the object has holes.

Shape Factor
The Shape Factor can be defined as the smoothness of the object given by the formula: $4\pi A/p^2$, where **A** is the area and **p** is the perimeter of the object. A value close to 1 indicates that the object is smooth and round. A value close 0 means that it is elongated and/or rough.

Specific Length
This parameter will give the length along a sinus-like object (fiber) and is given by the formula:

$\frac{1}{4}(p+\sqrt{p^2-16A})$, where **A** is the Area and **p** is the perimeter of the object.

Specific Width.
This parameter will give the width of a sinus-like object and is given by the formula: $\frac{1}{4}(p-\sqrt{p^2-16A})$.

Area Fraction
Area Fraction gives the ratio of the object area to the box area containing the object. It is calculated by: (area) / (box area). (See Par. 10.7.34).

NOTE: A rectangle which is drawn vertically or horizontally on the image has a value of 1.

Volume By Area
This gives the volume of a sphere with the radius of the circle equal in area to the area of the object:

$(\Pi \text{ x (eauivalent diameter) x } 1/6)^3$

Orientation

This gives the **Orientation** of the main axis of an object from 0 to 180 degrees based on the first movement of inertia.

Gray Level

This gives the average **Gray Level** of the object.

IOD

This gives the Integrated Optical Density of the object.

$$IOD = \sum_{\substack{i=1 \\ j=1}}^{n} -\log\left(\frac{G.L.}{\max.G.L.}\right)$$

Average Ferret

The average ferret diameter of the object is given. The ferret diameter is the longest chord of the projection of the object at a specific angle. The system allows for up to 36 ferret diameter measurements per object (one every 5 degrees).

Min. Ferrets

The minimum ferret diameter is given (accuracy 1degree or better).

Min. Ferrets Angle

The angle of the minimum ferret diameter is given (accuracy 1degree or better).

Max. Ferrets

The maximum ferret diameter is given (accuracy 1degree or better).

Max. Ferrets Angle

The angle of the maximum ferret diameter is given (accuracy 1degree or better).

Aspect Ratio

This is the shape parameter of the object given as (min ferret diameter)/(max ferret diameter). This factor gives the squareness of the object where circle (or square) = 1 and line close to 0.

$$\frac{\textit{Min ferets}}{\textit{Max ferets}}$$

NOTE: A sinus-like object may have an aspect ratio close to 1 and a shape factor and area fraction close to 0.

Volume By Average Ferrets
This parameter gives the volume of a sphere of diameter equal to the average ferret diameter.

Vertical Diameter
The ferret diameter at 90 degrees is given. This value is the vertical projection of the object.

Horizontal Diameter
The ferret diameter at 0 degrees is given. This value is the horizontal projection of the object.

Box Area
The area of a box inscribing the object is given.

Ferret (0) x ferret (90 degrees)

Box Ratio
This gives the ratio of the width of the box to the length of the box expressed as:

Horizontal projection
Vertical projection

Min. Radius
The minimum radius of the object from its center of gravity to the perimeter is given.

Min. Radius Angle
The angle of the minimum radius is given.

Max. Radius
The maximum radius of the object from its center of gravity to the perimeter is given.

Max. Radius Angle
The angle of the maximum radius is given.

Radius Ratio
This gives the ratio of the minimum radius to the maximum radius.

Holes Area
This gives the total area of all the holes in the object (only after Fill Holes has been executed).

Holes Ratio
This gives the ratio of the total hole area to the object area (including hole area).

Number Holes
The number of holes in the object is given.

Moment of Inertia
This gives the moment (area x distance) of the object.

Object Type
If the object was typed in analysis or by shape filters, the chosen type category is given. If it was not typed the type will be "All".

Fiber Volume
Fiber Volume is the specific length x (specific width)^2
The Fiber Volume gives an estimation for the volume of the fiber, assuming that its length and cross section were measured.

Cube Volume
The Cube Volume is $4/3\Pi^{1/2}$ x (area)$^{3/2}$
The Cube Volume gives an estimation for the volume of the cube, assuming that its maximum circle cross section was measured.

Fractal Dimension
The Fractal Dimension of an object is an image is derived as a relationship between the log of the perimeter against the log of the resolution. This ratio allows for Fractal analysis of the edges (perimeter) of the measured shape.
The mathematical relationship is established by the formula:

$$L(r) = Mr^{(1-D)}$$

Where L(r) is the length of the perimeter measured at stride length r, M is a constant, and D is termed the Fractal dimension of the surface; it was found to be constant over a wide range of values of r. If one were to plot log L(r) against log (r), one would obtain a straight line of slope

(1-D) over the range of r for which D is constant.

Focus Level
The Focus Level represents the contrast of the objects regarding its near surroundings. The range of focus level values is 0-256. The higher number indicates better focus.