UV Protective Effect and Properties According to the Surface Status, Shape and Size of Silica

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Introduction:

Pigments are colorants ingredients in cosmetics that define insoluble substances under the aqueous phase or oil phase are dispersed such as mica, kaolin, silica, etc. Among these pigments, the constitutional pigments have important roles in the cosmetic formulation as constituents. Silica is a typical constitutional pigment that improves the rough texture of cosmetics or absorbs sweat or sebum from the skin. For these reasons, silica helps with long-lasting makeup or smooth and oil-free skin. So silica plays various roles in skin-care, makeup, and sun care cosmetics. Silica has different characteristics such as malleability, spreadability according to the shape of particles, surface state and particle size. Recently, various shapes of porous and hollow type silica has been developed briskly. Because of their structural features, this silica may improves the protective effect from ultra-violet rays (UV) by multiple diffraction or resonance effects of light through the surface and pores. However, the relationship with the UV protection factor according to the characteristics of silica has not been significantly confirmed. Therefore, in this study, the change of the UV protection factor according to the particle size and surface state of silica was evaluated. Furthermore, the UV protection factor was maximized by applying the new porous type silica in the sunscreens.

Materials & Methods:

First, specific gravity, pH, oil absorption and coefficient friction of silica was evaluated for identifying properties by the particle size and surface state of silica. pH of silica was detected by 10% silica aqueous dispersion. Oil absorption of silica was evaluated using castor oil. And friction coefficient was determined using Tribo Touch Meter of Heidon Inc for evaluation of texture (Figure 1A).
Next, in order to confirm the correlation between silica and the UV protection factor, silica was applied to the O/W type and the W/O type sunscreens for each particle size and surface condition.
Finally, to evaluate UV protection factor, we applied 28.6mg of samples on the Helio plates HD6. After 30 minutes, UV protection factor was measured by SPF-290AS of Solar Light Inc (Figure 1B).

A. Tribo Touch Meter of Heidon Inc

B. SPF-290AS of Solar Light Inc

Figure 1. Devices for evaluating of the silica

Results & Discussion:

Physical properties of silica: In this study, various types of silica were selected. To determine the characteristics of the silica, their physical properties were evaluated. Table 1 shows their properties that their particle size, shape, pH and oil absorption. First, particle size of the selected silica was almost different. Only PS-5k and SS-5k had the same particle size, their other properties were all different. Next, selected silica had spherical, porous and meso-porous types. Their pH was measured around pH 7.0, which is neutral pH. The oil absorption of all silica was different. It is considered that oil absorption affects the surface status of silica.

Table 1. Physical Properties of Silica

	Particle Size	Shape	pH	Oil Absorpstion
PS-7.5K	7.5 μm	Porous	7.41	0.95
PS-5K	5 μm	Porous	7.01	1.31
SS-5K	5 μm	Spherical	7.26	0.92
MS-1K	1 μm	Meso-porous	6.89	0.33
MS-300	0.3 μm (300 nm)	Meso-porous	7.17	0.48
MS-050	0.05 μm (50nm)	Meso-porous	6.94	3.09

Results & Discussion:

- Evaluation of friction coefficient: Friction coefficient means the toughness of materials. Most silica has a low friction coefficient that causes silky and smooth texture with in cosmetics. However, numerical data on these are difficult to find. In this study, tribo touch meter was used for evaluating the texture of the materials, which can detect the friction of materials. The silky and smooth could be measured by friction coefficient. So this value reflects the roughness or spreadability of the materials. For this reason, the texture of silica could be inferred from the friction coefficient.
Friction coefficient of each silica is shown in Figure 2.
As a result, SS-5K had the lowest friction coefficient that means that their texture is silky and smooth. However, HS-050 showed the highest friction coefficient. However, the results could be analyzed more closely by comparing their physical properties. First, in the case of macrosize silica, the larger the particle size of silica, the lower the friction coefficient. Second, there was a large difference in the coefficient of friction depending on the shape of the particle.
- UV protective effect: In this study, the SPF in vitro test was performed by applying 3% of silica to the sunscreen. SPF in vitro test shows that UV protective effect of each silica. As a result, all of the selected silica showed the effect of SPF and PA enhancement (Figure 3). Therefore selected silica has UV protection enhancing effect significantly.

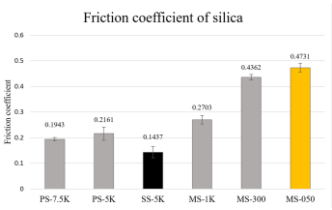

Figure 2. Friction Coefficient of Silica

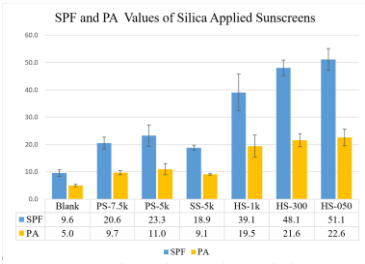

Figure 3. SPF and PA Values of Silica Applied Sunscreens

Conclusions:

Silica, one of the constitutional pigments, was applied to the sunscreen according to particle shape and size to determine the UV protective values according to each characteristic. Most of all, novel silica applied sunscreen had the highest values of SPF and PA. These materials had excellent oil absorption that could provide long-lasting effects on sunscreens. It may diminish UV rays by multiple diffraction or resonance effects of light on the surface and pores of silica.Therefore, the sunscreen applied with silica has improved spreadability and glossiness as well as long-lasting UV blocking effect.In conclusion, the purpose of this study is to suggest the possibility of developing advanced cosmetic materials in the future by confirming the shape and surface of the ideal silica that helps protect UV rays.

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