Pigments: Optimizing Opacity, Performance & Sustainability in Powder Coatings

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General Requirements – Pigments for Powder Coatings

1. Pigments introduced into resin at 200-230 F
2. Coating cured at 250-450 F
3. Substrate – almost always metal
4. Opacity 2-3 mil
5. Weather fastness
6. Pigment heat stability critical

Old Universal (Dream) Pigments for Powder Coatings

Lead Chromate, Moly Orange, Cadmium Reds, Iron Oxides, and Titanium Dioxide

Excellent thermal stability, excellent opacity, excellent solvent resistance, excellent duablity, work in all systems

Color Matching in Liquid & Powder Coatings possible with the same pigments until the seventies, and then came the “Lead Issue”.

Powder Coatings Applications

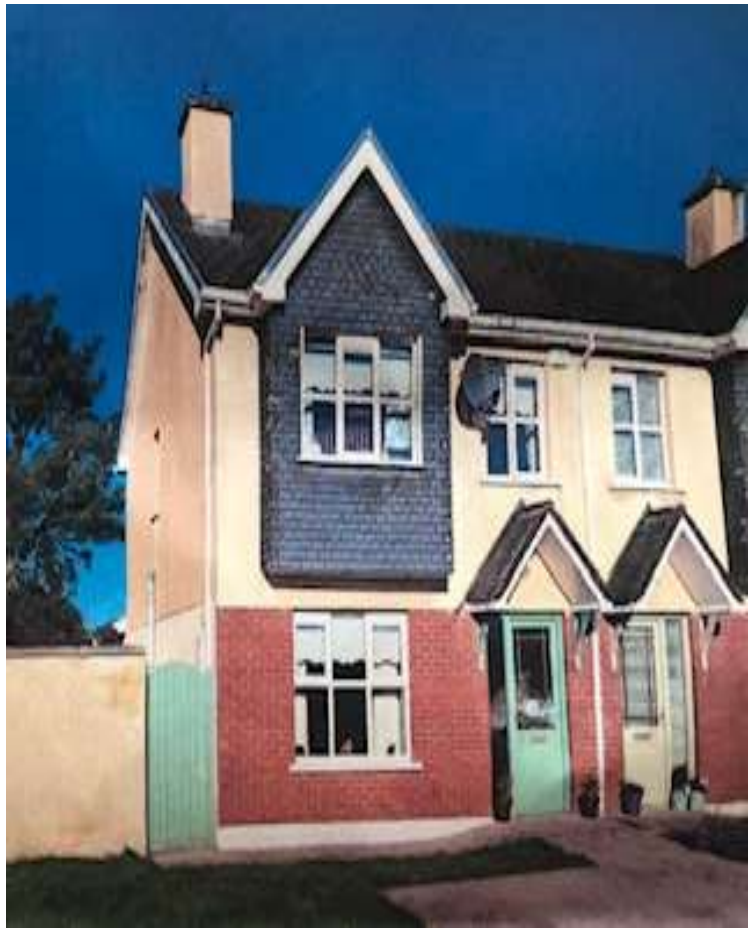
Low Performance

Medium Performance

High Performance

Not so Powder Coatings Applications

Coal Tar & Organic Pigments



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Powder Coatings Systems – Opacity & Gloss

Inorganic pigments (high scattering power & opacity).

- Pigments (organic) and common resins in powder coatings are made of similar elements (C, H, N, etc.) and thus have similar density.
- Similar refractive index leads to relatively low light scattering and poor opacity.

- Inorganic pigments (based on Ni, Ti, Bi, Fe, etc.) have higher density than those of the resins, and thus high scatterings and opacity.

Highly opaque organic pigments with inorganic pigments is the optimum for even better viscosity, gloss and performance.

Important Inorganic Pigments for Powder Coatings

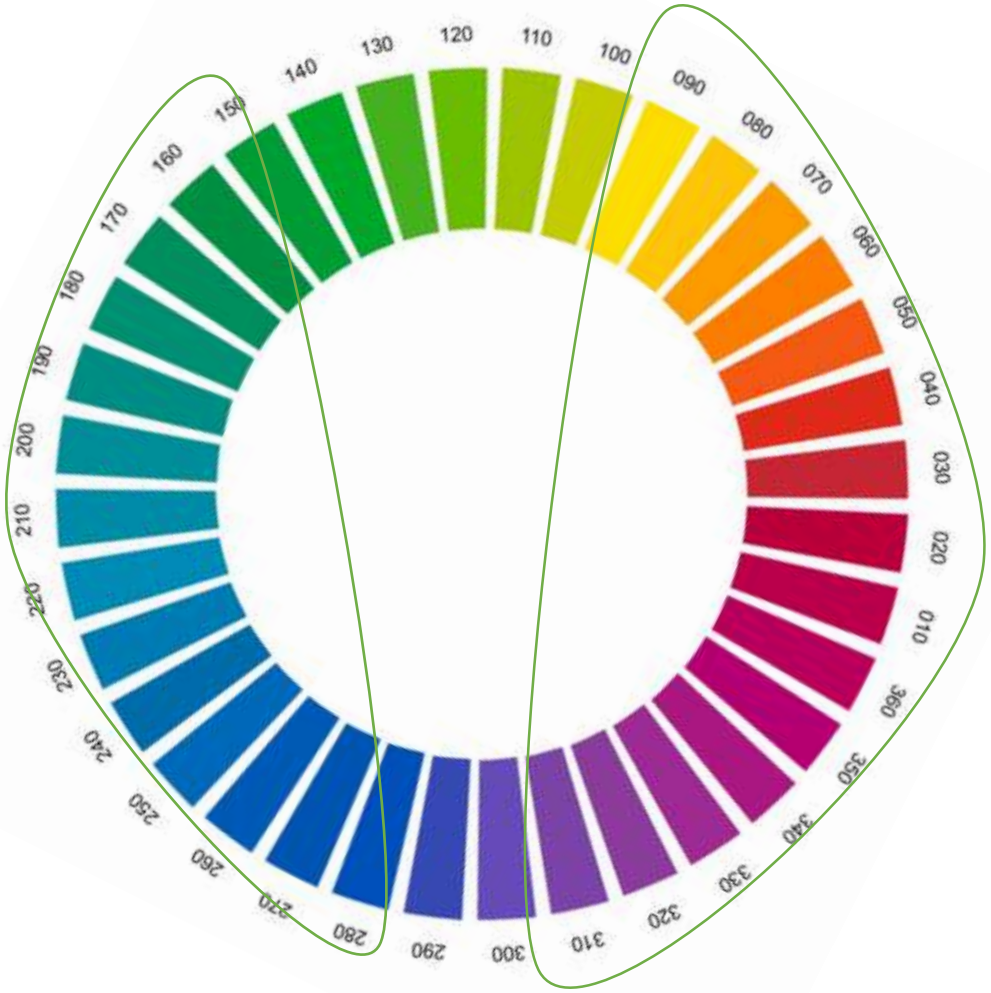
Using inorganic pigments (high scattering power) with chromatic organic pigments – optimum solution.

- Iron Oxide Yellow and Red
- Nickel Titanate
- Chrome Titanate
- Bismuth Vanadate
- Titanium Dioxide

Using highly opaque organic pigments with inorganic pigments is the optimum for viscosity, gloss and performance.

Color Gamut - Organic pigments (azo- and polycyclic chemistries)

blue to green:
copper phthalocyanine



greenish yellow:
Quinaphthalone

greenish yellow to orange:
monoazo

greenish yellow to medium red:
isoindoline / isoindolinone, diaryl

greenish yellow to violet:
benzimidazolone

medium yellow to blue:
anthraquinone

orange to pink:
naphthol, diketo-pyrrolo-pyrrol, perylene, quinacridone

Opacity – Inorganic vs. Organic Pigments

Important Yellow-Orange- Red Pigments – Powder Coatings

Pigment Shade	General Performance	Exterior Performance
Greenish Yellow	PY 138, 151, 155, 194	PY 53, 154, 184,
Reddish Yellow	PY 83 & 139 (opaque) & 110	PY 110, PBr 24
Orange	PO 36, 62, 73, 74,	PR 168
Yellowish Red	PR 170, 188, 254	PR 254 (blue shade, in near masstone only)
Bluish Red	PV 19 types, PR 122	PV 19 types

Important Violet, Blue & Green – Softer Texture - Powder Coatings

Pigment Shade	Exterior Performance
Violet	PV 23
Blue	PB 15:1, 15:3 & 15:6
Green	PG 7 & 36
Bluish Red	PV 19 types, PR 122

The groups of pigments and their CF values

Inorganic pigments and fillers

2.3 ± 30 % kg $CO_{2,eq.}$/kg product

Metal and effect pigments

8.1 ± 20 % kg $CO_{2,eq.}$/kg product

Organic pigments

Single stage synthesis

11 ± 30 % kg $CO_{2,eq.}$/kg product

Multi-stage synthesis

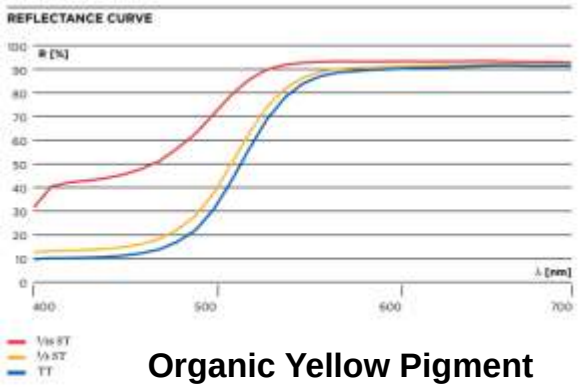
24 ± 10 % kg $CO_{2,eq.}$/kg product

More about opacity challenge for organic pigments?

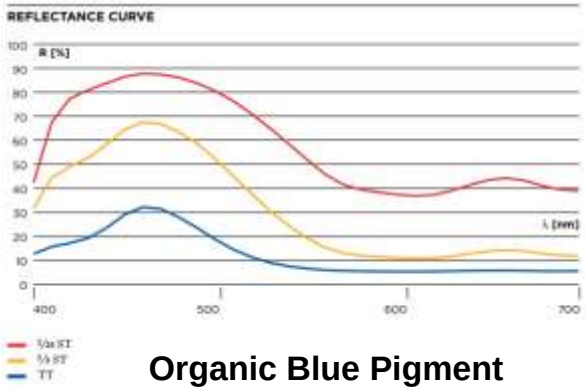
Carbon black absorbs light throughout the complete visible spectrum, leading to high opacity.

Green, blue and violet organic pigments absorb in a relatively wide, whereas red, orange and especially yellow pigments absorb only in a small area of the visible spectrum and appear more transparent.

The challenge of optimum opacity of coatings occures mainly in YELLOW, ORANGE and RED shades.



Organic Yellow Pigment



Organic Blue Pigment

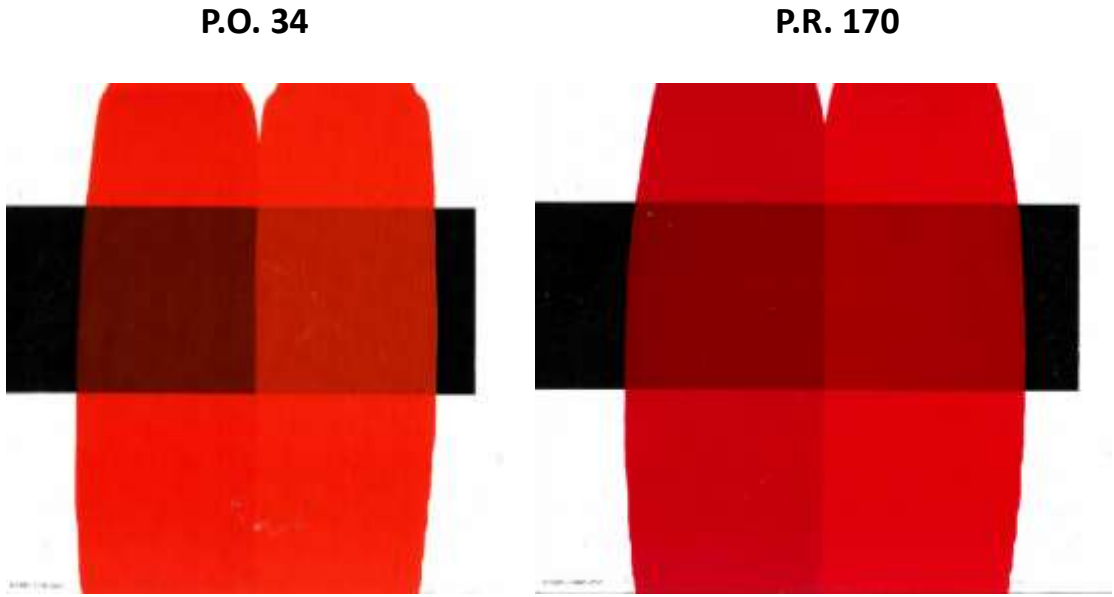
Improving Opacity with optimum particles

PY 83
Regular type
(D_{50} = 0.046 micron)

PY 83
Opaque type
(D_{50} = 0.28 micron)

Advantages of Opaque organic pigments

- Bigger particle size → smaller specific surface
- Higher opacity
- Improved fastness
- Very good dispersibility
- Improved flow properties
- Higher pigment load during process possible



Opacity - Yellow, Orange and Red Pigments
(maximum possible pigment loading)

Standard organic yellow pigments	> 250 µm
High opacity organic yellow pigments	appr. 120-150 µm
Chrome yellow pigments	appr. 80-100 µm

Standard organic red/orange pigments	> 150 µm
High opacity organic red/orange pigments	appr. 70-80 µm
Molybdate orange	appr. 35-50 µm

(dry film thickness)

Opacity - Inorganic pigments

	Dry film thickness
Titanium Dioxide	appr. 60-70 µm
Bismuth/Vanadate	appr. 50-55 µm
Chrome Titanate	appr. 30 µm
Nickel Titanate	appr. 60-70 µm
Iron Oxide Yellow	appr. 30 µm
Iron Oxide Red	appr. 10 µm

RAL 1012 Lemon Yellow

Lead-free (performance)		lead containing	
26.2%	Opaque PY 151	63.3%	Chrome yellow medium
0.12%	PG 7	6.5%	Iron oxide yellow
33.5%	Chrome Titanate	30.1%	Titanium Dioxide
7.0%	Iron oxide yellow	0.11%	Carbon black
33.2%	Titanium Dioxide		
A.	ca. 44%	A.	ca. 56%
B.	ca. 18.4%	B.	ca. 23,3%
C.	ca. 40 µm	C.	ca. 35 µm
D.	1:3	D.	—

A.: Pigment calculated on solid binder
B.: Pigments in wet paint
C.: Opacity
D.: Cost ratio compared with lead containing formulation

Optimum Formulation for RAL 3000 Flame Red

(organic & inorganic pigments blend & optimum performance)

	Powder
Pigment Orange 36 (Op)	41.17 organic
Pigment Red 254	23.53 organic
Red Iron Oxide	09.80 inorganic
Titanium Dioxide	25.49 inorganic
Pigment loading (%)	**10.20**

(high opacity & lower carbon footprint)

Other options for improving opacity

- Increase coating film thickness (3mil to 10 mil)
- Increase pigment loading (may effect gloss, flow, & cost)
- Blending inorganic pigments with organic pigments (optimum solution)
- Use highly opaque organic pigments (improves gloss, opacity & durability)
- Blending complimentary pigments

Complimentary Pigments – Improving Opacity

Combination of red with green, Yellow with blue, orange with greenish blue improves opacity without loss of performance.

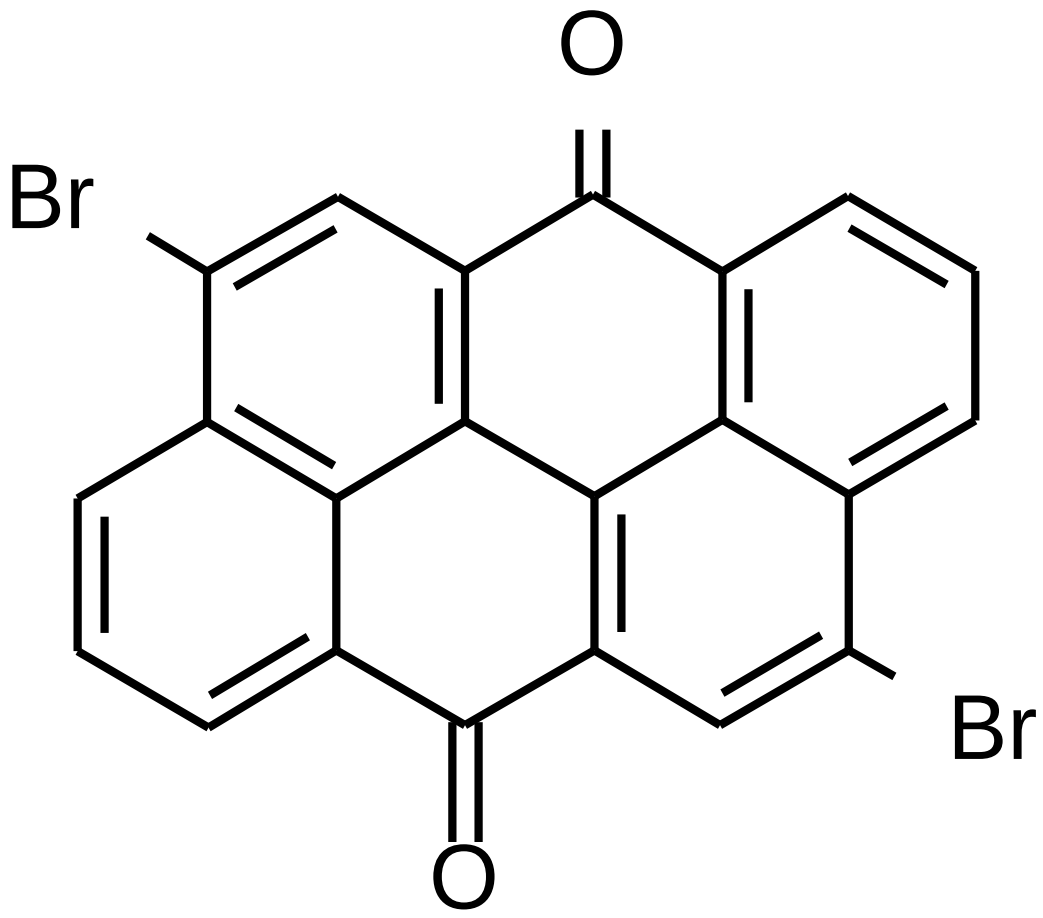
Opacity Optimization (2 mil)
(blends with complimentary pigments)

PY 184 & PR 254 (4:1)

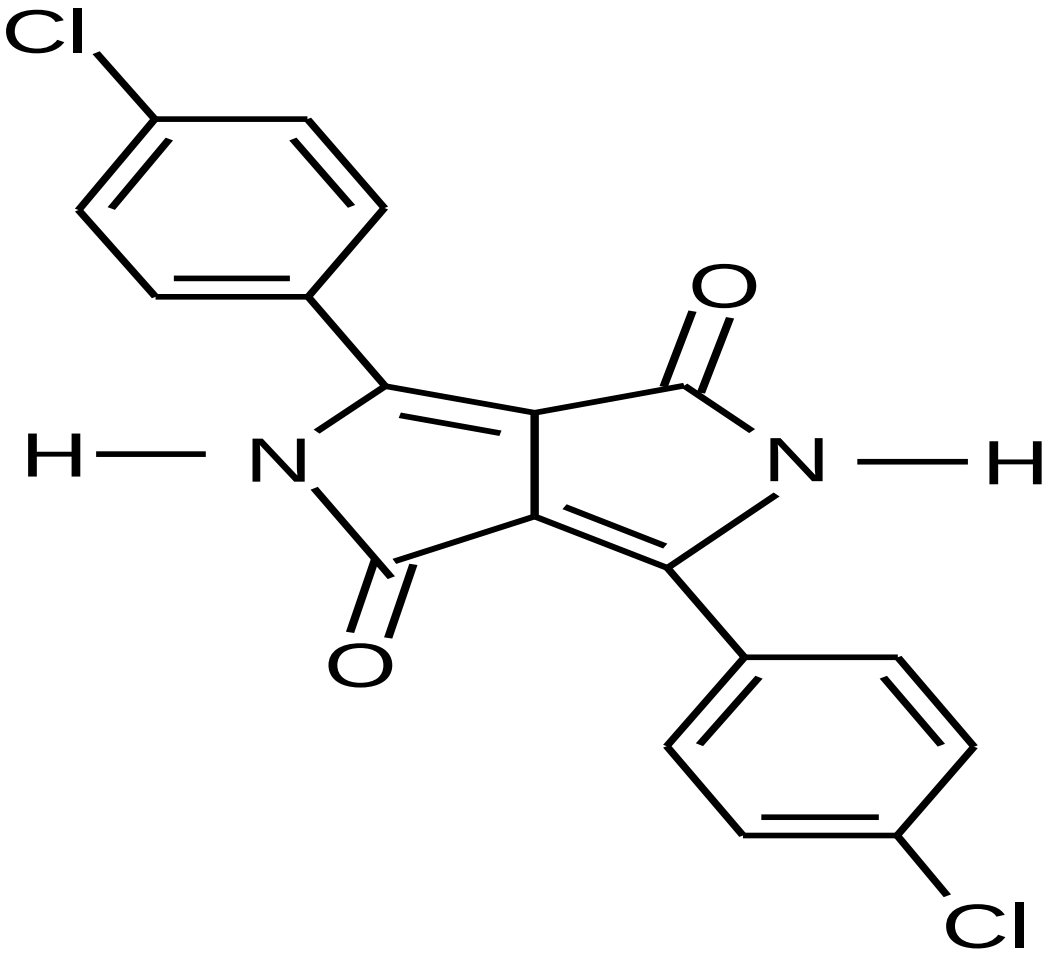
PY 184 & PR 254 (1:4)

PR 254 & PG 7 (99:1)

Pigment Red 168



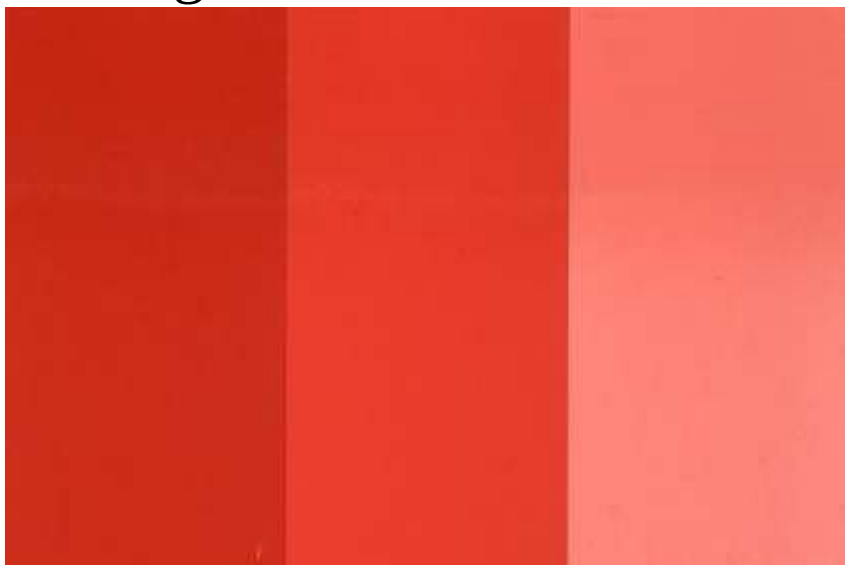
Pigment Red 254



PR 168 : Most Weatherfast Organic Pigment

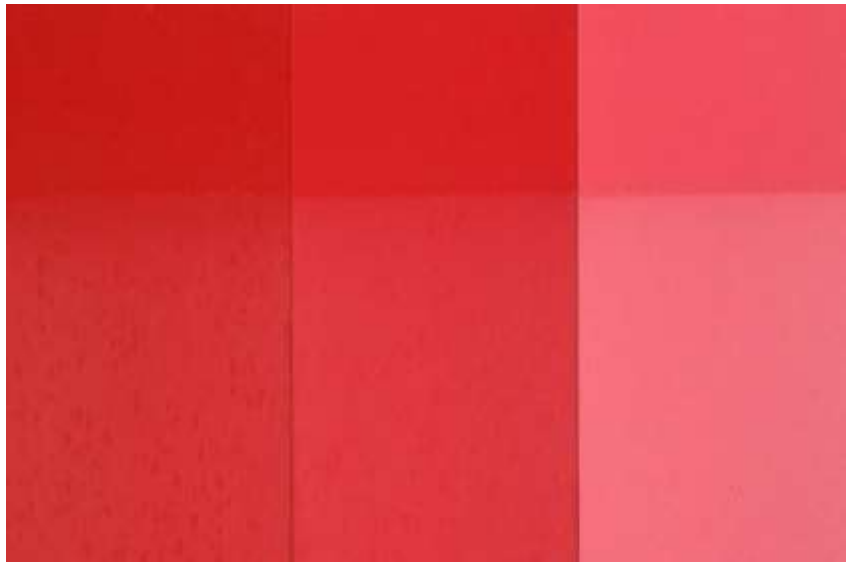
(5 Year Florida Exposure)

Pigment Red 168



(4:1), 5 yrs. (1:1), 5yrs. (1:4), 5 yrs.

Pigment Red 254



(4:1), 4 yrs. (1:1) 2 yrs. (1:4), 2 yrs.

(blends with titanium dioxide)

Bright, Opaque & Durable Blends – Orange Hues
(PY 184 & PR 168 (4:1) blend)

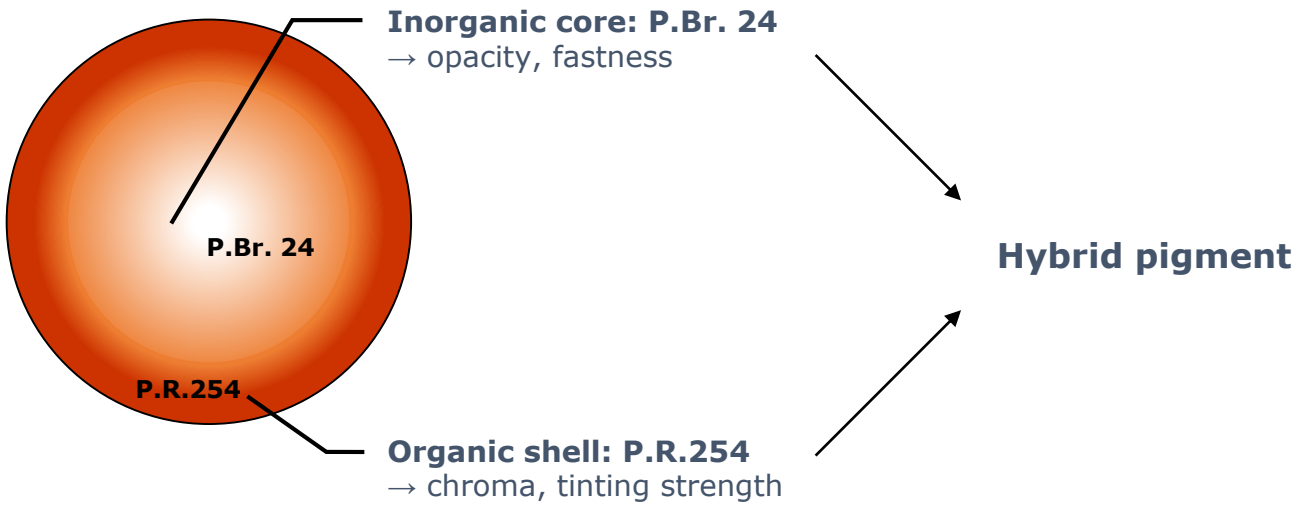
Bright, Opaque & Durable Blends – Yellow Hues (PY 184 & PY 154 (4:1) blend)

Hybrid Pigments - Concept

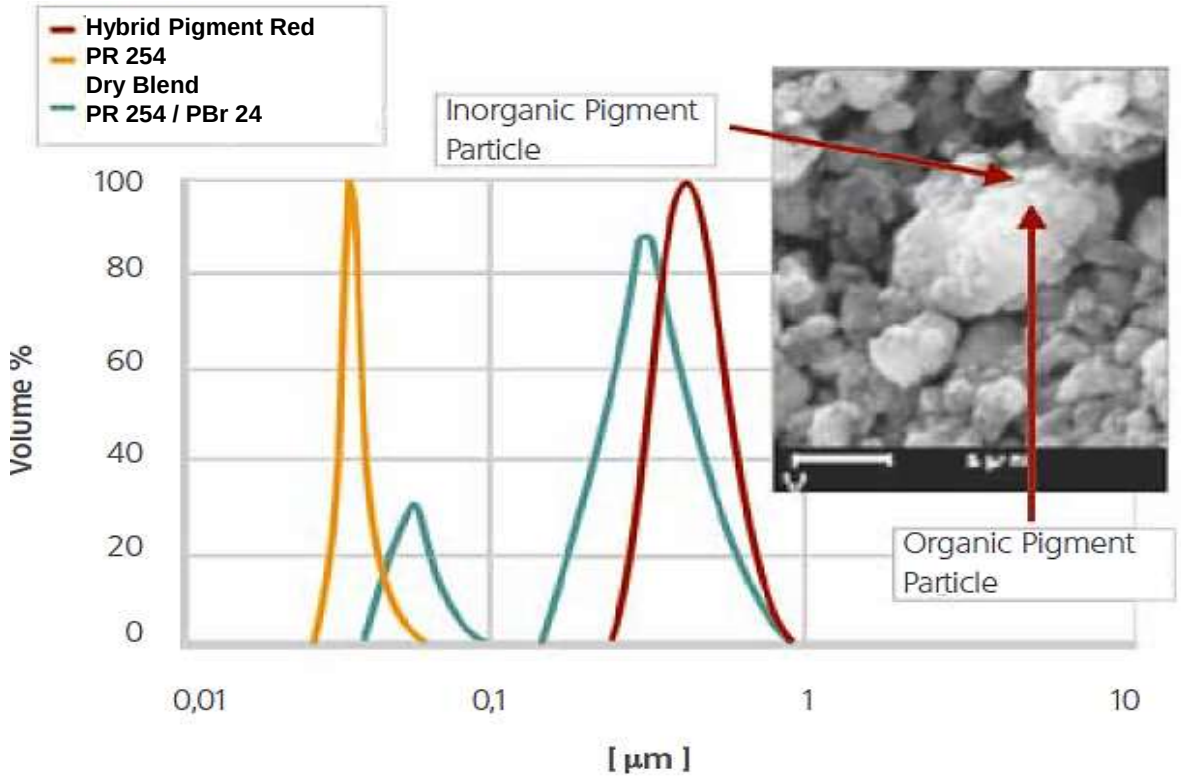
- Hybrid pigments are made by a proprietary co-finishing process
- A shell of organic pigments is attached to a core of inorganic pigments

➢ Core- shell- structure

A Hybrid Red Pigment

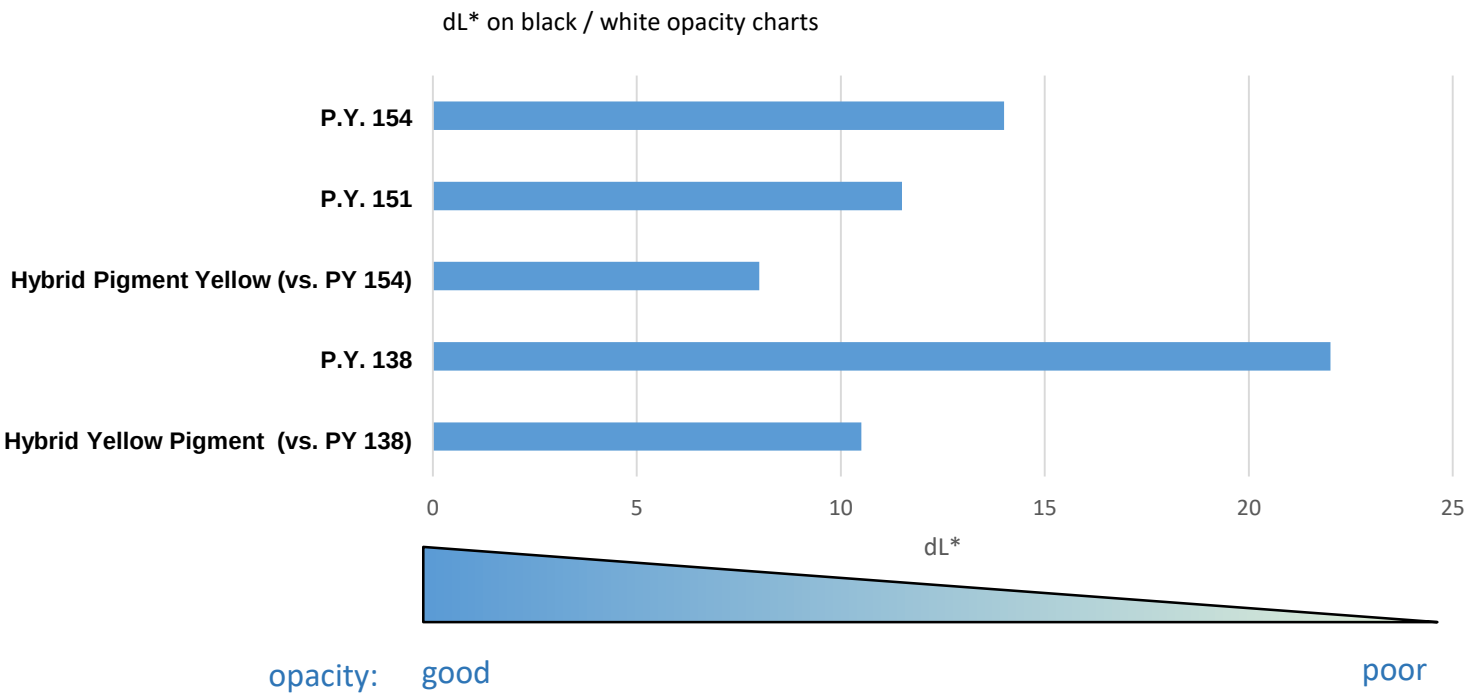


Hybrid Pigments - Monomodal particle size distribution

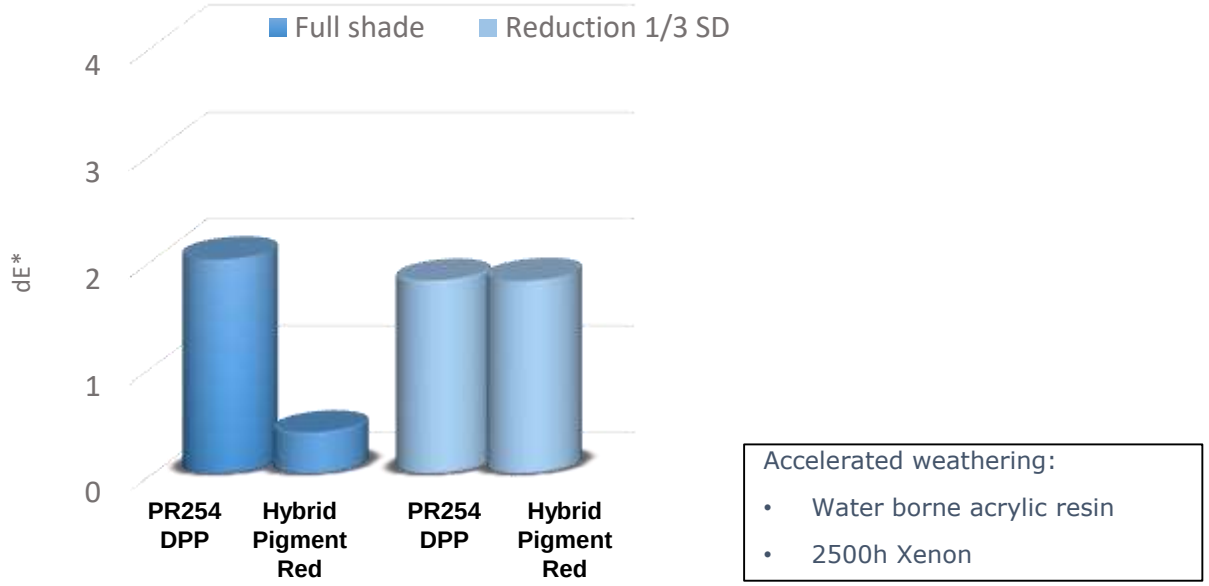


Monomodal particle size distribution of Hybrid Pigment Red 655

Hybrid Pigments - Improved Opacity versus organic pigments



Hybrid Pigments - Improved weatherfastness



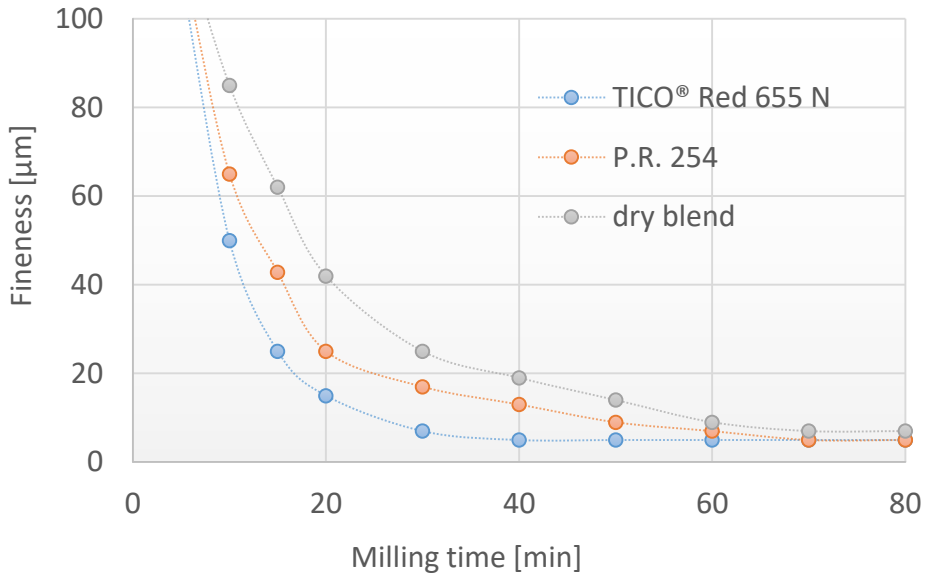
Accelerated weathering:

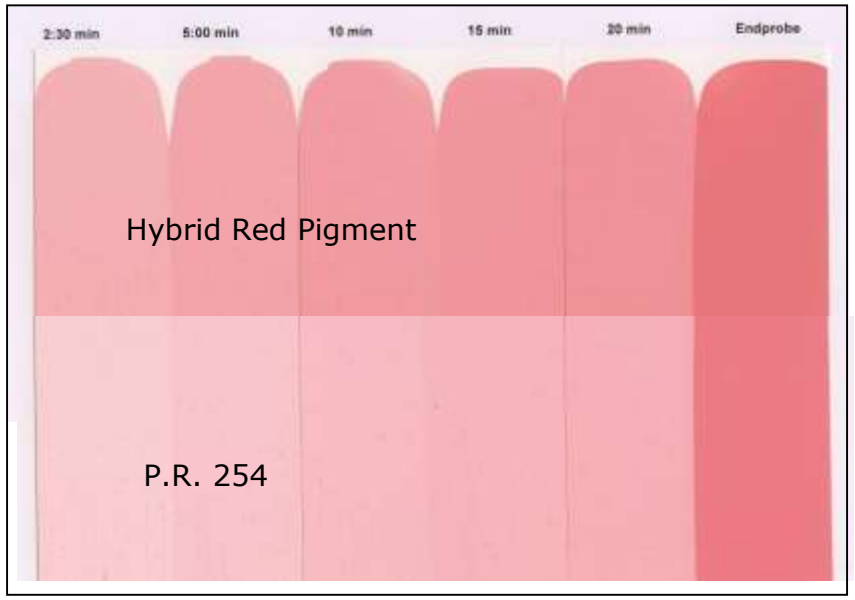
- Water borne acrylic resin
- 2500h Xenon

- Improved performance compared to pure organic DPP pigment (P.R. 254)
- Performance in reduced shades is comparable to pure organic pigment
- Photo-catalytic effect of TiO_2 reduces fastness benefits from Hybrid Pigments

Hybrid Pigments - Fast color development

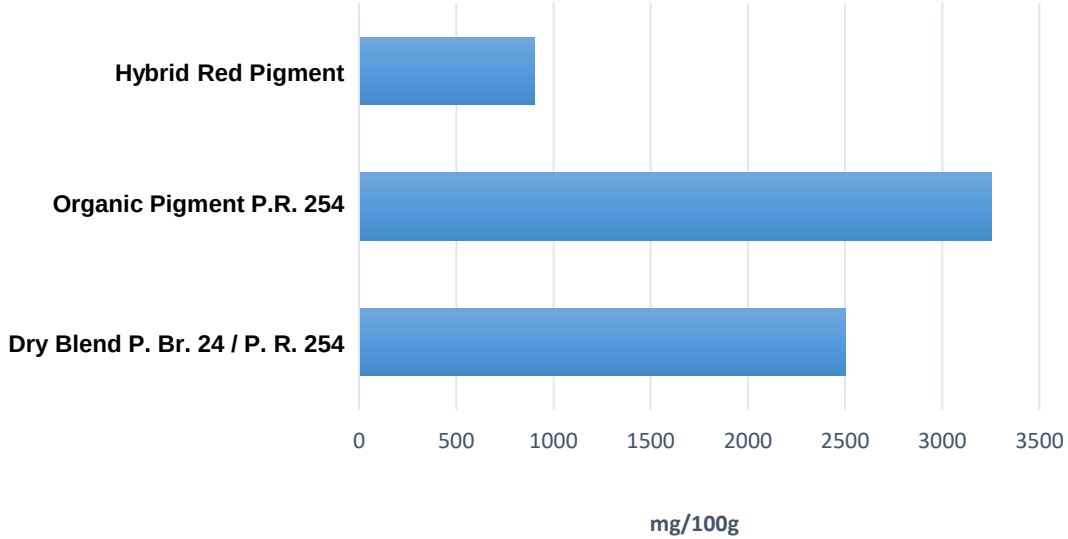
- Shorter dispersing time (25 vs. 45 minutes)
- Lower dispersing energy usage
- Better color development





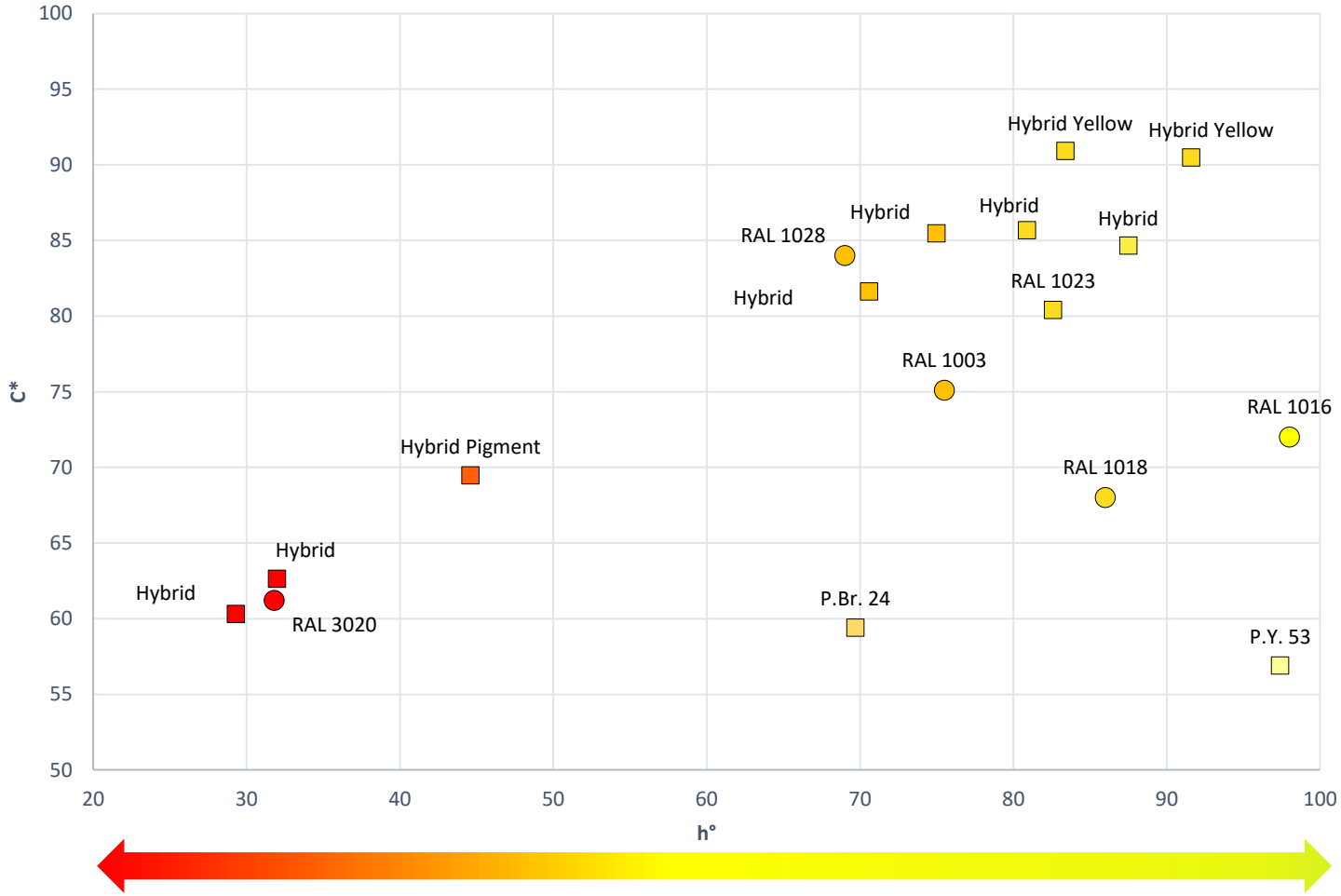
Hybrid Pigments – Low Dustin

Lower (70-90%) dusting compared to regular pigments



Measurement acc. DIN 55992-1 with Heubach Dustmeter Type I

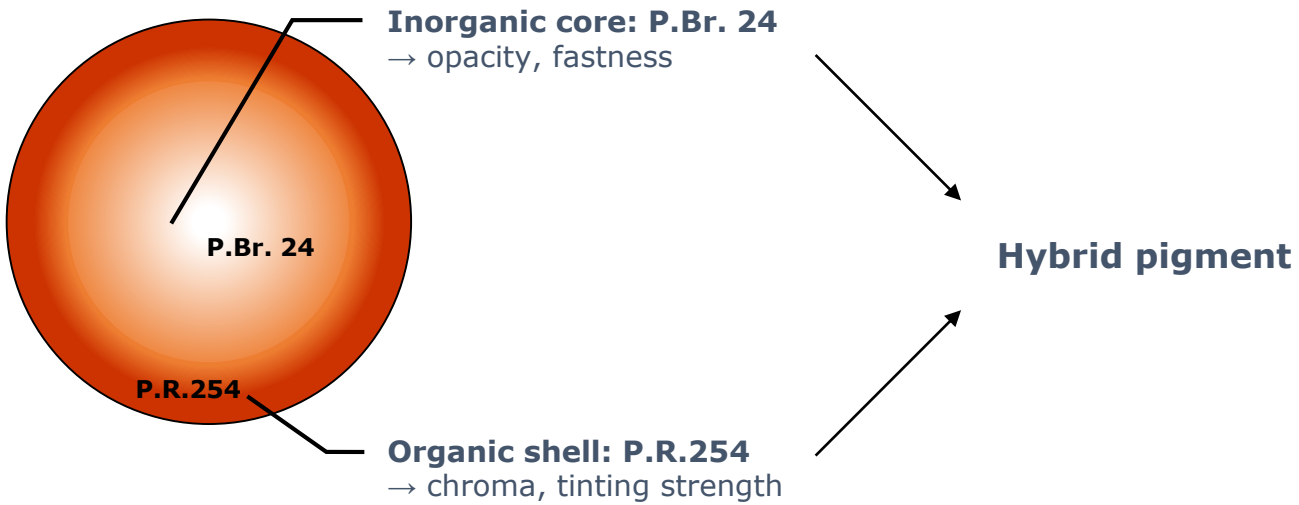
Hybrid Pigments – Color Space



Hybrid Pigments – Key Advantages in Powder Coatings

- Made to optimum shades (like RAL)
- Excellent for small powder batch production
- Low dusting means less mill cleaning
- Universal – work in all resin systems
- Color matching eliminated – quicker customer response

A Hybrid Red Pigment



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Powder Coatings : Most sustainable in Coatings

Resin systems: Over ten types (PE/TGIC, PU, PE/Epoxy some of the common ones).

100% solids, dry blending, extrusion, and baking

No waste & No VOC

High Durability (toughness)

Enviorenmentally safe

Acknowledgements

Heubach Global Technical & Marketing Teams

Thanks for your attention!

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