Technical Information
PS02

Pigments and Special Products

Cool Colors®

Asphalt driveways, shingled roofs, and black cars have something in common: out in the sun, they are quite hot. In fact, temperatures of dark roofs can easily be 85 °C or more. Why? It is because dark colours absorb a big quantity of the infrared radiation of the sun.

A lot of energy is needed in cooling houses and cars to create a comfortable environment, but there is a growing interest in energy saving and in economically preferred products. How can we solve this dilemma?

The solution is Cool Color® pigments!

Cool Color® pigments, a development by Ferro, stay much cooler in the sunlight. They offer you a great possibility to decrease the undesirable absorption in the IR region. Ferro Cool Color® pigments reflect the infrared light to a big extend, while still appearing as intensely coloured as comparable conventional pigments.

So cool does not mean „white“! Certainly objects coloured white have a high reflectivity of sunlight, but modern design requires colours, including very dark shades.

Objects coloured with Cool Color® pigments stay cooler. Several other advantages result from this fact:

- improved comfort levels for building occupants
- lower air conditioning costs, energy saving
- cooler cities
- the coloured parts are less subject to thermal expansion and contraction
- increased service life
- less product degradation
- intense colours available

How does infrared reflection work?

Figure 1 shows the spectrum of sunlight. Approximately half of the radiation lies within the infrared region.

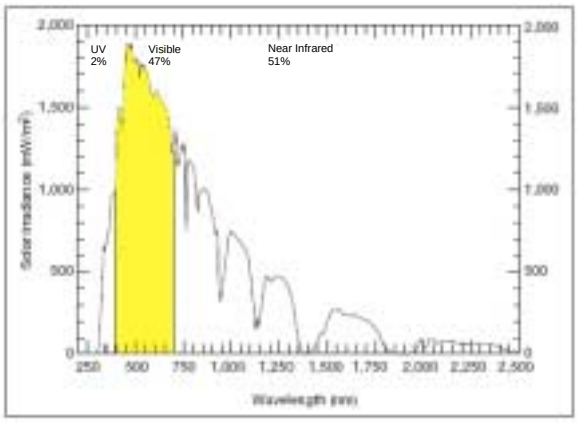

Fig. 1: Solar radiation spectrum [1]

The infrared radiation emitted by the sun is absorbed by roofs, walls, facades, and the like, leading to a heat build-up inside. Fig. 2 illustrates the energy transfer from the outside inside the building. All energy that is not reflected, convected or re-emitted, is conducted into the inside of the building and thus increases the interior temperature.

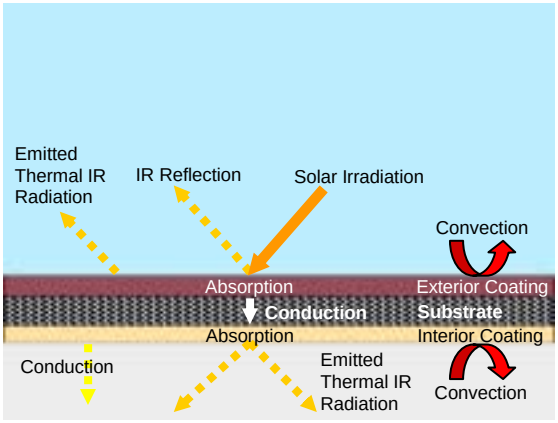

Fig. 2: Energy transfer in buildings

One possibility to work against this increasing temperature is a higher reflectance of the exterior surface of the building. What can be done to achieve this?

We need to modify the coating with a pigment that shows high infrared reflectance!

Fig. 3 and 4 show the solar reflectance spectra of the Cool Color® pigments, measured in a PVDF system. While still a major portion of the visible light is absorbed and the pigment appears brightly coloured, the biggest difference to conventional pigments can be found in the infrared area. The IR reflective pigments of the Cool Color® range reflect the infrared radiation to a great extend, almost as good as the white pigment titanium dioxide, whereas carbon black or other black pigments absorb almost all infrared light.

Therefore the coated objects do not absorb as much solar energy and stay cooler. Of course every pigment has a different reflectance spectrum. The percent of solar reflectance is the important figure. Whereas Carbon Black has a solar reflectance of 5 %, the solar reflectance of Ferros Cool Color® pigments is significantly higher (see Table 1).

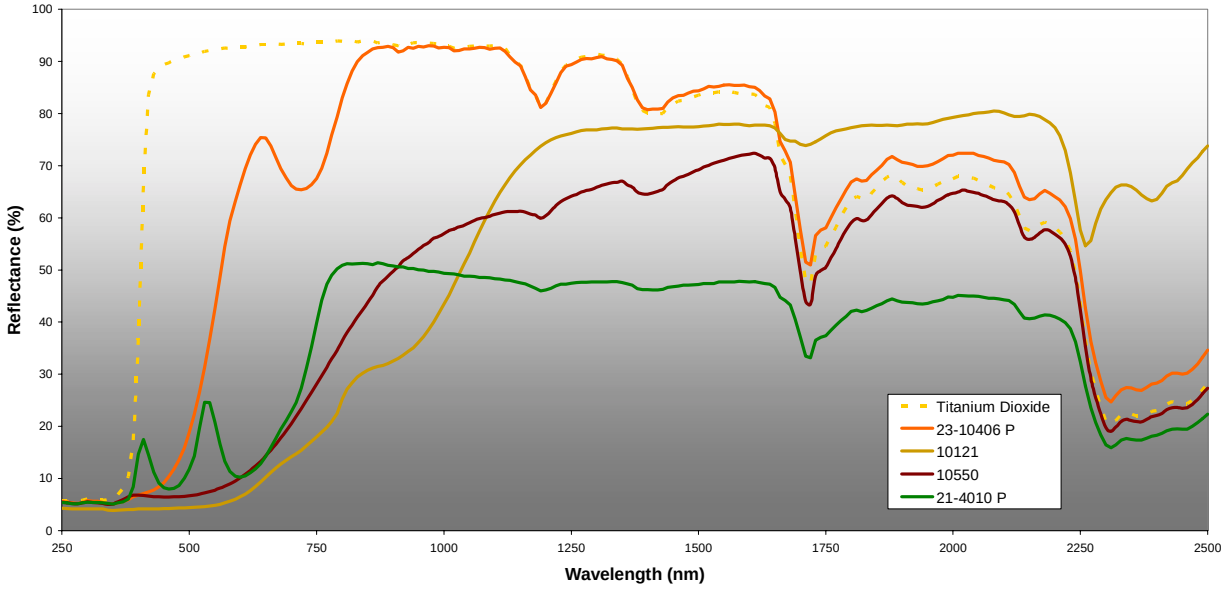

Fig. 3: Reflectance spectra of the Cool Color® pigments (masstone), with spectrum of titanium dioxide (Kronos RN 56) for comparison

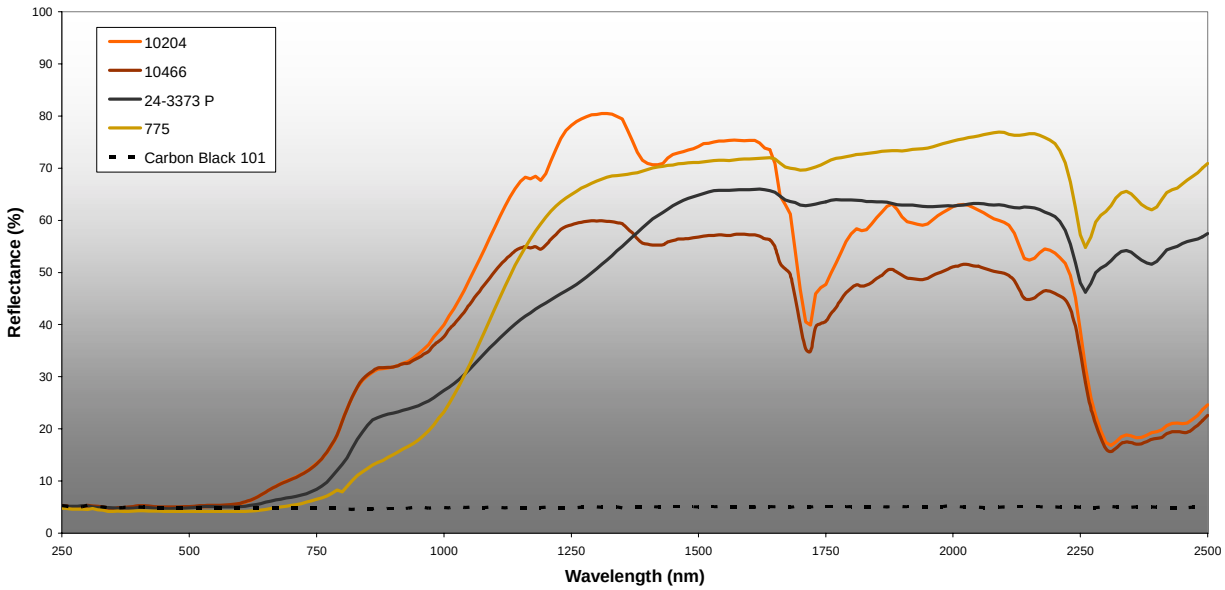

Fig. 4: Reflectance spectra of the Cool Color® pigments (masstone), with spectrum of carbon black (Pigment Black 7) for comparison

Colours

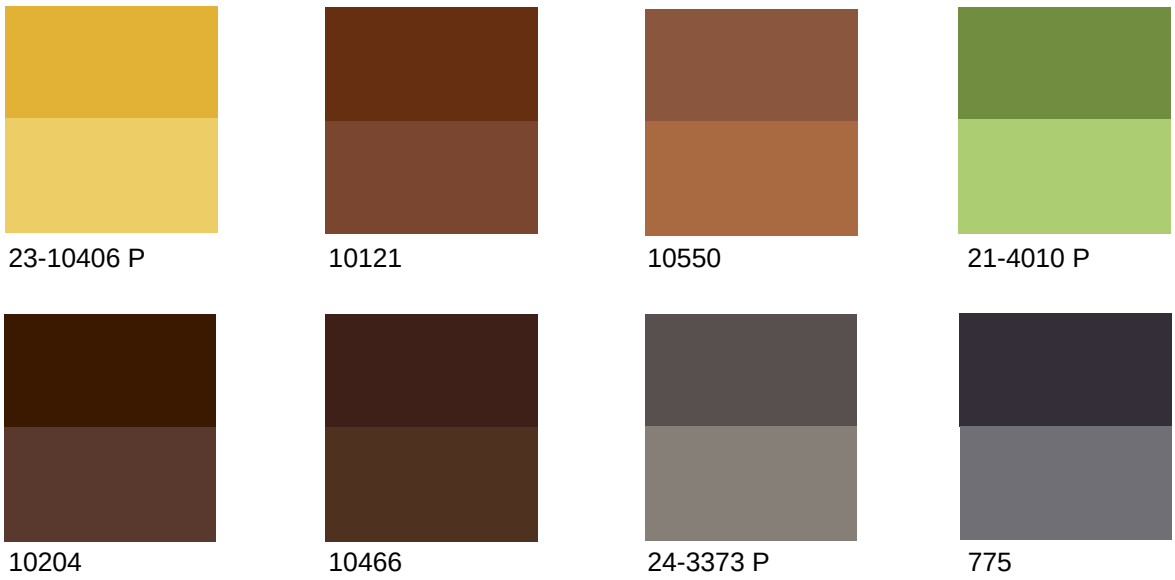

Fig. 5: Colour samples of the Cool Color® pigments in masstone and in 1:3 tint

While every attempt has been made to reproduce colours exactly, the colour samples shown here may differ slightly from the original.

Table 1: Technical data

Pigment	Colour Index/ Colour Index No.	Composition	CAS No.	EINECS No.	Solar Reflectance
23-10406 P	Brown 24 / 77310	Ti-Sb-Cr	68186-90-3	269-052-1	~ 57 %
10121	Brown 29 / 77500	Fe-Cr	12737-27-8	235-790-8	~ 28 %
10550	Yellow 164 / 77899	Ti-Sb-Mn	68412-38-4	270-185-2	~ 37 %
21-4010 P	Green 17 / 77288	Cr	1308-38-9	272-713-7	~ 29 %
10204	Green 17 / 77288	Cr-Fe	68909-79-5	272-713-7	~ 31 %
10466	Green 17 / 77288	Cr-Fe	68909-79-5	272-713-7	~ 27 %
24-3373 P	Green 17 / 77288	Cr-Fe	68909-79-5	272-713-7	~ 29 %
775	Green 17 / 77288	Cr-Fe	68909-79-5	272-713-7	~ 24 %

Applications

Although originally, Ferro scientists began to work on pigments with selective reflection and absorption for other applications many years ago, we are today finding commercial applications for this technology in various areas.

Cool Color® pigments are currently used in a number of different applications such as building exteriors, „cool roofs“, vinyl siding, automobiles, industrial coatings – shortly: in all applications where solar heat reflection and energy saving properties are desired.

Several research studies have been conducted to investigate the level of energy saving in buildings with cool roofs. The studies show that the cooling energy use in buildings can be reduced by more than 15 %, when the solar reflectance is increased from a typical value between 10 and 20 % to 50 % [2].

In a comparative study, different coatings on two otherwise identical elementary school buildings in Georgia, USA, were tested [3]. The infrared reflection of one of the buildings was increased from 12 to 29 %. For this building, energy savings of more than 12 % were stated [4].

In a study from Athens, the increasing heat island effect in urban areas is investigated [5]. The heat island effect is causing more and more discomfort, energy demand and the formation of smog. Infrared reflecting pigments were found to lower the surface as well as near surface air temperatures. The surface temperature can be up to 10 °C lower, and the air temperature up to 1.6 °C lower. The pigments are incorporated into pastes or other coating materials. Alternatively, the pigments may directly be used in building materials.

Not only in the building sector, but also in the automotive area there is a big need for reflective coatings. Cool Color® pigments can have advantages in the coatings of car shells, seats and dashboards. BMW launched its 1 series convertible with infrared reflecting pigments in the coating of the leather upholstery, in order to prevent the seats from heating up. Cool Color® pigments can also enhance the comfort of leather clothing in summer.

A simple experiment shows the different temperature behaviour of conventional inorganic pigments and Cool Color® pigments. The pigments are incorporated into PVC and processed into panels. On their backside a thermocouple measures the temperature, while being heated with a lamp. In the example shown in fig. 6, a brown RAL shade, the temperature of the Cool Color® pigment is 30 °C lower than that of the conventional brown pigment.

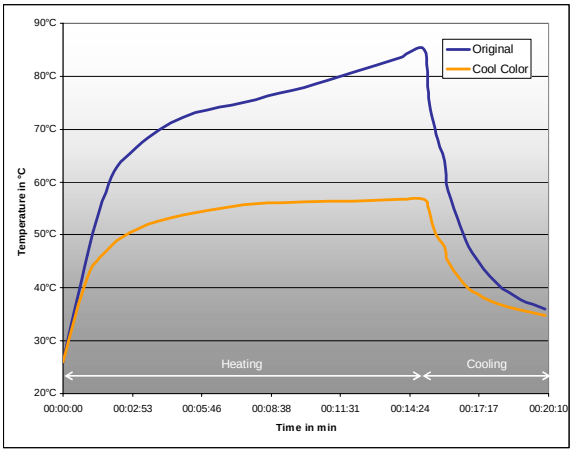

Fig. 6: Comparison of two coated panels with RAL shade 8028

Pigment Properties

In addition, Cool Color® pigments from Ferro show many other positive features. They have excellent heat and weathering resistance, lightfastness, opacity, and they are chemically inert. In most applications they are non-warping and non-bleeding. The inherent properties of these pigments allow for a wide range of end uses. Applications include many different kinds of polymers, high quality industrial coatings, coil coating, powder and high heat resistant coatings, weatherproof facade coatings, silicate coatings and stuccos.

The colour card in fig. 5 and the table with technical details show how even dark shades are available with high infrared reflectivity.

All Cool Color® pigments can be mixed with each other. Together with titanium dioxide, a full colour palette can thus be achieved.

The matching of specific RAL colours is also possible. If your desired colour is not included in this brochure, please contact us. Our Technical Service team will be happy to support you in finding a solution.

Summary

In this brochure, the new generation of infrared reflective pigments is presented. These pigments do not only show excellent colours, they also have outstanding functional properties regarding heat reflection.

In case of questions to our products and their application, please do not hesitate to contact us.

Ferro – your partner for innovative products.

[1] Hulstrom, R., R. Bird, and C. Riordan, Spectral solar irradiance data sets for selected terrestial conditions. Solar Cells, 1985. 15: p. 365-391.
[2] Akbari, H, Berdahl, P., Desjarlais, A. et al., .“Cool Colors: A Roofing Study is Developing Cool Products for Residential Roofs,” ECO Structure, 2004, Sept./Oct., 50-56.
[3] Partyka, B., Metal Roofing, ECO Structure; 2006; Jan./Feb., 42-44.
[4] Cool Metal Roofing Coalition: Case study „Metal roofing goes to school for big energy savings“
[5] Synnefa, A., Dandou, A., Santamouris, M. and Tombrou, M., 1997. Cool colored coatings for passive cooling of cities, International Workshop on Energy Performance and Environmental Quality of Buildings, July 2006, Milos Island, Greece, 1-6.

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