New black pigment with superior heat insulation properties


Katsura Kawashima and Yoshiki Hashizume, Research and Development Department, Core Technology Center, Toyo Aluminium K.K.

Coated plates used as samples

【 1. Introduction 】

As requirements for electric power and energy saving increase, so are the demands for heat insulating coatings. For black in particular, carbon black, used at present, absorbs a lot of heat, so if it is coated on items such as automobiles, then the interior temperature rise is great and the result is that a lot of energy is required for cooling. The pigments to be blended into heat insulating coatings are required to have high infrared-ray reflection characteristics. For black too, consideration has been given to use of perylene black and complex inorganic black pigments, which have high rates of infrared reflectance. However, the effectiveness of these is not fully sufficient. The black pigment introduced in this report is an aluminium flake pigment that exhibits black color due to light interference (a black interference aluminium pigment). This report describes how this pigment enables heat insulating effect that is greater than that of perylene black.

【 2. The structure of black interference aluminium pigment 】

The structure of the black interference aluminium pigment is shown in Figure 1. This pigment has aluminium flakes as a base material and a half-mirror structure is formed on the surface of the flakes with a silica layer and a layer of silver particles. The pigment then has a protective layer of silica formed on the top. The black color is created by adjusting the thickness of the silica film and the amount of the silver particle coating.

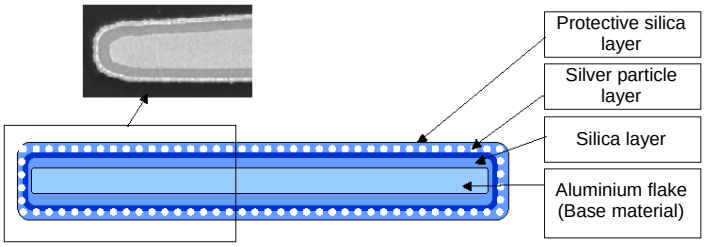

Figure 1 The structure of black interference aluminium pigment

【 2. Example performance evaluations (Comparison with other pigments) 】

As items for comparison, an evaluation was performed using carbon black and perylene black, which is attracting attention as a heat insulating pigment because of its high infrared reflection effect.

(1) Spectral reflectance

Figure 2 shows the spectral reflectance curve for the black interference aluminium pigment (using an ultraviolet-visible-near-infrared spectrophotometer) in comparison with that of pelylene black. This pigment shows low reflectivity in the visible region but reflects light in ultraviolet and infrared regions. However, it does not show the rapid rise in reflectivity in the infrared region that perylene black does.

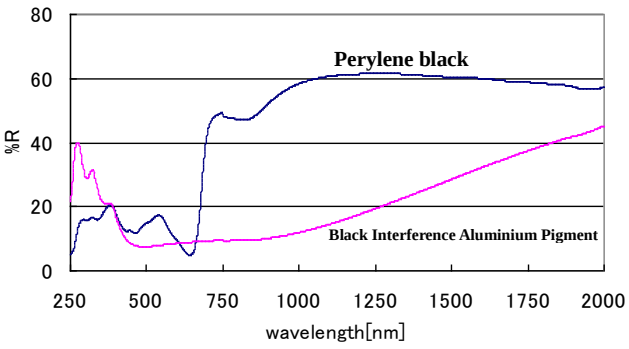

Figure 2 Spectral reflectance of sample pigments

(2) Preparation of coated plates

Table 1 shows compositions of the coatings used for preparation of the coated plates. The specific gravities and color tones of each pigment evaluated were all different, so loading quantities of the pigments were adjusted so that the coatings had equivalent hiding power.

The coated plates were prepared by drawing down these coatings onto tin plates using a 9 mm doctor blade. The figure at the top shows photographs of the coated plates used as samples for heat insulation measurement.

Table 1 Details and blending quantities for each sample

Pigment	Coating formulation (g)	
	Pigment (Solid content conversion)	Acrylic lacquer (Solid content: 32 wt%)
Black interference aluminium pigment	2.0	23.0
Carbon black	0.3	24.7
Perylene black	1.0	24.0

(3) Evaluation of heat insulation properties

The test device (Figure 3) was a box-shaped container with an electric light bulb installed in the center and circular windows on each side wall. The coated plates for measurement were attached to these windows. The light came through the windows and hit the coated plates and the change in temperature of each coated plate by the light was observed using a thermocouple attached to the rear of the plates. During the measurements, a standard coated plate was placed on the measurement window on one side to check that there was no fluctuation in the temperature change due to factors such as the light source or the external air temperature.

Figure 3 Device for measurement of heat insulation properties

(4) Results and consideration

The results of the measurement of the heat insulation properties are shown in Figure 4. The sample with the greatest rise in temperature was carbon black, and perylene black finally showed a temperature 2 to 3°C lower than this. On the other hand, the black interference aluminium pigment showed a final temperature around 10°C lower than carbon black, demonstrating that it has a heat insulating property that is superior to that of perylene black.

Observation of the spectral reflectance curve for the black interference aluminium pigment reveals that the reflectivity in the near infrared region is low and it appears that it would not be particularly effective as a heat insulating pigment. However, when we examine the structure of it, except for the light that is absorbed in the silica film, the majority of the light is being reflected by metals. Therefore, the majority of the light energy is also being reflected back, which is why it is thought to exhibit an excellent heat insulating effect.

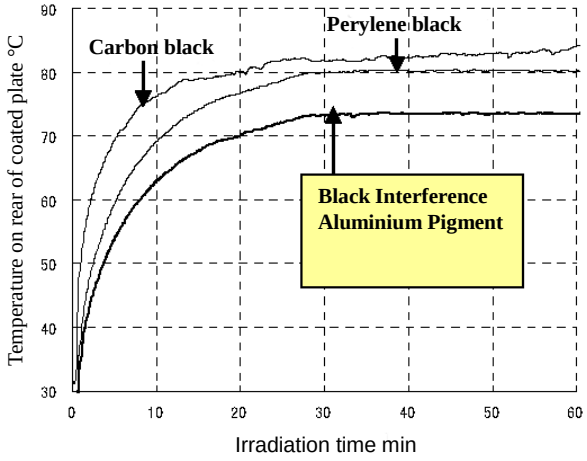

Figure 4 Results of measurements of heat insulation properties of coated plate samples

Reference documents

1) Published unexamined patent application 2004-10851
2) Kansai Paint Co., Ltd. “Research on Coatings” Nakai, Omori, Shimada 68-74 No. 144 Oct. 2005
3) Published unexamined patent application 2010-214292