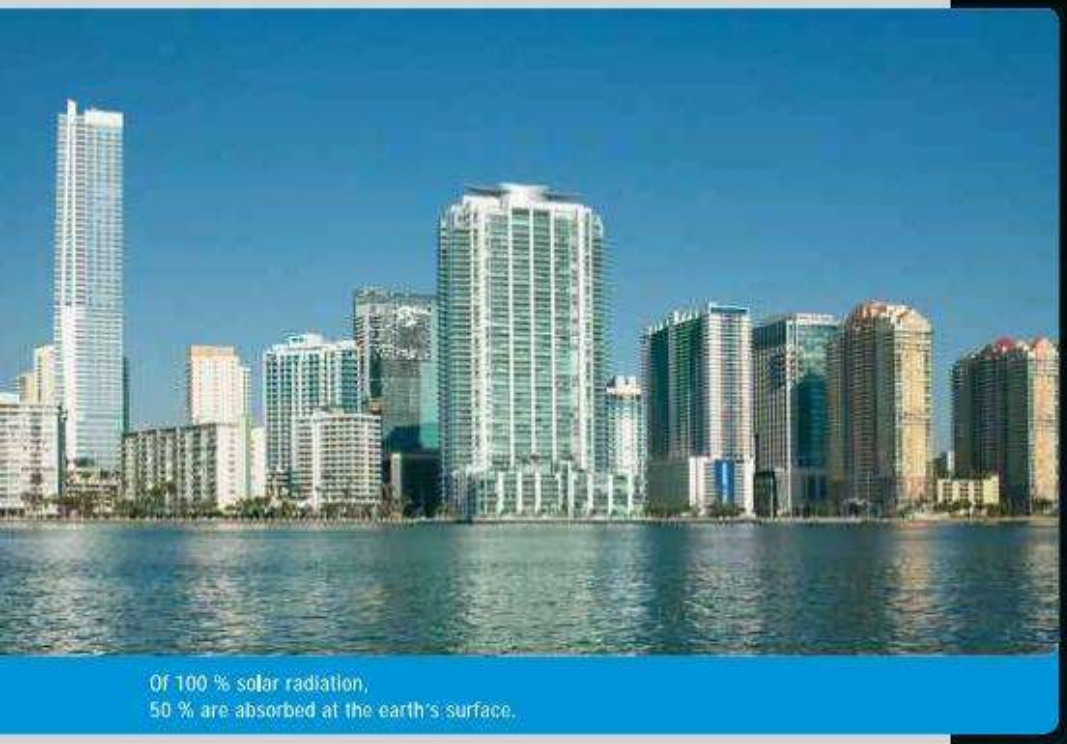
Paint it cool!

Pigments for solar heat management in paints

SMART SHEILD

Reflection instead of absorption keeps the coated surface cool



Of 100 % solar radiation,
50 % are absorbed at the earth's surface.

Absorption 25 % ∆
TSR (Total Solar Reflectance) 75 %

Rising energy costs, pronounced urban heat-island effect and global warming increase the need for intelligent solar heat management solutions like cool paints.

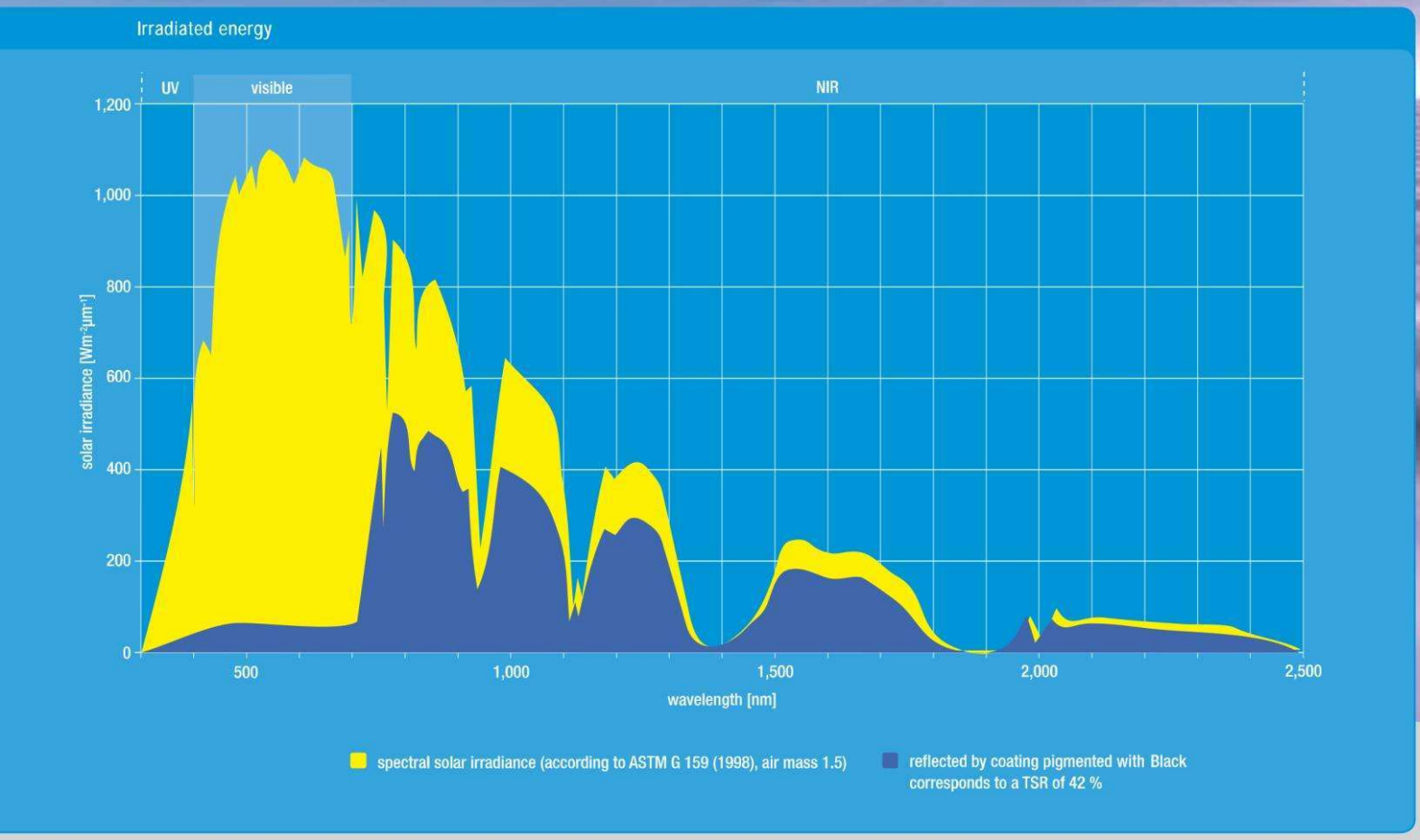
Roughly 50 % of solar radiation are absorbed at the earth's surface. Black surfaces usually absorb up to 90 % of this energy and therefore get hot. White surfaces, on the other hand, absorb only up to 25 % and tend to stay much cooler.

But white is not always an option, much more often color and especially dark shades are desired or even required. For cool paints, the starting point is always to look at the absorbing components in a formulation.

SMART SHIELD offers a solution with Black colour to formulate any dark shade with less absorption than the conventional black pigments. A Black grade is under development.

Absorption 90 % ≙
TSR (Total Solar Reflectance) 10 %

Cool pigments for cool paints

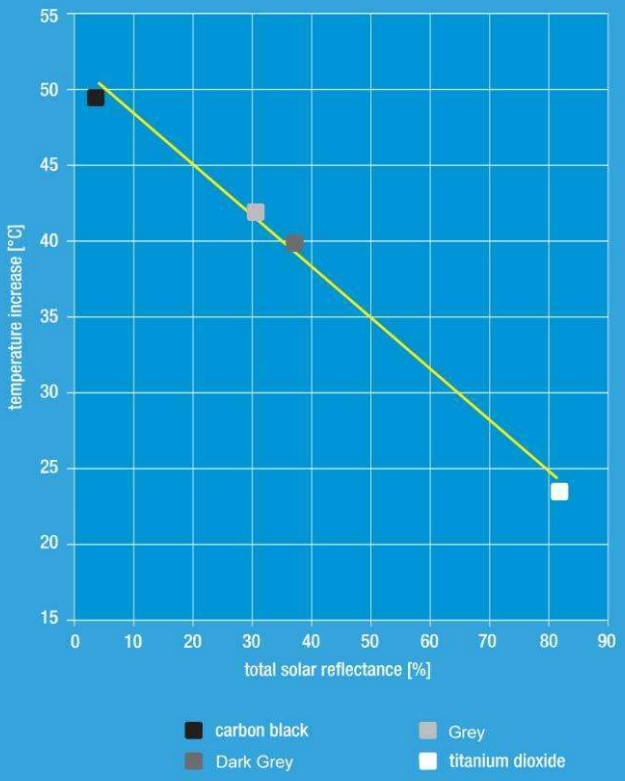


Total Solar Reflectance (TSR) is the percentage of irradiated energy that is reflected by an object. If this is coated with a film based on Black, the TSR is 42 %. Usually an object like a roof, a facade or the interior of a car, needs to have a certain color and therefore the pigment choice for the visible wavelength range is not free. To ensure the right color for the cool paint, the pigment or pigment combination with the right NIR properties has to be chosen. SMART SHIELD can predict the most suitable pigmentation for any given color and substrate to create coolness.

The sun emits energy from 300 to 2,500 nm

This wavelength range can be divided into three ranges:	
ultraviolet (UV)	300 - 400 nm
visible (VIS)	400 - 700 nm
near infrared (NIR)	700 - 2,500 nm
which contribute to the total irradiated energy like:	
ultraviolet (UV)	3 %
visible (VIS)	39 %
near infrared (NIR)	58 %

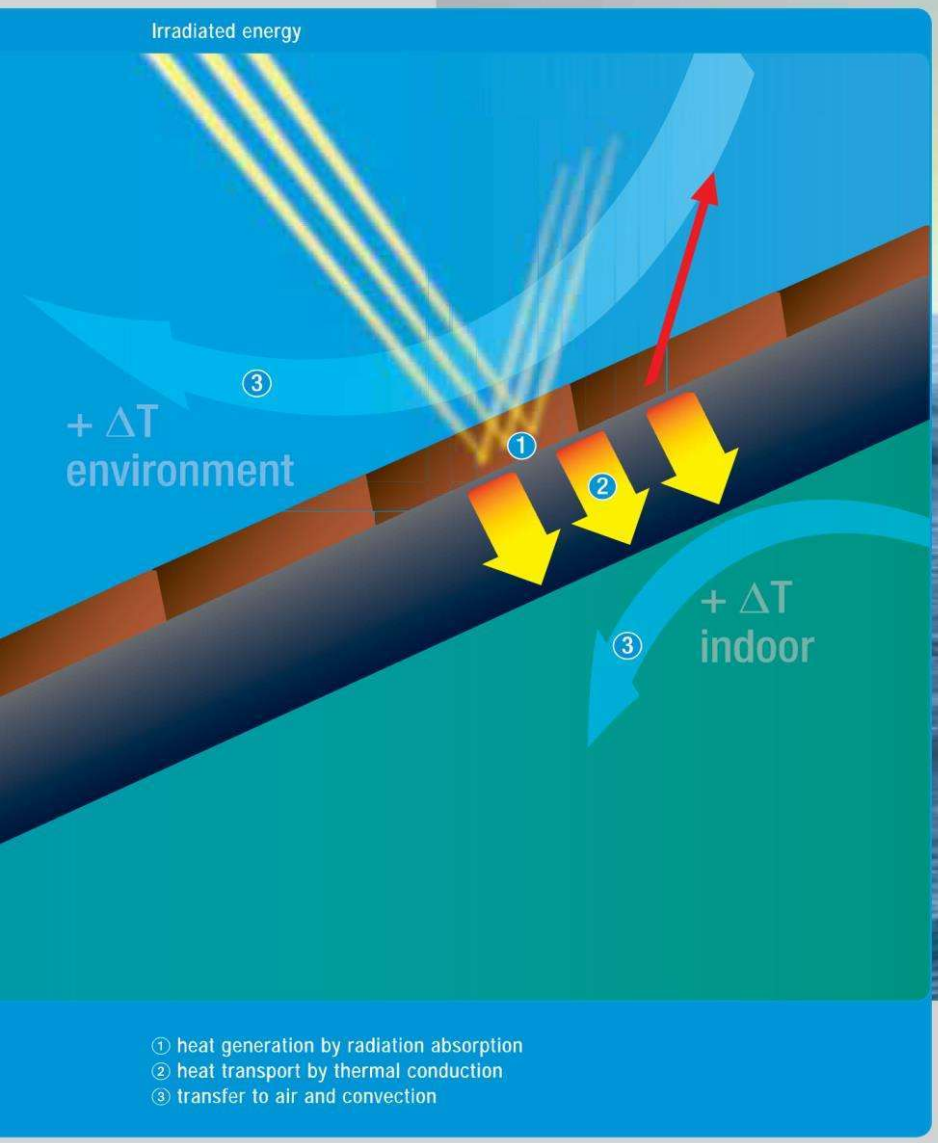
Experimental correlation between TRS value and heat build-up

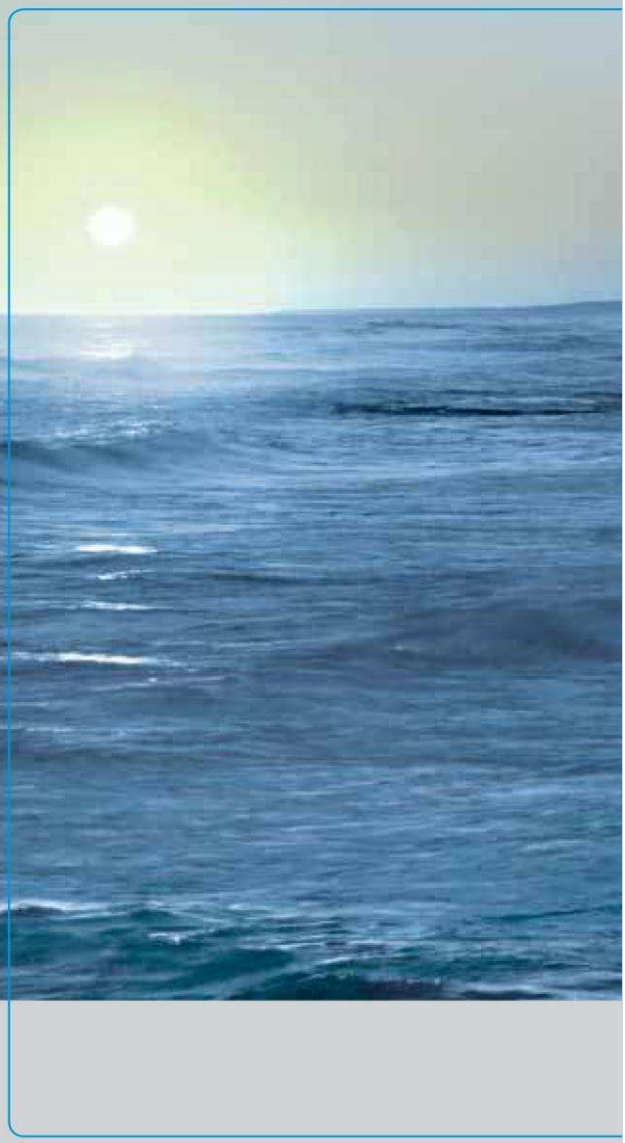


The assessment of suitable pigmentations is based on Total Solar Reflectance (TSR). The above graph shows the correlation between TSR and the temperature increase of titanium dioxide, carbon black and alternative black pigments suitable for cool paints. Carbon black shows the highest temperature increase and lowest TSR value, the alternatives offer both reduced temperature increase and higher TSR. Titanium dioxide gives the lowest temperature increase and the highest TSR. This clearly shows the relationship between Total Solar Reflectance and heat build-up.

Cool pigments for cool surfaces

Black





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Shade examples

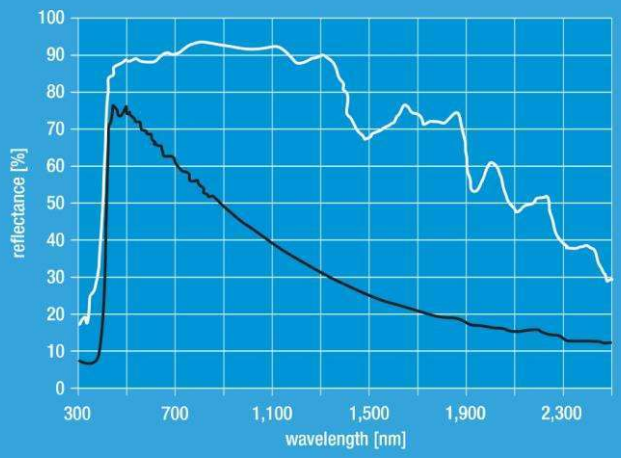
cobalt blue	chocolate brown	jet black

The shade examples show the impact of the black pigment used to formulate the respective shade. Of course it is not only applicable to blue, brown and black shades, but SMART SHIELD offers the service to predict the TSR for any given pigment combination over a given substrate with defined film thickness and pigment content.

Cool pigments for cool applications

Black

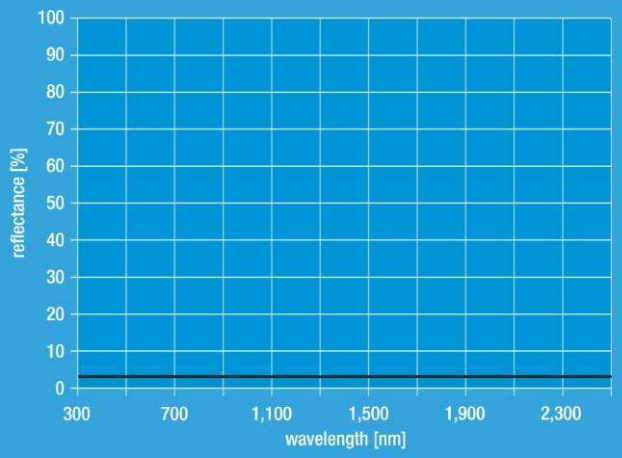
titanium dioxide – reflectance curves and TSR values



titanium dioxide on white substrate
titanium dioxide on black substrate

- TSR over white: 84.8 %
- TSR over black: 50.6 %
- calculated with
  - 10 % PWC
  - 40 µm dry film thickness
  - substrate: LENETA opacity chart FORM 2A black and white

lamp black 101 – reflectance curves and TSR values values



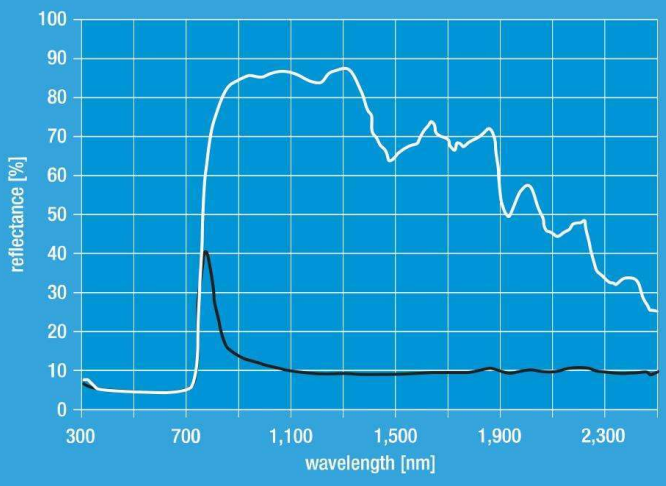
lamp black 101 on white substrate
lamp black 101 on black substrate

- TSR over white: 4.0 %
- TSR over black: 4.0 %
- calculated with
  - 10 % PWC
  - 40 µm dry film thickness
  - substrate: LENETA opacity chart FORM 2A black and white

The first graph shows the reflectance curves of a coating pigmented with titanium dioxide over a white-and-black substrate. There is only little difference between the two curves, which indicates the good hiding and reflectance properties of titanium dioxide.

The second graph shows the respective reflectance curves of carbon black, which is the standard black for most applications. There is no significant influence of the substrate. The coating pigmented with carbon black absorbs the energy irradiated by the sun throughout the whole spectral range.

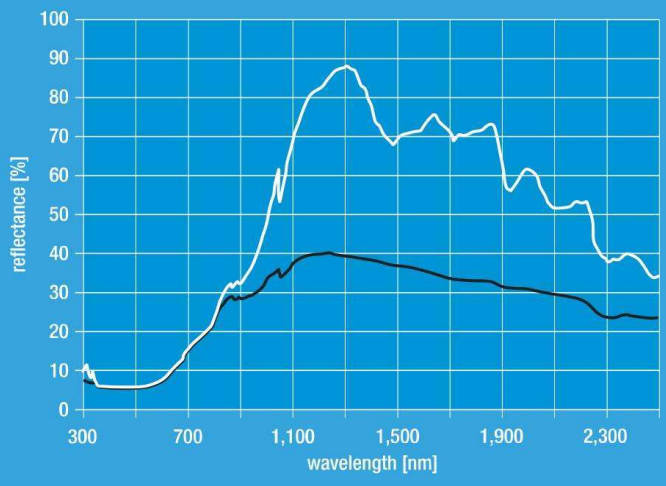
Black – reflectance curves and TSR values



Black on white substrate
Black on black substrate

- TSR over white: 42.0 %
- TSR over black: 10.4 %
- calculated with
  - 10 % PWC
  - 40 µm dry film thickness
  - substrate: LENETA opacity chart FORM 2A black and white

Black – reflectance curves and TSR values



Black on white substrate
Black on black substrate

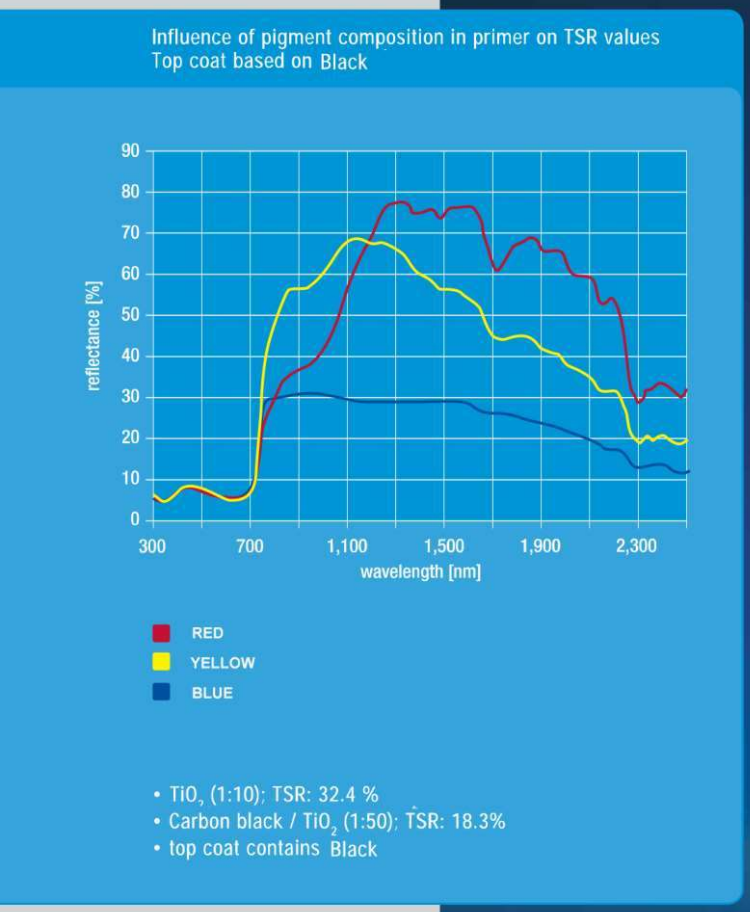
- TSR over white: 30.9 %
- TSR over black: 20.3 %
- calculated with
  - 10 % PWC
  - 40 µm dry film thickness
  - substrate: LENETA opacity chart FORM 2A black and white

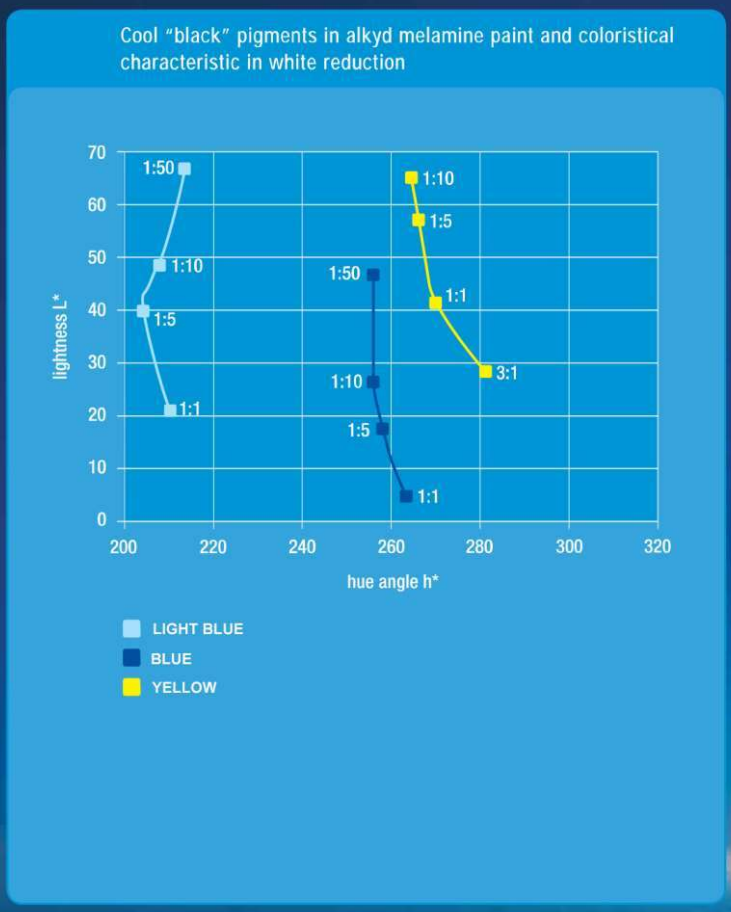
The graph shows the performance of Black, an organic black pigment, which shows hiding in the visible (VIS) range. For the near-infrared range, the substrate impacts the reflectance performance. Black is suitable for cool paints on reflective substrates or in combination with reflective pigments. For black shades it yields up to 42 % Total Solar Reflectance (TSR).

The second alternative offered by SMART SHIELD is Black, an inorganic pigment. The reflectance curves clearly show that it is a near-infrared-reflective pigment and is therefore partially hiding in the NIR-range. The TSR yield for black shades is up to 30 %.

Cool pigments for cool compositions

Red / Yellow / Blue





Normally paint films are applied as top coats to a thickness, where a good visible hiding (e.g., of a black and white contrast) is obtained. Often, there is still a transparency in the infra red range. For best cut of heat build-up this needs to be compensated by:

• higher pigment concentration in the top coat - not always possible from the technological point of view

• higher film build in the top coat - risk of delamination and others

• special pigmentation in the lower paint layer(s) or in the plastic substrate - replace IR-absorbing components by IR-reflecting or IR-transparent pigments

The coloristical profile of cool pigments

Pigments with good IR-transparency or IR-reflecting properties show a different coloristical profile, compared to obtain a neutral gray shade, the greenish Black can be mixed with Brown (ratio: - 7:1). Please note the differences in tinting strength as shown in the graph.