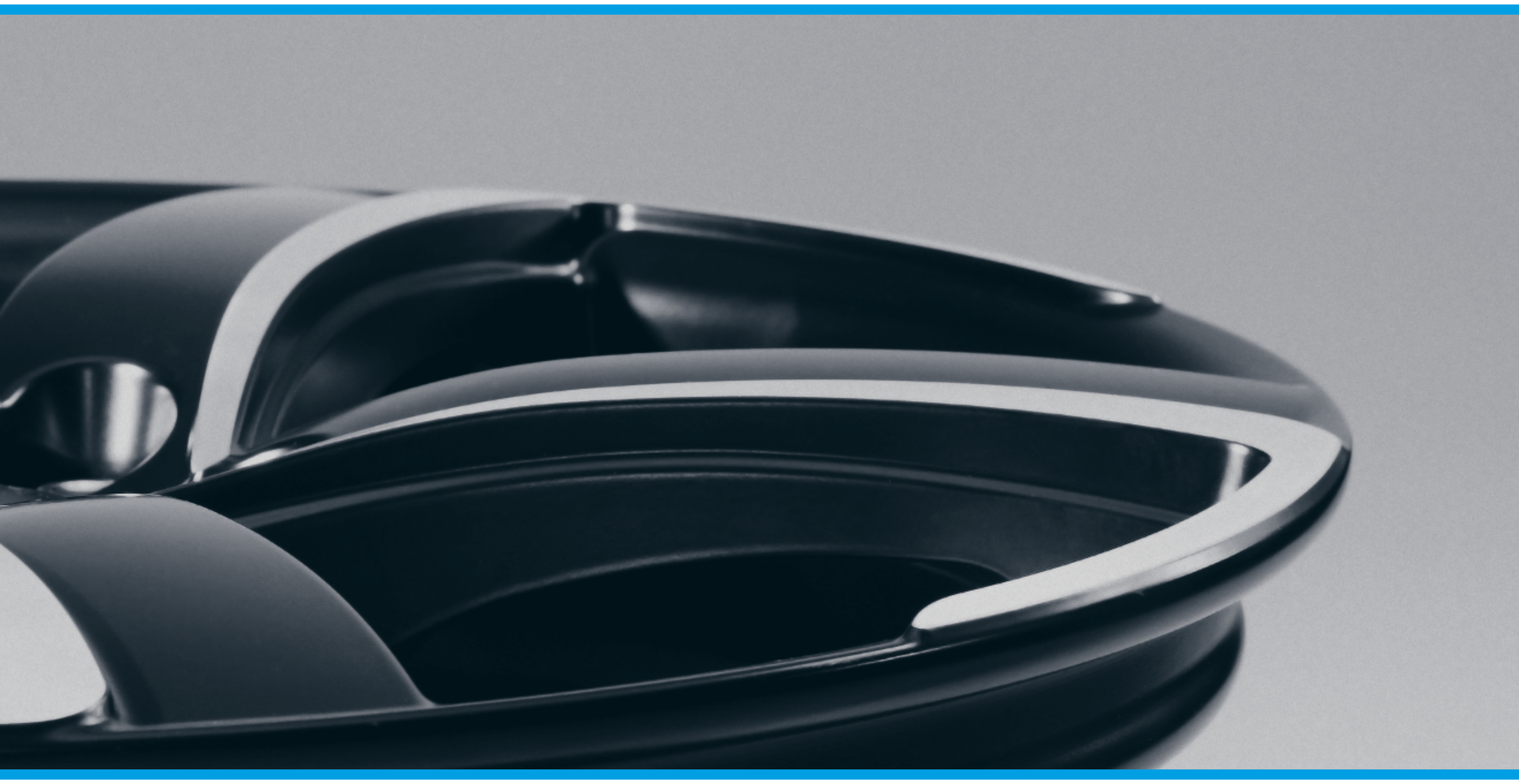
Specialty carbon blacks for powder coatings

Technical Information 1293



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1 Introduction

Powder coatings are applied to metal, plastic, glass substrates to form highly durable and attractive finishes. They are manufactured and applied without the use of organic solvents; therefore, they are highly desirable from an ecological standpoint and help to fulfill the VOC guidelines (VOC = volatile organic compound) that have been enacted in Europe and other parts of the world, due to stringent air pollution control legislation.

In the 1960s, application of powder coatings by electrostatic spray became the preferred method. This process was superior to other application methods in that a thinner (1-3 mm) film can be easily applied to the substrates.

Currently, about 80 – 90 % of the powder coatings are applied using this technique, which is also economically attractive. Furthermore, the overspray can be re-circulated and about 95 % of the coating can be utilized, much more than in liquid spraying systems.

Today, most industrial powder coating formulations are based on thermosetting resin technology, which are predominantly epoxy and saturated polyester types with carboxyl or hydroxyl functional groups. Epoxies are preferred for their overall physical properties, while the saturated polyesters exhibit better outdoor weathering properties.

2 The differences between liquid coatings and powder coatings systems – principles and processes

Specialty carbon blacks are typically used in paints and coatings for mass tone and tinting application. They are utilized in many types of coating applications, from industrial and automotive to decorative paints. The quantity of pigment added depends on the type of Specialty carbon black, the coating system and the required coloristic properties. Multiple types of specialty carbon blacks with a wide range of primary particle sizes are available for coating applications. Dispersing carbon blacks with small average primary particle sizes is one of the most challenging steps in the production process of black coatings.

In liquid coating systems, the full coloristic potential of a carbon black can only be achieved by sufficient dispersion of the pigments to break the carbon black agglomerates. The milling step needs to go along with a proper stabilization of the in-situ generated carbon black aggregates to avoid re-agglomeration. Typically, bead mills are used to finely disperse the carbon blacks and certain additives are used to stabilize the dispersions. The concentration of carbon black in the mill base is about 10 to 20 %, depending on the type of carbon black. In the final letdown, the concentration of carbon black is about 1.0 - 3.0 %. For optimal dispersion, a well-balanced mill base viscosity is essential to obtain sufficient shear force to break down the pigment agglomerates. The powder form of carbon black is typically preferred in liquid coatings because it is easier to disperse than the beaded version.

Considering the manufacturing process of powder coatings, the most important difference regarding the dispersion of the specialty carbon black in comparison to a liquid coating system is the time available to disperse the pigment. Thermosetting powders are made by a three-step process. Production operations are performed batchwise; the usual product mix consists of comparatively small volumes of powder made in a variety of colors rather than a few formulations with very high volume. Most producers use multiple units of relatively small-volume equipment rather than single large-scale machines in order to have greater flexibility and possibility to make some of their products in dedicated equipment. In addition, cleanup of smaller equipment between batches is easier and less time consuming.

- **Pre-blending of dry raw materials:**

A powder coating formulation is often composed of about fifteen ingredients that must be thoroughly mixed to ensure homogeneous production. The pre-blending operation is performed using a high-speed dispersing mixer for two to four minutes. To avoid dust, carbon blacks in beaded form are preferably used.

- **Extruding:**

The pre-blend material is fed into a plastics compounding extruder, where it is subjected to heat and high-shear conditions. The resin is melted and combined with curing agents, pigments and other raw materials, which are effectively dispersed in the melt mix.

The dispersion of the carbon black beads in a medium of molten polymer with a viscosity above 100,000 mPa•s is exposed to different shear force compared to those of a liquid coating in a bead mill. The higher shear forces benefit jetness development of the carbon black. There is no concentrated stage of carbon black in the powder coating system as mentioned in the liquid dispersion process. The final carbon black concentration in the powder coating is 0.5 % to 3.0 % dependent on the application (tinting or mass tone). The mix exits the extruder as a taffy-like rope; it is then cooled, flattened into a thin sheet, and crushed to produce flaked materials.

- **Milling into fine particles:**
The flakes are fed into a hammer mill where they are ground into powder (average size is 30 - 40 µm in diameter). The resulting powder is collected and packaged for sale.

3 Choice of powder coating systems for carbon black evaluation

Powder coatings are composed of four key raw materials – film formers or binders (consisting of resins and curing agents), pigments, fillers and additives. The most common resins and curing agents used for binding are given in table 1.

Table 1

Popular resin systems and types of curing agents used for powder coatings

Resin systems	Type of curing agents
Epoxy / Carboxyl-functional polyester (Hybrid)	None; resins react with each other to form binder
Epoxy	Amines or phenolics
Polyester (carboxyl-functional)	Triglycidyl isocyanurate (TGIC) and beta-hydroxyalkylamide (HAA)
Polyester (hydroxyl-functional)	Polyurethane / blocked isophorone diisocyanate (IPDI) or uretdione
Acrylic (functionalized with glycidyl methacrylate)	Dodecanoic acid, polyanhydrides, carboxyl-terminated polyesters

Nowadays, most industrial powder coating formulations are based on thermoset resin technology, which is predominantly comprised of epoxies and saturated polyester types with carboxyl or hydroxyl functional groups. Epoxies are preferred for their durability, chemical and corrosion resistance, ease of use and a wide range of cure schedules. However, epoxies do not weather well, and exterior exposure can cause them to chalk or fade. The saturated polyesters exhibit better outdoor weathering properties and are the most commonly used in powder coatings. They provide good mechanical and chemical resistance. Powder coatings based on saturated polyesters also provide enormous choice of colors, gloss levels and special effects.

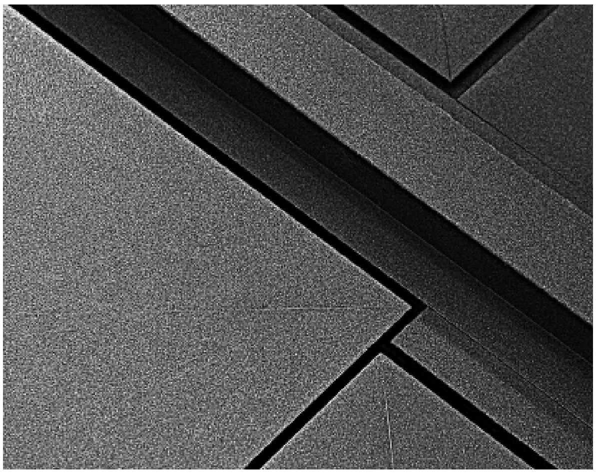
In Europe, HAA has replaced TGIC as curing agent for carboxyl-functional polyesters. TGIC is known to be a hazardous raw material, but TGIC is still relevant for powder coatings systems in Americas and Asia.

Epoxy and polyester are often mixed together to form hybrid systems. Depending on the needs and the requirements of the application, the ratio of epoxy / polyester can be varied. In this study, the hybrid system and the polyester with both HAA and TGIC curing agents were tested along with various types of specialty carbon blacks from Orion Engineered Carbons.

4 Experimental protocol

General preparation of powder coatings

The powder coatings were prepared by micronizing the raw materials separately in a high-speed dissolver with a dissolver disc. A tubular mixer with defined mixing conditions was used to premix the micronized raw materials. For the subsequent extrusion, a twin-screw volumetric feeder fed the premix into an extruder. A two-roll mill immediately cooled the extruded melt and the powder coating was broken down into chips. The chips were pre-micronized, and the milled powder coating was sieved. Afterwards, the powder coatings were applied onto steel panels and cured under defined conditions.



Formulations

Formulation 1

Epoxy-hybrid system - mass tone

Raw material	Description	Concentration (%)	Concentration (%)
Uralac® P3560 DSM N.V.	Hybrid resin consisting of polyester and epoxy (70/30)	68.4	68.0
Araldite® GT 7004 Huntsman Advanced Materials	Epoxy resin	29.3	29.2
Benzoin Merck KGaA	Aromatic hydroxy ketone, degassing aid	0.5	0.5
Resiflow® PV 5 Worlée-Chemie GmbH	Flow / wetting additive	1.0	1.0
Specialty carbon black	Various grades	0.8	1.3
Total		**100.0**	**100.0**

Formulation 2

Carboxyl-functional polyester system / HAA Crosslinker – mass tone (OH:COOH = 1:1)

Raw material	Description	Concentration (%)
Vestagon® HA 320 Evonik Industries AG	Hydroxyalkylamide (HAA) crosslinker	3.3
Uralac® P 865 DSM N.V.	Polyester resin	68.2
Benzoin Merck KGaA	Air-released agent	0.5
Resiflow® PV 88 Worlée-Chemie GmbH	Flow / leveling agent	1.5
Blanc Fixe™ F Venator Materials PLC	Extender	25.0
Specialty carbon black	Various grades	1.5
Total		**100.0**

Formulation 3

Carboxyl-functional polyester system / HAA Crosslinker - tinting - grey-tone (OH:COOH = 1:1, TiO_2: specialty carbon black = 100:5)

Raw material	Description	Concentration (%)
Vestagon® HA 320 Evonik Industries AG	Hydroxyalkylamide (HAA) crosslinker	3.1
Uralac® P 865 DSM N.V.	Polyester resin	64.0
Benzoin Merck KGaA	Air-released agent	0.4
Resiflow® PV 88 Worlée-Chemie GmbH	Flow / leveling agent	1.0
KRONOS® 2160 KRONOS Worldwide, Inc.	Titanium dioxide	30.0
Specialty carbon black	Various grades	1.5
Total		**100.0**

Formulation 4

Carboxyl-functional polyester system / TGIC Crosslinker – mass tone

Raw material	Description	Concentration (%)
CRYLCOAT® 2471 Allnex Netherlands B.V.	Carboxylated-polyester resin	81.4
Resiflow® P-67 Worlée-Chemie GmbH	Flow / leveling agent	1.0
TGIC Huntsman Advanced Materials	Crosslinker	6.1
Benzoin Merck KGaA	Air-released agent	0.5
Huberbrite® 1 Huber Engineered Materials	Barium sulfate brightener / extender	10.0
Specialty carbon black	Various grades	1.0
Total		**100.0**

Formulation 5

Carboxyl-functional polyester system / TGIC Crosslinker – tinting - grey-tone

Raw material	Description	White reduction	
		98/2	50/50
Ti-Pure™ R-706 ChemoursTM	Titanium Dioxide	9.8	1.0
CRYLCOAT® 2471 Allnex Netherlands B.V.	Carboxylated-polyester resin	73.0	80.5
Resiflow® P-67 Worlée-Chemie GmbH	Flow / leveling agent	1.0	1.0
TGIC Huntsman Advanced Materials	Crosslinker	5.5	6.0
Benzoin Merck KGaA	Air-released agent	0.5	0.5
Huberbrite® 1 Huber Engineered Materials	Barium sulfate brightener / extender	10.0	10.0
Specialty carbon black	Various grades	0.2	1.0
Total		**100.0**	**100.0**

Processing parameters

Table 2

Process parameter used for epoxy-hybrid and carboxyl-functional polyester / HAA system

Process steps	Instruments	Parameter	Epoxy-hybrid system	Carboxyl-functional polyester / HAA
Premix	Tubular mixer T2F	Time [minutes]	10	10
		rpm	46	46
Feed into the extruder	K-Tron T35	Mass flow [kg/h]	8-10	8-10
Extrusion	Werner & Pfleiderer ZSK 30 (L/D=15)	T [°C] heating zone 1-4	80	80
		T [°C] heating zone 5	105	105
		rpm	270	270
		Melt temperature [°C]	118	127
Cooling	Two-roll mill	Diameter of rolls [mm]	105	105
		Distance of rolls [mm]	1.5	1.5
		Speed	Adjust to melt flow	Adjust to melt flow
Premicronization of powder coating	Dissolver Pendraulik LM 34	Disc diameter [mm]	100	100
		rpm	1000-4000	1000-4000
		Time [s]	40	40
Milling	Retsch ZM 1 with 1.5 mm sieve	rpm	14000	14000
		Dosing by shaking channel AEG KF1-1	Adjust to milling behavior	Adjust to milling behavior
Sieving	Engelsmann JEL-Fix 50	Mesh size [µm]	Fraction 25-100	Fraction 25-63
Application	Wagner: Airmatic powder gun PE11-C62(Corona)/EPG 2007	Voltage [kV]	70	70
		Air pressure [bar]	2	2
		Number of applied layers to achieve 60 - 80 µm thickness of final coating	7	7
Crosslinking	Oven	Time, temperature	10 mins, 180°C	10 mins, 180°C

Table 3

Process parameter used for carboxyl-functional polyester / TGIC system

Process steps	Instruments	Parameter	Carboxyl-functional polyester / TGIC
Premix	Vitamix 3600	Time [seconds]	10
Feed into the extruder	K-Tron T35	Mass flow [kg/h]	15
Extrusion	19 mm APV Twin Srew	T [°C] heating zone 1	100
		T [°C] heating zone 2	100
		rpm	500
		Melt temperature [°C]	118
Cooling	Two-roll mill	Diameter of rolls [mm]	105
		Distance of rolls [mm]	1.5
		Speed	Adjust to melt flow
Milling	Strand Mill - Ambient	rpm	14000
		Dosing by shaking channel AEG KF1-1	Adjust to milling behavior
Sieving	Engelsmann JEL-Fix 50	Mesh size [µm]	140
Application	Parker Ionics GX – 8500 system with GX – 131 handgun	Voltage [kV]	100
		Film thickness [µm]	46 - 71
Crosslinking	Oven	Time, temperature	10 mins, 400°F (204°C) metal temperature

5 Results

An overview what types of specialty carbon black and powder coating formulations have been used is given in Table 4.

Table 4

Tested specialty carbon blacks - listed by descending mean primary particle size (except for the last five conductive carbon blacks)

Specialty carbon black	Type	Epoxy - hybrid mass tone	Carboxyl-functional polyester / HAA – mass tone	Carboxyl-functional polyester / HAA – tinting	Carboxyl-functional polyester / TGIC – mass tone	Carboxyl-functional polyester / TGIC – tinting
LAMP BLACK 101 POWDER	LB	●	●	●	●	●
HIBLACK® 160 BEADS	LCF	●		●		
PRINTEX® G POWDER	LCF	●	●	●	●	●
PRINTEX® G BEADS	LCF		●	●		
NEROX® 1000 POWDER	LCF				●	●
SPECIAL BLACK 100 POWDER	LCF			●	●	●
HIBLACK® 5L POWDER	RCF	●		●		
PRINTEX® 35 POWDER	LCF	●				
PRINTEX® 300 BEADS	RCF	●		●	●	
NEROX® 305 POWDER	RCF	●		●		
PRINTEX® 45 POWDER	RCF	●				
PRINTEX® 55 POWDER	RCF				●	●
PRINTEX® U POWDER	RCG	●			●	●
SPECIAL BLACK 4 POWDER	RCG	●	●		●	●
SPECIAL BLACK 4 BEADS	RCG		●	●	●	
NEROX® 500 POWDER	RCF	●		●		
NEROX® 505 POWDER	RCF	●		●		
NEROX® 600 POWDER	RCF	●		●		
NEROX® 605 POWDER	RCF	●		●		
PRINTEX® 60 POWDER	RCF	●	●		●	●
PRINTEX® 60 A BEADS	RCF		●	●		
PRINTEX® 260 POWDER	RCF				●	●
COLOUR BLACK S160 POWDER	MCG	●	●			
AROSPERSE® 11 BEADS	RCF				●	●
HIBLACK® 50L POWDER	MCF	●		●		

Specialty carbon black	Type	Epoxy - hybrid mass tone	Carboxyl-functional polyester / HAA – mass tone	Carboxyl-functional polyester / HAA – tinting	Carboxyl-functional polyester / TGIC – mass tone	Carboxyl-functional polyester / TGIC – tinting
HIBLACK® 50LB BEADS	MCF	●		●		
Competitor MCF 1	MCF		●	●		
COLOUR BLACK S170 POWDER	MCG	●				
SPECIAL BLACK 6 POWDER	HCG	●	●			
SPECIAL BLACK 6 BEADS	HCG		●	●		
PRINTEX® 85 POWDER	MCF	●	●	●	●	●
PRINTEX® 85 BEADS	MCF		●	●		
HIBLACK® 600L POWDER	MCF				●	●
HIBLACK® 600LB BEADS	MCF	●	●			
PRINTEX® 95 BEADS	HCF		●	●	●	●
HIBLACK® 890 BEADS	HCF	●		●		
PRINTEX® 90 BEADS	HCF			●	●	●
COLOUR BLACK FW 200 POWDER	HCG	●	●	●		
COLOUR BLACK FW 200 BEADS	HCG		●	●		
COLOUR BLACK FW 285 POWDER	HCG	●				
Competitor HCF 1	HCF		●	●		
Competitor HCF 2	HCF	●	●			
COLOUR BLACK FW 1 POWDER	HCG				●	●
COLOUR BLACK FW 171 POWDER	HCF	●	●		●	●
COLOUR BLACK FW 255 POWDER	HCF				●	●
PRINTEX® L POWDER	CB	●			●	●
PRINTEX® L6 POWDER	CB	●				
PRINTEX® kappa 50 POWDER	CB				●	
PRINTEX® XE2 B BEADS	ECB				●	

Nomenclature

HCG High color gas
MCG Medium color gas
RCG Regular color gas
(Degussa gas black process)

HCF High color furnace
MCF Medium color furnace
RCF Regular color furnace

LCF Low color furnace
LB Lamp black
ECB Extra conductive black
CB Conductive black

5.1. Gloss and haze

Gloss and haze values were measured using a BYK Gardener gloss/haze meter following the DIN EN ISO 2813 test method. Gloss was measured at 20° and at 60° angles; reflective haze was measured at 20°.

Results from this study suggested that there was no significant difference in gloss and haze when testing different carbon blacks in the same resin system. Table 5 shows the average gloss at 60°, 20° and haze of the typical resin systems.

Table 6

The average gloss obtained in epoxy-hybrid and polyester / HAA systems

	Epoxy-hybrid formulation – mass tone, 0.8 %	Epoxy-hybrid formulation – mass tone, 1.3 %	Carboxyl-functional polyester/ HAA – mass tone, 1.5 %	Carboxyl-functional polyester/ HAA – tinting (100 : 5)
Gloss 60 °	94 – 97	97 – 99	76 – 79	86 – 90
Gloss 20 °	88 – 93	92 – 94	45 – 55	65 – 75
Haze	30 – 50	30 – 60	180 – 320	100 – 200

Gloss and haze values for the different powder coating systems.

5.2. Coloristic properties

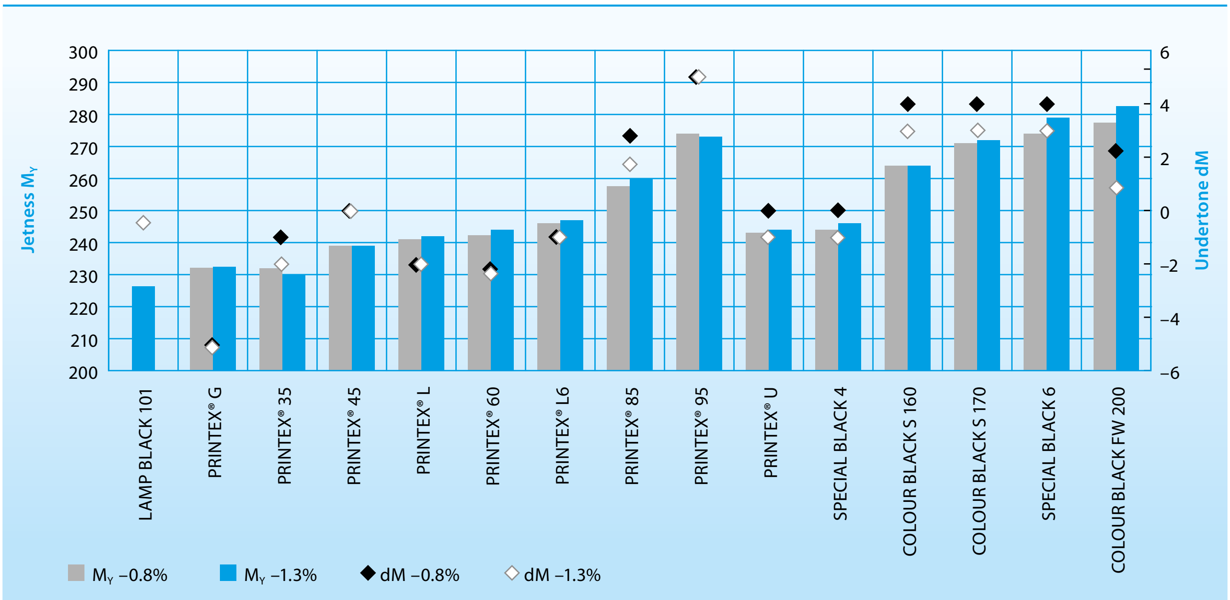
The coloristic properties of the coated panels were measured using a Pausch® Q35 with a 45°/0° geometry. Jetness M_Y and the undertone dM for the black mass tones were determined in accordance to DIN 55979. The grey number G_Y and the undertone dG of the tinted (grey) coatings were obtained following the same mathematical transformations used to calculate M_Y and dM. For further details, please refer to K. Lippok-Lohmer (Farbe + Lack, (1986), vol. 92, p. 1024) or K. Krauss (European Coatings Journal 05/2019 p. 35 ff – BLACK- THE FINE DETAILS).

The higher the M_Y and the G_Y value, the higher the jetness of the mass tone and the darker the grey color of the tinted coating. The higher the dM and the dG value, the stronger the bluish undertone of the mass tone and the grey coating. This also indicates how well the pigment is dispersed and stabilized in the coating system.

5.2.1. Epoxy-hybrid system

Figure 1

Jetness M_Y and undertone dM for the epoxy-hybrid powder coatings with 0.8 % and 1.3 % of specialty carbon black concentration



In the epoxy-hybrid powder coating system (Figure 1) two different carbon black concentrations (0.8 % and 1.3 %) were evaluated in the mass tone application. With coating thicknesses between 60 and 80 µm, the achieved jetness M_Y and undertone dM values for both concentrations were very comparable for most of the evaluated specialty carbon blacks. Only for SPECIAL BLACK 6 and COLOUR BLACK FW 200 the jetness M_Y increased with higher carbon black concentration. A difference in the dM value of 1 to 2 is negligible.

With LAMP BLACK 101 “semi” transparent films were observed with carbon black concentration of 0.8 %. Therefore, no color value was measured for LAMP BLACK 101 with a concentration of 0.8 %. Typically, LAMP BLACK 101 is not used for mass tone, but for tinting applications. LAMP BLACK 101 showed a neutral undertone dM combined with low jetness M_Y at a concentration of 1.3 %.

After-treated gas blacks like e.g. SPECIAL BLACK 6 showed slightly better coloristic values compared to the non-after-treated countertypes, in this case COLOUR BLACK S170.

For high jet grades, COLOUR BLACK FW 200, SPECIAL BLACK 6 and PRINTEX® 95 showed the best coloristic performance, providing high jetness with blue undertone.

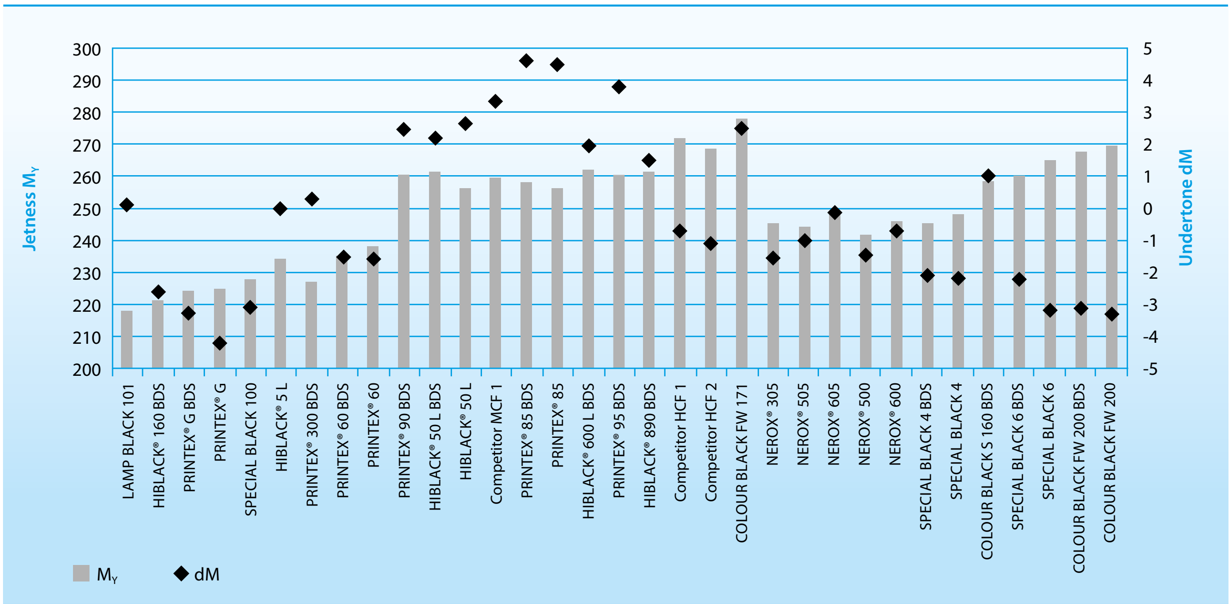
COLOUR BLACK S160 and PRINTEX® 85 showed good coloristic performance for medium jetness applications.

For lower jetness levels, specialty carbon blacks like PRINTEX® U, SPECIAL BLACK 4, PRINTEX® 60 or PRINTEX® 45 can be considered.

5.2.2. Carboxyl-functional polyester / HAA-Mass tone application

Figure 2

Jetness M_Y and undertone dM for the carboxyl-functional / HAA powder coatings with 1.5 % of specialty carbon black concentration



In this system, the furnace blacks with low to medium mean primary particles sizes showed good performance. High jetness values combined with strong bluish undertones were achieved with PRINTEX® 95, PRINTEX® 85, PRINTEX® 90, HIBLACK® 50L, HIBLACK® 600L and HIBLACK® 890. For low-end applications, PRINTEX® 60, PRINTEX® 300, HIBLACK® 5L and the NEROX® types could be an option. LAMP BLACK 101 resulted in low jetness with a neutral undertone.

The highest jetness and bluish undertone of all specialty carbon blacks tested was achieved with COLOUR BLACK FW 171. Comparable competitor products show lower jetness values M_Y and undertone dM.

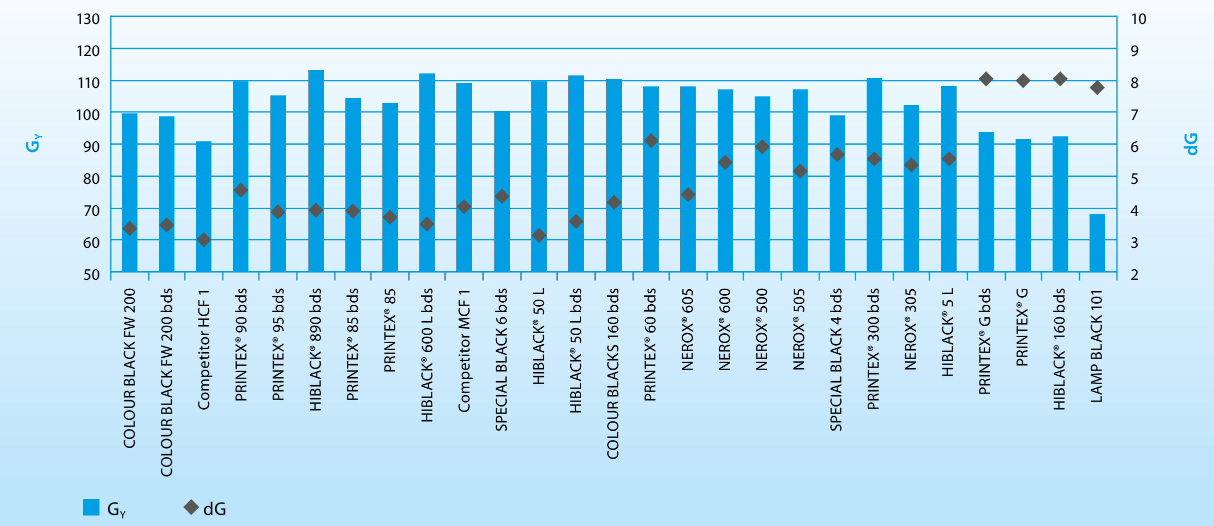
In general, the after-treated gas blacks such as SPECIAL BLACK 4, SPECIAL BLACK 6 and COLOUR BLACK FW 200 showed good jetness values M_Y but lower undertone dM.

Since powder coating manufacturers prefer beaded specialty carbon blacks due to low dust and easy handling, a direct comparison between beads and powders based on the same type of specialty carbon black was included into the evaluation. Results indicated, that there are no significant differences in the coloristic properties between beads and powder version of the same grade.

5.2.3. Carboxyl-functional polyester / HAA-tinting application

Figure 3

Greyness G_Y and undertone dG for the carboxyl-functional polyester / HAA powder coatings with titanium dioxide to specialty carbon black = 100:5



Certain specialty carbon blacks were tested in a tinting powder coating formulation based on the carboxyl-functional polyester / HAA system. The grey numbers G_Y and the undertones dG are displayed in figure 3. The ratio of titanium dioxide to carbon black was 100:5 for all samples. The values were sorted by increasing mean primary particle size.

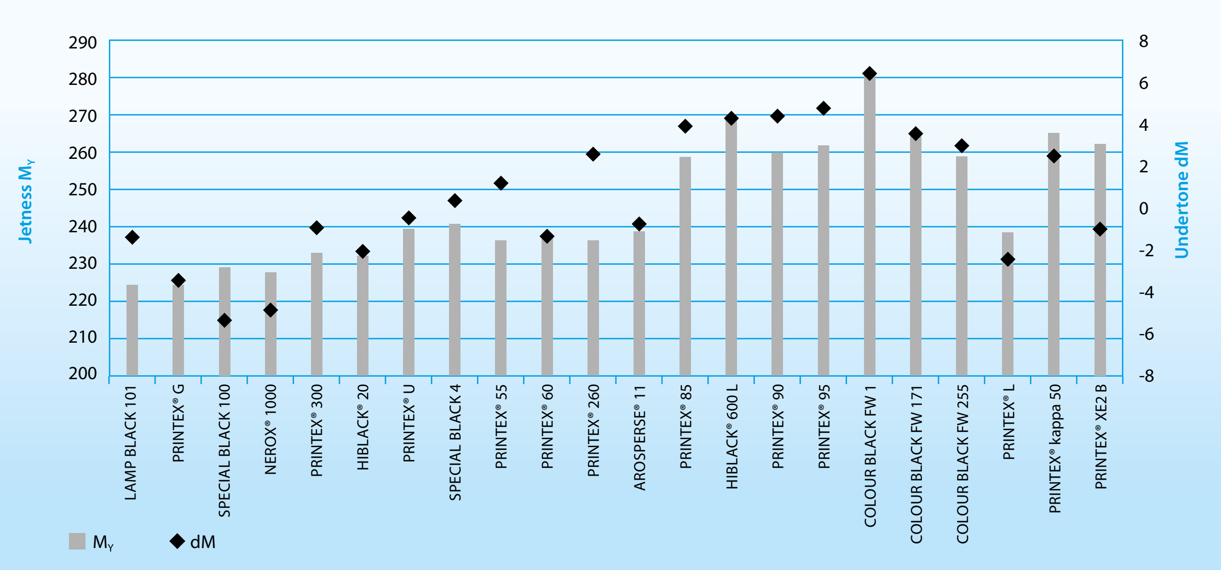
The development of the tinting strength did not follow the mean primary particle size as usually obtained in liquid coating systems. The undertone dG for the grey powder coatings in Figure 3 roughly followed the color performance trend in liquid coatings: The fine particle sized carbon blacks showed low dG values, whereas the coarse particle sized carbon blacks provided high dG values, translated into a strong bluish undertone.

For a reasonable tinting strength and blue undertone, combined with a good price-performance ratio, PRINTEX® 60, PRINTEX® 300 and HIBLACK® 5L could be the first choice, followed by the NEROX® types. For grey coatings with a strong bluish undertone, PRINTEX® G, HIBLACK® 160 and LAMP BLACK 101 could be recommended.

5.2.4. Carboxyl-functional polyester / TGIC- mass tone application

Figure 4

Jetness M_Y and undertone dM for the carboxyl-functional / TGIC powder coatings with 1.0 % of specialty carbon black concentration



In this system, carbon blacks with fine to medium mean primary particles sizes showed good performance. High jetness values M_Y combined with strong bluish undertones were achieved with HIBLACK® 600L, PRINTEX® 95, PRINTEX® 90, COLOUR BLACK FW 171, COLOUR BLACK FW 1 and COLOUR BLACK FW 255.

The highest jetness and bluish undertone of all specialty carbon blacks tested, were achieved with COLOUR BLACK FW 1.

The conductive grade PRINTEX® kappa 50 also showed good coloristic performance in terms of high jetness and bluish undertone.

5.2.5. Carboxyl-functional polyester / TGIC- tinting application

Figure 5

Greyness G_Y and undertone dG for the carboxyl-functional / TGIC powder coatings with titanium dioxide to specialty carbon black = 98:2

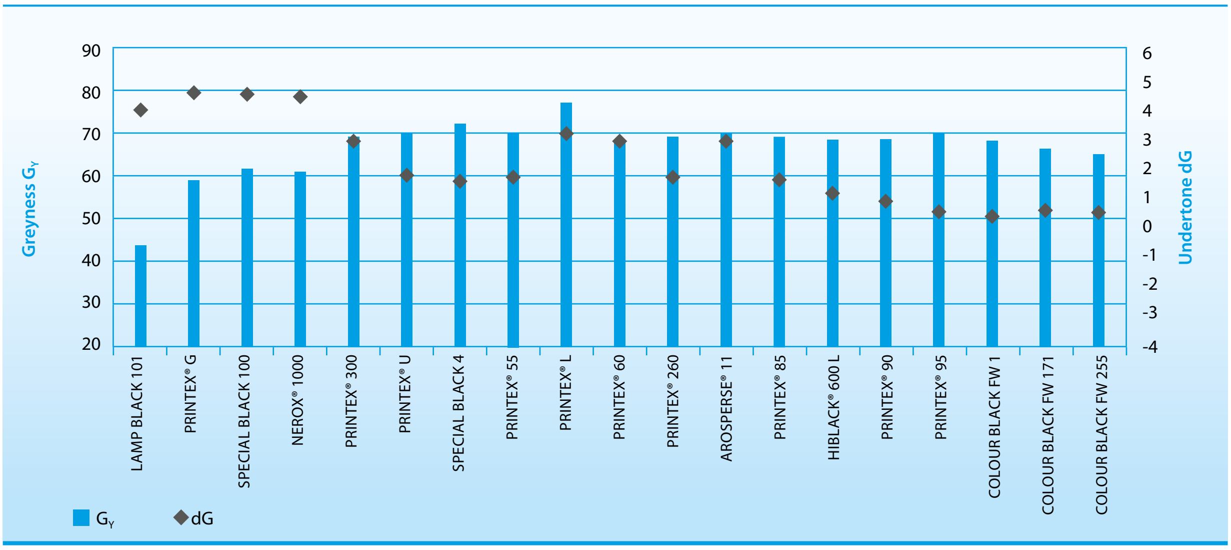


Figure 6

Greyness G_Y and undertone dG for the carboxyl-functional / TGIC powder coatings with titanium dioxide to specialty carbon black = 50:50

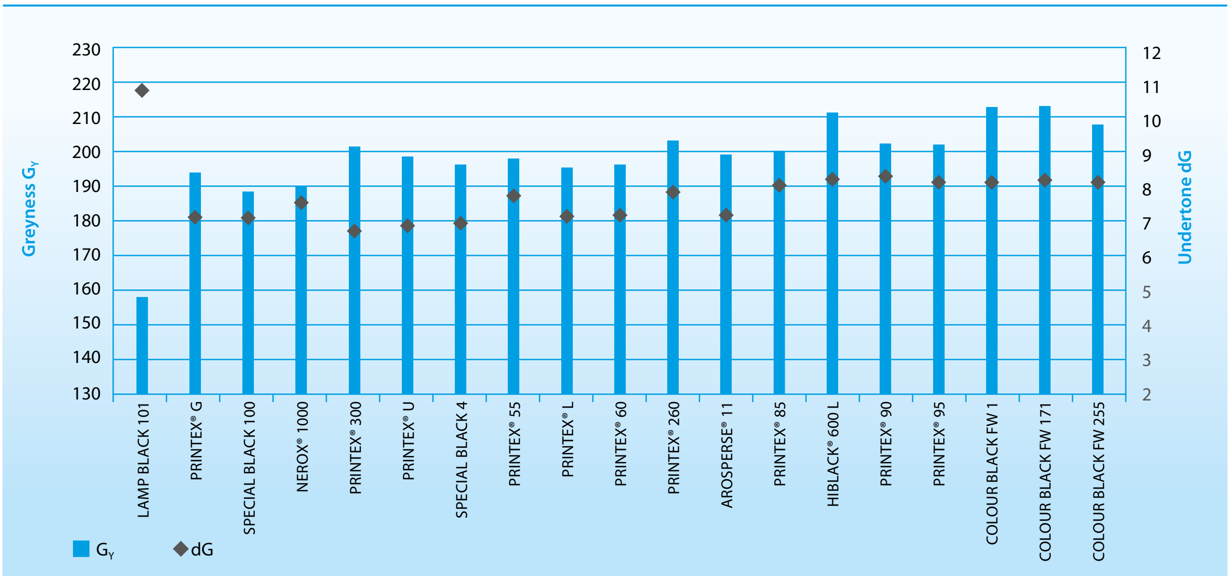


Figure 5 and 6 show the color performance in a carboxyl-functional polyester / TGIC system for tinting application.

In lighter grey shade (TiO_2: specialty carbon black = 98:2), the typical tinting grades with coarse mean primary particle size like LAMP BLACK 101, PRINTEX® G and SPECIAL BLACK 100 showed lower greyness G_Y but slightly more bluish undertone compared to evaluated specialty carbon blacks with finer mean primary particle sizes.

In darker grey shade (TiO_2: specialty carbon black = 50:50), especially LAMP BLACK 101 showed clearly lower greyness G_Y but combined with a strong bluish undertone. Highest greyness values combined with a bluish undertone were achieved with HIBLACK® 600L, COLOUR BLACK FW 1, COLOUR BLACK FW 171 and COLOUR BLACK FW 255.

Generally, color differences in tinting application for this powder coatings system are not as significant as in mass tone application and are mainly driven by the TiO_2 / specialty carbon black ratio.

6 Conclusions

A broad range of the most important specialty carbon blacks of Orion Engineered Carbons' portfolio were evaluated in three different powder coating formulations, predominantly found in the market – epoxy-hybrid, carboxyl-functional polyester / HAA and carboxyl-functional polyester / TGIC. The study's results were as follows:

The binder system has a strong impact on the resulting coloristic performance.

The use of beaded carbon blacks was advantageous due to low dust and better handling. No significant differences in coloristic performance have been found between beaded and powder version of the same grade.

To obtain opaque films, the thickness of the powder coating should be between 60 to 80 µm, the concentration of the carbon black should be 1 % to 2 %. Below a concentration of 1 %, the risk of transparent film increased, especially for coarser types of specialty carbon blacks.

For mass tone applications, where high jetness and bluish undertone were required, COLOUR BLACK FW 1, COLOUR BLACK FW 200, COLOUR BLACK FW 171 and COLOUR BLACK FW 255 were the pigments of choice.

For powder coatings mass tone application with medium- to high jetness levels, PRINTEX® 95, PRINTEX® 90, PRINTEX® 85, HIBLACK® 50L, HIBLACK® 600L and HIBLACK® 890 are recommended.

For low to medium jetness applications, PRINTEX® U, PRINTEX® 60, PRINTEX® 300, HIBLACK® 5L, the NEROX® types, PRINTEX® 45 and PRINTEX® 260 are suitable.

For tinting application, coarser types like PRINTEX® 60, PRINTEX® 300, HIBLACK® 5L and PRINTEX® 260 are recommended. If a strong bluish undertone is required, PRINTEX® G, HIBLACK® 160 and LAMP BLACK 101 showed the best results.

Based on the results from this study, after-treated grades do not provide coloristic benefits in comparison to non-after-treated grades. The use of after-treated specialty carbon blacks might improve the flow behavior and processability. In general, non-after-treated specialty carbon blacks give a better cost / performance ratio in powder coatings.

Focused. Innovative. Responsive.

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