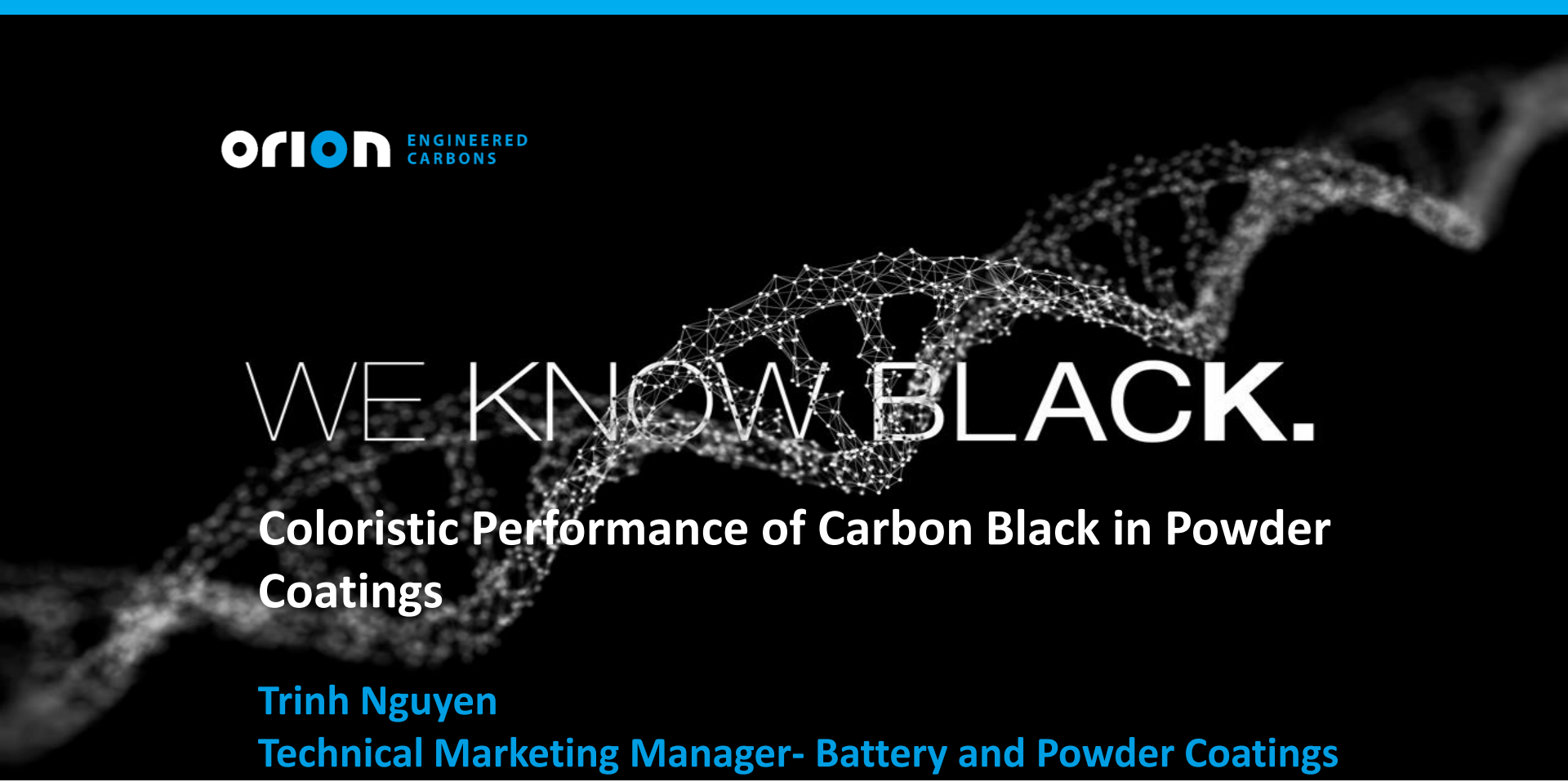

Coloristic Performance of Carbon Black in Powder Coatings

Trinh Nguyen
Technical Marketing Manager- Battery and Powder Coatings

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

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History

2011 orion ENGINEERED CARBONS

2007 EVONIK INDUSTRIES

1930s-2007 degussa. creating essentials

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OEC global production and applied technology network

14 Production Sites – 4 Technical Centers – 1,441 Employees –

2017: 1.18 bn € Sales – Sold Quantity of 1,087,000 tons

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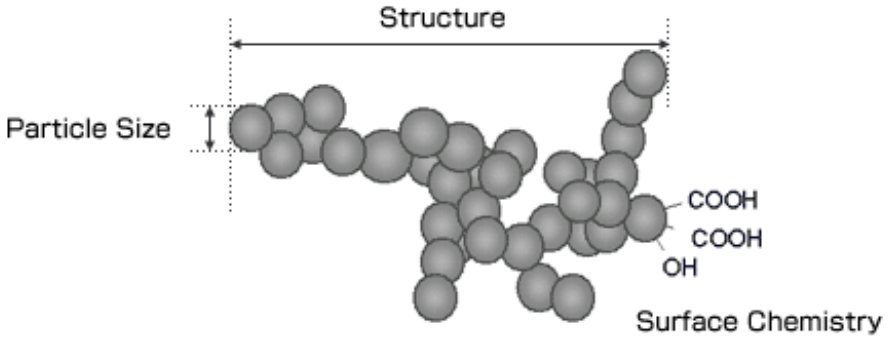
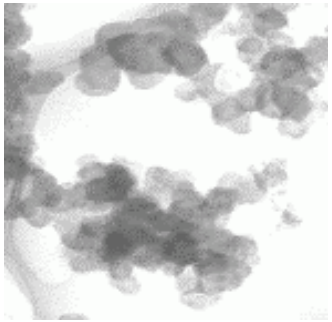
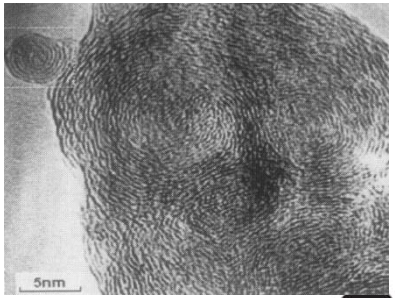
What is Carbon Black?

- Carbon Black is 95 to 98% pure Carbon
- Properties are:
  - Particle Size
  - Structure
  - Surface Area
  - Surface Chemistry



- Multiple Types/Grades of Carbon Black





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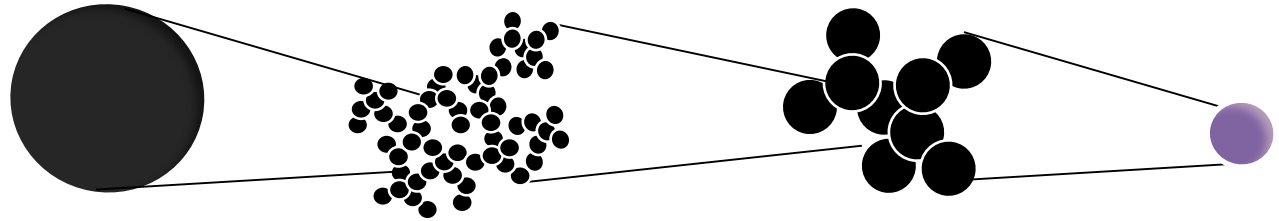
Primary particles, aggregates and agglomerates

- 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.



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Primary Particles, Aggregates and Structure

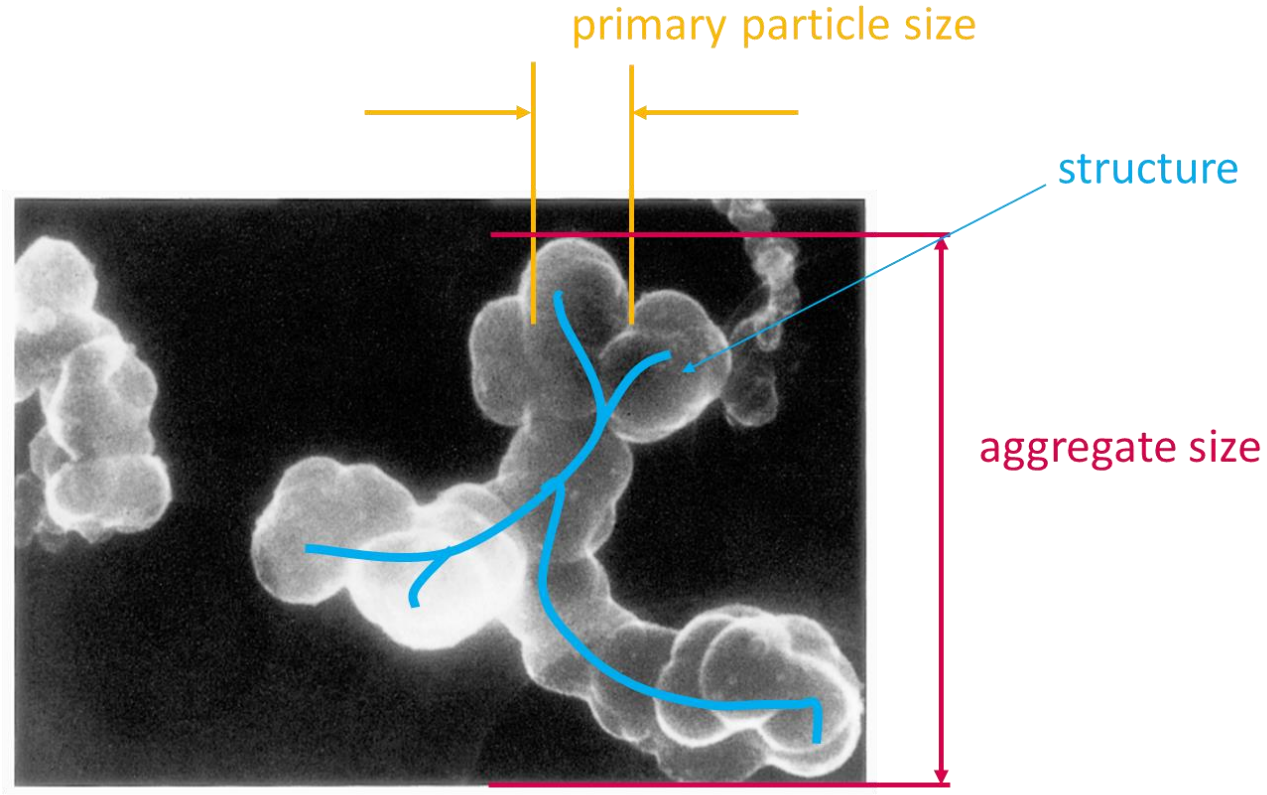

Image: Field Emission Scanning Electron Microscope - Method

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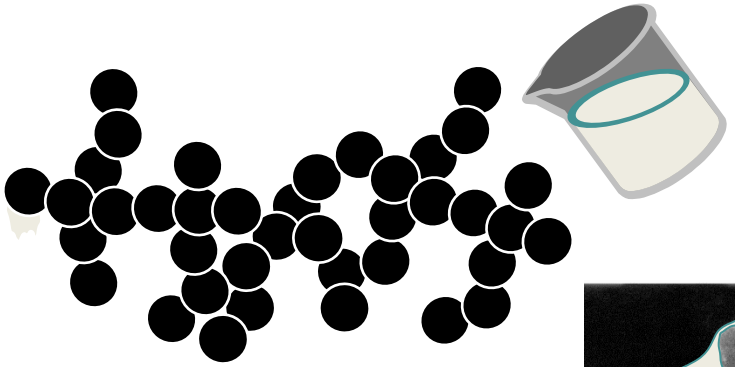
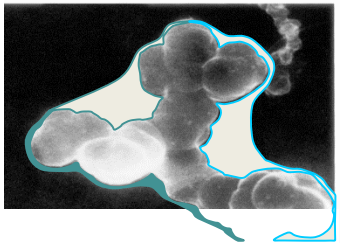
Structure (OAN Number)

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]

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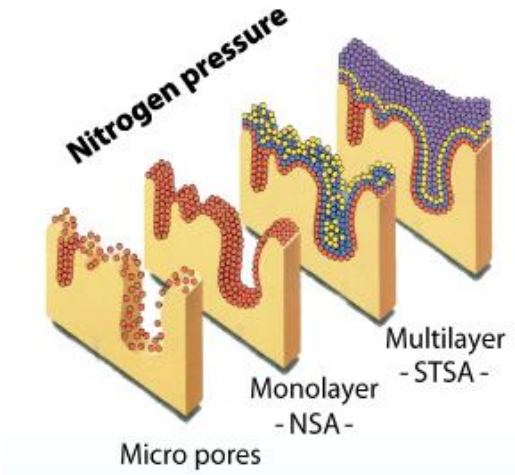
Primary particle size and specific surface area

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 (m^2/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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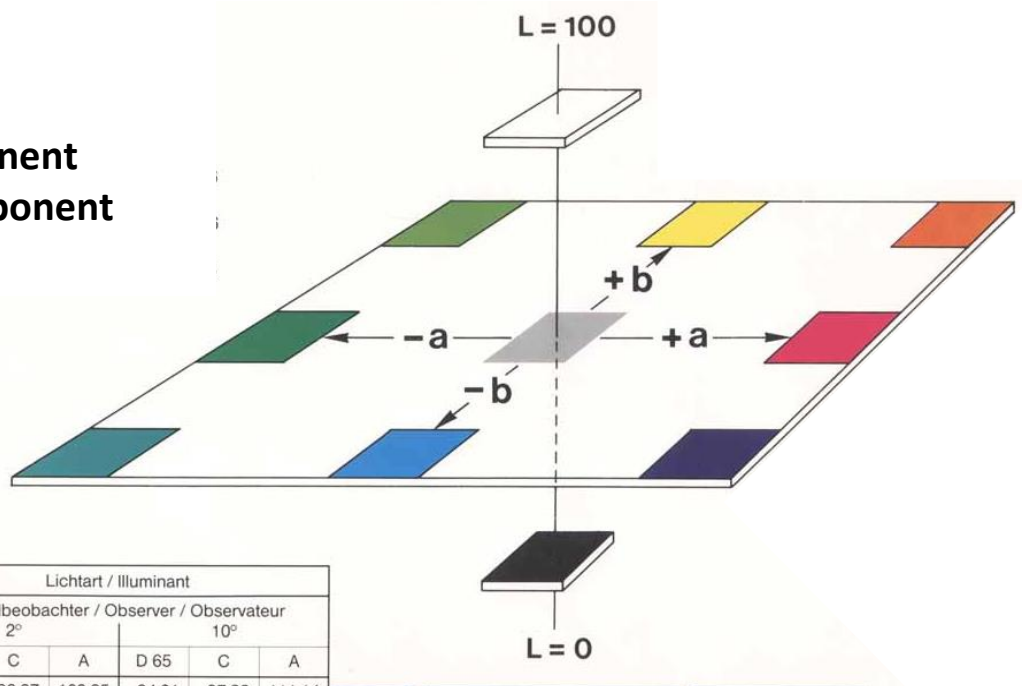
LAB Color Space – Cartesian Coordinates

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



	Lichtart / Illuminant					
	Normalbeobachter / Observer / Observateur 2°			10°		
	D 65	C	A	D 65	C	A
X_n	95,05	98,07	109,85	94,81	97,28	111,14
Y_n	100,00	100,00	100,00	100,00	100,00	100,00
Z_n	108,90	118,22	35,58	107,34	116,14	35,20

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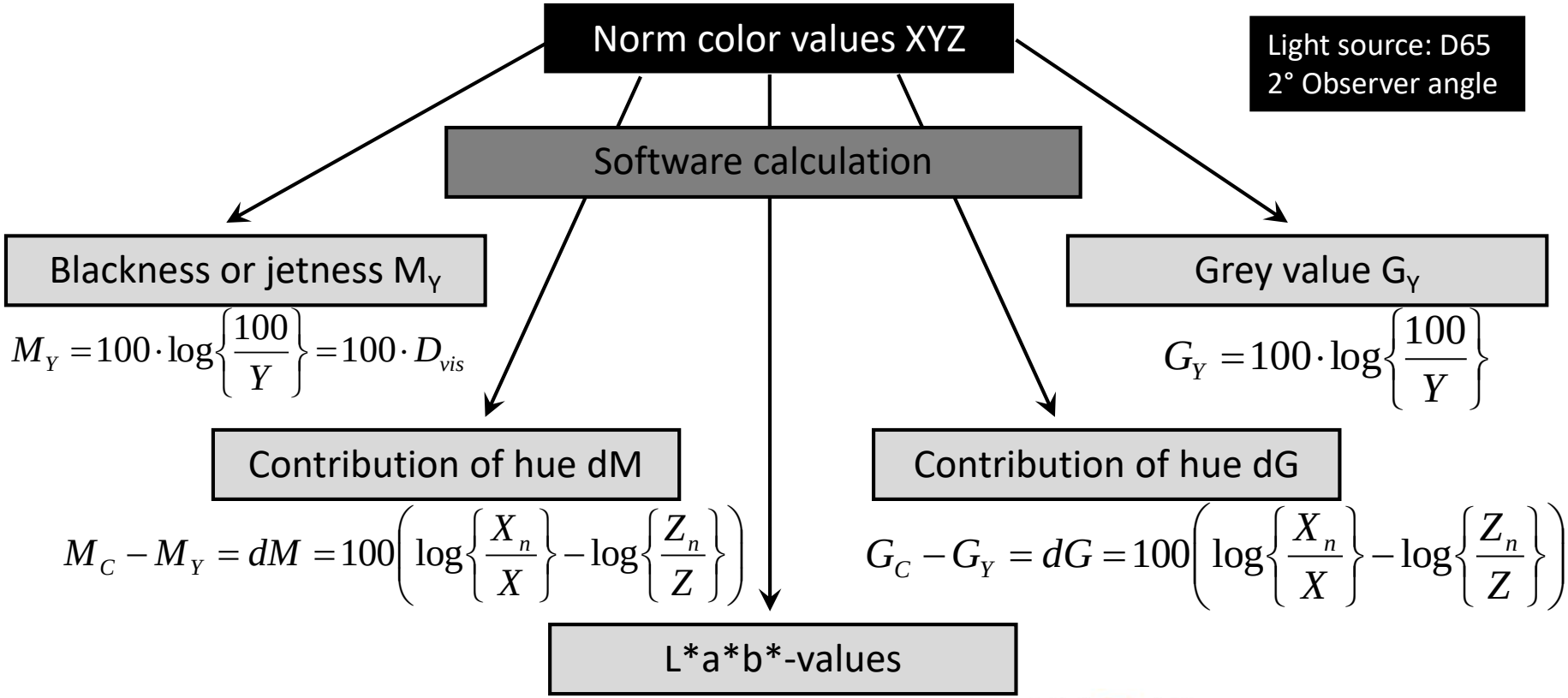
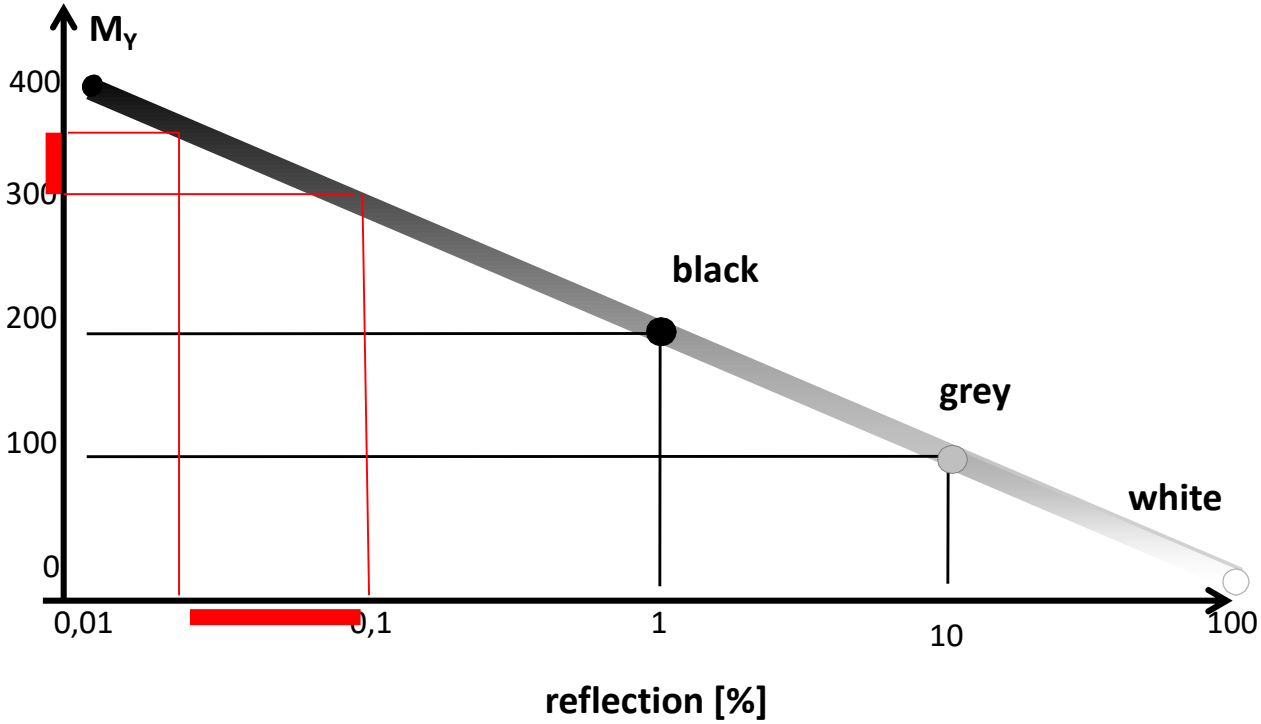
Calculation of coloristic for coatings



Jetness M_Y as a function of reflection



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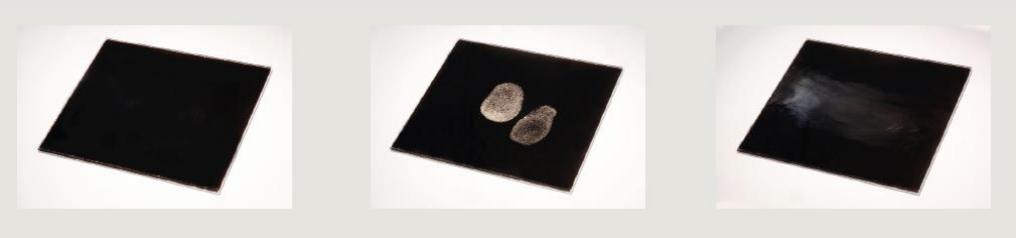
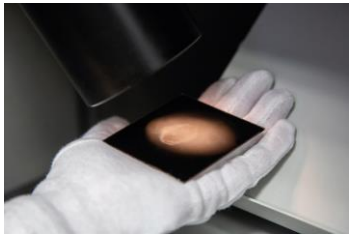
Measuring blackness on a scientific level



- 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°/0° device to be preferred compared to d/8° device if highest jetness is being measured. d/8° leads to higher values, but is not reproducible.



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Measurement values using different devices

45°/0°	X	Y	Z	M_Y	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_Y	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_Y	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

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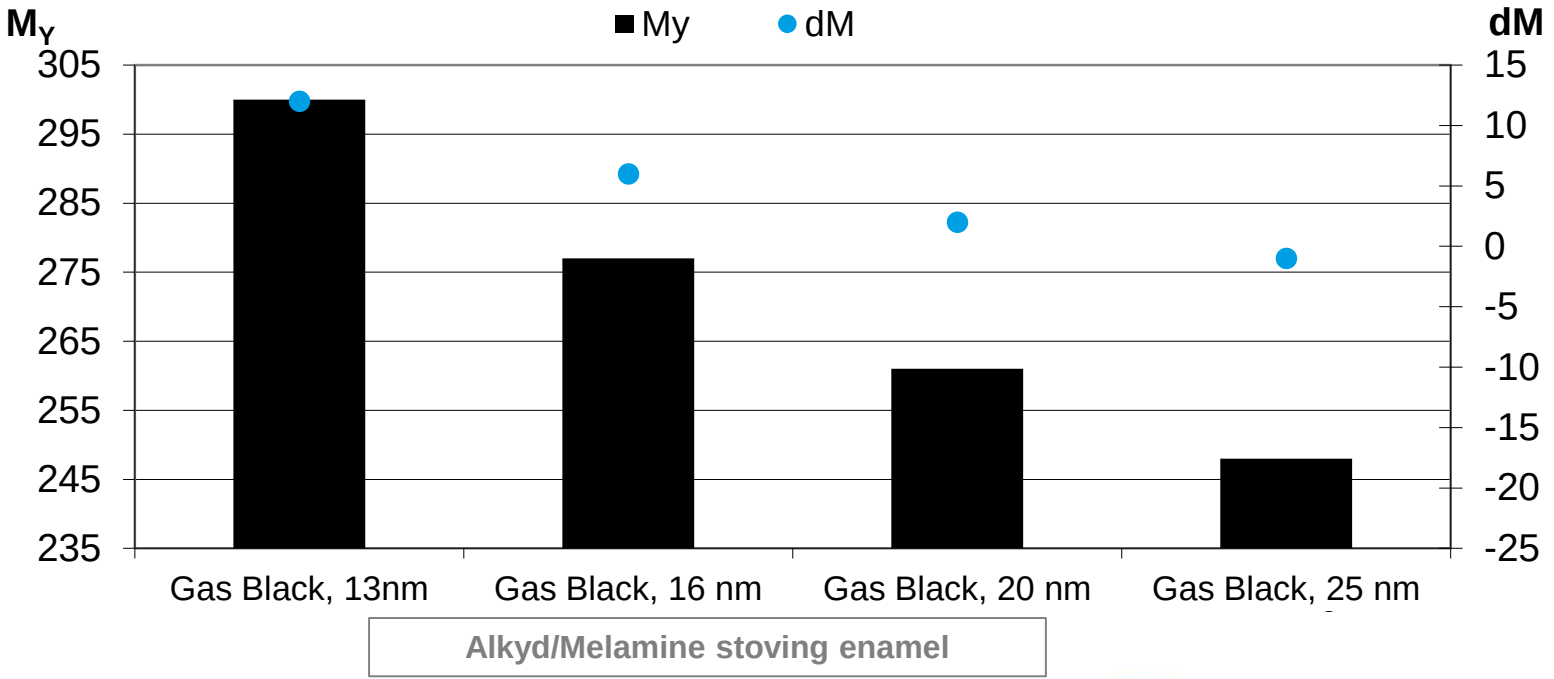
Correlation between primary particle size and jetness

Primary Particle Size

higher — **lower**

Jetness in masstone



Alkyd/Melamine stoving enamel

The coloristic data are for guidance purposes only.

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Primary particle size as key parameter

Small primary particle size		Big primary particle size
more	Amount of binder	less
lower	CB concentration in mill base	higher
harder	Dispersibility	easier
higher	Jetness	lower
higher	Tinting strength	lower
bluish	Undertone (masstone)	brownish/reddish
brownish/reddish	Undertone (transparent or grey coatings)	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
Total		**100.00**	**100.00**	**100.00**

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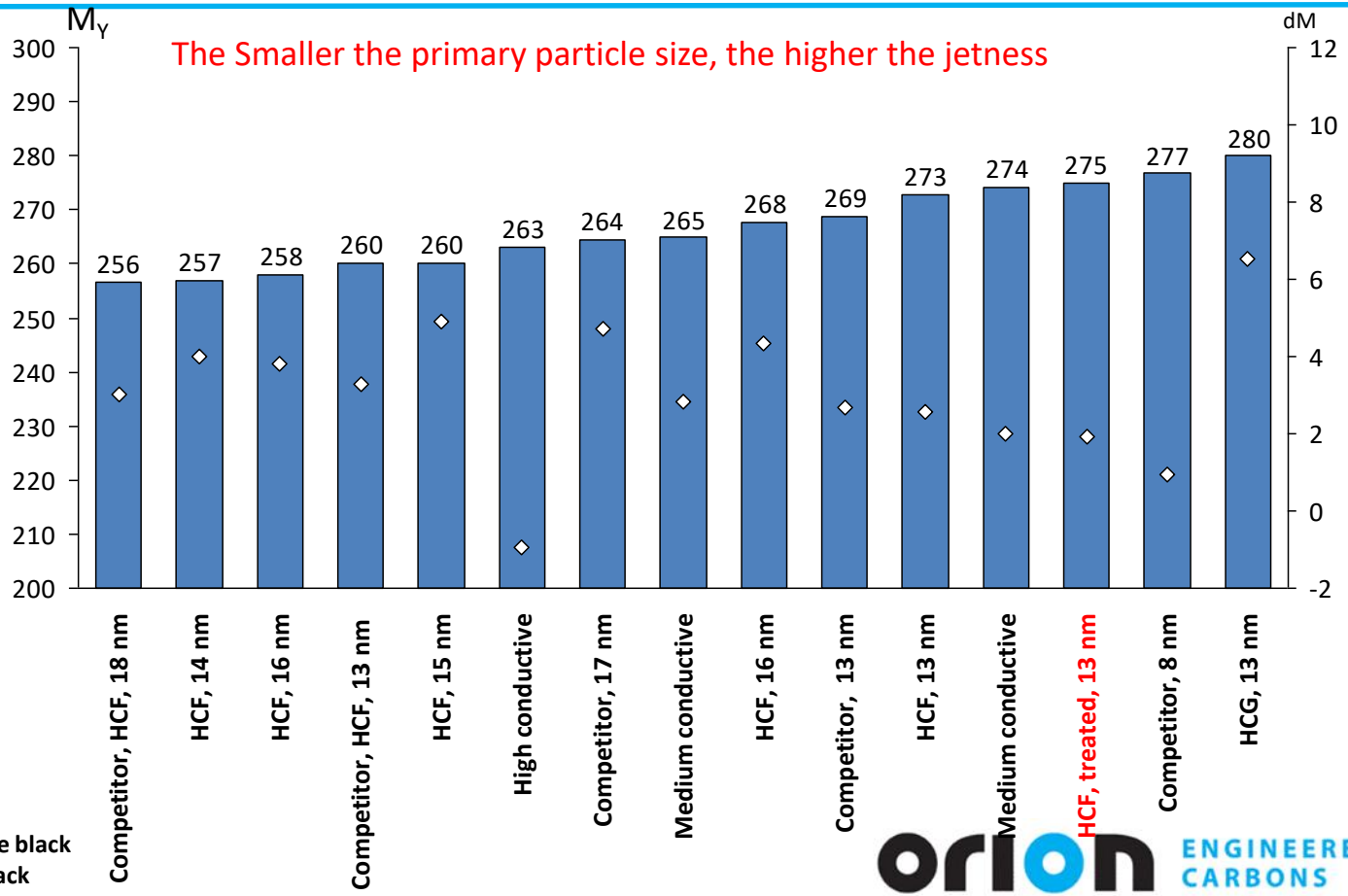
Full tone- High Jet Carbon Black- Polyester/ TGIC



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

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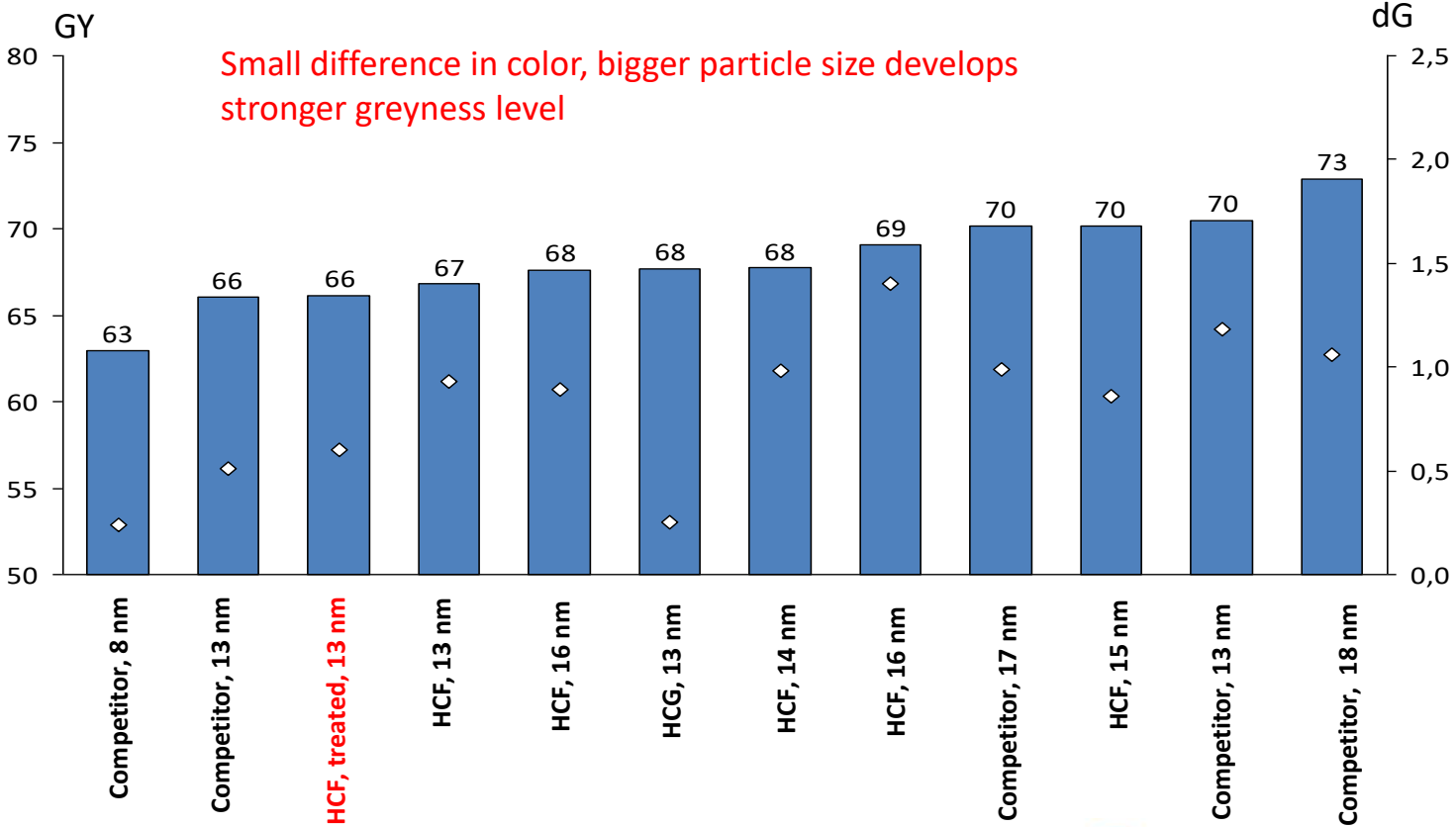
Tinting 98:2- High Jet Carbon Black- Polyester/ TGIC



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

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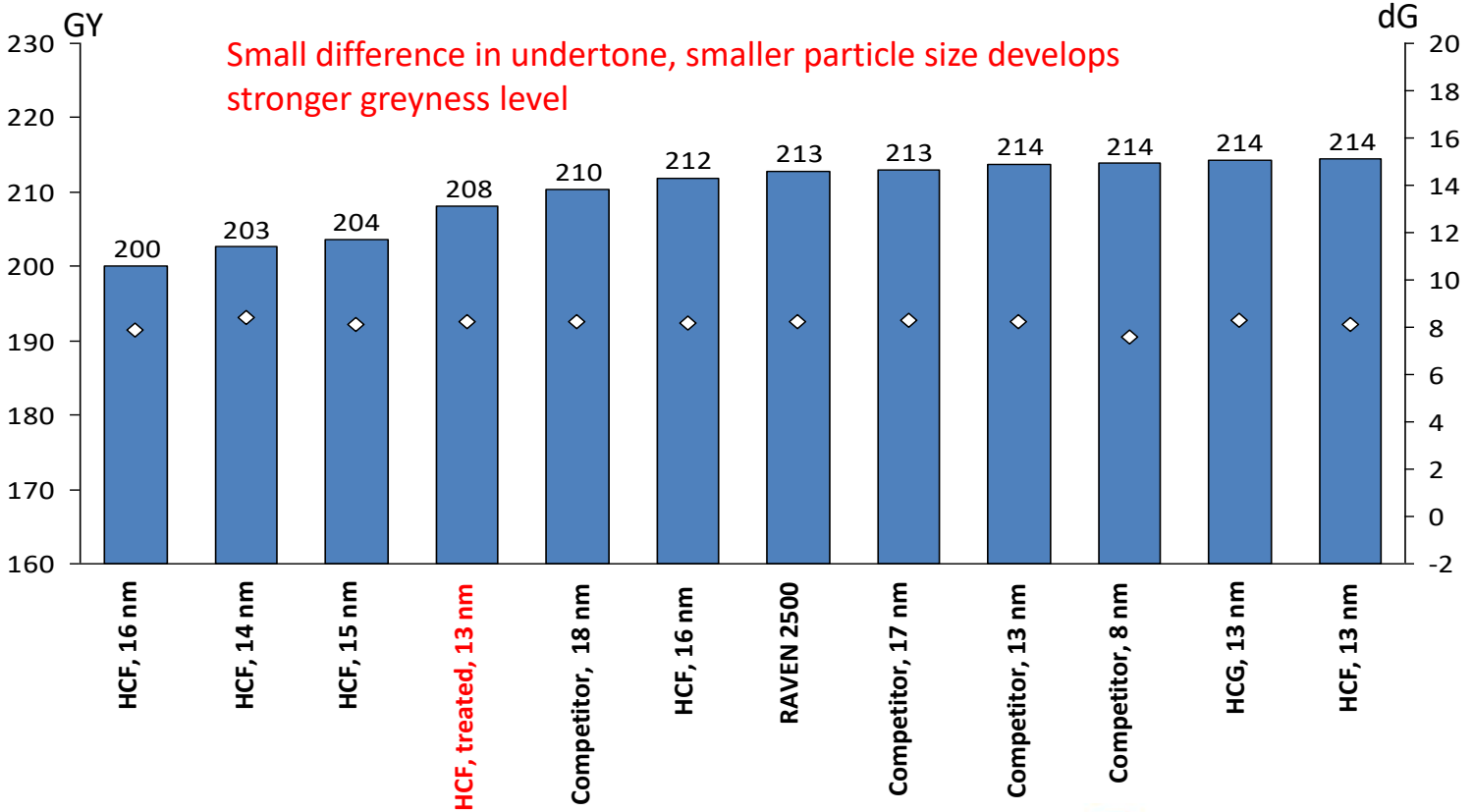
Tinting 50:50- High Jet Carbon Black- Polyester/ TGIC



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

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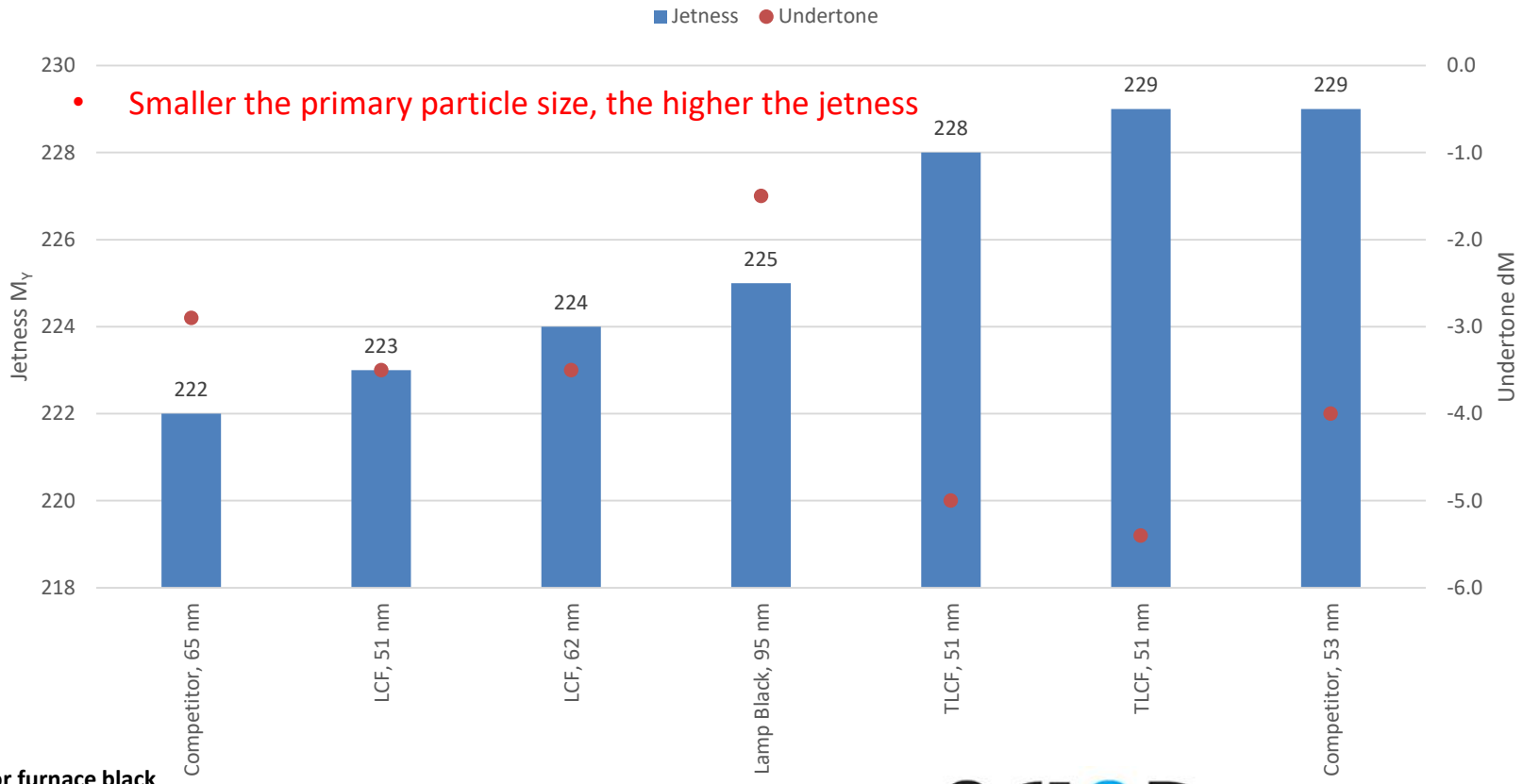
Full Tone- Low Jet Carbon Black- Polyester/ TGIC



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

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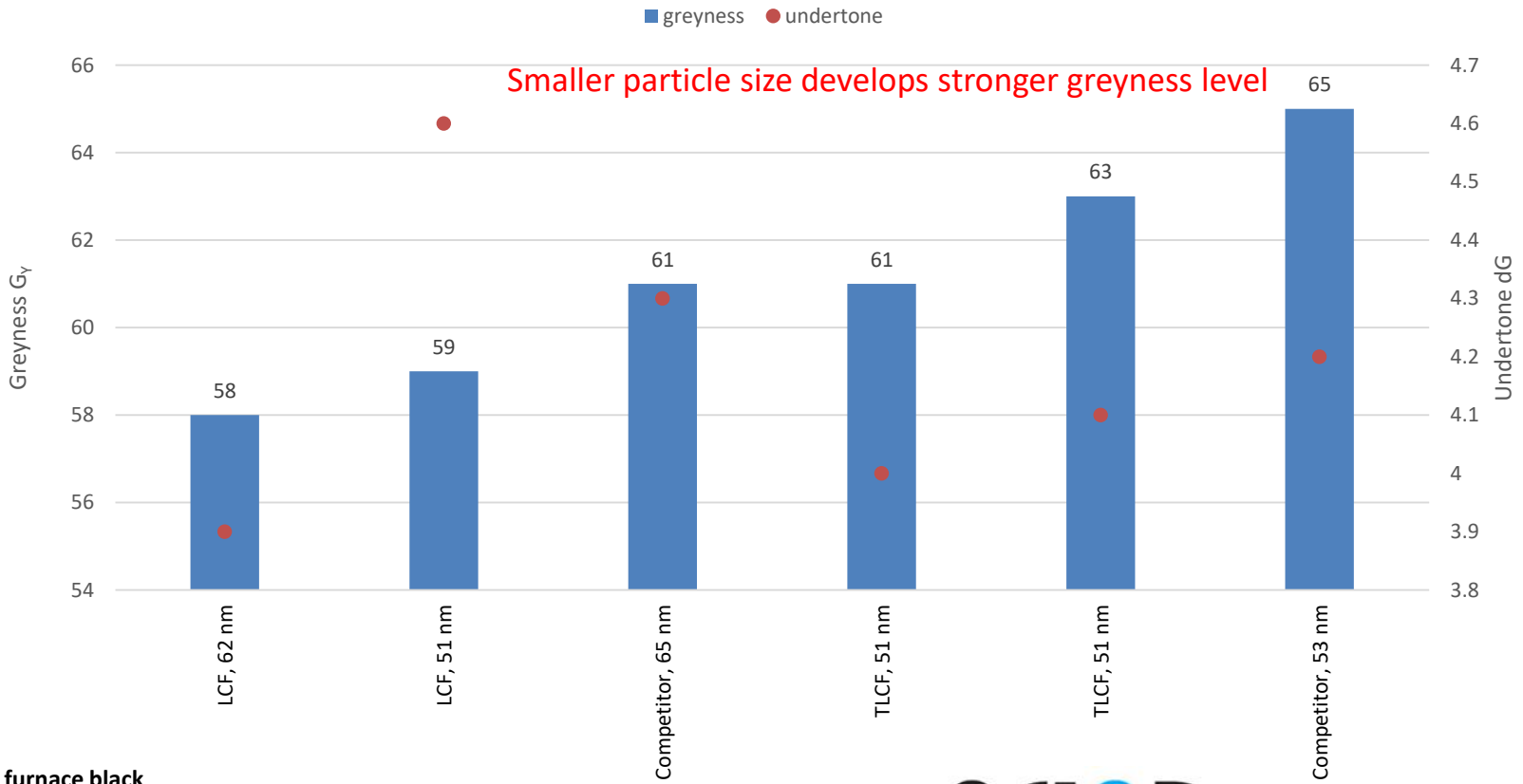
Tinting 98:2- Low Jet Carbon Black- Polyester/ TGIC



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

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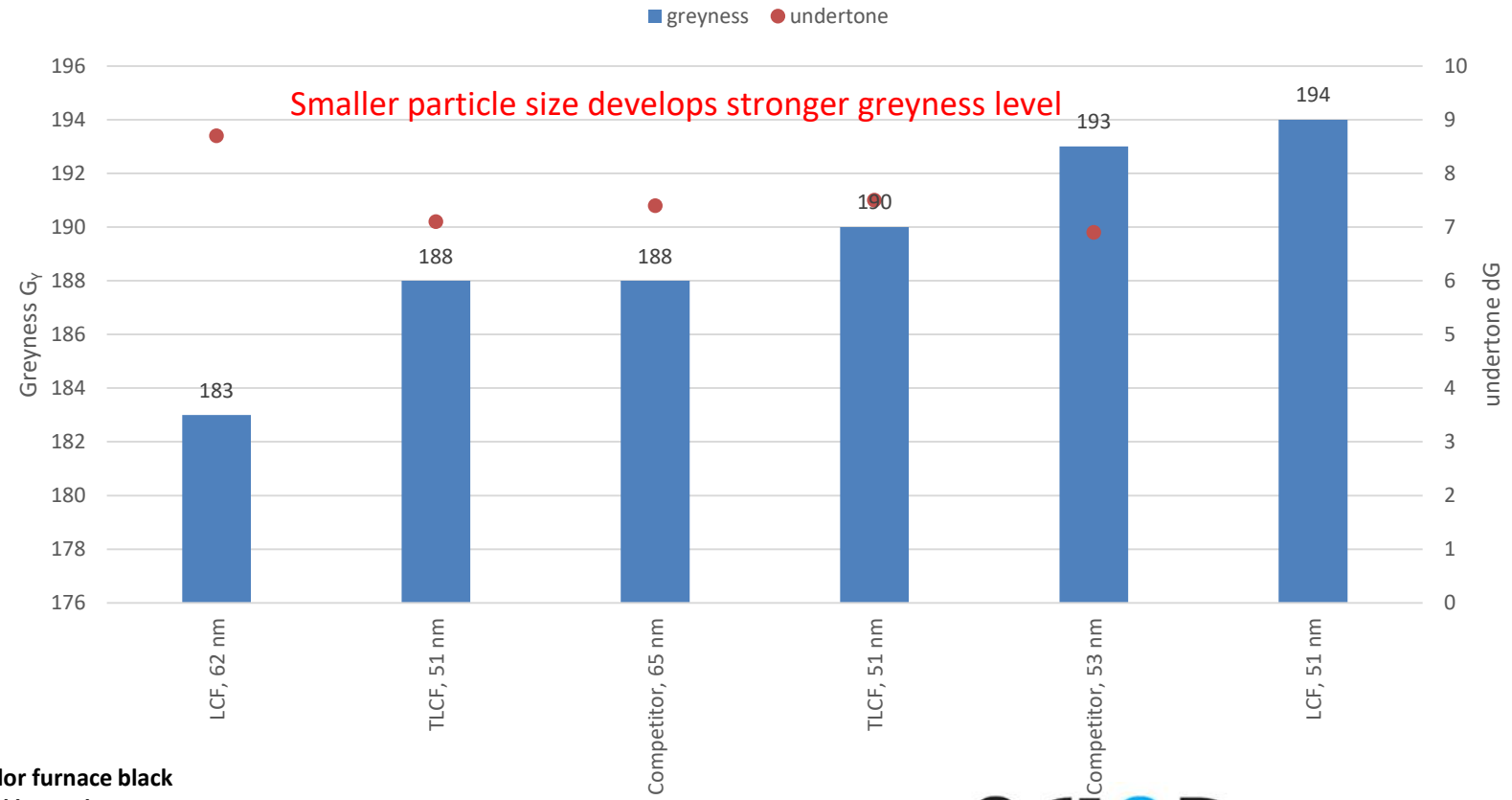
Tinting 50:50- Low Jet Carbon Black- Polyester/ TGIC



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

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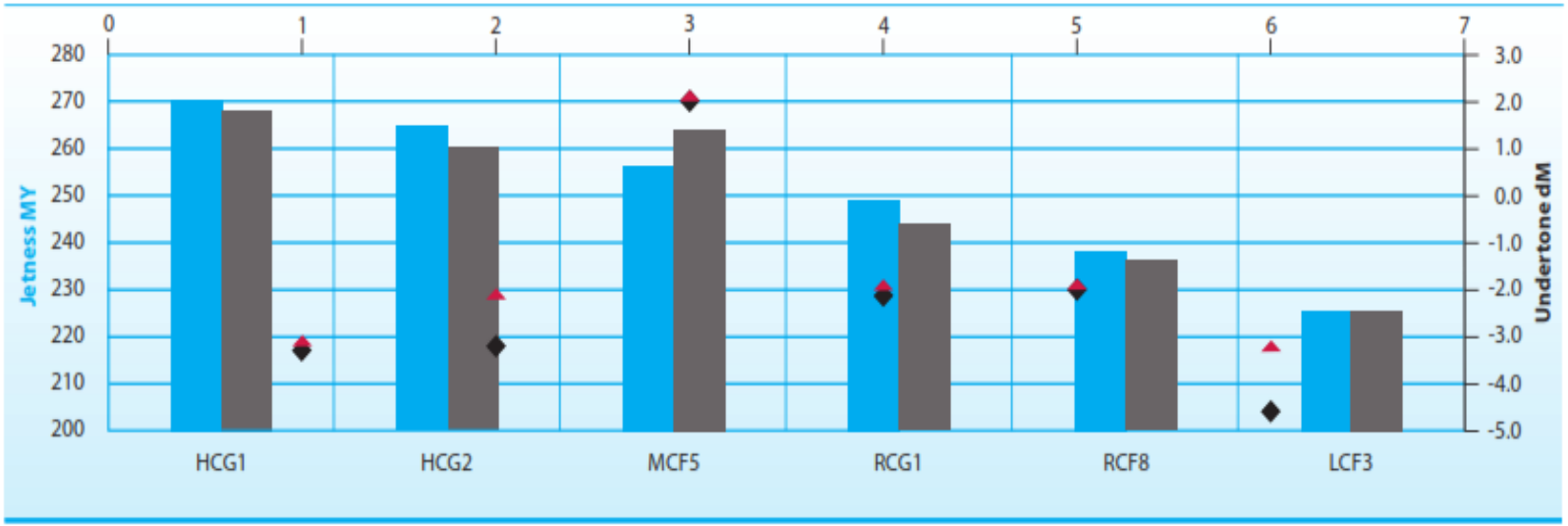
Beads Versus Powder



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

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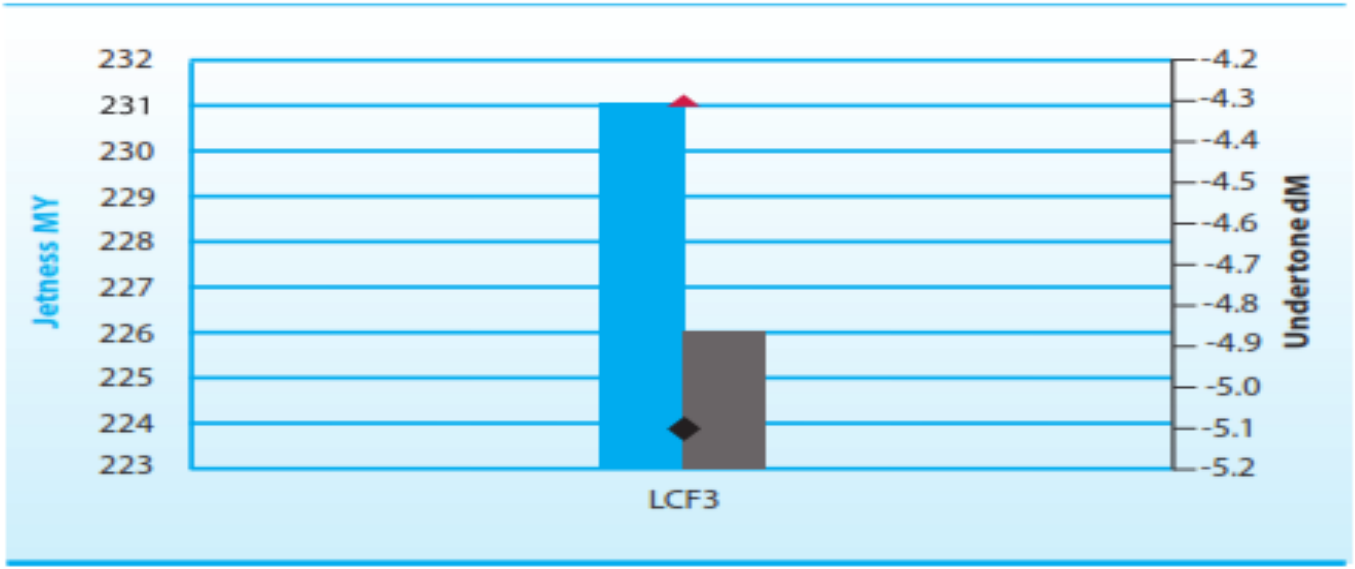
Same carbon black- different resin systems



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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 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-

- 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

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Thank you very much for your attention.

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