Characteristics of vacuum metalized aluminium pigments for water borne formulation

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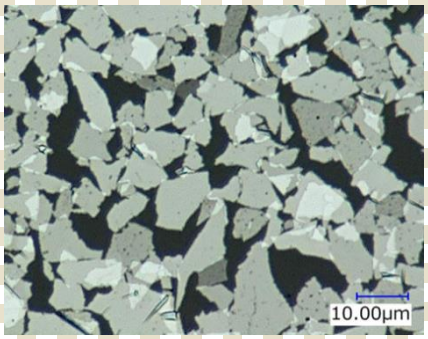

[1. Introduction]

Aluminium pigments are materials essential for delivering metallic design and are widely used in the fields including automotive paint, plastics paint, and printing inks.

The properties of aluminium pigments that affect design include lightness, contrast between highlight and shade, granularity, and distinctness of image.

Existing aluminium pigments are made by deforming aluminium powder with a particle size distribution obtained by the gas atomization method into flake shapes with a ball mill. Dispersing the aluminium particles into a paint enables design with silver metallic gloss.

To respond the recent customer needs for high-quality design, we have been developing bright aluminium pigments of the silver dollar type with well controled particle size distribution, flake aluminium particles (hereinafter simply referred to as “aluminium particles”) of even thickness having edges processed neatly[1].

On the other hand, vacuum metalized aluminium pigment enables specular design that cannot be achieved with conventional silver dollar type and has recently attracted attention . In the automotive field, the development of paints and painting techniques to make full use of vacuum metalized aluminium pigment are underway[2].

Vacuum metalized aluminium pigment are, however, practically under development because it has problems such as low dispersibility in paints, difficulty in controlling orientation of aluminium particles in the coated film, and instability of the pigments in water borne paints.

This report discusses characteristics of vacuum metalized aluminium pigment and introduces that we have recently developed for water borne paints .

[2. Characteristics of vacuum metalized aluminium pigment]

A **vacuum metalized aluminium pigment** is made as follows. First, aluminium is evenly evaporated onto a plastic film sheet in vacuum condition . Next, the evaporated thin aluminium film is separated from the plastic film. Only the thin aluminium film is then crushed and a pigment is obtained after the particle sizes are adjusted.

The obtained pigment consists of very thin aluminium particles of even thickness mostly equal to or smaller than 30 nm, varying depending on the grade. Highly orientated **vacuum metalized aluminium provides** extremely high brightness and flip-flop effect as shown in Fig. 1 because of its very smooth metal layer in the coated film.

Fig. 1 Appearance of evaporated aluminium pigments

Fig. 1 shows the design obtained with the two types of vacuum metalized aluminium pigment available in our TOYALSHINE® series: TS-710PM and TS-408PM.

TS-408PM has a more blackish luster than TS-710PM as seen in the photo of Fig. 1 because TS-408PM is thinner than TS-710PM.

Fig. 2 schematically shows arrangement of the aluminium particles in cross section of a paint film. As shown in this model, the aluminium particles of vacuum metalized pigment are highly orientated in thin paint film. As a result, the paint film behaves like a sheet of smooth metal film with minimized diffuse reflection, delivering specular design.

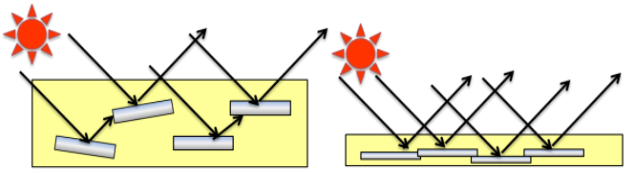

Fig. 2 Orientation of aluminium pigment particles and light reflection behavior
Left: Cross section of paint film of general aluminium pigment
Right: Cross section of paint film of highly-oriented aluminium pigment particles in thin paint film

[3. Water-based vacuum metalized aluminium pigment]

As an aluminium pigment is an amphoteric metal, it reacts with acid, alkali, and water contained in the formulation of a water-based paint or ink to form hydrogen, causing the aluminium to corrode. When this reaction takes place, not only hydrogen is formed but also appearance is deteriorated. In the past, we developed silica coated aluminium pigment EMERAL® series by the sol-gel process as a technique to make aluminium pigments compatible with water-based paints[3].

Whereas the EMERAL® series are primarily the products made by forming a silica film on the surfaces of aluminium particles in the silver dollar type, the EMERALSHINE® series that we have developed recently are applied for vacuum metalized pigment. The aluminium particles obtained through vacuum metalizing are very thin as mentioned above. Therefore, their specific surface area is much larger than that of a general aluminium pigment and thus it was very difficult to make an applied silica film thick enough to ensure water resistance. We have successfully developed a technique that enables the formation of a very smooth and even coating layer by greatly improving the silica coat process.

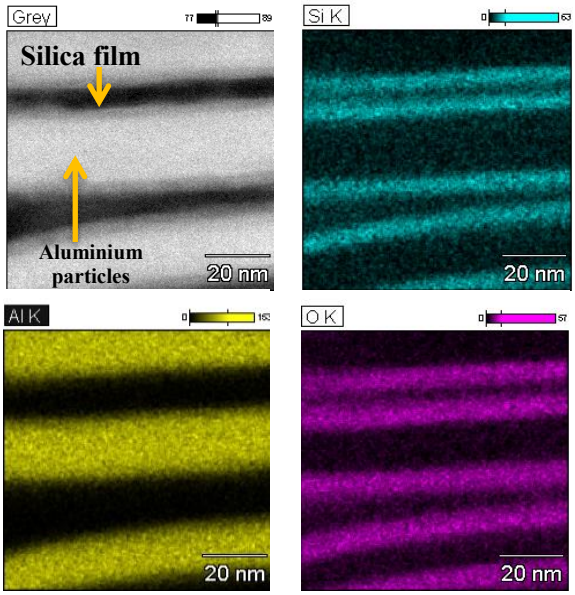

Fig. 3 Cross-section structure of EMERALSHINE®

Fig. 3 shows the TEM images and elemental analysis mapping of a cross section of the aluminium particles in the EMERALSHINE® by the improved process. It can be seen that the surfaces of the aluminium particles are coated with a thin even silica film.

Fig. 4 shows the results from evaluating water resistance of the vacuum metalized aluminium pigment coated with silica EMRS-D710.

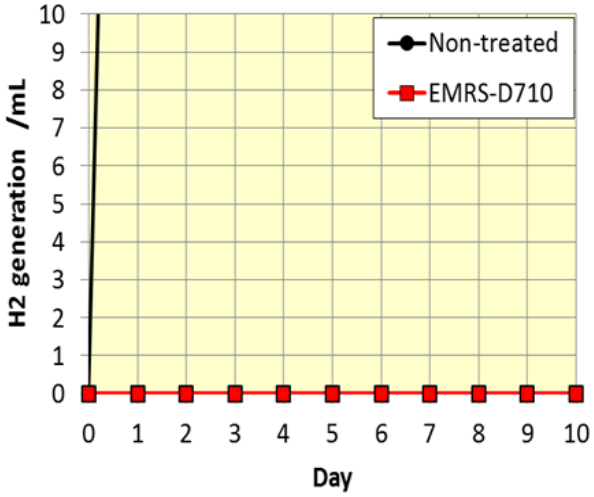

Fig. 4 Water resistance property of EMERALSHINE®

The gas generation test was conducted under the conditions as follows. In the mixed solution of 45 g of ion exchanged water and 45 g of butyl cellosolve, 11.5 g of pigment was dispersed as solid content to form a test solution. Two hundred grams of the test solution* adjusted at pH 10.5 with 2-dimethylaminoethanol was maintained at 40°C and then generated hydrogen gas was measured each test day . (* The nonvolatile content of this pigment is 10% and so 200 g of the test solution can be secured.)

As shown in Fig. 4, water resistance of EMRS-D710 is dramatically increased because of silica coat. It is expected that this leads to a significant improvement of water resistance in a water borne formulation.

[4. Conclusion]

This report introduces characteristics of vacuum metalized aluminium pigment and the latest technology to make vacuum metalized aluminium pigment compatible with water borne paints. To deliver specular design with an vacuum metalized aluminium pigment, it is absolutely necessary to improve the orientation of the aluminium pigment in a paint coating film. This holds good with not only an approach by the pigment manufacturer but also the technique of a customer to make full use of the technology. We aim to create new design by accelerating concerted efforts in cooperation with customers in the future as well.

[References]

1) Keita Nagano; Winter 2015, Toyal Technical Report
2) Shinichi Fujiwara; Surface Technology, 67, 242, (2016)
3) Yoshiki Hasizume; Winter 2012, Toyal Technical Report