FERRO
Where innovation delivers performance™

Color Solutions for Cool Roofs

Dani Lladó,
12th Oct 2016, RAMSPEC, Milano.

About Ferro

- Founded in 1919 as Ferro Enameling Company in Cleveland, Ohio USA
- Worldwide leader in the production of inorganic pigments, glass enamels, porcelain enamels, ceramic tile coatings
- Nearly 5,000 associates working in 26 countries
- 2015 sales of $1.1 billion
- On 7th July 2015 Nubiola was acquired by Ferro

Approaching centennial as a growing innovator of glass-based coatings and color solutions

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When innovation and passion unite, your color needs are met.

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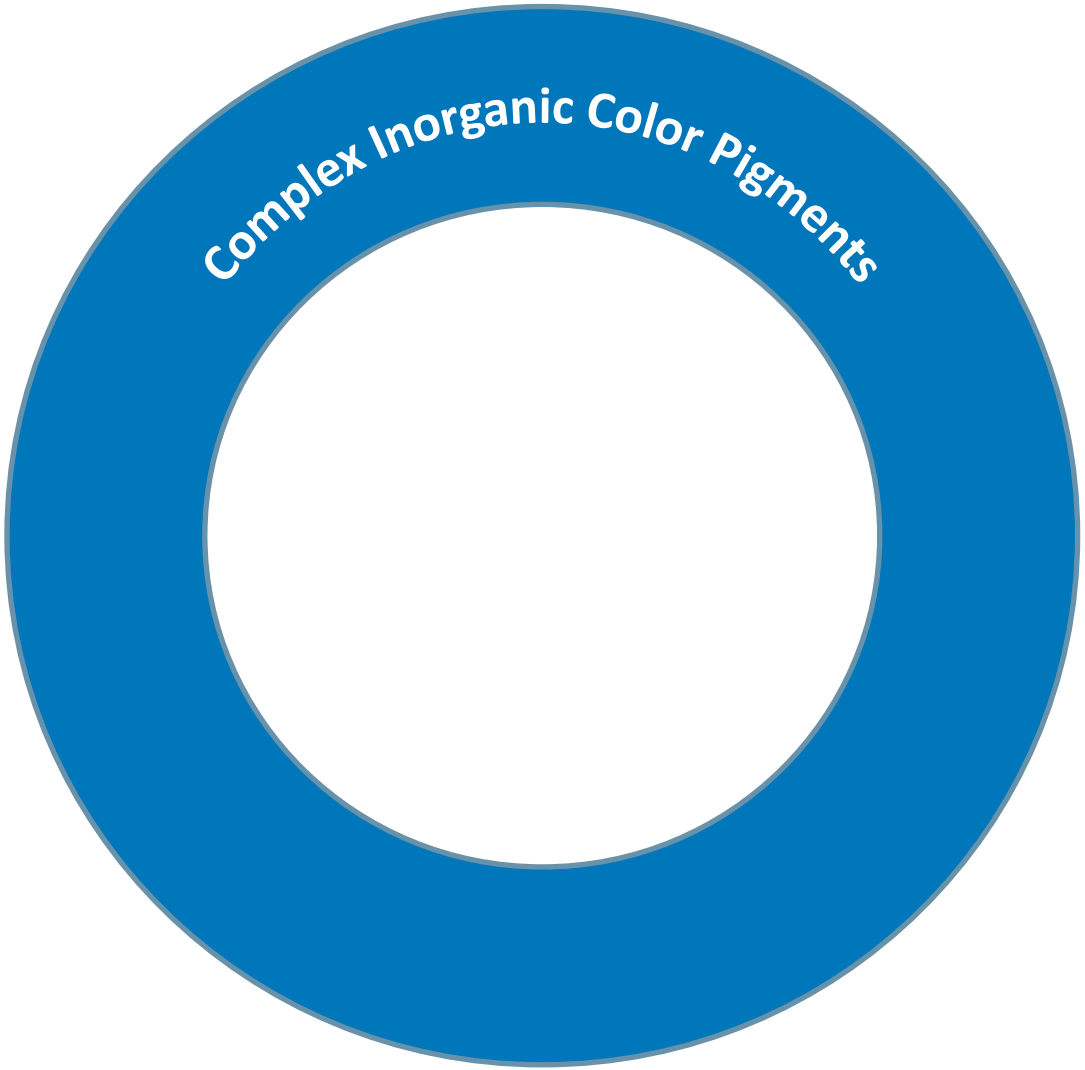
A larger, high quality product portfolio



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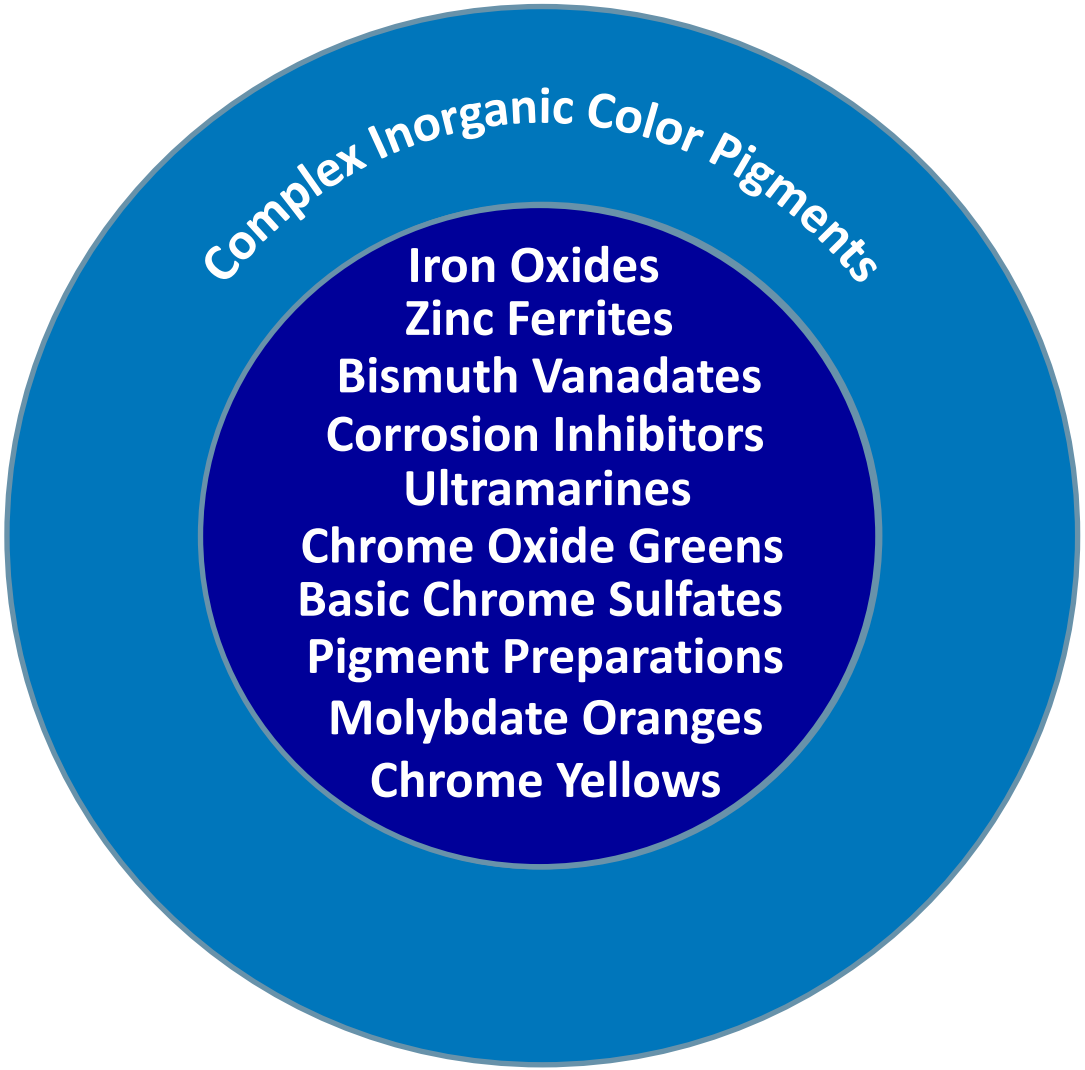
A larger, high quality product portfolio



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Cool pigments CIELab color map

Pigment Yellow 53

Pigment Green 17
Pigment Green 26
Pigment Green 50

Pigment Blue 28
Pigment Blue 36
Pigment Blue 29

Pigment Brown 24
Pigment Yellow 164
Pigment Black 12
Pigment Yellow 119

Pigment Brown 29
Pigment Green 17
Pigment Brown 30
Pigment Black 32

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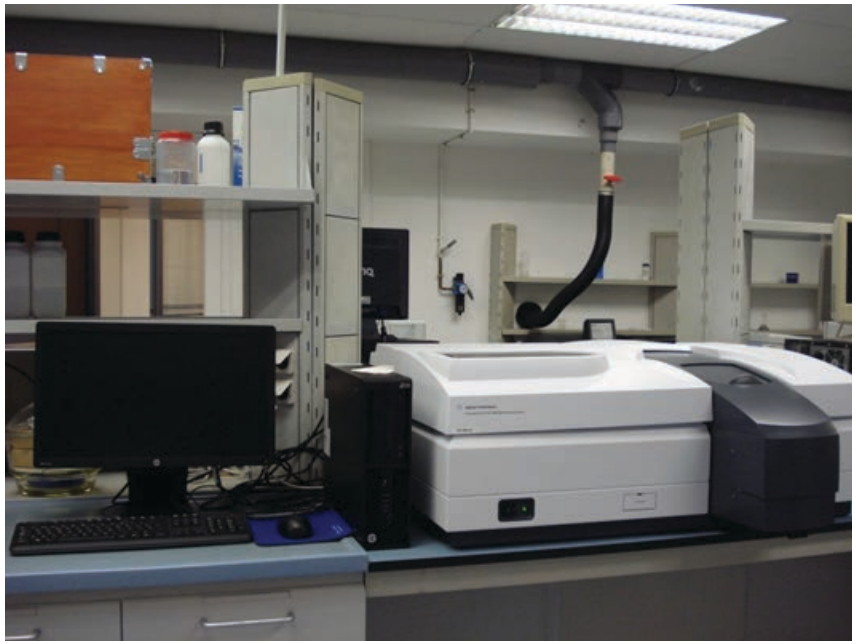
Total Solar Reflectance (TSR)

- Measurements: **spectrophotometer UV-Vis/NIR**



spectrophotometer UV-Vis/NIR Agilent Cary 5000

  - Reflectance curves in a range from 280 to 2500nm
  - total TSR and the TSR values in each region

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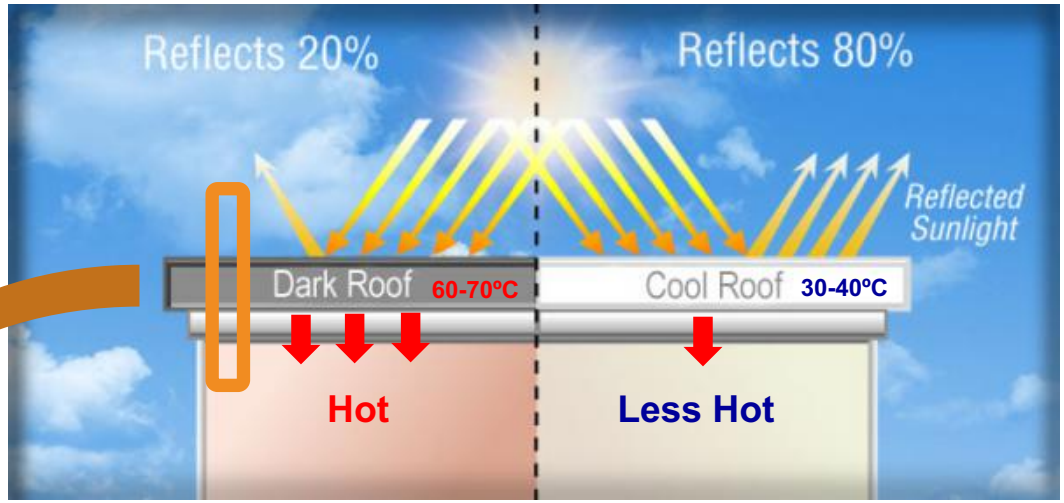
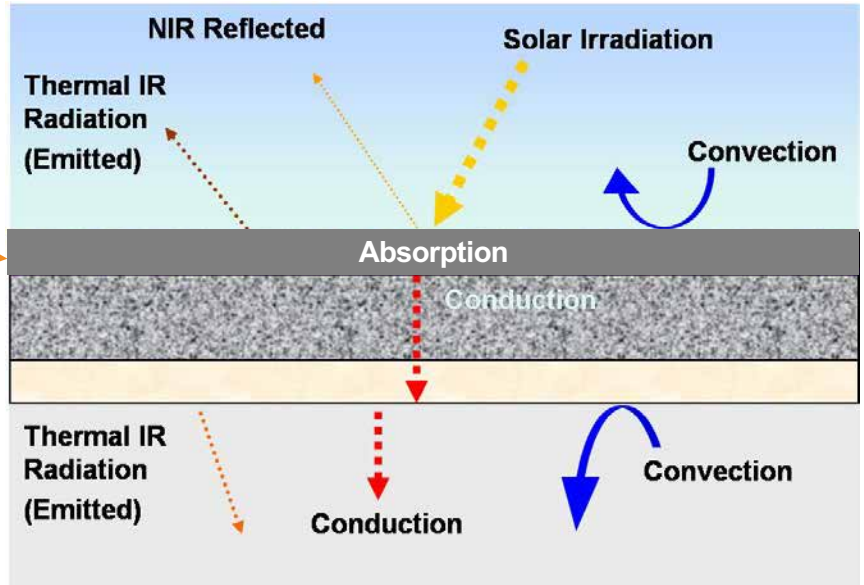
What is the “cool” concept about?





Source: Heat Island Group/Lawrence Berkeley National Laboratory

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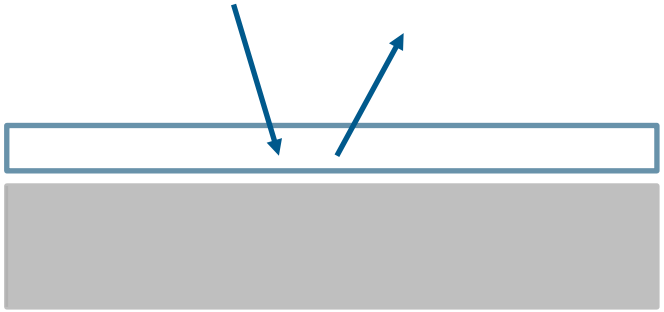
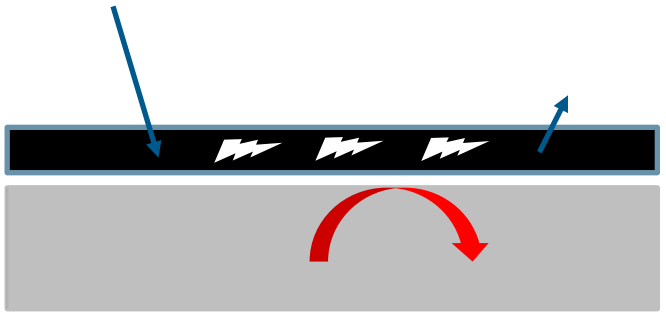
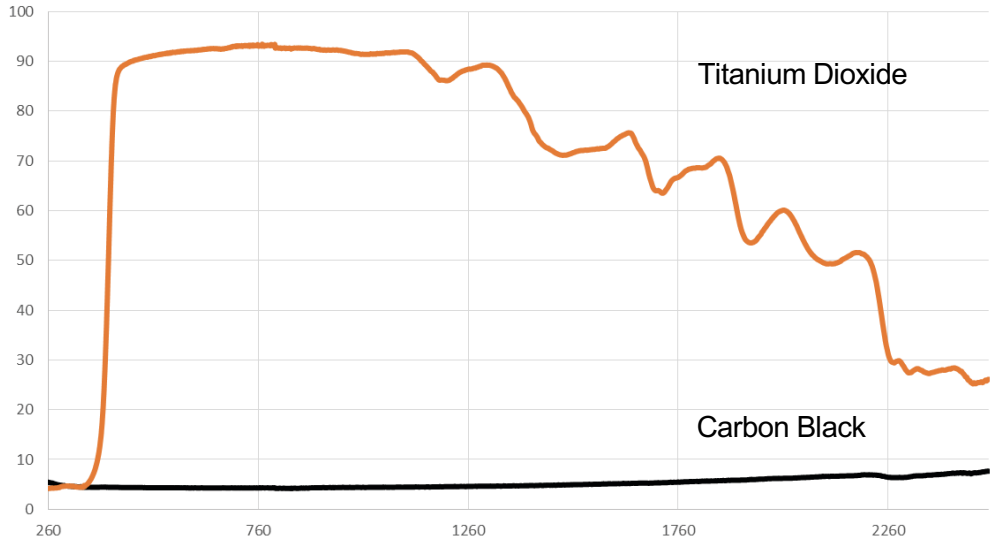
Total Solar Reflectance (%TSR)



Vs



Coil Coating, PVDF-Acrylic (70:30) – 20µ DFT



White coating (TiO_2)	**%TSR 84**
Black coating (Carbon Black)	**%TSR 5**

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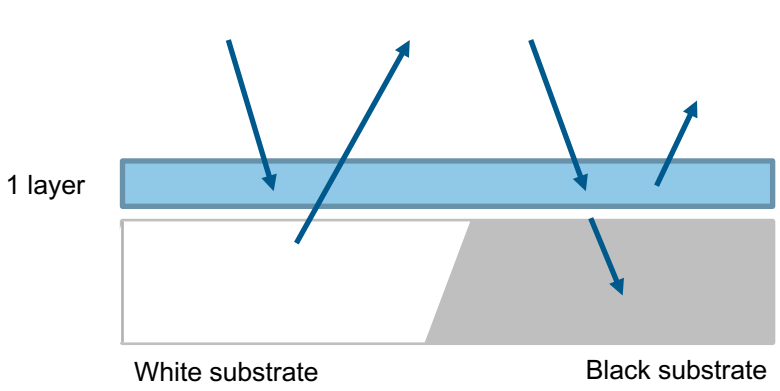
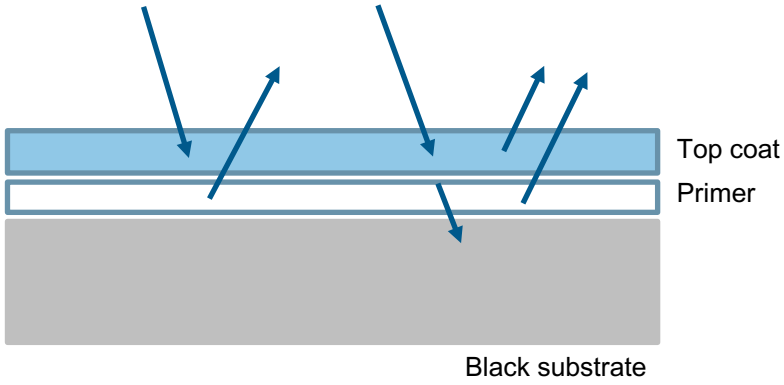
Some things to take into account…





- … the substrate; material, color
- … the resin; type, thickness
- … the number of layers; the primer
- … the pigment chemistry, content
- …

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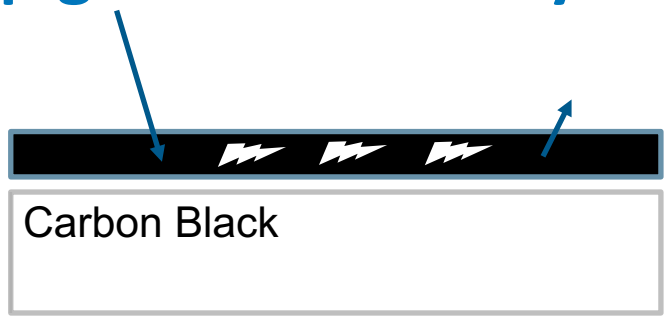
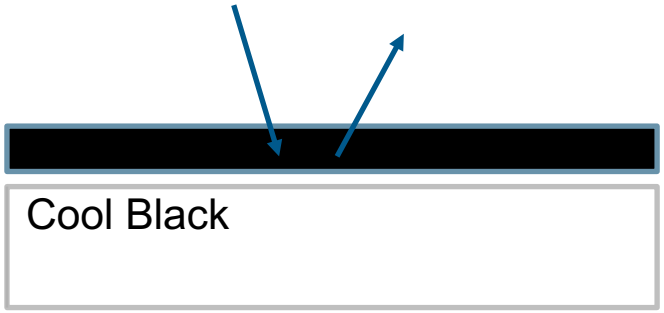
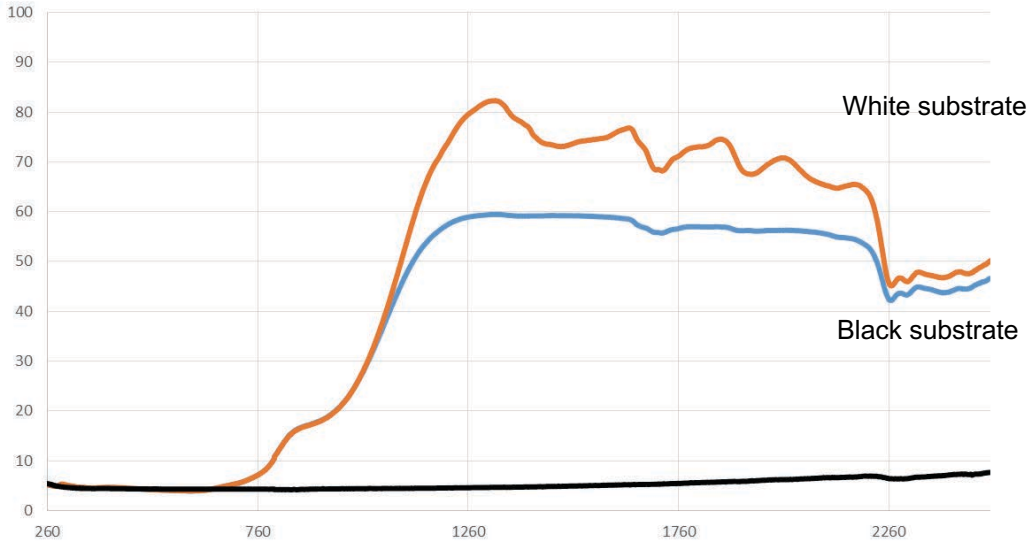
… pigment chemistry - cool black



Vs



Coil Coating, PVDF-Acrylic (70:30) – 20µ DFT



Pigment Brown 29 (Cool Black)	**%TSR 21**
Black coating (Carbon Black)	**%TSR 5**

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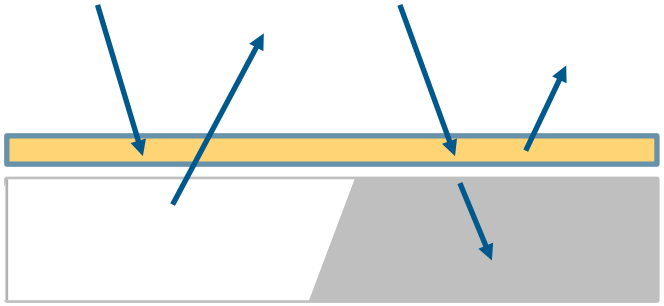
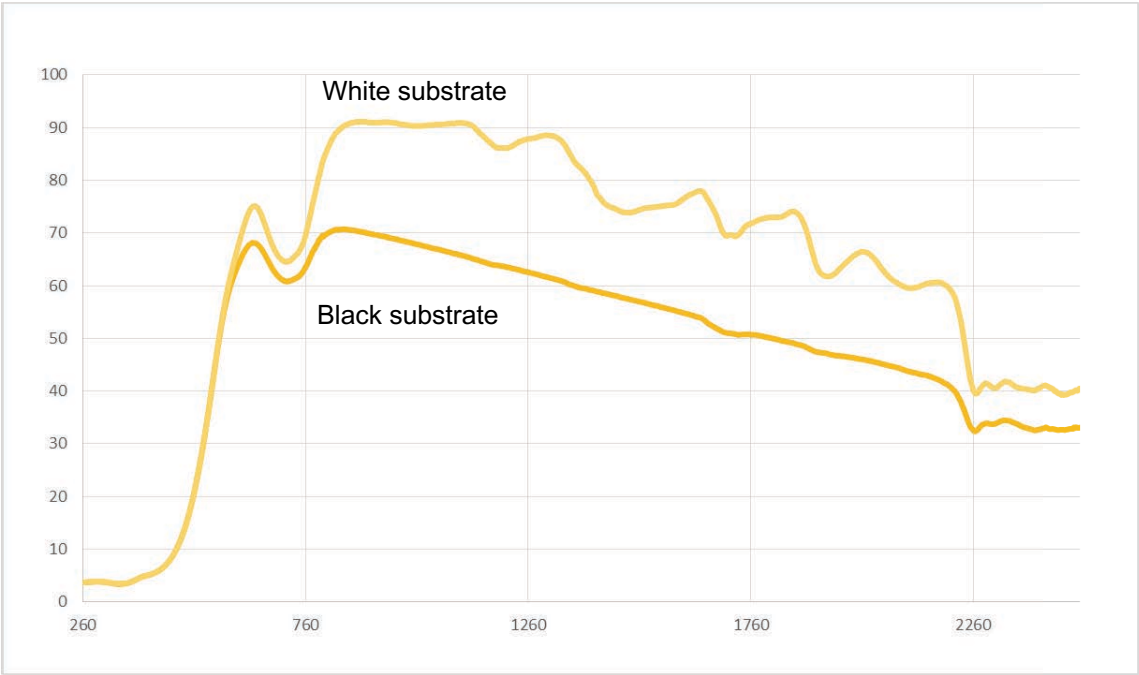
… substrate and pigments

Coil Coating

PVDF-Acrylic (70:30) – 20µ DFT

Pigment Brown 24





Pigment Brown 24 (White substrate)	**%TSR 59**
Pigment Brown 24 (Black substrate)	**%TSR 49**

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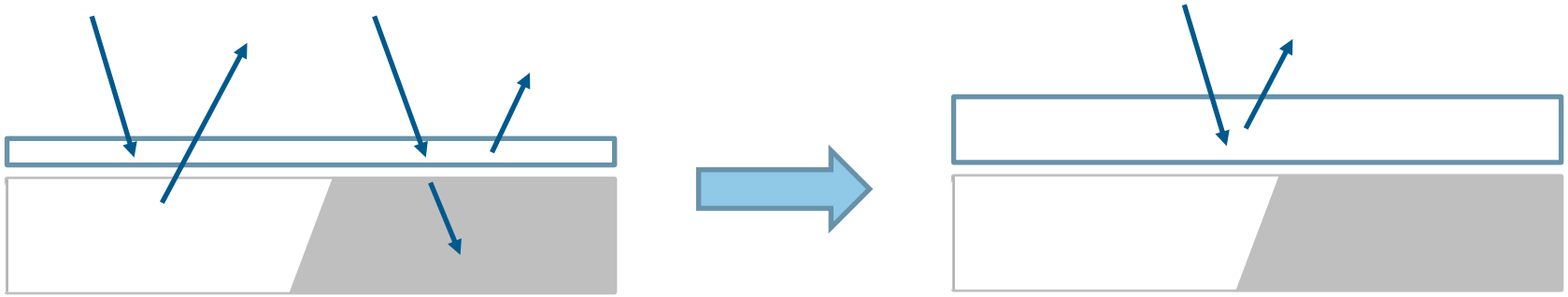
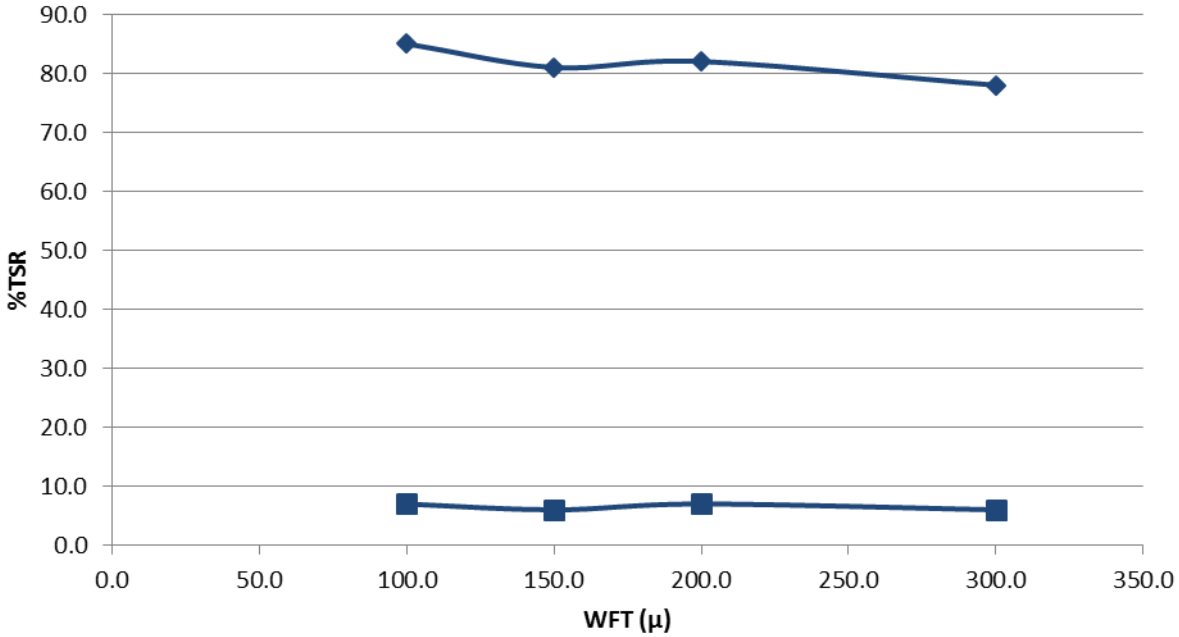
… substrate and thickness



Coil Coating, PVDF-Acrylic (70:30) – 20µ DFT



Over White substrate;
The thicker the film, the lower the %TSR due to certain absorption

Over Black substrate;
As film is not reflective, no effect of the thickness on the final %TSR result

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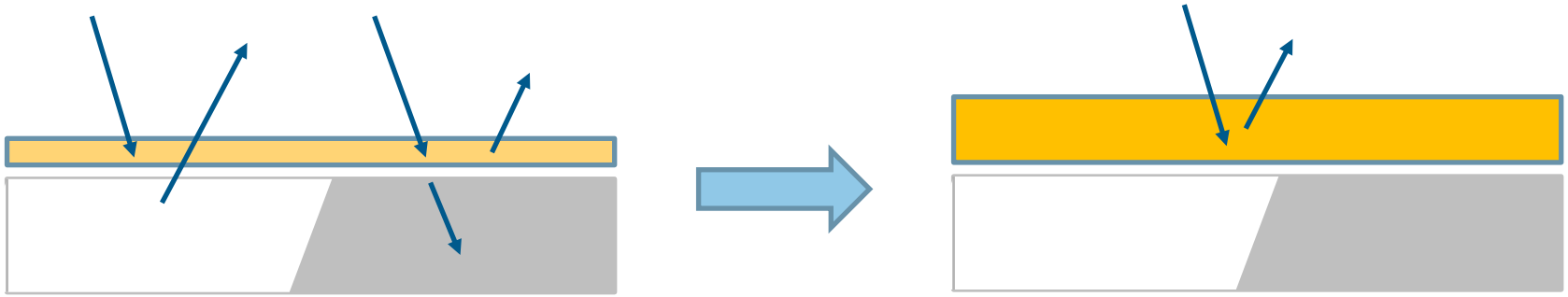
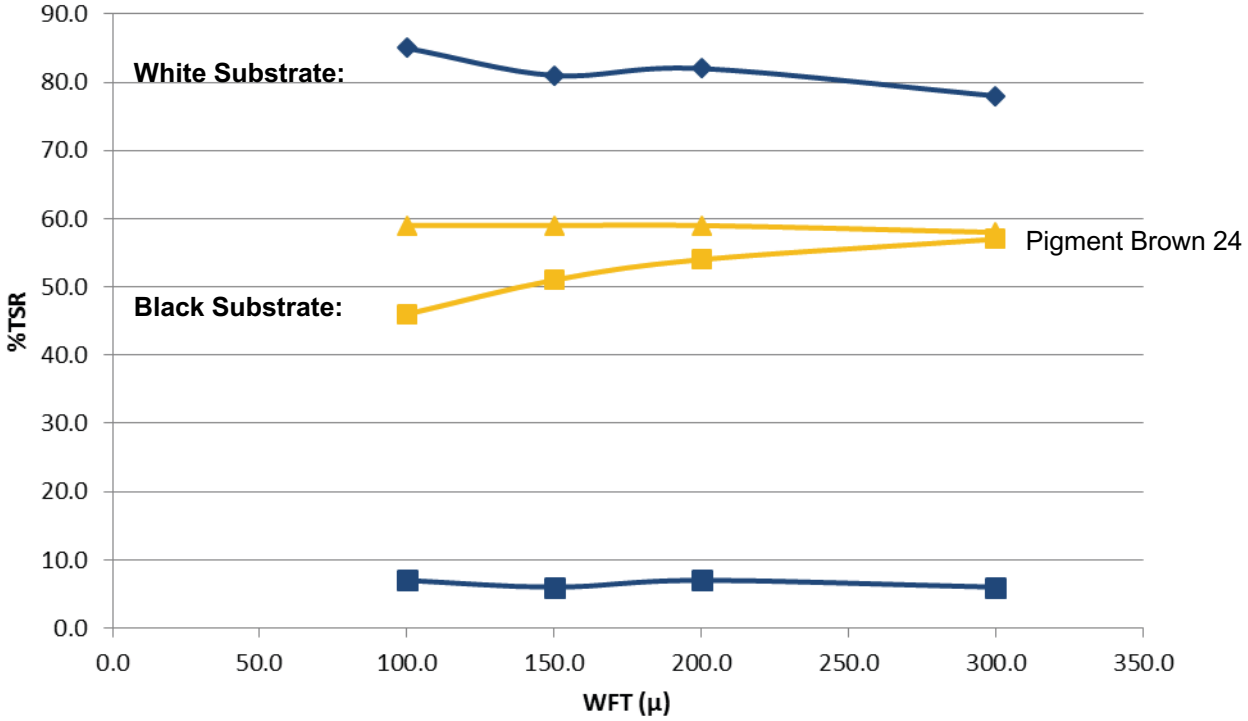
… substrate, thickness and pigments



Coil Coating, PVDF-Acrylic (70:30) – 20µ DFT



Over White substrate;
Using a reflective pigment there is no effect of the thickness on the %TSR

Over Black substrate;
Pigment reflectance makes TSR higher with thickness

When using a reflective pigment the substrate has less influence on the TSR value

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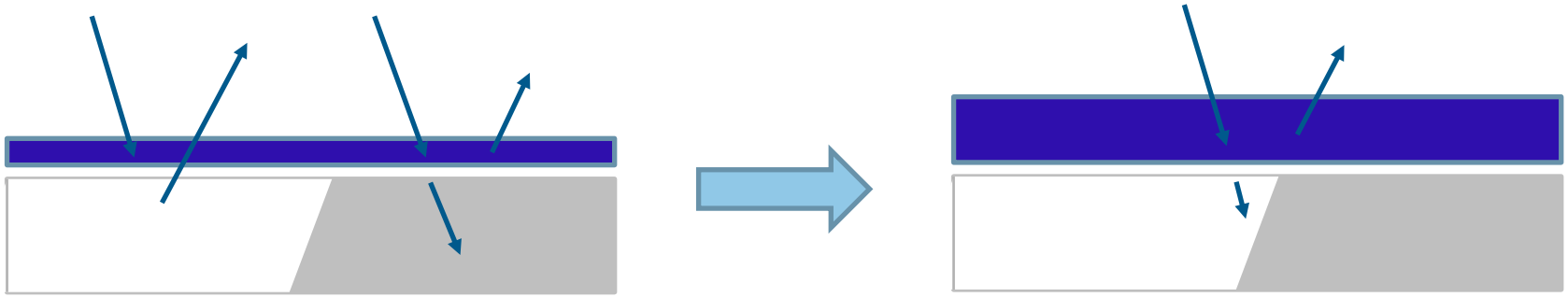
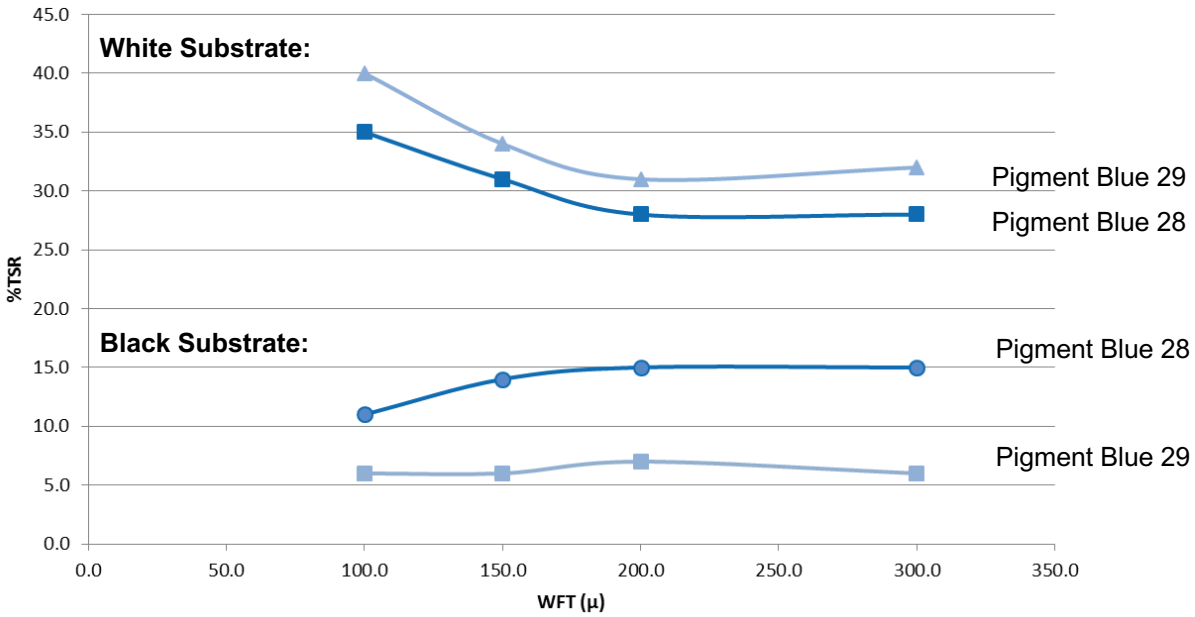
… substrate, thickness and pigments



Coil Coating, PVDF-Acrylic (70:30) – 20µ DFT



Over White substrate;
Pigment absorbance makes TSR lower with thickness

Ultramarine Blue is transparent to NIR so substrate has an influence on the result

Over Black substrate;
PB28, Pigment reflectance makes TSR higher with thickness

PB29, No Pigment Reflectance

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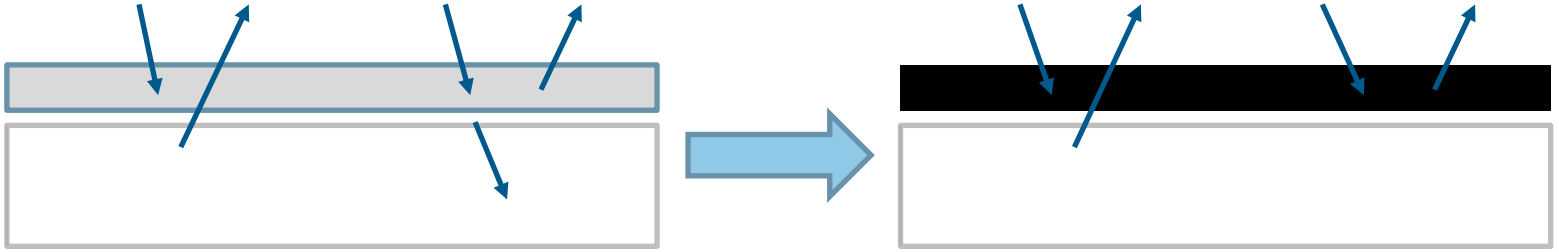
… L value



Coil Coating

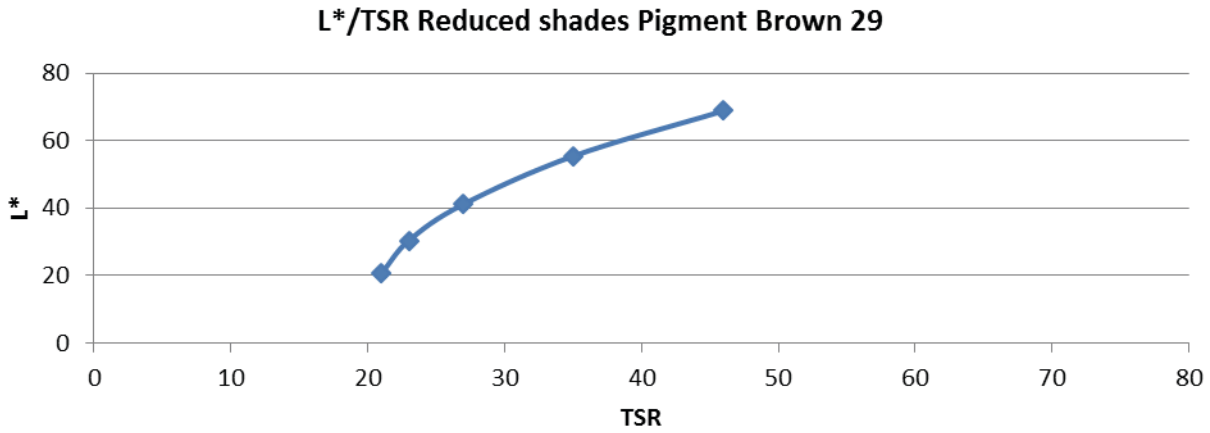
PVDF-Acrylic (70:30) – 20µ DFT

(white background)

Bluish Pigment Brown 29

+ TiO_2

L*	68.85	55.4	41.2	30.4	20.6
TSR	46	35	27	23	21



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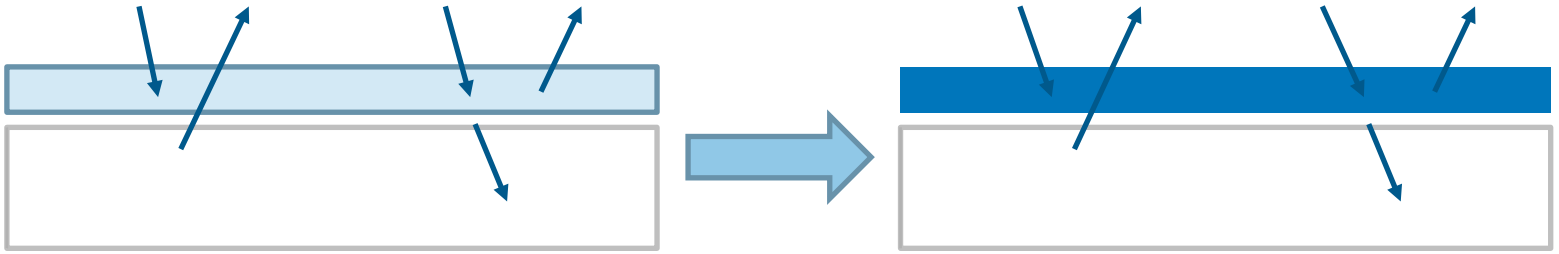
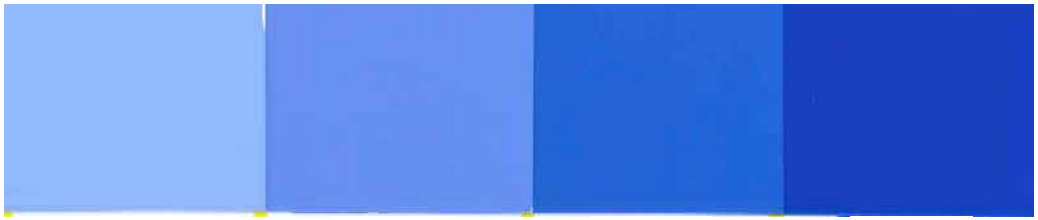
… L value



Coil Coating PVDF-Acrylic (70:30) – 20µ DFT (white background)

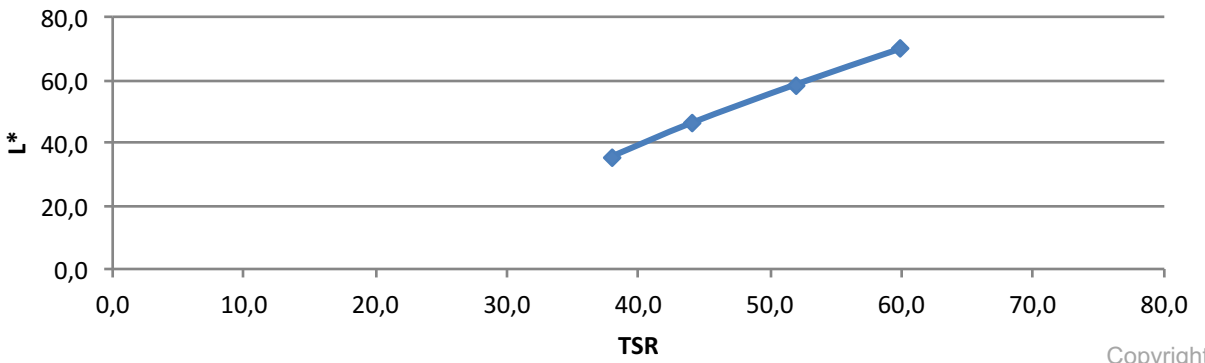
SuperReddish Ultramarine

+ Titanium dioxide



	75% TiO_2 25% SR UMB	50% TiO_2 50% SR UMB	25% TiO_2 75% SR UMB	10% TiO_2 90% SR UMB
L*	70.0	58.6	46.3	35.8
TSR	61	52	44	39

L*/TSR Reduced shades Nubicoat HRD



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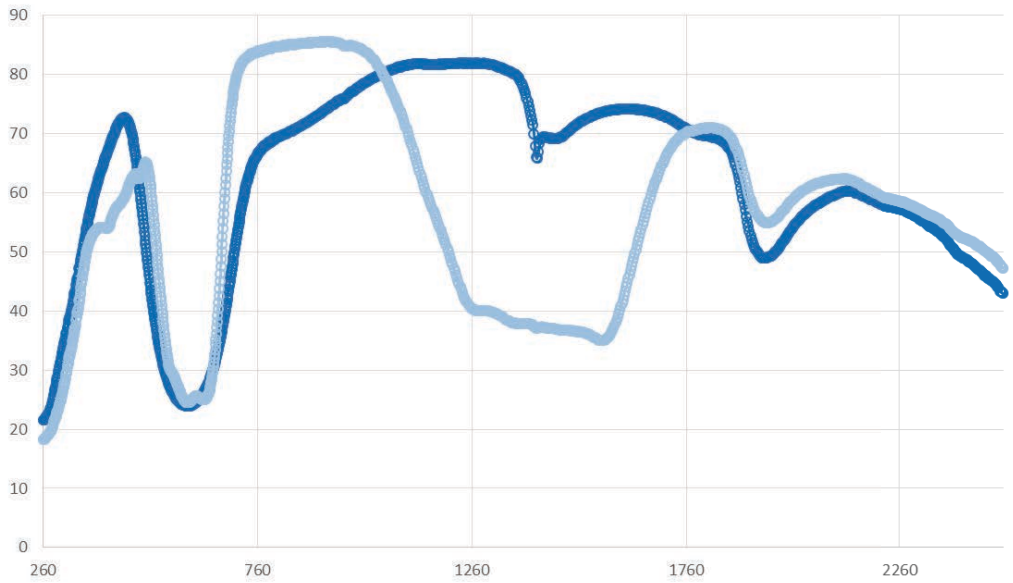
… pigment mixtures

Blue concrete samples, 4% pigmentation using White cement



Pigment Blue 28	%TSR 58
Pigment Blue 29	%TSR 58

2 different pigments but the same %TSR

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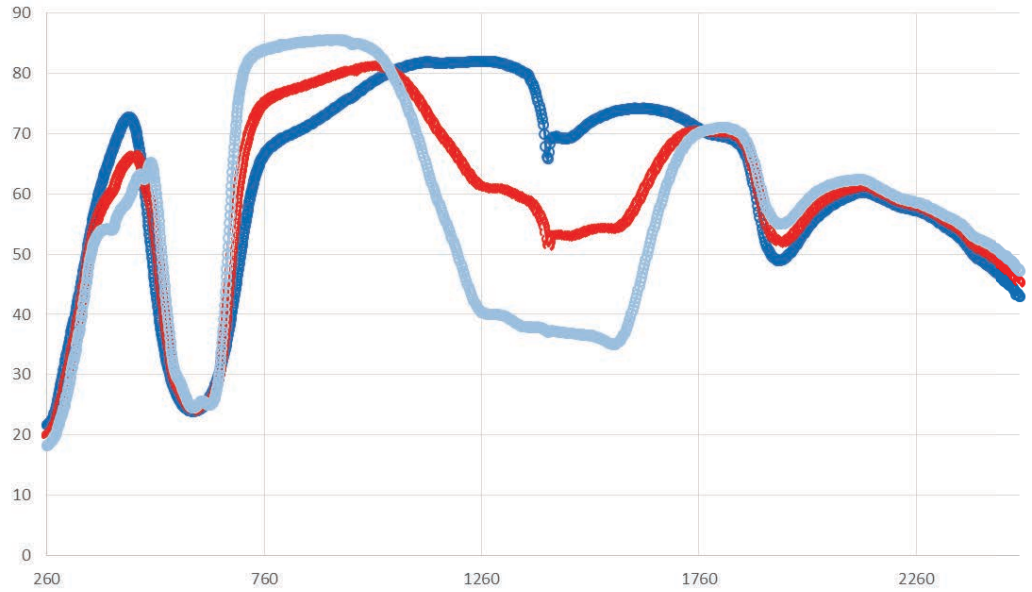
… pigment mixtures

Blue concrete samples, 4% pigmentation using White cement

2% Pigment Blue 28 + 2% Pigment Blue 29



Pigment Blue 28	%TSR 58
Pigment Blue 29	%TSR 58
Theoretical curve	%TSR ?

What is the resulting curve when mixing two pigments?

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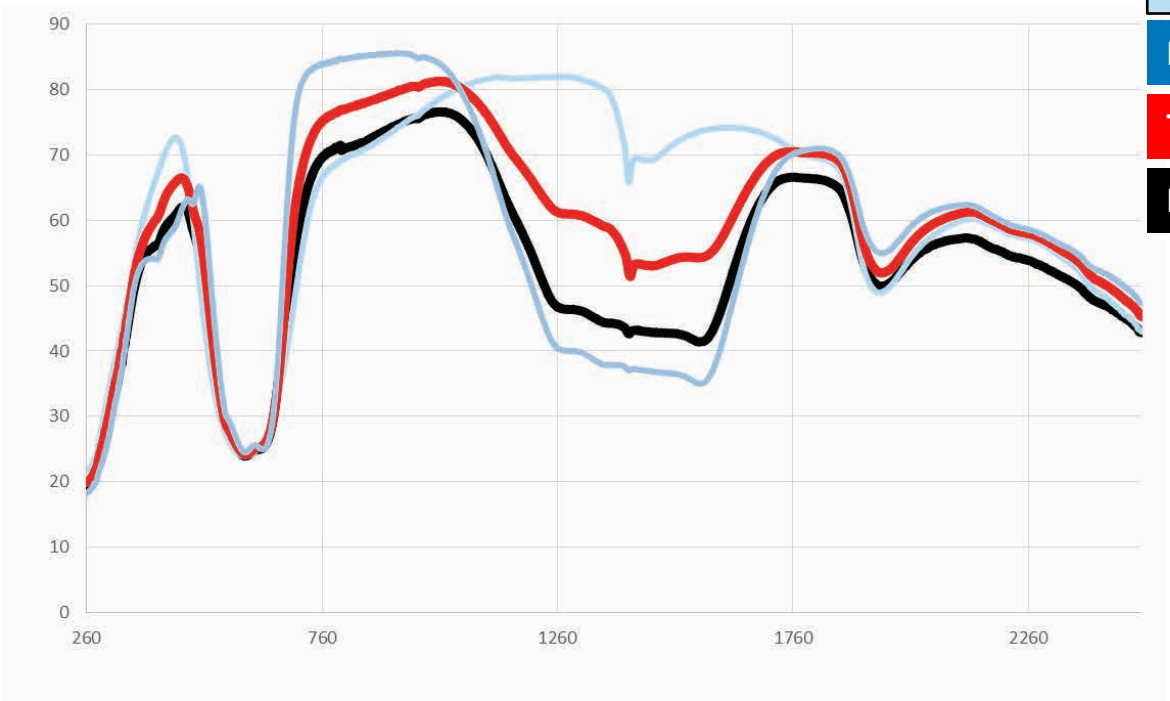
… pigment mixtures

Blue concrete samples, 4% pigmentation using White cement

2% Pigment Blue 28 + 2% Pigment Blue 29



Pigment Blue 28	%TSR 58
Pigment Blue 29	%TSR 58
Theoretical curve	%TSR ?
Real Curve	%TSR 54

The resulting TSR curve of a mixture is not the average of the separate pigments

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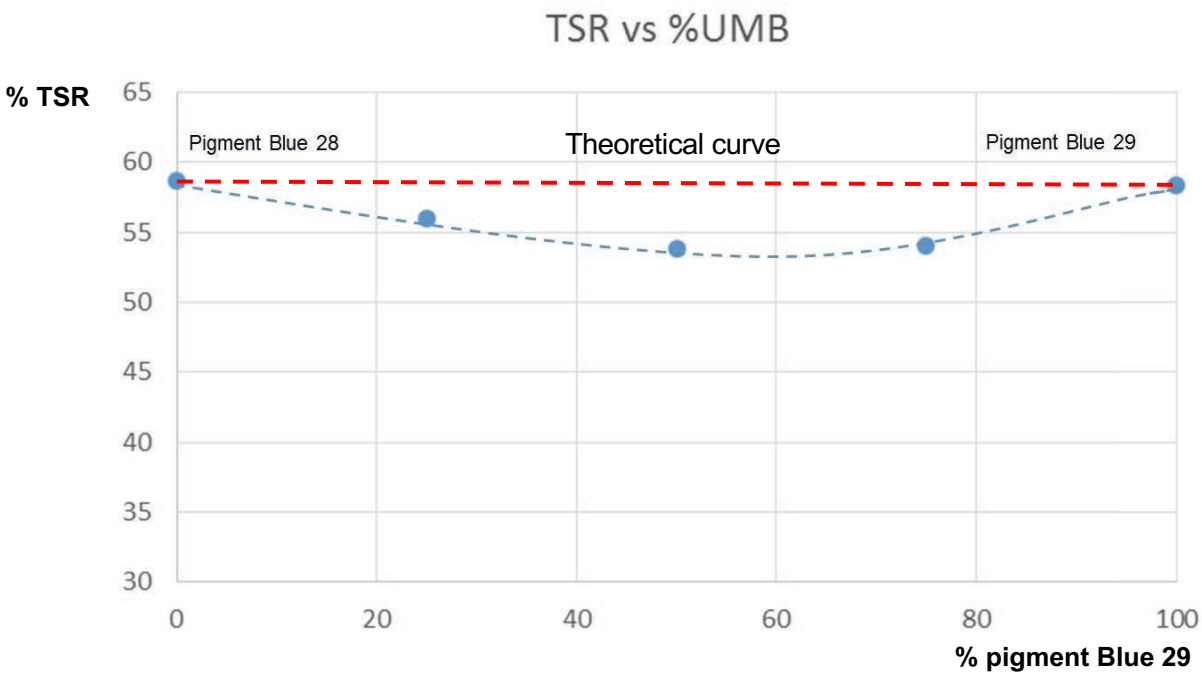
… pigment mixtures

Blue concrete samples, 4% pigmentation using White cement



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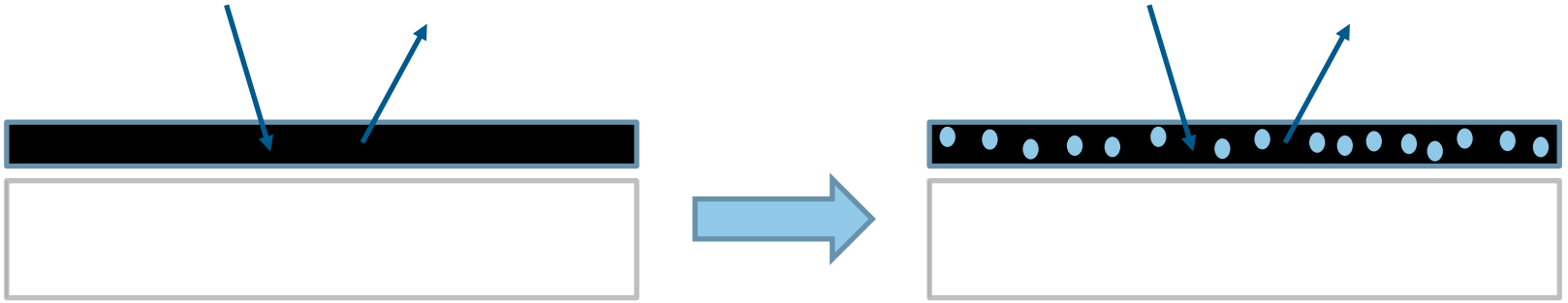
Cool blacks with enhanced bluish undertone

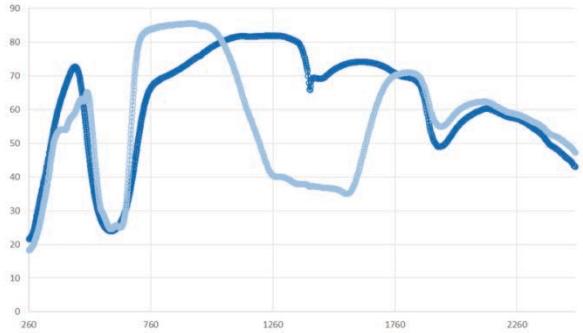


Coil Coating

PVDF-Acrylic (70:30) – DFT 20µ

(white background)

Reddish Pigment Brown 29 + Blue pigment



- Pigment Brown 29 (Cool Black)
- 90:10 with …
  - Pigment Blue 28 (Cobalt Blue)
  - Pigment Blue 29 (Ultramarine Blue)

	L	b
Pigment Brown 29	18.74	-1.26
+ Ultramarine Blue	18.87	-2.43
+ CoBlue	19.49	-1.95

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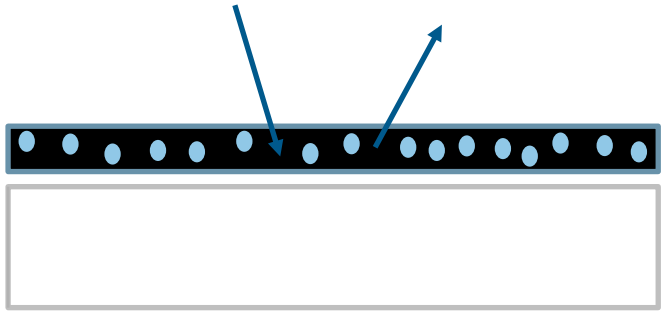
Cool blacks with enhanced bluish undertone

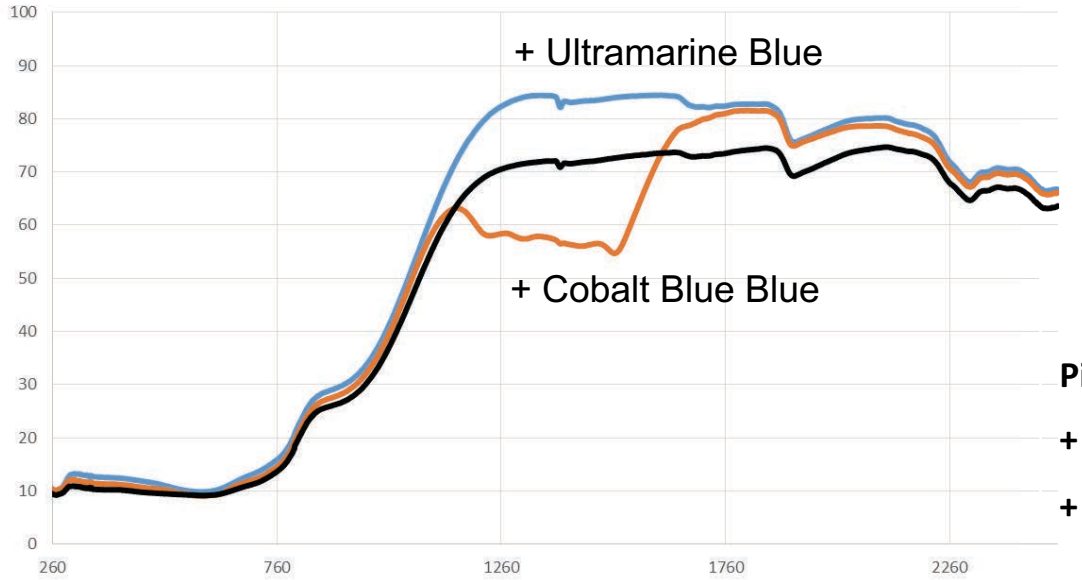
Coil Coating

PVDF-Acrylic (70:30) – DFT 20µ

(white background)

Pigment Brown 29 + Blue pigment





Pigment Brown 29

	L	b	%TSR
Pigment Brown 29	18.74	-1.26	**22**
+ Ultramarine Blue	18.87	-2.43	**21**
+ CoBlue	19.49	-1.95	**19**

- When mixing different pigments it is important to take into account the overlapping of the curves in the different parts of the spectrum

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Formulating with Cool Colors

- Do not use IR absorbers like: Carbon Black or Black 28 as this eliminates any improvement

- The combination of pigments should be taken into account when formulating cool colors

- Substrate:
  - Must be White or IR reflecting to ensure a higher %TSR
  - If primer is IR absorbing, it may affect IR reflecting performance

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Conclusions

- Ferro offers a whole range of Cool pigments
- Total Solar Reflectance can be measured by Ferro – just send panels
- Ferro can assist you in the development of your Cool Color formulas

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Where innovation delivers performance™

Thank you

Pigment Brown 29 – (bluish) **10466** and (reddish) **V-785**
Pigment Brown 24 – **10406**
SuperReddish Ultramarine Blue – **Nubicoat HRD**
Pigment Blue 28 – **5091**
Pigment Blue 29 Cement – **Nubicem B-101**

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