

# WE KNOW BLACK.

## Coloristic Performance of Carbon Black in Powder Coatings

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## Agenda

- **Introduction to Orion Engineered Carbon**
- Carbon Black Morphology & Analysis
- Color theory- Particle size and coloristic value
- Coloristic performance of different types of carbon black in powder Coatings

# History



2011

**orion** ENGINEERED  
CARBONS

2007

 **EVONIK**  
INDUSTRIES

1930s-2007

**degussa.**  
*creating essentials*

**orion** ENGINEERED  
CARBONS

# OEC global production and applied technology network



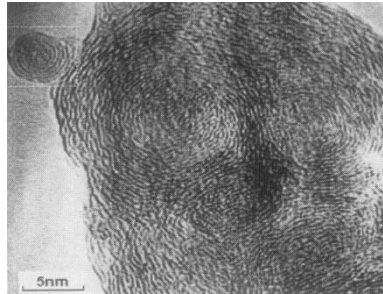
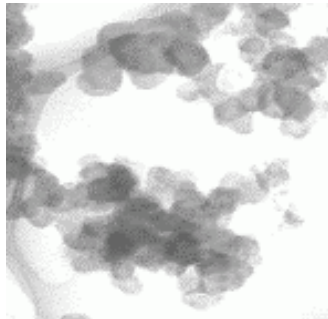
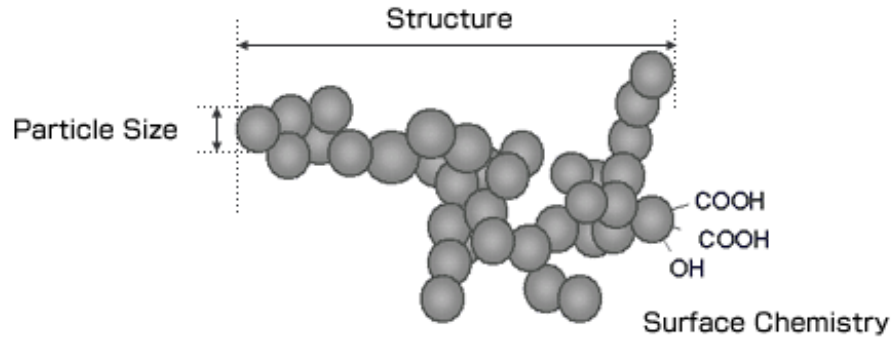


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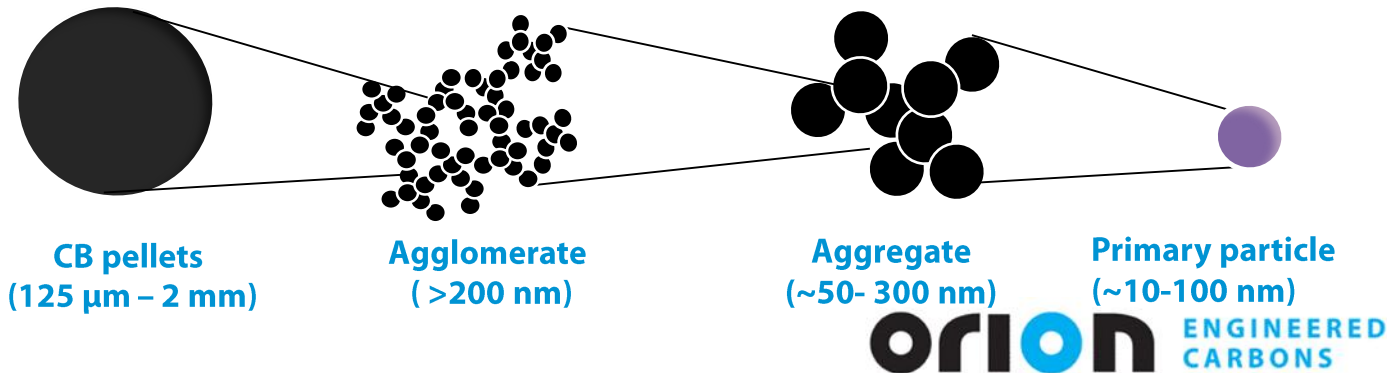
# What is Carbon Black?

- Carbon Black is 95 to 98% pure Carbon
- Properties are:
  - Particle Size
  - Structure
  - Surface Area
  - Surface Chemistry
- Multiple Types/Grades of Carbon Black



# Primary particles, aggregates and agglomerates

- Nearly spherical **primary particles** are physically fused together
- **Aggregates** are branched together and extremely stable against various mechanical and chemical treatment. They are the **smallest basic unit** in Carbon black particles . Aggregates are characterized by primary particle size, number of primary particles and spatial arrangement of primary particles in aggregates.
- Aggregates are loosely bonded into **agglomerates**. Size, shape and tap density are depending on the actual state (powder, beads or state of dispersion in a matrix ). Agglomerates can be **separated to aggregates during mechanical dispersion treatments** such as mixing, with certain shear forces.





# Primary Particles, Aggregates and Structure

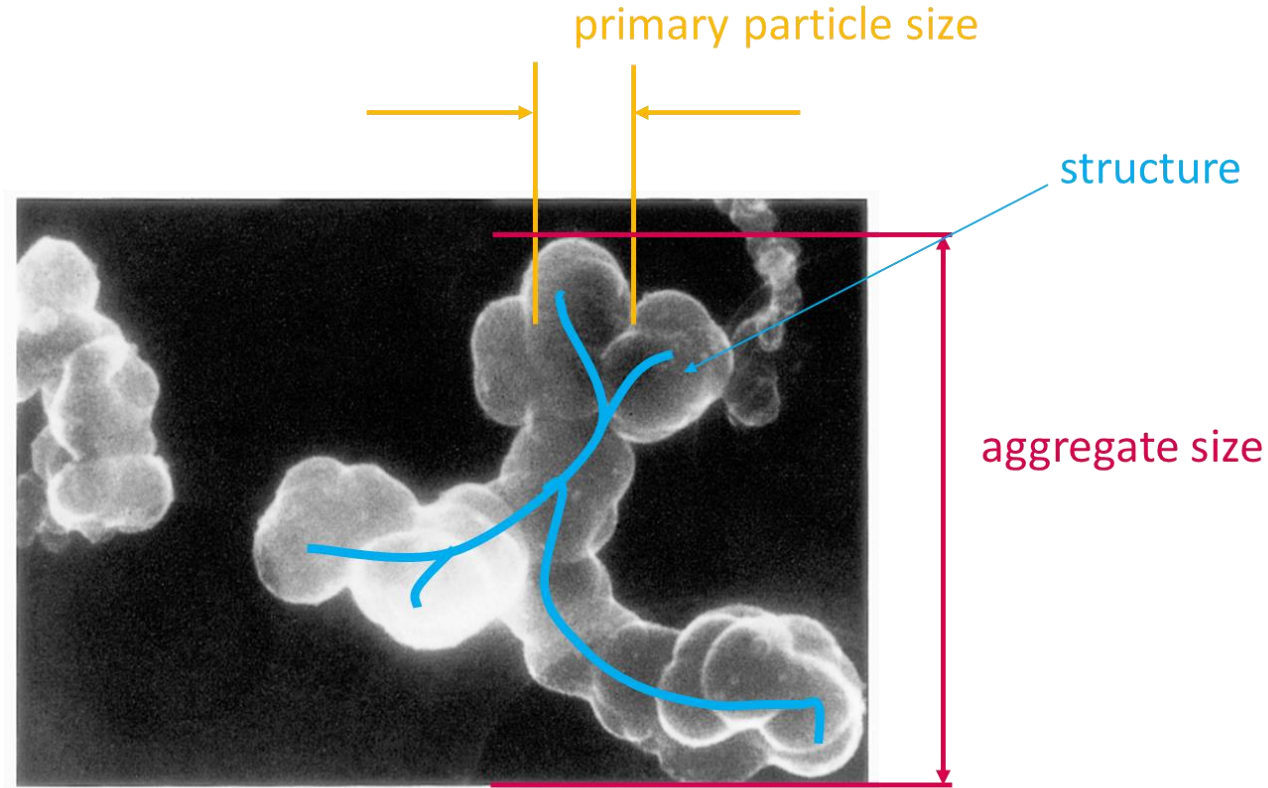
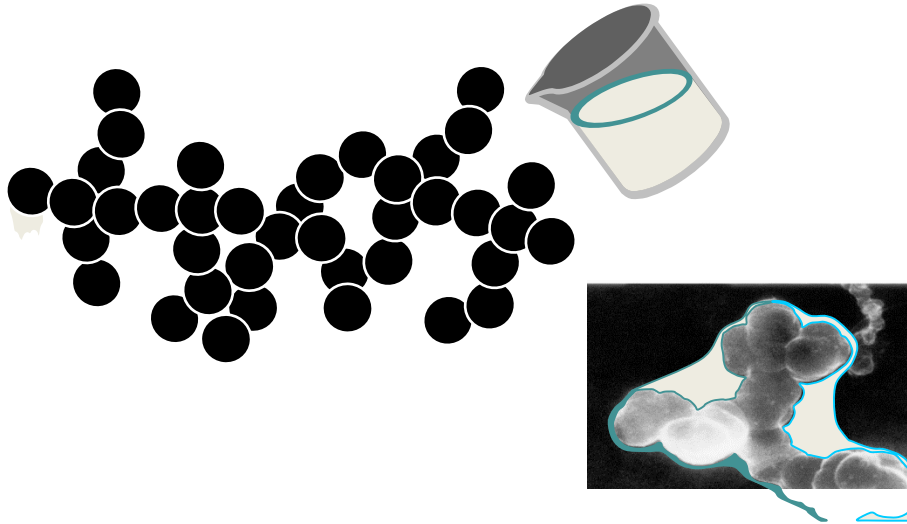


Image: Field Emission Scanning Electron Microscope - Method



# Structure (OAN Number)

The Carbon Black **structure** describes in general the branching and clustering of primary particles ,can be identified by **Oil Absorption Number (OAN)**



Oil Absorption Number testing machine

→ The OAN is representing the void volume of aggregates and is defined as the amount of oil needed to absorb 100g of Carbon Black [ml/100g]

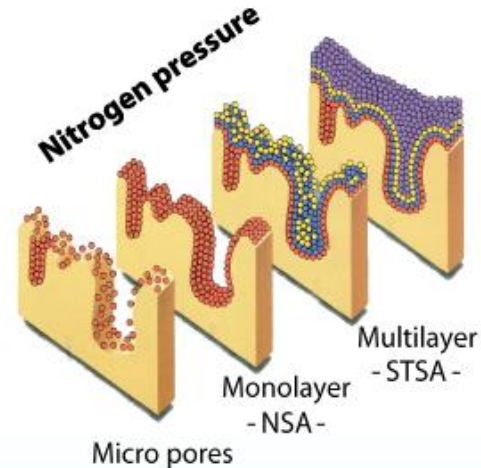
# Primary particle size and specific surface area

## Primary particle size

Transmission Electron Microscopy (TEM)

## Specific surface area

NSA - specific surface (BET), STSA – statistical thickness surface area, Iodine number



**Note:** Nitrogen (BET) surface area ( $\text{m}^2/\text{g}$ ) may be used as an indicator of relative particle size. In general, particle size is inversely related to the BET surface-area.

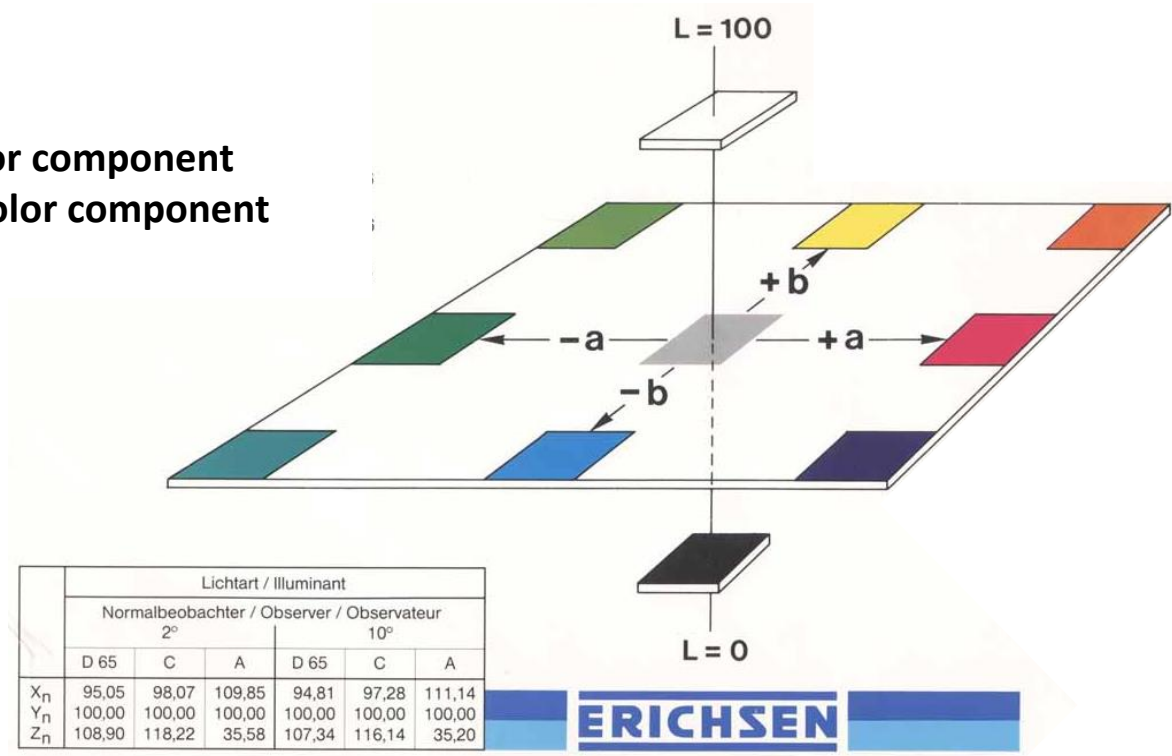


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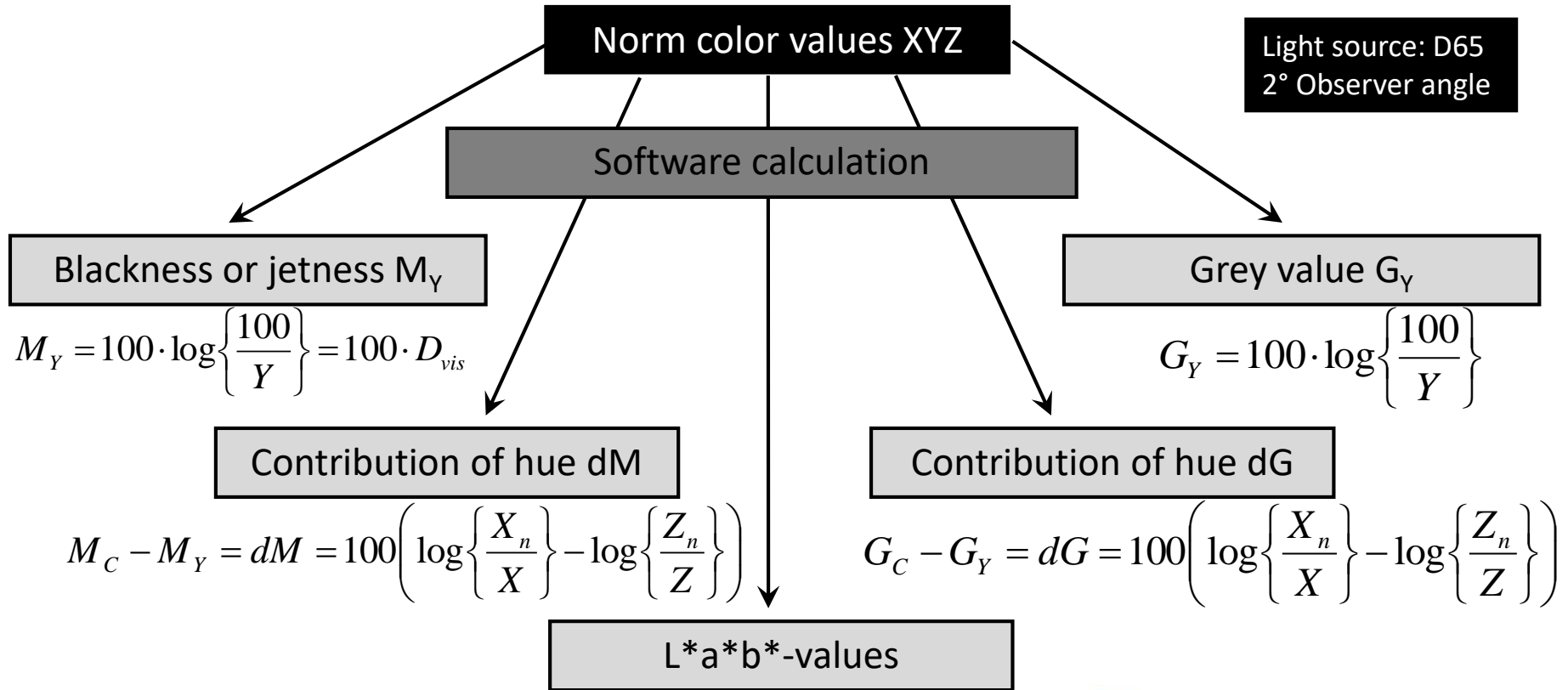
# LAB Color Space – Cartesian Coordinates

$L^*$  = lightness  
 $a^*$  = red-green color component  
 $b^*$  = yellow-blue color component

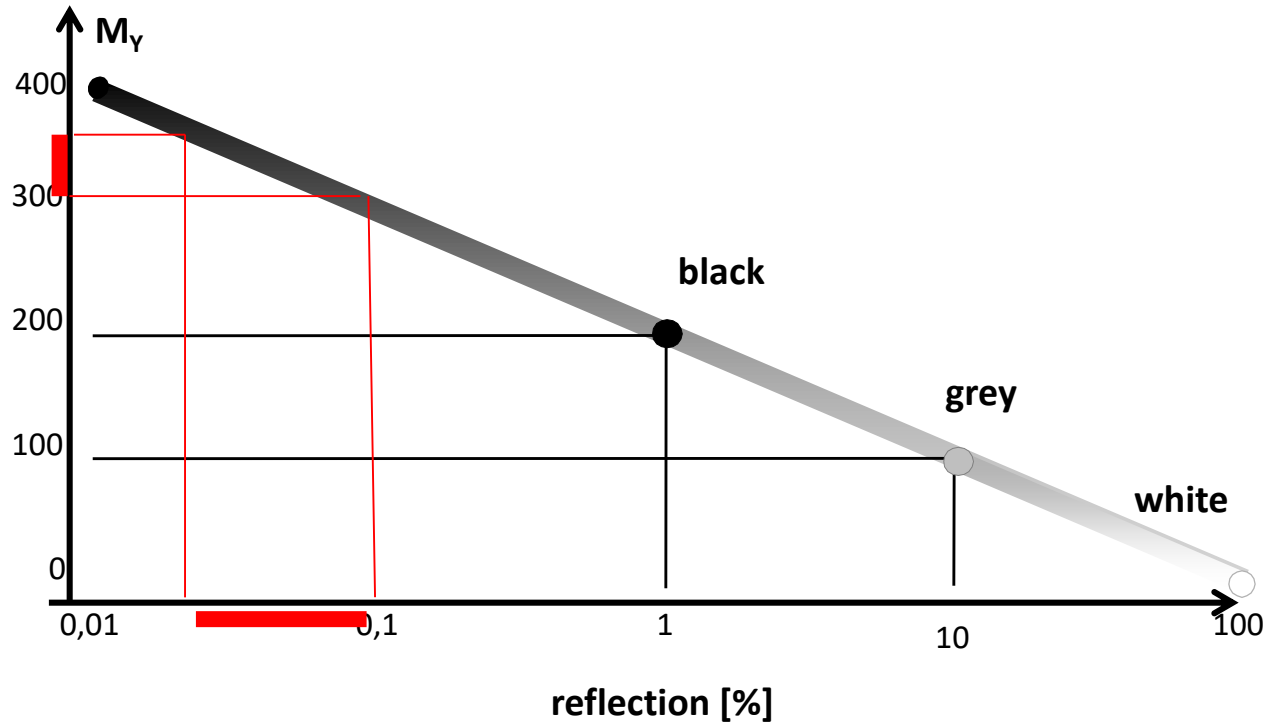


**ERICHSEN**

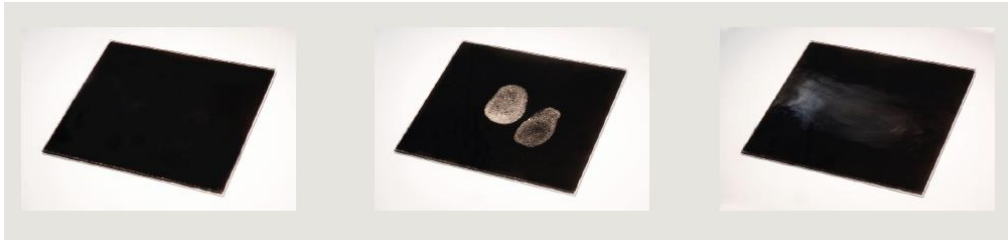
# Calculation of coloristic for coatings



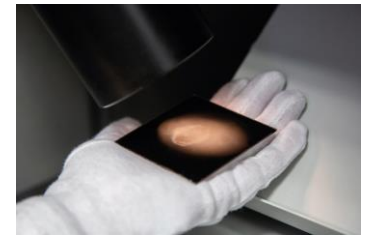
# Jetness $M_Y$ as a function of reflection



# Measuring blackness on a scientific level



- Great demands on sample preparation as well as the measurement technology and calibration.
- The use of calibration plates usually does not suffice, as they are not black enough. Instead, a so-called black hollow body, which absorbs virtually all the light, is used.
- As deep black can only be measured on high-gloss and clean plates, any contaminants must be very thoroughly removed and the plates must be absolutely free of scratches, finger prints before measuring.
- $45^{\circ}/0^{\circ}$  device to be preferred compared to  $d/8^{\circ}$  device if highest jetness is being measured.  $d/8^{\circ}$  leads to higher values, but is not reproducible.

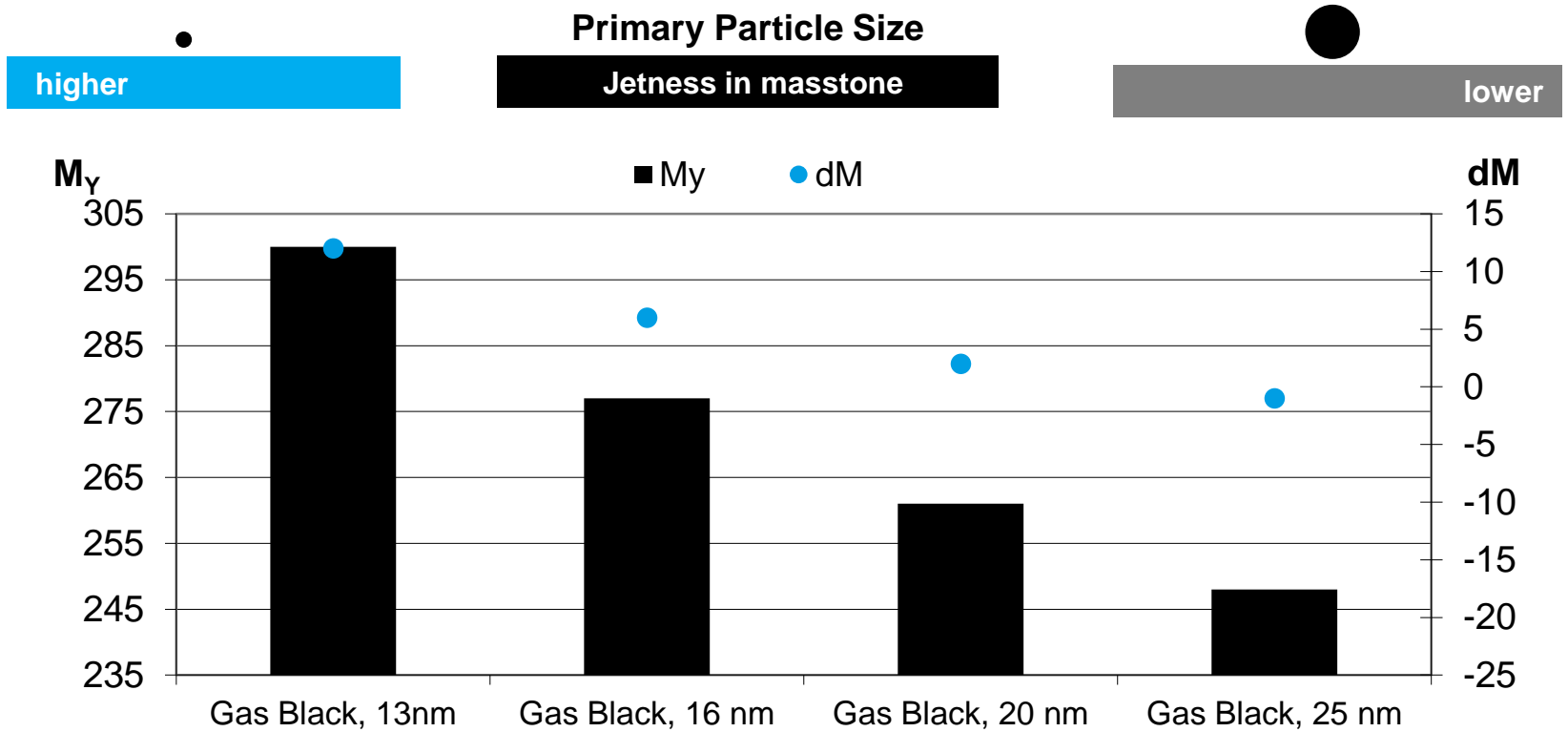




# Measurement values using different devices

45°/0°	X	Y	Z	M <sub>y</sub>	dM
Plate 1	0,4985	0,5220	0,5156	228	-3,9
Plate 2	0,0957	0,1010	0,1026	300	-2,4
Plate 3	0,0258	0,0283	0,0374	355	10,6
Plate 4	0,0237	0,0248	0,0308	361	6,0
d/8° Measurement without gloss (gloss trap open)	X	Y	Z	M <sub>y</sub>	dM
Plate 1	0,4725	0,4973	0,4928	230	-3,6
Plate 2	0,0878	0,0938	0,0967	303	-1,2
Plate 3	0,0169	0,0187	0,0290	373	18,0
Plate 4	0,0171	0,0183	0,0258	374	12,4
d/8° Measurement with gloss (gloss trap closed)	X	Y	Z	M <sub>y</sub>	dM
Plate 1	4,3771	4,6215	4,9224	134	-0,3
Plate 2	3,9904	4,2192	4,5352	137	0,2
Plate 3	4,4093	4,6693	5,1565	133	1,4
Plate 4	3,9832	4,2121	4,5404	138	0,3

# Correlation between primary particle size and jetness



Alkyd/Melamine stoving enamel

The coloristic data are for guidance purposes only.

# Primary particle size as key parameter

Small primary particle size



more
lower
harder
higher
higher
bluish
brownish/reddish

Amount of binder
CB concentration in mill base
Dispersibility
Jetness
Tinting strength
Undertone (masstone)
Undertone (transparent or grey coatings)

Big primary particle size



less
higher
easier
lower
lower
brownish/reddish
bluish



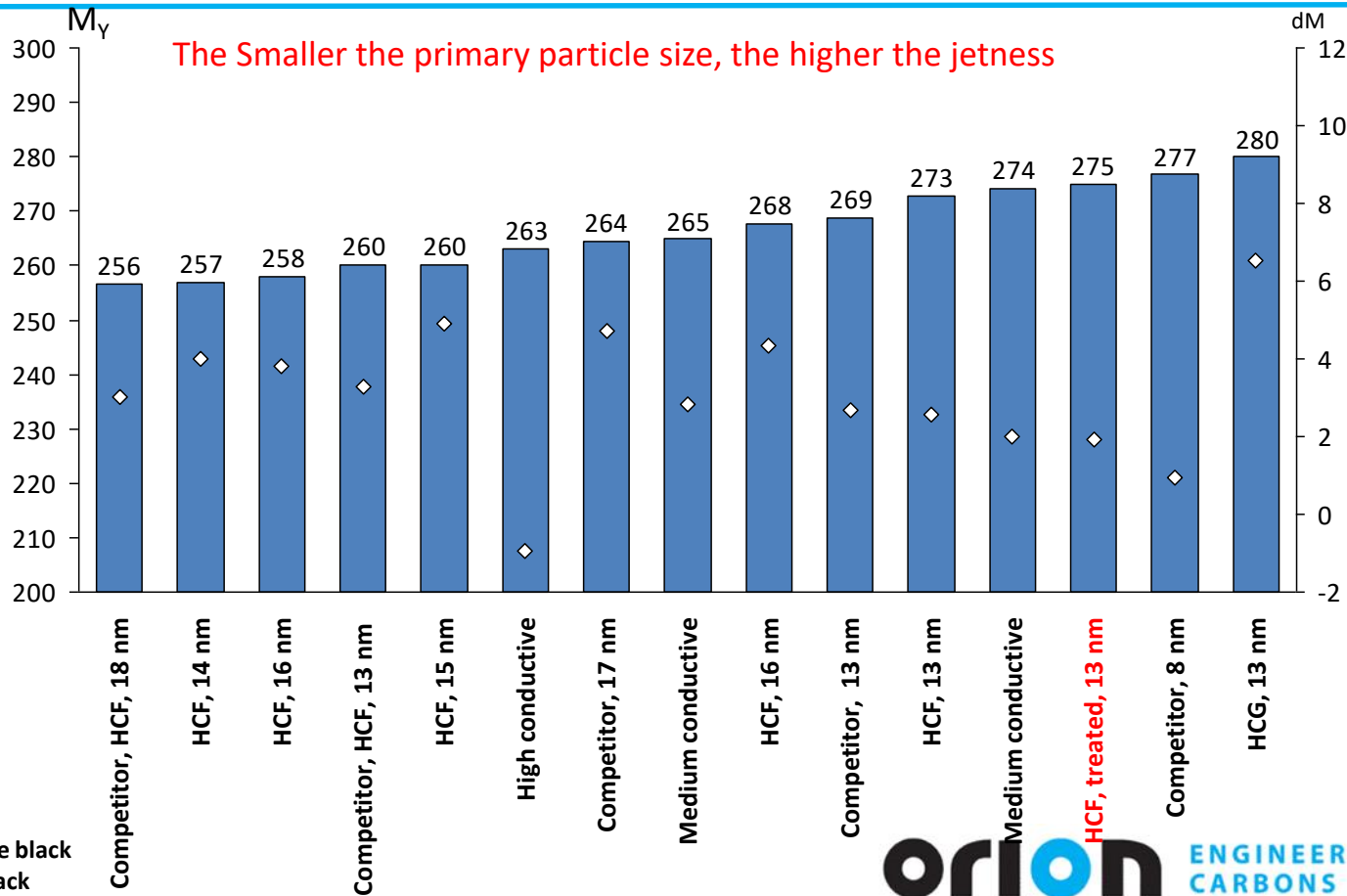
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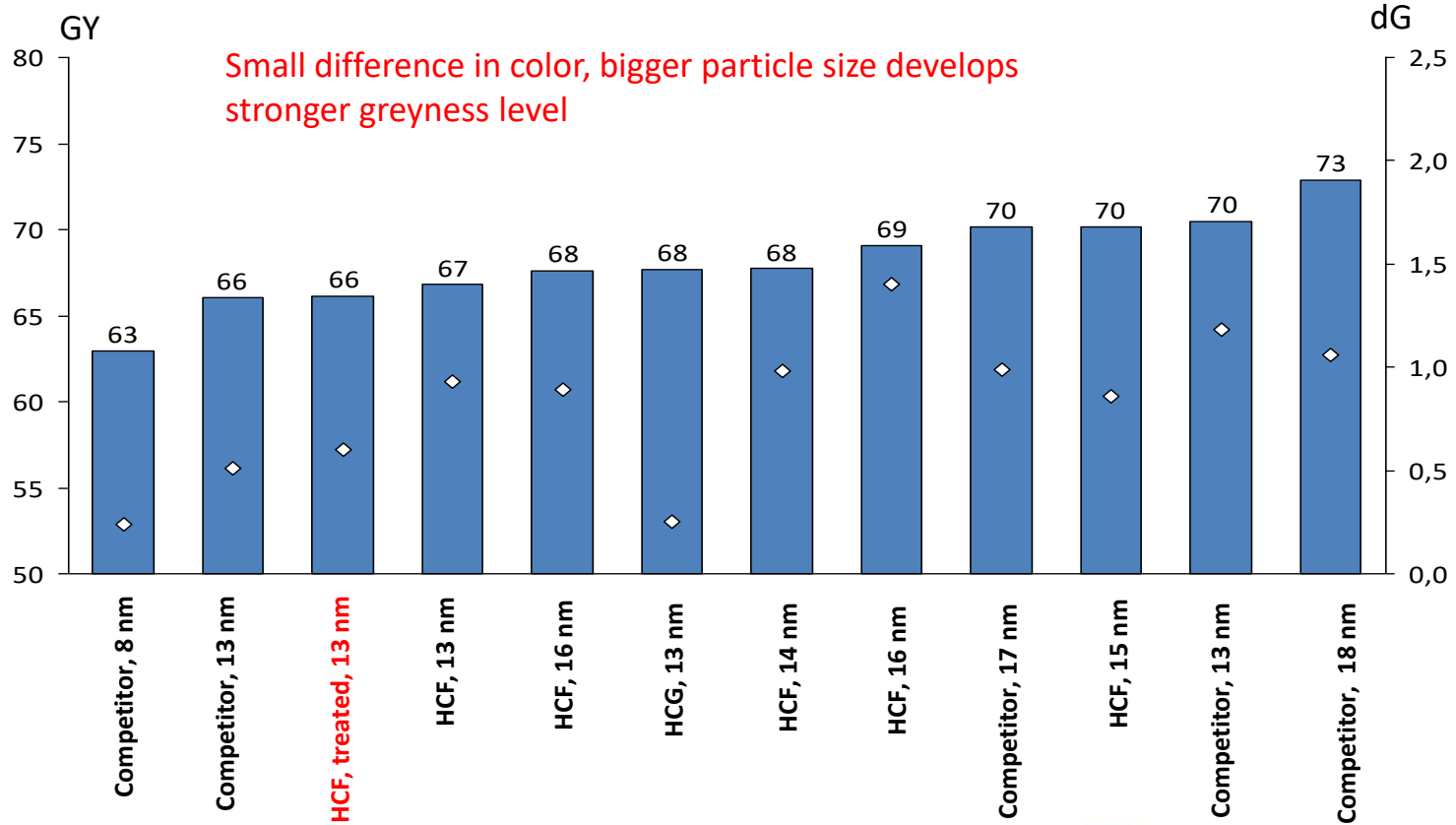
# Carboxyl-functional Polyester / TGIC System

Ingredients		Full Tone	White Reductions	
			98/2	50/50
		[%]	[%]	[%]
Specialty Carbon Black	Various grades	1.00	0.20	1.00
Titanium Dioxide	Ti-Pure™ R-706	0.00	9.80	1.00
Resin (carboxylated polyester)	CRYLCOAT® 2471	81.38	73.00	80.45
Flow/Levelling agent	Resiflow P-67	1.00	1.00	1.00
Crosslinker	TGIC	6.12	5.50	6.05
Air-release agent	Benzoin	0.50	0.50	0.50
Barium Sulfate (brightener/extender)	Huberbrite® 1	10.00	10.00	10.00
<b>Total</b>		<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

# Full tone- High Jet Carbon Black- Polyester/ TGIC



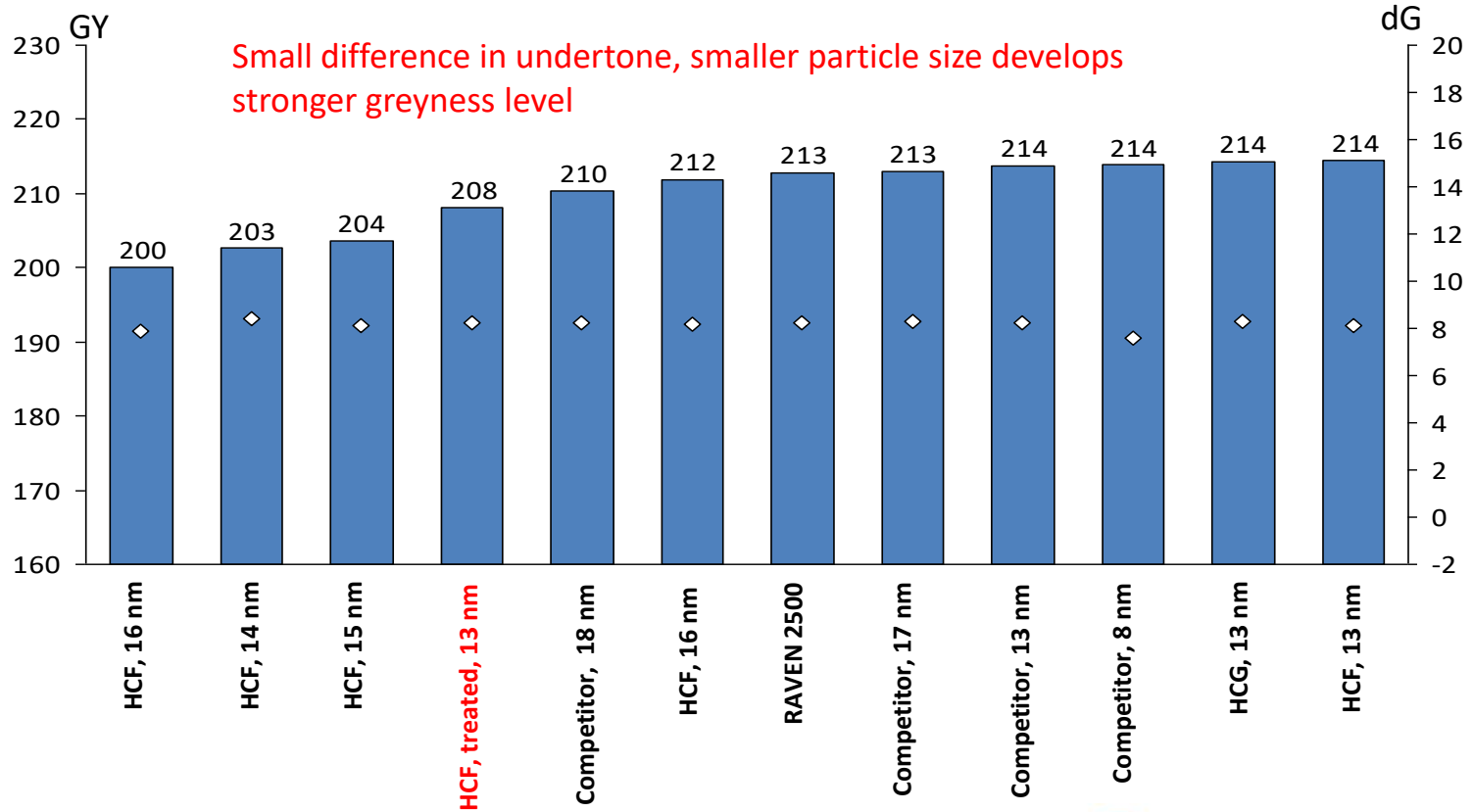
# Tinting 98:2- High Jet Carbon Black- Polyester/ TGIC



HCF= high color furnace black  
HCG= high color gas black

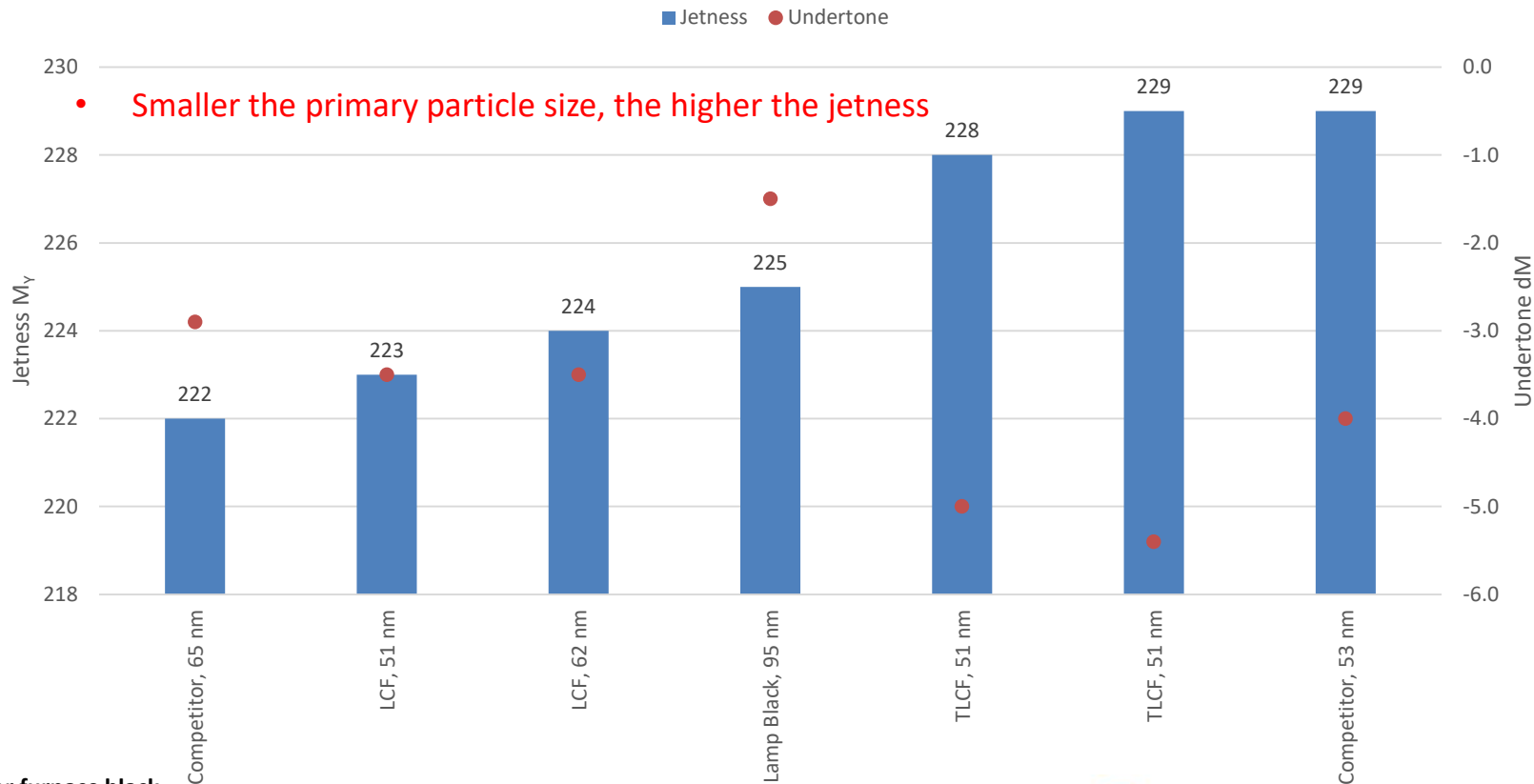


# Tinting 50:50- High Jet Carbon Black- Polyester/ TGIC



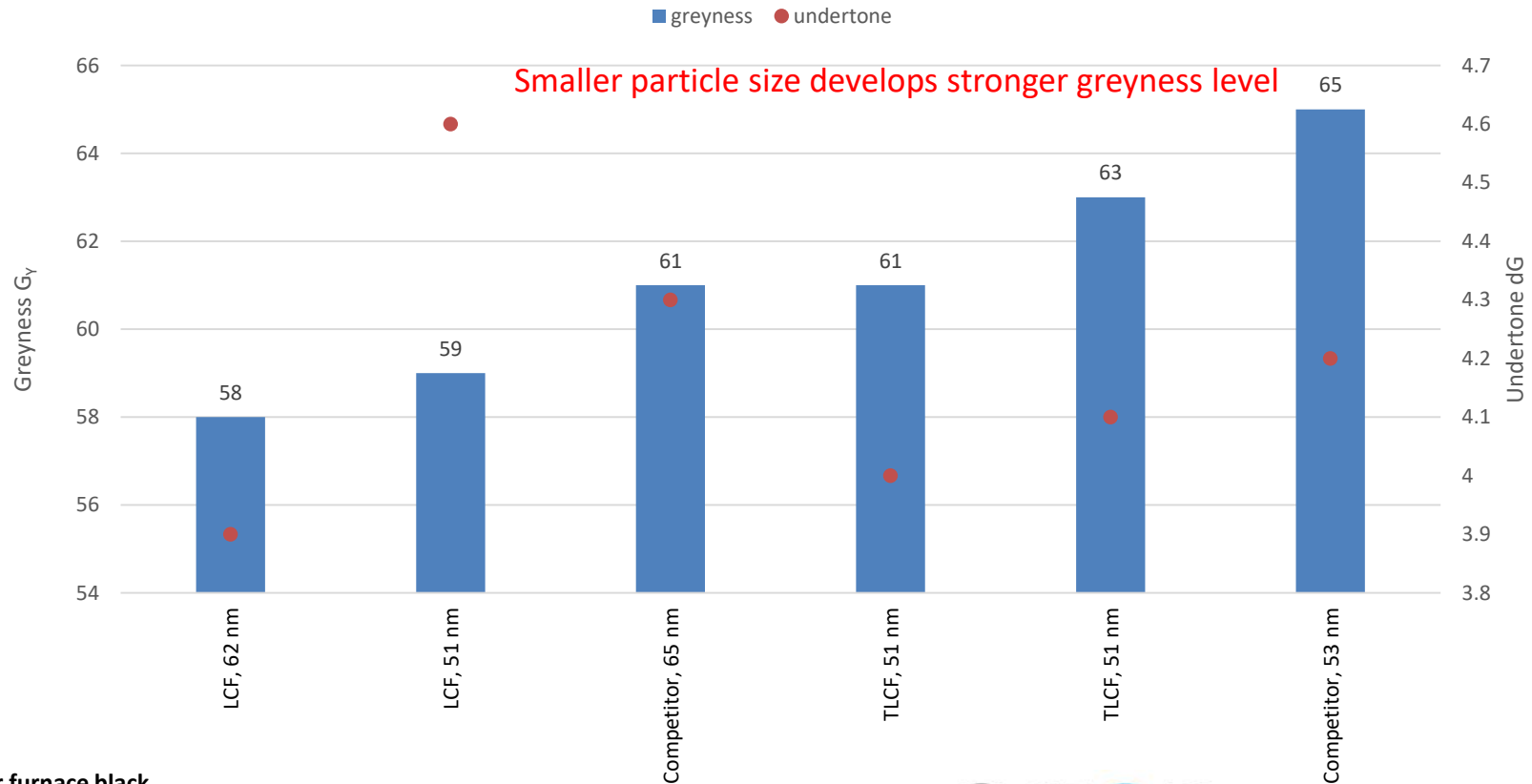
HCF= high color furnace black  
HCG= high color gas black

# Full Tone- Low Jet Carbon Black- Polyester/ TGIC



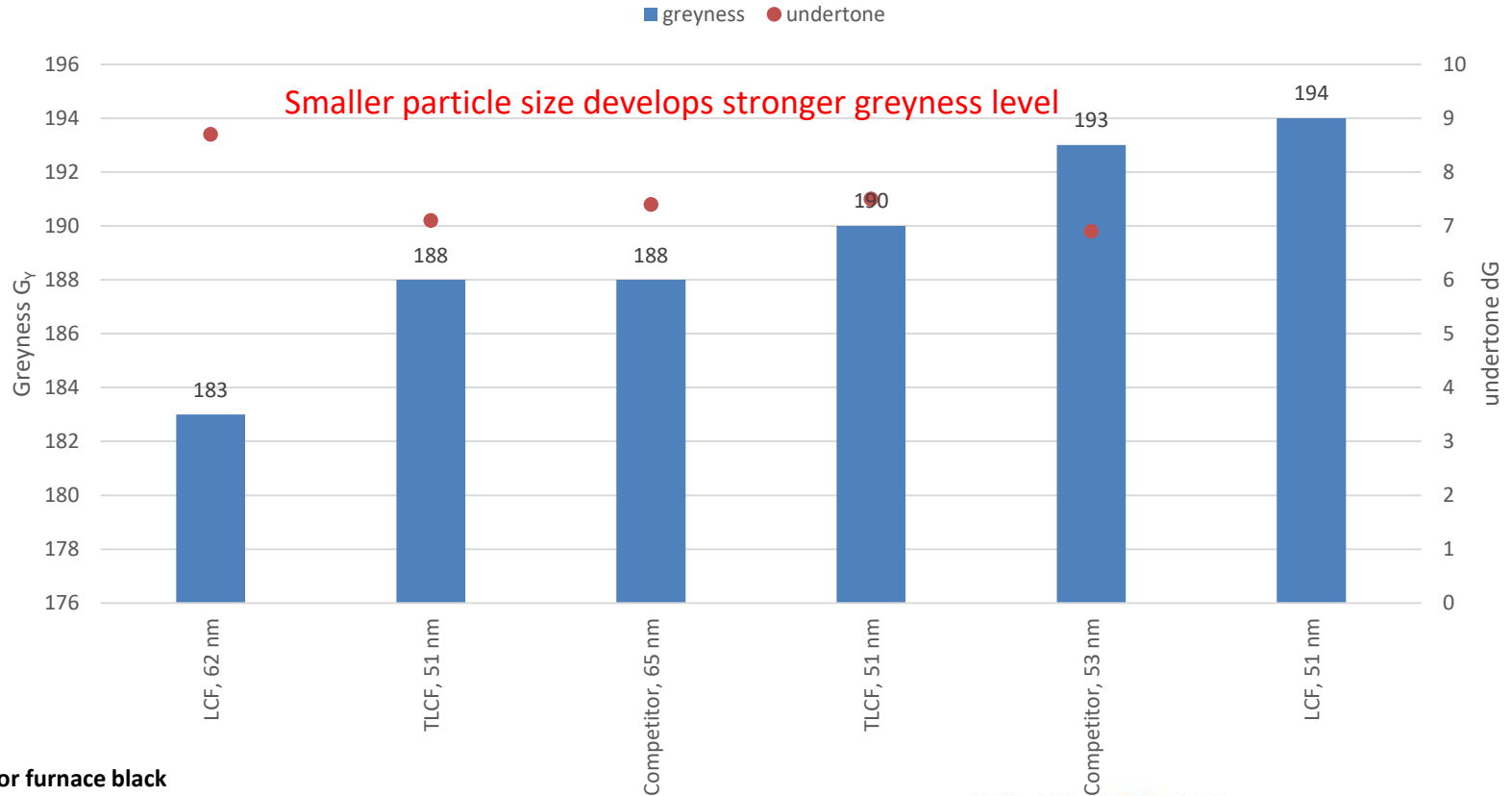
LCF= Low color furnace black  
TLCF= treated low color  
furnace black

# Tinting 98:2- Low Jet Carbon Black- Polyester/ TGIC



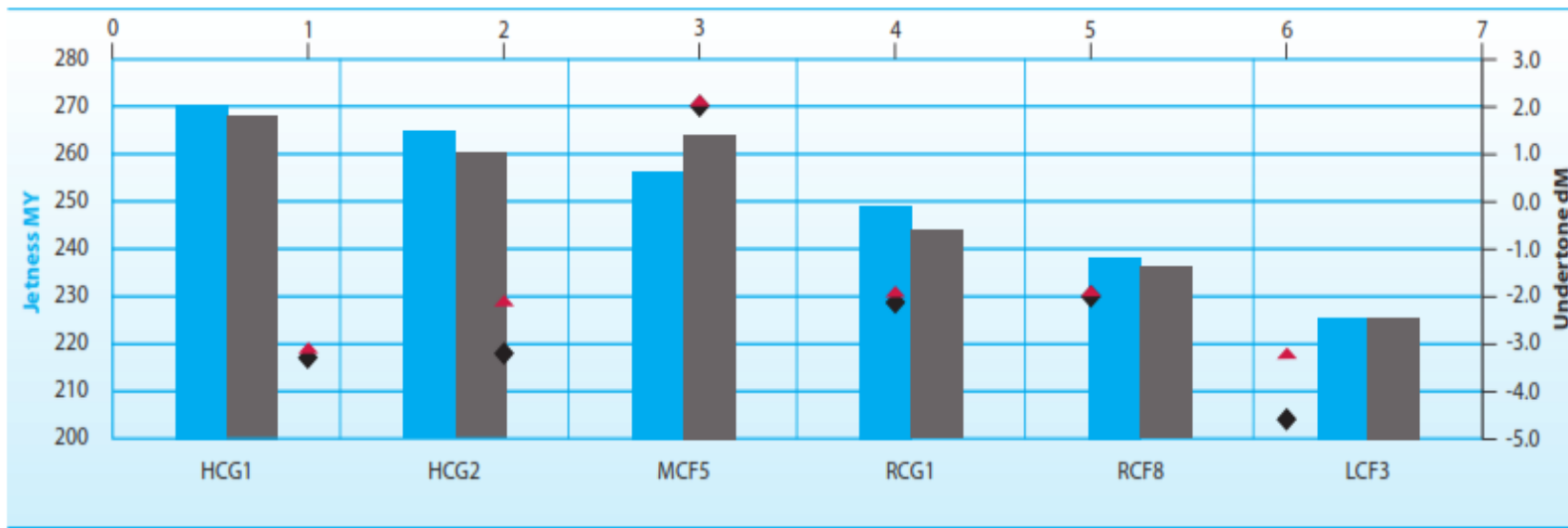
LCF= Low color furnace black  
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# Tinting 50:50- Low Jet Carbon Black- Polyester/ TGIC



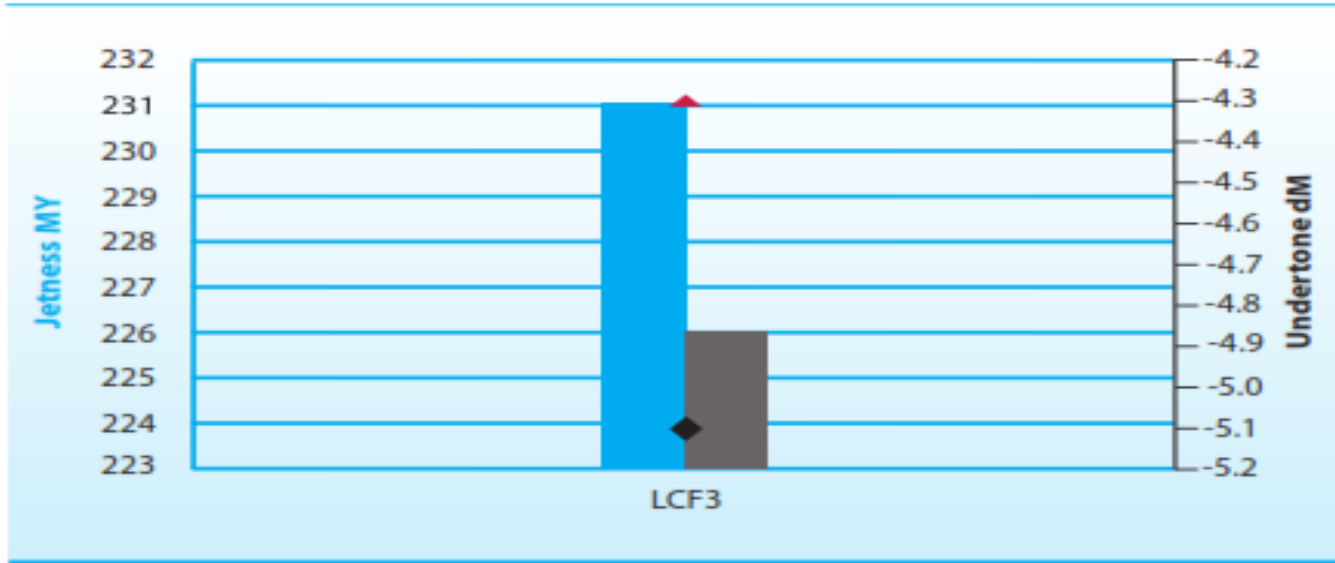
LCF= Low color furnace black  
TLCF= treated low color  
furnace black

# Beads Versus Powder



- Jetness MY (bar) powder @ 1.5% CB loading
- Jetness MY (bar) beads @ 1.5% CB loading
- Undertone dM (diamond) powder @ 1.5% CB loading
- Undertone dM (triangle) beads @ 1.3% CB loading

## Same carbon black- different resin systems



- Jetness MY (bar) @ 0.8% CB loading in epoxy hybrid
- Jetness MY (bar) @ 1.0% CB loading in polyester
- ◆ Undertone dM (diamond) @ 0.8% CB loading in epoxy hybrid
- ▲ Undertone dM (triangle) @ 1.0% CB loading in polyester

## Findings-

- In full tone, the most decisive factor in color properties is particle size → the smaller, the higher the jetness
- Gas black with natural high structure provide better processing of the pigment
- In tinting applications, the color differences are much smaller, driven primarily by the  $\text{TiO}_2$ /SCB ratio
- After-treatment typically does not provide a benefit in coloristic performance
  - non-after-treated grades give better cost / performance ratio



## Findings-

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- Beads and powder forms of the same carbon black grade show no difference in the coloristic performance of the system
- Binder systems have a great impact on the color properties of the carbon black in powder coatings

**Thank you very much for your  
attention.**