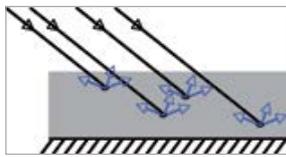


Introduction

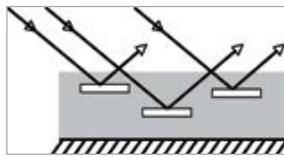
Metallic Coatings

Today effect finishes play a dominant role in many applications as they make an object distinctively appealing.

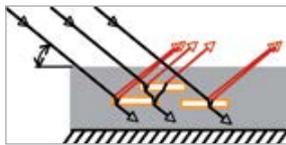
In contrast to conventional solid colors, effect finishes change their appearance with viewing angle and lighting conditions. Interference finishes show not only a lightness change with different viewing angle, but also a change in chroma and hue. The latest developments are special effect pigments, which create sparkling effects when lighting conditions change from sunlight to cloudy sky.



Absorption pigments



Metallic pigments

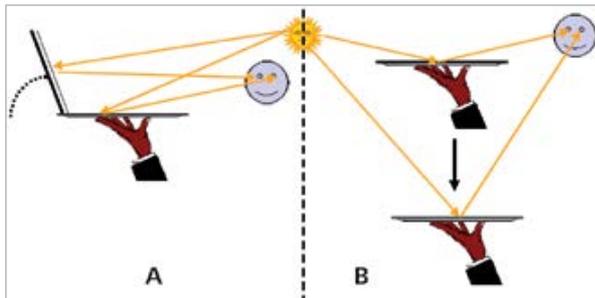


Interference pigments

Courtesy of Merck

Visual Evaluation of Effect Coatings

As metallic finishes show a lightness change with different viewing angles, the sample needs to be tilted to create the same effect during visual evaluation. This effect is also referred to as "light-dark flop". The bigger the lightness changes between the angles of view are, the more the contours of an object will be accentuated. In order to observe color travel of interference finishes, the panel should be moved to allow increasing or decreasing the angle to the light source.



Visual evaluations of traditional metallic finishes

Visual evaluation of effect coatings with color flop

Courtesy of Merck



Appearance

Metallic Color

Physical Properties

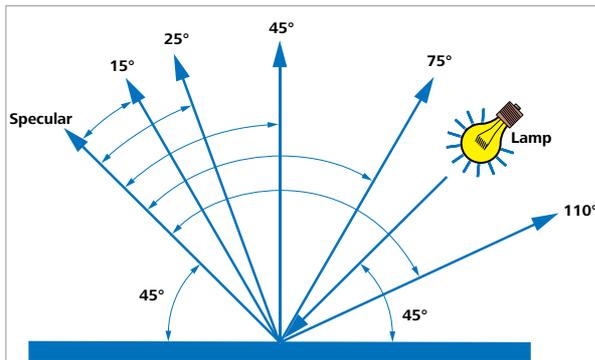
Technical Service

Index

Instrumental Color Measurement of Effect Coatings

Multi-angle color measurement

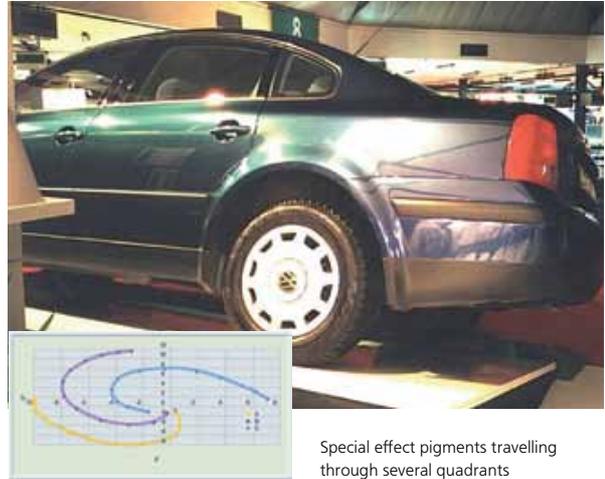
ASTM, DIN and ISO standards define multi-angle color measurement to objectively describe the color of metallic finishes. Research studies show that a minimum of three, and optimally five viewing angles are needed. The measurement geometry for multi-angle color measurement is specified by aspecular angles. The aspecular angle is the viewing angle measured from the specular direction in the illuminator plane. The angle is positive when measured from the specular direction towards the normal direction.



Directional illumination is used versus circumferential illumination because circumferential illumination minimizes the contribution from directional effects such as the Venetian blind effect and surface irregularities. Thus, averaging of the circumferential illumination would cause the measured color values of two specimens to be the same, while visually the two specimens would not match.

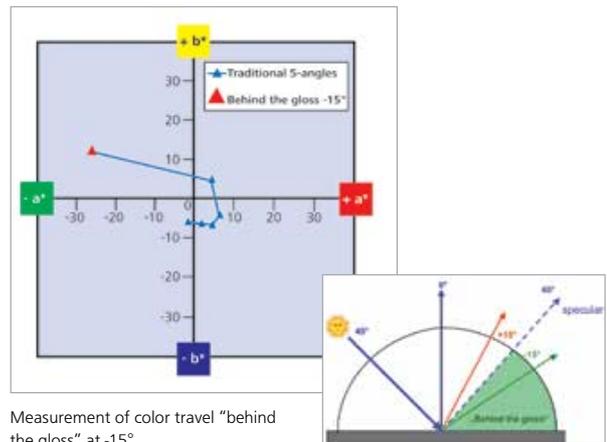
For color QC, the colorimetric data L^* , a^* , b^* (or L^* , C^* , h°) and ΔE^* can be used. The tolerances are usually higher for the near specular (15° , 25°) and the flop angle (75° , 110°) than the 45° tolerance. In order to have a unique tolerance parameter independent of color, weighted factors have to be used. Therefore, automotive companies often have set specifications on ΔE CMC or $\Delta E'$ based on DIN 6175-2 using 3 or 5 angle instrumentation. Another useful index is the flop index, a measure of the change in lightness of a metallic color as it is tilted through the entire range of viewing angles.

In the last years a new generation of special effect pigments has become more and more popular. For some of these new pigments the color travels over a wide range.



Special effect pigments travelling through several quadrants

In order to fully capture the color travel of these interference pigments it is necessary to add viewing and illumination angles. To keep the whole procedure practical for industrial use with a portable spectrophotometer it was determined that an additional angle behind the gloss e.g. -15° is of benefit.



Measurement of color travel "behind the gloss" at -15°

Flake Characterization

In addition to color changes our total perception is also influenced by the effect of the metallic flakes or other sparkling pigments. This effect changes with the lighting conditions, for example direct sunlight versus cloudy sky.



Direct sunlight: Sparkle effect

Cloudy sky: Graininess

Sparkle

A sparkling or glitter impression can be observed under direct sunlight. This effect is often described with different words such as sparkle, micro brilliance or glint and is generated by the reflectivity of the individual effect pigment. Therefore, it is influenced by the

- flake type and size
- concentration level of the effect pigment
- orientation of the effect pigment
- application method

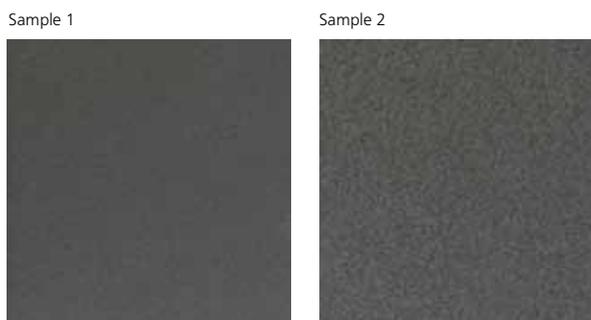
The sparkle impression changes depending on the illumination angle.

Graininess

Apart from the sparkle effect under direct sunlight, another effect can be observed under cloudy conditions, which is described as coarseness or salt and pepper appearance. This visual graininess can be influenced by the flake diameter or the orientation of the flakes resulting in a non-uniform and irregular pattern. The observation angle is of low relevance when evaluating graininess.

Multi-angle color and effect measurement with the BYK-mac

Traditional 5-angle color measurement calculates color values by averaging the spectral reflection over the entire illuminated spot and therefore can not differentiate between the color of the basecoat and the reflection of the aluminum flakes. As a consequence, two effect finishes can have the same color values with a 5-angle spectrophotometer, but visually appear very different. The visual difference is a result of the flake effects.



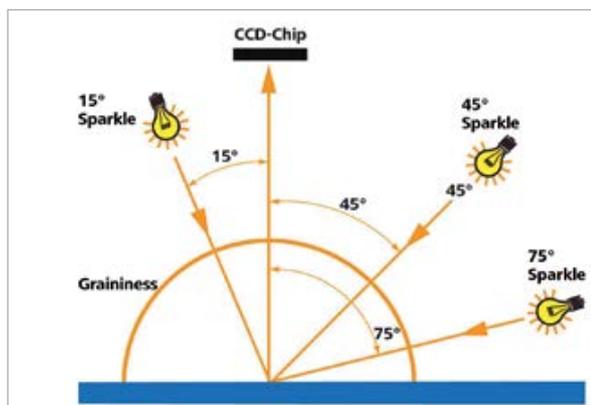
Same color but visual difference

	ΔL^*	Δa^*	Δb^*
-15°	-0.35	0.25	0.42
15°	0.16	0.19	0.43
25°	-0.65	0.20	0.48
45°	-0.10	0.05	0.00
75°	0.46	-0.11	-0.60
110°	0.69	-0.11	-0.89

	Δ Sparkle	Δ Graininess
15°	7.85	
45°	4.17	
75°	1.48	
Diffused		3.81

To characterize the impression of effect finishes under different viewing angles and illumination conditions, the BYK-mac spectrophotometer objectively measures the total color impression:

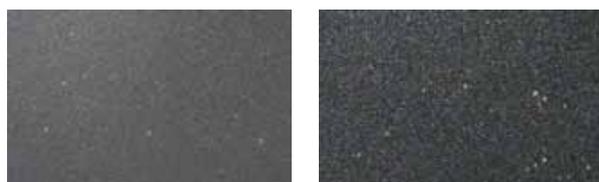
- Multi-angle color measurement (6-angles) clearly defines the light-dark as well as color flop behavior of effect finishes
- Sparkling and Graininess control with a high resolution CCD camera simulates effect changes under direct and diffuse lighting conditions



BYK-mac effect measurement geometries

Sparkle measurement under direct illumination at three angles

The sparkle impression changes with the angle of illumination. Therefore, the BYK-mac spectrophotometer illuminates the sample under three different angles 15°/45°/75° with very bright LEDs and takes a picture with the CCD camera located at the perpendicular.

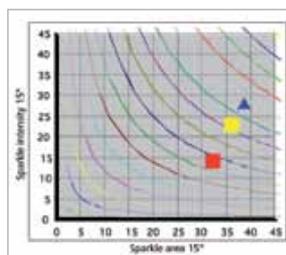


Low sparkle (glint)

High sparkle (glint)

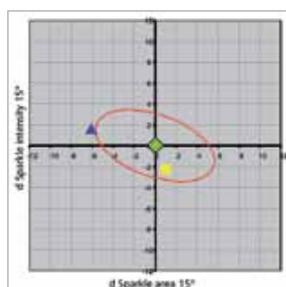
The pictures are analyzed by image analyzing algorithms using the histogram of lightness levels as the basis for calculating sparkle parameters.

To allow better differentiation, the impression of sparkle is described by a two dimensional system: sparkle area and sparkle intensity for each angle.



For simplicity sparkle area and intensity are summarized in one value: sparkle grade. Sparkle grade is represented by the colored lines in the diagram.

The sparkle evaluation is done by comparing a sample to a defined standard – like color measurement. Therefore, the sparkle data are also displayed in a difference graph.



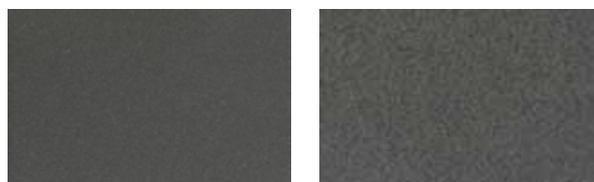
In order to set visually acceptable limits a new sparkle tolerance model was developed together with several partners from the automotive, pigment and paint industry. As a guideline the weighted total color difference equations were used resulting in an elliptical tolerance model.

The human eye is less critical to a change within a sparkle grade than it is to a change from grade to grade. Therefore, the longer axis of the ellipse is towards the sparkle grade lines.

To use the model as a Pass/Fail tool for paint batch or part QC, the total sparkle difference between sample and standard is calculated: $\Delta\text{Sparkle}$.

Graininess measurement under diffused illumination

Graininess is evaluated by taking a picture with the CCD camera under diffused lighting conditions, created by a white coated hemisphere. The picture is analyzed using the histogram of lightness levels whereby the uniformity of light and dark areas is summarized in one graininess value.



Low graininess (coarseness)

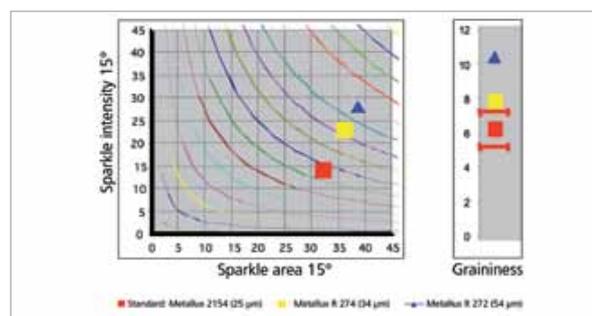
High graininess (coarseness)

A graininess value of zero would indicate a solid color, the higher the value the grainier or coarser the sample will look under diffused light.

Influence of flake size on sparkle and graininess

Sparkle and graininess data give information on flake size and concentration levels. The sample below shows a silver finish with three different flake sizes (25 μm – 34 μm – 54 μm).

Visually, the silver finish with the coarser aluminum pigments appears more sparkling under direct illumination and more “grainy” under diffused lighting.



The BYK-mac measurement correlates with the visual judgment: sparkle area, sparkle intensity and graininess increase with flake size.

Influence of flake Orientation on total color impression

Besides flake types and concentration levels, the comparison of sparkle area at 15° and 75° illumination gives information about flake orientation.

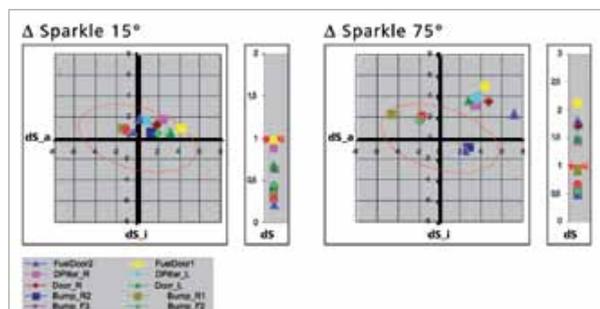
Different application method

In order to increase paint efficiency the basecoat application is changing to 100% electrostatic application. Metallic finishes containing coarser aluminum flakes will show more non-parallel oriented flakes. The result will be a lower light-dark flop and more sparkling at a low grazing illumination angle. In the following example the basecoat of the car body was applied 100% electrostatically and the bumpers were painted with a bell / pneumatic application. The total color difference using the mean ΔE_{DIN} was acceptable.

	ΔE_{DIN} avg.
FuelDoor2	0.59
FuelDoor1	0.88
DPillar_R	0.63
DPillar_L	0.56
Door_R	0.53
Door_L	0.62
Bumper_R2	0.56
Bumper_R1	0.40
Bumper_F3	0.89
Bumper_F1	0.87
Bumper_F2	0.90

ΔE_{DIN} is well below one for all measurement points

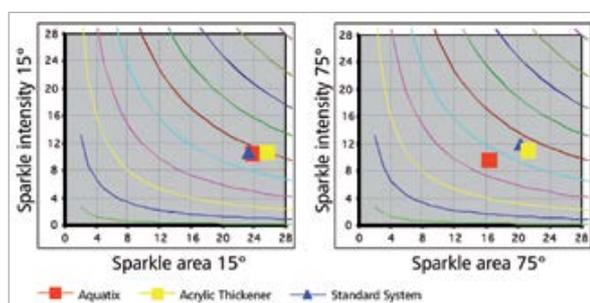
Yet, visually, the car body was sparkling considerably more than the bumper. The BYK-mac measurement data reflects the visual impression clearly evaluating the Sparkle 75° data. The Sparkle 75° measurement evaluates the aluminum flakes which are non-parallel oriented; therefore the main changes can be seen in an increasing sparkle area.



Different rheology additives

Flake orientation can also be influenced by the paint formulation, e.g. the rheology additive. As fine aluminum flakes have more edges and consequently more light is scattered, the orientation is more important for coarser pigments. The use of an optimized rheology additive will result in a better light-dark flop and less sparkling at lower grazing angles.

In the following example a waterborne system was evaluated using three different rheology additives: a standard system, an acrylic thickener and the BYK-Chemie wax additive AQUATIX®. Visually, the three panels look the same under direct illumination at a steep angle. When comparing at a lower grazing angle, the system using the BYK-Chemie wax additive shows less sparkling.



BYK-mac measurement data correlates with a visual judgment. The sparkle area for the system with wax additive at 75° is smaller than for the two other systems. As Sparkle 75° evaluates flakes which are non-parallel oriented, this clearly shows that by using the BYK-Chemie wax additive AQUATIX® the orientation of the aluminum flakes is improved.



BYK-mac measures total color impression

Info!

For more information on visual evaluation of effect finishes see byko-spectra *effect* page

BYK-mac

Total color impression of effect finishes

The appearance of effect finishes is influenced by different viewing angles and viewing conditions. Apart from a light-dark flop and color shift special sparkling effects can be created.

The BYK-mac spectrophotometer is unique as it measures both multi-angle color and flake characterization in one portable device.

- Traditional 5-angle color measurement: 15° / 25° / 45° / 75° / 110°
- Additional color measurement behind the gloss for color travel of interference pigments: -15°
- Sparkle and graininess measurement for flake characterization

Ergonomic design and easy operation

The shape of the instrument is designed to ensure easy handling and true portability. Due to its intuitive menu quality control of metallic finishes has never been easier.

- Menu guided operation according to your own sampling procedure
- Designated buttons for standard and sample readings
- Scroll wheel to select menu functions
- Large display: complete statistics for selectable values and alphanumerical name input
- Storage of up to 1000 readings in selectable memories
- auto-chart software for professional analysis, documentation and data management



D65-10°	Center Hood	L/S
-15°	AEP	A5 A6
15°	1.24	
25°	1.28	3.2
45°	0.94	
75°	1.27	1.5
110°	1.61	
dBT	1.10	
RoyalBlue		4.7



Reliable readings at any time

In order to guarantee stable positioning, the BYK-mac is equipped with trigger pins on the bottom plate of the instrument. If the pins do not have contact with the surface, an error message will be displayed. This ensures reproducible results on test panels as well as curved parts ($r > 500$ mm).

Additionally, the surface temperature is measured and saved with each measurement.

Accurate results and low maintenance

The BYK-mac spectrophotometer uses a light source with long-term stability and patented illumination control which provides superior accuracy and low maintenance for many years.

- Stable, long-term calibration – needed only every three months
- Temperature independent measurement results between 10 - 40 °C – without calibration
- Excellent agreement between instruments
- 10 year warranty on the light source – no lamp changes needed



Always ready

The instrument is operated with a rechargeable battery pack (Li-Ion). The docking station automatically charges the battery pack in the instrument as well as a spare pack located in the docking station.

Optionally the instrument can be operated with 4 standard mignon alkaline or rechargeable batteries.

The docking station also transfers measured data to a PC.



Info!

For more information on visual evaluation of effect finishes see *byko-spectra effect*, page 127.

BYK-mac with small aperture

Measurement of effect finishes on small or curved parts

Special effect finishes are used in many applications to create new color impressions emphasizing the design of a product. Objects like mobile phone housings, bicycles or window handles are very small or curved. They require a color instrument with small aperture and repeatable sample placement. The BYK-mac with 12 mm aperture guarantees repeatable results even on such products.

Total color impression of effect finishes

- Traditional 5-angle color measurement: 15° / 25° / 45° / 75° / 110°
- Additional color measurement behind the gloss for color travel of interference pigments: -15°
- Sparkle and graininess measurement for flake characterization



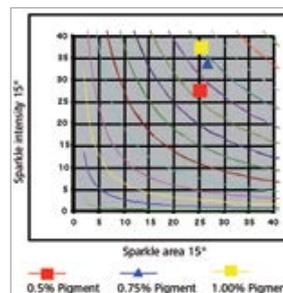
New!



Reliable readings at any time

Menu guided operation with designated buttons for standard and sample readings

- Scroll wheel to select menu functions
- Storage of up to 1000 readings in selectable memories
- Stable, long-term calibration – needed only every three months
- Temperature independent measurement results between 10 – 40°C – without calibration
- 10 year warranty on light source – no lamp changes needed
- Operated by a rechargeable battery pack – good for 1000 readings
- auto-chart software for professional analysis, documentation and data management



BYK-mac data for effect pigments with different concentration levels.

In compliance with:

Standards

ASTM	D 2244, E 308, E 1164, E 2194
DIN	5033, 5036, 6174, 6175-2
ISO	7724
SAE	J 1545



Ordering Information

Cat. No.	Description
6362	BYK-mac*
6397	BYK-mac*
6363	BYK-mac Sensor
6398	BYK-mac Sensor
107306340	Extended Warranty one year additional

Comes complete with:

Multi-angle spectrophotometer
 Black calibration standard
 White calibration standard with certificate
 Cyan and effect checking reference
 Protective cap
 Cleaning set for bottom plate
 2 light protection covers
 Seal replacement kit
 *BYKWARE auto-chart software
 Docking station with USB cable for memory transfer
 Instrument interface cable for online data transfer
 2 rechargeable Li-ion battery packs
 Battery holder; 4 x AA batteries
 Short instructions; Operating manual on CD
 Carrying case; Training

Free 1x preventive maintenance service during warranty period

Hardware Requirements:

Operating system: Windows® 2000 or higher
 Excel® version: 2002 or higher VBA
 Memory: min. 256 MB RAM (recommended 512 MB)
 Hard disk capacity: min. 100 MB
 Monitor resolution: XGA (1024 x 768) or higher
 Disk drive: CD-ROM or DVD
 Interface: USB-port

Technical Specifications

Measuring Area	
	23 mm diameter
	12 mm diameter
	23 mm diameter
	12 mm diameter
Color	
Measuring	45° illumination -15°, 15°, 25°, 45°, 75°, 110°
Geometry	aspecular viewing
Spectral Range	400 – 700 nm, 10 nm resolution
Measurement Range	0 to 400 % reflectance
Repeatability¹	0.02 ΔE* (10 consecutive measurements on white)
Reproducibility¹	0.20 ΔE* (average on 12 BCRA II tiles)
Color Scales	ΔE*; ΔE CMC; ΔE 94; ΔE 2000; ΔE 99; ΔE DIN6175
Illuminants	A; C; D50; D65; F2; F7; F11; F12
Observer	2°; 10°
Effect	
Measurement	15° / 45° / 75° and diffused illumination
Geometry	perpendicular viewing
Effect Parameters	ΔS; ΔS _a ; ΔS _i ; ΔG
Repeatability¹	S _a / S _i : 5% or > 0.50 / G = ± 0.05
Reproducibility¹	S _a / S _i : 10% or > 1.00 / G = ± 0.15
Measuring Time	< 6 seconds
Memory	1000 standards / samples
Language	English, German, French, Italian, Spanish
Power Supply	Rechargeable battery pack or 4 mignon AA batteries (alkaline or rechargeable)
Operating Temperature	10 to 42° C (50 to 110 ° F)
Relative Humidity	up to 85%, 35° C (95° F); non-condensing
Dimensions	21.8 x 8.1 x 14.7 cm (8.6 x 3.2 x 5.8 in.)
Weight	approx. 1.3 kg (approx. 2.86 lbs)

¹ Standard deviation

BYK-mac Training

BYK-Gardner offers you more than just an instrument. We assist you in analyzing your color readings as well as sparkle and graininess data. As a result you will be able to use the BYK-mac to save time and money, while at the same time improving quality. Therefore, the instrument comes with a one day training course including:

1. Color and Effect Theory

- Parameters influencing total color impression of effect finishes
- Color and effect differences for trouble shooting

2. Operation and Software training

- Standard management
- Set-up an "organizer" to create a routine measurement procedure
- Programming of the instrument with "organizer" and measurement of several samples
- Data transfer to auto-chart software and saving in a database for routine QC
- Data analysis using standard reports:
 - Lab-scatter graph per angle to show at one glance whether all parts are within specifications
 - Color travel by sample to show how individual measurement zones perform per measurement angle
 - Effect graph to control whether sparkle and graininess values are within specification

- Create your own reports in Excel®
 - Transfer data from the database to Excel®
 - Pivot function to define layout in Excel®

The training can be performed in one day or two half days. It is recommended to split the training into two half days:

- Day 1: Theory and basic operation (set-up organizer, taking readings and saving in a database)
- Day 2: 3-4 weeks later to ensure readings were taken and saved in a database. Data analysis and standard QC report can be explained using custom specific data.

Certified For Preventive Maintenance see page 271.

Ordering Information

Cat. No.	Description
6332	Black Calibration Standard
6336	Protective Cap, BYK-mac 23 mm measuring area
6399	Protective Cap, BYK-mac 12 mm measuring area
6360	Docking Station
6337	USB Interface Cable
6413	Instrument Interface Cable, online
6359	Battery Pack
6364	Cleaning Set for Bottom Plate
6348	Seal Replacement Set
6414	Light Protection Cover
4809	BYKWARE auto-chart

Accessories

To perform zero calibration
Snap on cover to protect optics and interior components
Snap on cover to protect optics and interior components
Incl. USB interface cable and charger 100 – 240 V self adapting (For BYK-mac with catalog number 6340 and 6345, please contact customer service for an upgrade package)
To connect the docking station to the PC, USB-A plug, 3 m length
To connect the instrument directly to the PC
Rechargeable battery pack for automatic charge in docking station
To clean instrument aperture and pin covers from dust and grease
Including 3 light protection rubber seals and 8 rubber pin covers
To measure very bright colors; 10 pieces included
Software for data analysis with database management and professional documentation in Excel®

Note: For replacement of white, cyan or effect standard, please contact your local service department.

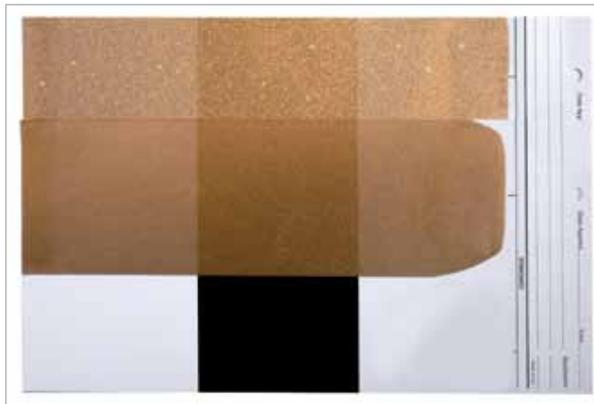
Accessories Cosmetics

Measurement of cosmetic products

The cosmetic industry is very much driven by the aesthetics. A lot of special effect pigments are used to create light-dark and color flop. Additionally, they start to sparkle when viewed in direct sun light. As many different sample types are used e.g. nail polish, lip gloss and eye shadow, standardized sample preparation is required for repeatable measurement results.

Measurement of Nail Polish

A drawdown is made on a black & white test chart. The use of BYK-Gardner byko-charts guarantee consistent color & gloss ensuring that the measured color difference only comes from product variations.



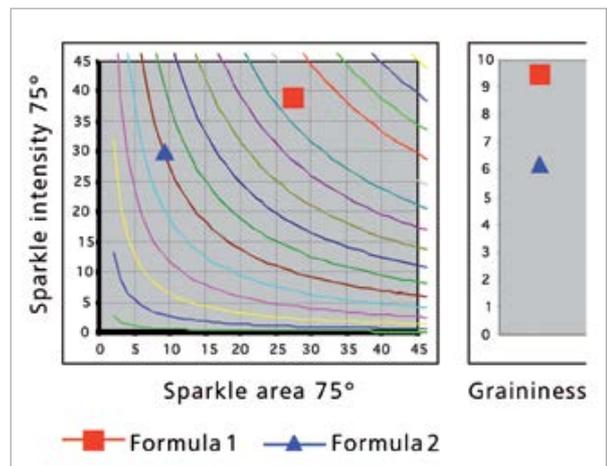
The orientation of effect pigments can create different looks. In the example on the right the same pigment was used in 2 different formulations. In formula 1 the flake orientation was not influenced. As a result it looks coarser and sparkles at a low grazing angle. In formula 2 the aluminium flakes were oriented parallel creating a fine, mirror like look with hardly any graininess. BYK-mac measurement data clearly detects this effect by an increase in sparkle area at 75° and graininess. Sparkle 75° detects the aluminium flakes which are non-parallel oriented.

New!



Info!

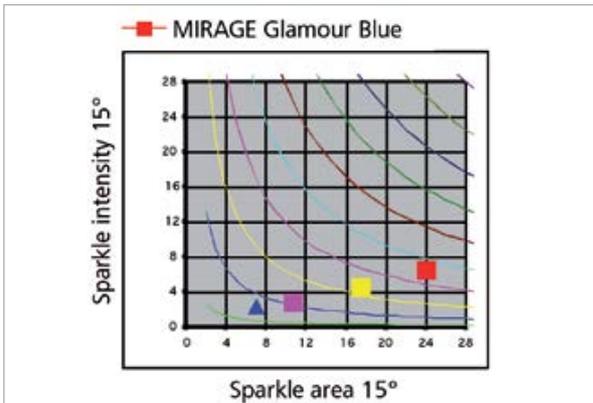
For more information on byko-charts, see pages 145 – 152.





Measurement of Powdery and Pasty Materials

Eye shadow, lipstick / lip-gloss or facial powder is pressed or poured into a sample cup and can be easily and repeatably measured with the BYK-mac sample holder.



Eye shadow using the new MIRAGE effect pigment line from ECKART was compared to products using natural mica based pigments. Visually, the new pigments distinguish themselves by their glamorous look and extraordinary sparkling effect. BYK-mac measurements of MIRAGE Glamour Blue show this effect by a much higher sparkle area and intensity value.

The holder is equipped with a mask custom made to fit the aperture of the BYK-mac and therefore, guarantees repeatable sample placement and measurement results. For sample preparation the holder comes with one adapter ring and five cuvettes (\varnothing 35.5 mm, height 4.5 mm).

To use it with custom specific cuvettes, customized adapter rings are offered.

- Maximum round container size: \varnothing 60 mm



Ordering Information

Cat. No.	Description
6415	Sample Holder
6416	Customized Adapter Rings

Accessories

To measure powdery and pasty materials;
including adapter ring and 5 cuvettes \varnothing 35.5 mm, height 4.5 mm
Five adapter rings of various sizes; please specify diameter

BYK-mac COLOR

Multi-angle color measurement

In order to control the lightness and / or color flop of an effect finish, the color needs to be measured under different viewing angles.

BYK-mac COLOR spectrophotometer offers an attractive solution by measuring

- Traditional 5-angle color at 15°/25°/45°/75°/110°
- An additional angle at -15° "behind the gloss" for color travel of interference pigments

Ergonomic design and easy operation

The shape of the instrument is designed to ensure easy handling and true portability. With an intuitive menu quality control of metallic finishes has never been easier.

Menu guided operation according to your own sampling procedure

- Designated buttons for standard and sample readings
- Scroll wheel to select menu functions
- Storage of up to 1000 readings in selectable memories
- 4 trigger pins on the bottom plate guarantee stable positioning even on curved surfaces



The left screenshot shows a menu with the following options: Measure, L Style 1, L 987 Light Blue Metallic, Line 1, Line 2, Delete, Data view, and Setup. The right screenshot shows a data table for 'Center Hood D65/10° 3/3' with columns for ΔL*, Δa*, Δb*, and ΔE*. The table contains data for viewing angles of -15°, 15°, 25°, 45°, 75°, and 110°. At the bottom of the right screenshot, it reads '987 Light Blue Metallic Style 1'.

	ΔL*	Δa*	Δb*	ΔE*
-15°	-0.53	0.35	0.96	1.15
15°	-0.14	0.26	0.81	0.86
25°	-1.77	0.11	0.42	1.82
45°	-2.99	0.01	0.41	3.01
75°	-1.28	0.26	0.98	1.63
110°	0.60	0.44	1.00	1.24

Reliable readings at any time

The BYK-mac COLOR uses a light source with long term stability and patented illumination control which provide superior accuracy and low maintenance for many years.

- Stable, long-term calibration – needed only every three months
- Temperature independent measurement results between 10 – 40 °C – without calibration
- Excellent agreement between instruments
- 10 year warranty on the light source – no lamp changes needed

Always ready

The instrument is operated with a rechargeable battery pack (Li-Ion). The docking station automatically charges the battery pack in the instrument as well as a spare pack located in the docking station. Optionally the instrument can be operated with 4 standard mignon alkaline or rechargeable batteries.

The docking station also transfers the measured data to a PC. For professional analysis, documentation and data management auto-chart software is included.

In compliance with:

Standards

ASTM	D 2244, E 308, E 1164, E 2194
DIN	5033, 5036, 6174, 6175-2
ISO	7724
SAE	J 1545



Certified For Preventive Maintenance see page 271.

Ordering Information

Cat. No.	Description
6395	BYK-mac COLOR*
6396	BYK-mac COLOR Sensor
107306395	Extended Warranty one year additional

Comes complete with:

Multi-angle spectrophotometer
 Black calibration standard
 White calibration standard with certificate
 Cyan checking reference
 Protective cap
 Cleaning set for bottom plate
 2 light protection covers
 Seal replacement kit
 *BYKWARE auto-chart software
 Docking station with USB cable for memory transfer
 Instrument interface cable for online data transfer
 2 rechargeable Li-ion battery packs
 Battery holder; 4 x AA batteries
 Short instructions; Operating manual on CD
 Carrying case; Training

Free 1x preventive maintenance service during warranty period

Hardware Requirements:

Operating system: Windows® 2000 or higher
 Excel® version: 2002 or higher VBA
 Memory: min. 256 MB RAM (recommended 512 MB)
 Hard disk capacity: min. 100 MB
 Monitor resolution: XGA (1024 x 768) or higher
 Disk drive: CD-ROM or DVD
 Interface: USB-port

Technical Specifications

Measuring Geometry	45° illumination -15°, 15°, 25°, 45°, 75°, 110° aspecular viewing
Measuring Area	23 mm diameter
Spectral Range	400 – 700 nm, 10 nm resolution
Measurement Range	0 to 400 % reflectance
Repeatability¹	0.02 ΔE* (10 consecutive measurements on white)
Reproducibility¹	0.20 ΔE* (average on 12 BCRA II tiles)
Color Scales	ΔE*; ΔE CMC; ΔE 94; ΔE 2000; ΔE 99; ΔE DIN6175
Illuminants	A; C; D50; D65; F2; F7; F11; F12
Observer	2°; 10°
Measuring Time	< 4 seconds
Memory	1000 standards / samples
Language	English, German, French, Italian, Spanish
Power Supply	Rechargeable battery pack or 4 mignon AA batteries (alkaline or rechargeable)
Operating Temperature	10 to 42° C (50 to 110 ° F)
Relative Humidity	up to 85%, 35° C (95° F); non-condensing
Dimensions	21.8 x 8.1 x 14.7 cm (8.6 x 3.2 x 5.8 in.)
Weight	approx. 1.3 kg (approx. 2.86 lbs)

¹ Standard deviation

BYK-mac COLOR Training

BYK-Gardner offers you more than just an instrument. We assist you in analyzing your color readings to enable you to use the BYK-mac COLOR to save time and money, while at the same time improving quality. Therefore, the instrument comes with a one day training course including:

1. Color Theory

- Parameters influencing color impression of effect finishes
- Color differences for trouble shooting

2. Operation and Software training

- Standard management
- Set-up an "organizer" to create a routine measurement procedure
- Programming of the instrument with "organizer" and measurement of several samples
- Data transfer to auto-chart software and saving in a database for routine QC
- Data analysis using standard reports:
 - Lab-scatter graph per angle to show at one glance whether all parts are within specifications
 - Color travel by sample to show how individual measurement zones perform per measurement angle
- Create your own reports in Excel®
 - Transfer data from the database to Excel®
 - Pivot function to define layout in Excel®



The training can be performed in one day or two half days. It is recommended to split the training into two half days:
Day 1: Theory and basic operation (set-up organizer, taking readings and saving in a database)
Day 2: 3-4 weeks later to ensure readings were taken and saved in a database. Data analysis and standard QC report can be explained using custom specific data.

Ordering Information

Cat. No.	Description
6332	Black Calibration Standard
6336	Protective Cap
6360	Docking Station
6337	USB Interface Cable
6413	Instrument Interface Cable, online
6359	Battery Pack
6364	Cleaning Set for Bottom Plate
6348	Seal Replacement Set
6414	Light Protection Cover
4809	BYKWARE auto-chart

Note: For replacement of white and cyan effect standard, please contact your local service department.

Accessories

To perform zero calibration
Snap on cover to protect optics and interior components
Incl. USB interface cable and charger 100 – 240 V self adapting
To connect the docking station to the PC, USB-A plug, 3 m length
To connect the instrument directly to the PC
Rechargeable battery pack for automatic charge in docking station
To clean instrument aperture and pin covers from dust and grease
Including 3 light protection rubber seals and 8 rubber pin covers
To measure very bright colors; 10 pieces included
Software for data analysis with database management and professional documentation in Excel®

BYK-mac ROBOTIC

Automatic measurement of total color impression of effect finishes at the line

Products can only be manufactured with uniform and consistent quality when process stability is guaranteed. Therefore, multi-angle color, sparkle and graininess must be measured on a routine basis. The BYK-mac ROBOTIC spectrophotometer allows automated total color control as it is mounted on a robotic arm. The robotic system not only measures a high number of cars, but also on the same areas.

Total color impression of effect finishes

The BYK-mac ROBOTIC measures both multi-angle color and flake characterization.

- Multi-angle color measurement at 6-angles clearly defines the light-dark as well as color flop behavior of effect finishes
- Sparkling and Graininess control with a high resolution CCD camera simulates effect changes under direct and diffuse lighting conditions.
- Multi-angle color and effect data help to analyze the cause of a color mismatch



New!

Reliable and objective color and effect data

The BYK-mac ROBOTIC spectrophotometer uses a light source with long-term stability and patented illumination control which provide superior accuracy and low maintenance for many years.

- Stable, long-term calibration – needed only every three months
- Temperature independent measurement results between 10 – 40°C – without calibration
- 10 year warranty on light source – no lamp changes needed
- Excellent agreement between instruments and correlation to BYK-mac and BYK-mac COLOR

Reliable readings at any time

In order to guarantee stable positioning, the BYK-mac ROBOTIC is equipped with trigger pins on the bottom plate of the instrument. The sensitivity of the pins can be adjusted to the curvature of the measurement area. If the pins do not have contact with the surface an error message will be displayed.

In compliance with:

Standards

ASTM	D 2244, E 308, E 1164, E 2194
DIN	5033, 5036, 6174, 6175-2
ISO	7724
SAE	J 1545

Ordering Information

Cat. No.	Description
6369	BYK-mac ROBOTIC
107306369	Extended Warranty one year additional

Comes complete with:

Multi-angle spectrophotometer
 White calibration standard with certificate
 Cyan and effect checking reference
 Light protection cover
 BYKWARE auto-chart software
 Communication software
 Installation kit
 Operating manual on CD
 Carrying case; Training

Free 1x preventive maintenance service during warranty period

Hardware Requirements:

Operating system: Windows® 2000 or higher
 Excel® version: 2002 or higher VBA
 Memory: min. 256 MB RAM (recommended 512 MB)
 Hard disk capacity: min. 100 MB
 Monitor resolution: XGA (1024 x 768) or higher
 Disk drive: CD-ROM or DVD
 Interface: USB-port



Technical Specifications

Color	
Measuring Geometry	45° illumination -15°, 15°, 25°, 45°, 75°, 110° aspecular viewing
Measuring Area	87 x 23 mm (in)
Spectral Range	400 – 700 nm, 10 nm resolution
Measurement Range	0 to 400 % reflectance
Repeatability¹	0.02 ΔE* (10 consecutive measurements on white)
Reproducibility¹	0.20 ΔE* (average on 12 BCRA II tiles)
Color Scales	ΔE*; ΔE CMC; ΔE 94; ΔE 2000; ΔE 99; ΔE DIN6175
Illuminants	A; C; D50; D65; F2; F7; F11; F12
Observer	2°; 10°
Effect	
Measurement Geometry	15° / 45° / 75° and diffused illumination perpendicular viewing
Effect Parameters	ΔS; ΔS _a ; ΔS _i ; ΔG
Repeatability¹	S _a / S _i : 5% or > 0.50 / G = ± 0.05
Reproducibility¹	S _a / S _i : 10% or > 1.00 / G = ± 0.15
Object Curvature	Radius > 400 mm
Measuring Time	< 6 seconds
Memory	1000 standards / samples
Language	English, German, French, Italian, Spanish
Power Supply	External power supply 24 VDC
Interface	RS 422
Robotic Requirements	Vibration-free operation
Operating Temperature	10 to 42° C (50 to 110 ° F)
Relative Humidity	up to 85%, 35° C (95° F); non-condensing
Dimensions	21 x 12.5 x 17.5 cm (8.3 x 5 x 6.9 in.)
Weight	approx. 3.5 kg (approx. 7.7 lbs)

¹ Standard deviation

BYK-mac ROBOTIC Training

BYK-Gardner offers you more than just an instrument. We assist you in operating the whole system and analyzing your color, sparkle and graininess data. Therefore, the instrument comes with a two day training course including:

Color and Effect Theory:

- Visual perception and instrumental measurement of multi-angle color, sparkle and graininess.
- Data interpretation for trouble shooting
- Support in integrating the BYK-mac ROBOTIC sensor into an automated measurement system

Software training

- Data analysis using standard reports:
 - Lab-scatter graph per angle to show at one glance whether all parts are within specifications
 - Color travel by sample to show how individual measurement zones perform per measurement angle
 - Effect graph to control whether sparkle and graininess values are within specification

- Day 1: Color and Effect theory with data interpretation for optimization and trouble shooting
Support in integrating the BYK-mac ROBOTIC sensor into an automated measurement system
- Day 2: Software training with data analysis using standard reports

Ordering Information

Cat. No.	Description
6417	Light Protection Cover
4809	BYKWARE auto-chart

Accessories

To avoid the influence of ambient light
Software for data analysis with database management and professional documentation in Excel®

Note: For replacement of white, cyan and effect standard, please contact your local service department.

Certified For Preventive Maintenance see page 271.



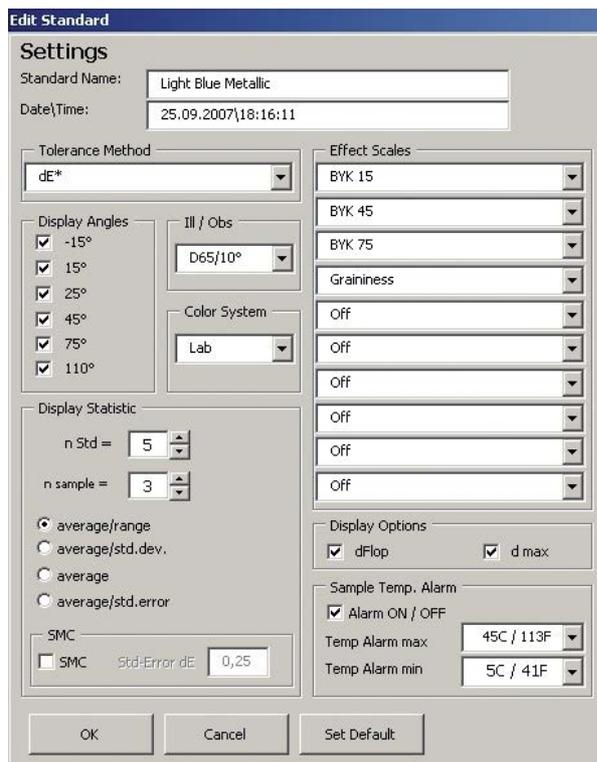
auto-chart

Efficient Data Analysis with auto-chart Software

Various process parameters influence the overall color impression of metallic finishes. Good process control requires systematic planning and efficient handling of large data sets. BYK-Gardner auto-chart gives you what you need to take a step forward in metallic color measurement and control.

Standard Management

As color and effect evaluation is always done by comparing the product to a defined standard, the first step is to pre-define the standard settings for each color (e.g. name, # of readings, color difference, effect scales).



These templates are then transferred to the instrument and the standard panels are measured. For data analysis and back-up purposes the standards can be stored in the auto-chart database.

Definition of Test Procedure

In order to perform efficient data analysis clear sample identification and a defined control sequence are necessary. Therefore, so called "Organizer Files" are created in auto-chart. These files are transferred to the color instrument, the parameters are selected on the instrument, and the user is guided through the measurement procedure.

1. Clear sample identification

Up to 5 parameters for object identification can be entered: e.g. model – color – line. The system is open to your specific needs.

2. Definition of measurement sequence

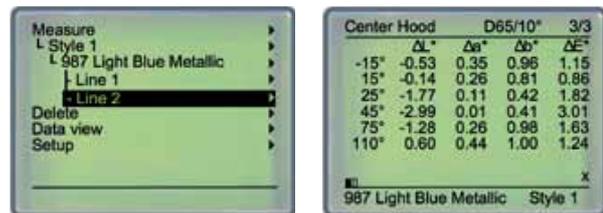
In the organizer file the name of each measurement area can be defined. Additionally, the instrument's sensitivity against tilting can be set for each individual area guaranteeing operator independent measurement results.

#	Block No.	Checkzone Comment	Din	Curvature
1	1	CenterHood	[x]	low
2	1	Hood Left	[x]	low
3	2	Left Door	[x]	low
4	2	CPI Left	[x]	low
5	1	Trunk/Centr	[x]	low
6	3	CPI Right	[x]	low
7	3	Right Door	[x]	low
8	1	Hood Right	[x]	low
9			[x]	low

Symbol	Curvature	Example
I	flat	Test panel
)	low	Hood
O	medium	Bumper
o	high	Mirror housing
Off		

3. Send organizer to instrument and take readings

Clear object identification without manual entry: just select on the display model, color and line and start measuring. The instrument guides the user automatically through the measurement sequence – reducing operator errors.



4. Transfer data and save

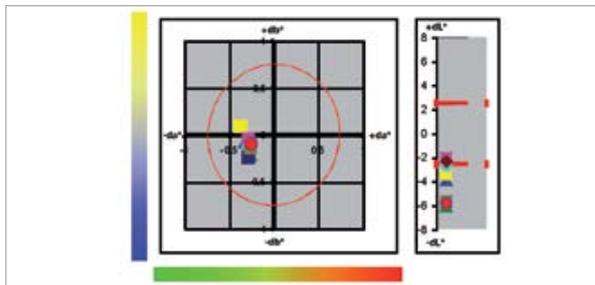
The measurement data is saved in the instrument, transferred to the PC and saved in the auto-chart database.

Professional Analysis and Documentation

auto-chart combines the efficient data management of Access® with proven Excel® functionality. After the data has been saved in the database, clearly structured filters are used for data selection and the results are directly transferred to standardized reports with graphics.

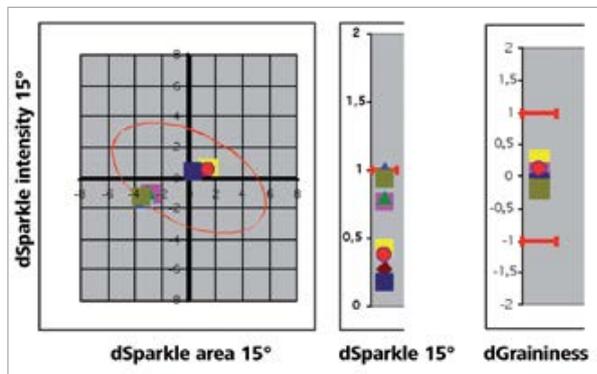
Lab-Scatter Graph

This standard report shows at a glance whether all parts are within specification. One graph per angle is shown and different tolerance models (e.g. CMC, DIN 6175-2) can be selected.



Effect Graph

Similar to the Lab-scatter graph, this chart easily shows whether effect differences are within tolerance. One graph per sparkle angle and graininess is displayed. Tolerances can be set to your specific requirements.

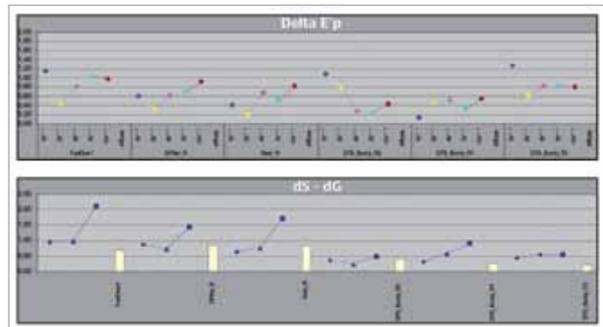


Color & Effect Travel by Sample

...the ideal tool to show how individual measurement areas or colors perform per measurement angle. In combination with a graph for sparkle and graininess values, total color impression can be easily controlled.

Example:

In the following example the basecoat of the car body was applied 100% electrostatically and the bumpers were painted with bell/pneumatic application. The total color difference Δ EDIN was acceptable.



Yet, visually the car body was sparkling considerably more than the bumper. This difference is clearly detected by Δ Sparkle 75° which is well above one. Sparkle 75° detects the aluminum flakes which are non-parallel oriented.

Ordering Information

Cat. No.	Description
4809	auto-chart

Comes complete with:

Software on CD-ROM

Note: auto-chart licence fee for more than two installations is quantity dependent. Please contact your local BYK-Gardner representative.

Technical Specifications

Software for BYK-mac, BYK-mac COLOR and BYK-mac ROBOTIC.
Depending on the instrument, not all graphs may be available.

Hardware Requirements:

Operating system: Windows® 2000 or higher
Excel® version: 2002 or higher VBA
Memory: min. 256 MB RAM (recommended 512 MB)
Hard disk capacity: min. 100 MB
Monitor resolution: XGA (1024 x 768) or higher
Disk drive: CD-ROM or DVD
Interface: USB-port