ALPASTE® for water-based coating

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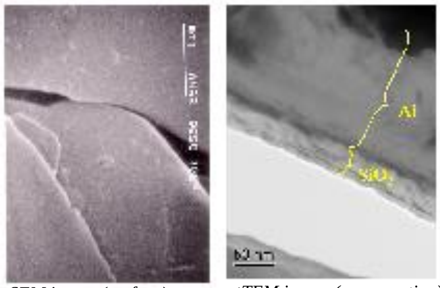

<SEM image (surface)> *<TEM image (cross section)>*

The surface and cross section of silica-treated ALPASTE

[1. Introduction]

Because of increasing demand for an environmentally friendly coating, reducing solvent used in metallic bases has become a significant challenge in the paint and coating industry. In particular, there is a major shift toward aqueous coatings for automobiles. Because switching metallic bases from a solvent- to water-based coating can significantly reduce the content of solvent from approximately 70% to 10%, a considerable reduction in the use of solvent is expected.

Given this situation, metallic pigments, which have problems such as reacting with water and poor dispersion, are required to be compatible with water-based coatings. This report covers a typical metallic pigment, alminium pigment (our product trade-named Alpaste), and describes its compatibility with water-based coatings.

[2. **Characteristics of alminium pigment**]

ALPASTE is typically produced by adding a fatty acid and a mineral spirit to alminium powders, and then wet grinding them into flakes in a ball mill. The final form of this product is a paste with a heating residue from about 60 to 80 wt%.

Fatty acids as a grinding aid are adsorbed on the surface of the alminium pigment particles. A particle with long-chain saturated fatty acids is called a leafing type and one with unsaturated fatty acids etc. is called a non-leafing type.

The alminium pigment used for a metallic coating generally has an average particle diameter of 5-30 μm, a thickness of 0.03-2 μm, and a specific surface area of ca. 1-30 m^2/g, and takes the form of thin scales.

An alminium pigment offers advantages of high reflectivity and brightness, and low specific gravity allows easy handling. Conversely, it has high reactivity with water, acids, and alkalis, which is a disadvantage.

When an alminium pigment is used with a water-based coating, in particular, generation of hydrogen gas by alminium pigments reacting with water, as described by the following equation, presents a serious problem.

$$2Al + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2\uparrow$$

According to this equation, the reaction of as little as one gram of alminium produces 1.36 L (normal state) of hydrogen gas. Such a reaction causes a can in which the coating is stored to swell, and also problems with the storage stability of coating such as agglomeration of alminium pigments and changes in the viscosity of coating.

In addition, as can be understood from its manufacturing process, a typical alminium pigment is designed to be hydrophobic. Therefore, using alminium pigments with water-based coatings requires a special technique to facilitate dispersion.

[3. ALPASTE for water-based coating]

The greatest challenge with alminium pigments for water-based coatings is to control (stabilizing) the reaction between water and alminium pigments. The methods for stabilizing alminium pigments are broadly categorized into three types: treatment with an inorganic compound, treatment with an organic compound, and stabilization by adding a passivator in the paint system. In the case of a water-based coating, surface treating alminium pigments often affects the performance of the coating including moisture resistance, therefore, an optimum treatment that is suitable for the paint system needs to be selected.

In the following paragraphs, we discuss treatments used for alminium pigments in a water-based coating.

1) Organic compound treatment

When treating with an organic compound, a phosphoric ester compound is generally used and alternatively an organic compound such as a dimer acid that exhibits a steric hindrance effect is used. Phosphoric esters are strongly adsorbed on the surface of an alminium pigment, exhibiting a good corrosion inhibiting effect. Some of the structures of phosphoric ester compounds, however, tend to severely deteriorate the adhesion of the coating, so it is important to consider their chemical structure. In general, it is difficult to achieve sufficient corrosion inhibition with only an organic compound treatment, while maintaining coating performance. This treatment is frequently combined with one using an inorganic compound.

2) Inorganic compound treatment

Among inorganic compound treatments are those using inorganic phosphates, molybdic acid, or chromic acid. In addition, silica-treated products have been developed.

In the inorganic phosphate treatment, orthophosphoric acid (H_3PO_4) is used to form an alminium phosphate film on the surface of the alminium pigment. This treatment has the merit of low cost, however, it might have no effect depending on the paint system used.

Molybdic acid treatments use ammonium molybdate or polymolybdic acid (as shown below) and were designed to improve stability and coating performance using an organic amine or a phosphoric ester compound together.

$$Mo_xO_y \bullet mH_20_2 \bullet nH_2O$$

A molybdic acid treatment typically has better stability and coating performance than treatment with an inorganic phosphate.

Although treatment using chromic acid is highly effective for controlling corrosion, recent trends to avoid using chromium compounds have been spreading throughout the industry, replacing this treatment with others.

Silica-treated products have a silica film formed on the surface of the alminium pigment through a sol-gel process as shown by the following equation. Because of its good corrosion inhibition and coating performance, it is receiving attention as a new treatment approach that is applicable to any paint system.

$$Si(OR)_4 + 4H_2O \text{ -> } Si(OH)_4 + 4ROH$$

(formation of silanol by hydrolysis)

$$Si(OH)_4 \rightarrow SiO_2 + 2H_2O$$

(condensation reaction of silanol)

The figures next to the title show the silica-treated alminium pigment with SEM and TEM.

Fig.1 illustrates gas generation by alminium pigments with various treatments in a water-based acrylic-melamine coating (pH=9.0).

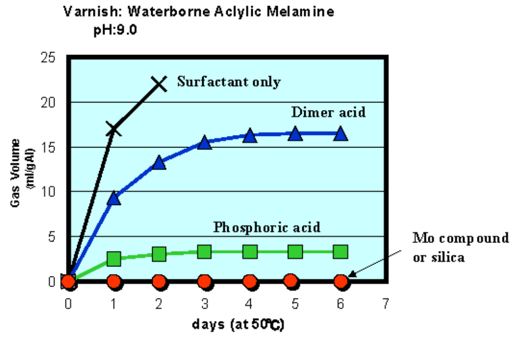

Fig.1 Results of gas generation test with Alpaste for water-based coating

3) Our ALPASTE for water-based coating

Table 1 shows types and applications of the treatment with our ALPASTE for water-based coating. Treatments offered are phosphoric acid treatment (WX Series), molybdic acid treatment (WL Series), silica-treated (WZ Series), organic and inorganic combined treatment (WRA Series). and the most suitable treatment can be selected for the required performance.

Table 1. Types and applications of ALPASTE for water-based coating

Treatment	Treatment method	Top coat for automobiles	Automobile repair	Plastic painting (1-coat)	Plastic painting (2-coat)	General coating
WX	Phosphoric acid treatment	○	△	×	○	○
WL	Molybdic acid treatment	⊙	○	×	○	○
WZ	Silica treatment	⊙	⊙	△	○	○
WRA	Inorganic and organic combined treatment	○	○	⊙	○	○