Preparation of Aqueous Dispersion of TiO₂ Nanoparticles using Plasma on Liquid Surface

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1. Introduction

TiO₂ nanoparticles have been widely used for ultraviolet (UV) protection in sunscreen cosmetics as dispersion liquid and powder. It is important to disperse the aggregated TiO₂ nanoparticles into an aqueous solution in order to enhance the efficient UV protection property of TiO₂. However, the nanoparticles easily form their aggregates because of their high surface energy. As the conventional methods, the addition of dispersing agent and/or the mechanical methods such as bead mill and homomixer have been used. On the other hand, plasmas in liquid have been used for preparation of colloid solutions of nanosized metals [1] or dispersion of ceramic powder [2].

In this study, we tried to prepare the aqueous dispersion of TiO₂ nanoparticles using the plasma on liquid surface [3].

2. Experimental

The method of the plasma on liquid surface consists of the needle electrode (tungsten) in air and the plate electrode (aluminium) in liquid. The needle was 1mm in diameter. The tip of the needle was set on 5 mm of liquid surface. A 60 Hz AC power (3 kV) was applied to the electrodes to generate the plasma. TiO₂ powder (rutile, primary particle size = 35 nm, Tayca Co., Ltd.) was used. As the pretreatment, we carried out the ultrasonication (frequency : 40 kHz, output power : 55 W) of the aqueous suspension of 0.01 wt% TiO₂ for 15 minutes. The plasma treatment on liquid surface with ultrasonication were demonstrated for 2 hours. The solution temperature was kept at 35 °C.

We evaluated the TiO₂ solutions by visual observation after 24 hours of the treatments. Moreover, the size distribution of dispersed nanoparticles in the solution was analyzed by dynamic light scattering (DLS).

3. Results

Figure 1 shows the photographs of the TiO₂ solutions with/without the plasma irradiation on liquid surface after 24 hours of the treatment. The TiO₂ solutions treated by an entirely ultrasonication showed the particles settling. On the other hand, the plasma-treated TiO₂ solutions with ultrasonication showed fine dispersed state of TiO₂ nanoparticles. Furthermore, from the DLS measurements, the fine dispersion of TiO₂ nanoparticles was obtained by the plasma treatment over 1 hour.

![Fig. 1 Photographs of TiO₂ solutions with/without plasma treatment after 24 hours of treatment.](image)

References