Physical properties of 'Titanium Phosphate' and its application to cosmetics

Poster 120

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Introduction:

It is desirable for foundation that the concave and convex portions of the skin such as pore and wrinkle are not conspicuous, while making the skin look beautiful. How to control the optical properties of foundation is important to meet these market demands. When hiding irregularities such as pores and wrinkles by adding high refractive index particles such as titanium dioxide is attempted, finish becomes thick.

Therefore, a soft focusing ability which gives skin natural finish has been being required. Since both low hiding property and high light scattering property are required for a particle which exhibits soft focusing property, a spherical particle having low refractive index such as silica and cellulose acetate is generally used.

We had previously reported that our Titanium Phosphate has high total-light-transmittance of greater than 80% and high haze of greater than 60% and concluded that our Titanium Phosphate is superior to titanium dioxide, boron nitride and mica in terms of easy-spreading capability and wrinkle-blurring capability [1]. In this study, we investigated the performance of our Titanium Phosphate by evaluating the angle dependency of light scattering and adhesion property to artificial leather comparing to the mixture of silica and cellulose acetate.

Conclusions:

The developed Titanium Phosphate having 1μm in diameter demonstrated a good soft focusing capability, due to its sufficiently high total-light transmission, higher light scattering, and a higher haze value than silica and cellulose acetate.

It was also found to exhibit an ability to make wrinkle and pore inconspicuous. By the nature of our Titanium Phosphate, there can be a possibility to adhere to both concave and convex portions on artificial leather, which brighten and reduce light-to-dark contrast in between, as well as blur the boundary.

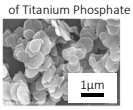
In the case that Titanium Phosphate replaced silica and cellulose acetate in foundation, it was concluded that its higher wrinkle blurring performance can be better than silica and cellulose acetate abovementioned, due to its improved light scattering, an uniform adhesion to the concave, convex portions, and its boundary on the artificial leather.

Materials & Methods:

Making of Titanium Phosphate powder

85% phosphoric acid and 2.2wt% aqueous titanyl sulfate solution were mixed under stirring with the molar ratio of phosphoric acid to titanyl sulfate being 9.3, followed by hydrothermal synthesis in an autoclave at 110 ° C for 5 hours [1]. The white turbid product was washed with pure water and then dried to obtain Titanium Phosphate. Titanium dioxide having 0.25μm in diameter, silica having 10μm in diameter and cellulose acetated having 7μm in diameter were selected for the comparison.

SEM image of Titanium Phosphate



■ **Evaluation of powder alone**

Measurement of total-light-transmittance and haze: After making a slurry and pouring an appropriate amount of the slurry on a slide glass, and the desired sample can be made on a bar coater with the wet thickness of 25μm, followed by drying at room temperature to obtain a sample. The total-light-transmittance and haze were measured by a haze meter.

Variable angle photometry: A small amount of powder was sprinkled on a sheet of artificial leather, the powder was spread gently and uniformly on the artificial leather sheet using a cosmetic brush, then the artificial leather sheet was stood upright and tapped the sheet on a desk a couple of times to let the non-adhered powder to the sheet drop from the surface, in this way the sample sheet was obtained. Reflected light was measured with a variable angle photometer at a variable angle of -90 to +90° for illumination light with an incident angle of 45° .

■ **Evaluation of powder foundation**

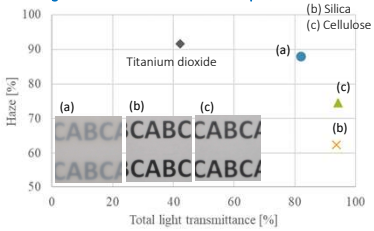
Making of powder foundation: A series of powder foundations were prepared to confirm the soft focusing property of Titanium Phosphate in a cosmetics formulation. As a reference, a typical powder foundation containing silica and cellulose acetate was prepared which is called powder foundation A. They were supposed to be replaced with Titanium Phosphate.

Observation of a powder-adhered artificial leather sheet: A sample sheet was prepared in the same manner as a variable angle photometry measurement. The effect of blurring wrinkles when applied on the artificial leather was visually able to be inspected.

Results & Discussion:

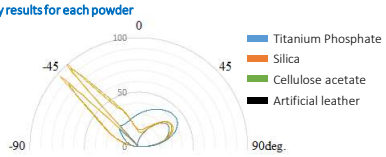
Comparison of total-light-transmittance and haze for each powder

(a) TTitanium Phosphate
(b) Silica
(c) Cellulose acetate



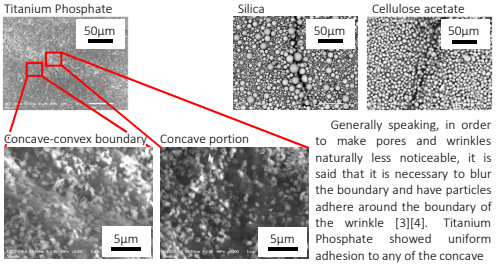
The total-light -transmittance of Titanium Phosphate is slightly lower than those of silica and cellulose acetate but sufficiently higher than titanium dioxide. The haze of Titanium Phosphate is superior to silica and cellulose acetate. The reason of the results is most likely due to the refractive index of Titanium Phosphate, which is 1.8 [1].

Variable photometry results for each powder



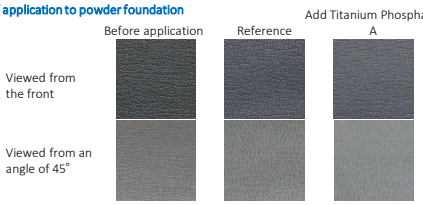
Although silica and cellulose acetate showed strong recursive reflection and great angular dependence of light scattering, Titanium Phosphate was found to have a smaller angle dependence of light scattering than those spherical particles. Therefore, our Titanium Phosphate has superior light scattering properties to silica and cellulose acetate. A plate-like particle having a small particle diameter is reported to show less specular reflection and lead to more scattering at the edge portion than a large plate-like particle [2].

SEM images of the powder-adhered artificial leather



Generally speaking, in order to make pores and wrinkles naturally less noticeable, it is said that it is necessary to blur the boundary and have particles adhere around the boundary of the wrinkle [3][4]. Titanium Phosphate showed uniform adhesion to any of the concave portions, the boundary between the concave and convex portions and the entire surface of the convex portion, it was expected to have the effect of making wrinkles less noticeable.

Effect of application to powder foundation



It is clearly observed that powder foundation A, when compared with the reference, showed less conspicuous wrinkles when viewed from any direction.

References:

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[2]. Takahiro Suzuki, Fukugoufuntai, Keshouhinkaihatsu to Nanotekunorozi (CMC Shuppansya,2007):24-38
[3] Masashi Shibata, Utsukushisa wo Tsukuru Shikizai Kougaku (Kagaku Kougyou Nippousya,2021):185.
[4]. Masashi Shibata, Utsukushisa wo Tsukuru Shikizai Kougaku (Kagaku Kougyou Nippousya,2021):196