

TiO₂가 담지된 일라이트의 UV 효과

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UV protection effect of TiO₂ loaded Illite

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Introduction

Talc, Mg₃Si₄O₁₀(OH)₂, classified as Mica group is a phase in the system MgOSiO₂-H₂O which finds extensive use in the manufacture of ceramics, paints and plastics. In talc, edge-sharing silicate tetrahedral form a two-dimensional hexagonal network or sheet. Two such opposing sheets are joined through their apical oxygens, which coordinate to magnesium ions situated in a plane between the sheets. Two hydroxide ions per unit cell are each bonded to three of these intersheet magnesium cations, completing the octahedral coordination of magnesium. The talc structure consists of ordered stacks of these tetrahedral-octahedral-tetrahedral sheets. On this wise, Talc has been used a lot of industrial area as useful additives for a long time. But the possibility that talc causes cancer dramatically hit the headlines of the daily Press when Talc containing products was reported to be contained asbestos particles originated in cancers of the ovary and uterine cervix on the end of 2009 in Korea. After that, so many researchers in a related pharmaceuticals and cosmetics have been searched alternation materials of Talc with similar characteristics [1-4].

Among clay minerals classified in Mica group, we selected illite as a substitution material of Talc. Because illite is a 2:1 phyllosilicate mineral with tightly held, nonhydrated, interlayer K cations balancing a high layer charge. As with many clay minerals, illite contains both planar and edge sites available for metal uptake. Planar sites are due to a net negative structural charge resulting from isomorphic substitution in the octahedral and tetrahedral sheets, and edge sites are due to broken Al-OH and Si-OH bonds at the edges of the clay crystallite. The presence of planar sites in illitic clays has properties such as high porosity with strong adsorbability and excellent thermal resistance. Hence, the illite has been widely used as filter aid, catalytic support, and adsorbent. Recently, the novel applications of illite as biological

support, pharmaceutical carrier, chromatogram support, and functional filler have attracted extensive attentions [5-6].

Especially, this study reports the investigation of the effect of TiO₂/illite as an inorganic UV blocking material for field that talc has been applied during the time. To obtain more accurate results, an improved scheme on light-object interactions based on recent progress in optical theory was proposed, describing how TiO₂ react to the light illuminating on illite.

Experimental

Sample preparation

Illite, K_{0.88}Al₂(Si_{3.12}Al_{0.88})O₁₀(OH)₂, was supplied by Yongkung Illite Co. Ltd. with illite mine of Yongdong area in Korea. A 50 g amount of illite was added to 500g of ion-exchanged water and then uniformly dispersed therein while thoroughly stirring. Then, 273.0 g of a 40% aqueous titanyl sulfate solution was added to the dispersion obtained above. The mixture was boiled upon mild temperature for 2 hours while stirring. After allowing to cool, the mixture was filtered and washed with water, followed by drying at a temperature of 100°C. Thus, 80g of the titanated illite, i.e., the illite coated with titanium dioxide, was obtained.

Charaterisation

The examination of the particle morphology and of the grain size distribution was carried out by an environmental scanning electron microscope (ESEM) using a Philips ESEM XL 30 FEG. This kind of SEM uses a chamber atmosphere of 1–3 Torr water vapour instead of high vacuum. The measurements were carried out using a high resolution LEO 1530 SEM with a Schottky emitter field emission gun under high vacuum (10⁻⁶Torr). Acceleration voltages between 10 and 20kV were applied using an aperture of 20 μm, with 20kV obtaining the best results.

UV/VIS spectra of TiO₂ aqueous suspensions in the wavelength interval 240–600 nm were recorded using a UV/VIS spectrometer UV-3600 (Shimadzu, Japan) with a large integrating sphere assembly using transmittance measurement accessory. TiO₂ suspensions with low concentrations (0.01–0.1 mg TiO₂ ml⁻¹, i.e., 1×10⁻⁵–1×10⁻⁴ g cm⁻³) were used in UV/VIS experiments.

Results and Discussions

The spectrophotometrically monitored extinction in heterogeneous titanium dioxide represents combination of absorption and scattering phenomena caused by particles. Fig. 1 shows the experimental extinction spectra measured in wavelength interval 240–600 nm. Our experiments

confirmed a significant contribution of scattering phenomena in the region 240–600 nm, in accordance with previously published results. The values of absorption and scattering coefficients calculated from the extinction data were used for the construction of UV/VIS absorption and scattering spectra in the wavelength interval 240–600 nm. The sets of experimental results

obtained at 310, 365, 405 and 500 nm, along with corresponding fittings to Kubelka-Munk model illustrates Fig. 2. The calculated absorption spectra was used to find amount of absorbed UV radiation (300–600 nm) under the given experimental conditions.

The SEM image of the naked illite shows that the sericite has a smooth surface in Fig.3. When TiO₂-coated illite powders are prepared by the deposition of TiO₂, the sericite powders are partially coated by the TiO₂ nano-particles with an average particle size of 26 nm as the

mass ratio of TiO₂ to sericite is 10% in Fig.3(b). While increasing the mass ratio of TiO₂ to sericite to 20%, the surfaces of the sericite powders are almost completely coated by the TiO₂ nanoparticles with an average particles size of 23 nm in Fig.3(c). With further increasing the mass ratios of TiO₂ to sericite to 30%, the SEM images show that dense and uniform TiO₂ coating layers have been formed on sericite surfaces and the average particle sizes of TiO₂ nanoparticles is 40 nm, respectively in Figs.3(d).

Conclusion

The analysis of UV/VIS spectra measured in TiO₂ dispersion confirmed significant contribution on scattering in ultra-band gap wavelength interval 240–00 nm; the extinction data observed for wavelengths $\lambda > 410$ nm are in good accordance with UVA scattering on nanoparticles. Also the differences in evaluated quantum efficiencies reflected the variation of photocatalytic reaction mechanisms.

Acknowledgements

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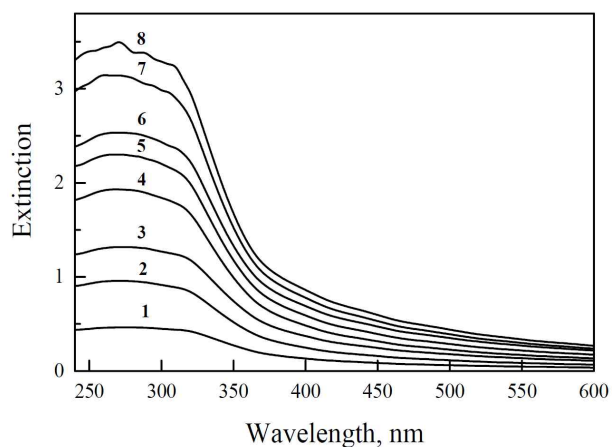


Fig. 1. The set of UV/VIS spectra measured with increasing TiO_2 loaded concentration. 1 \rightarrow 5; 1% \rightarrow 5% by 1% increasing, 6 \rightarrow 8; 10% \rightarrow 30% by 10% increasing,.

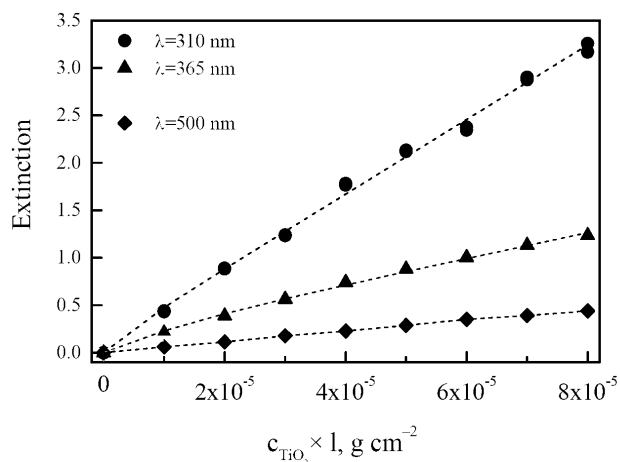
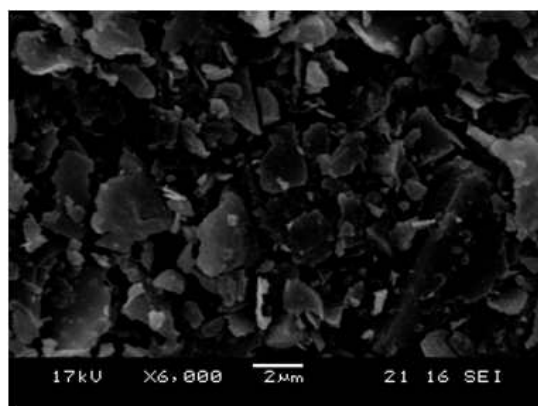
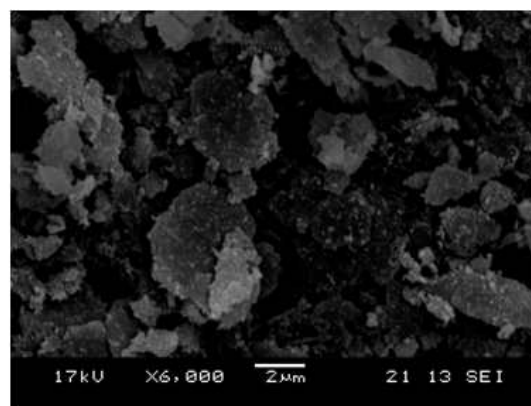


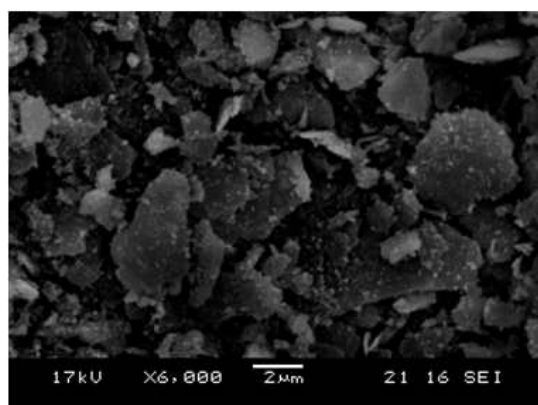
Fig. 2. The dependence of extinction at selected wavelengths upon product of TiO_2 loaded amounts.



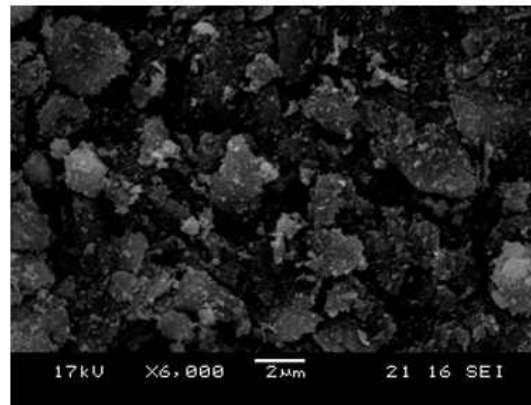
Illite



10wt% TiO_2



20wt% TiO_2



30wt% TiO_2

Fig 3. SEM images of naked illite (a) and TiO_2 -coated illite samples prepared with mass ratios of TiO_2 to sericite of 10% (b), 20% (c), and 30% (d), respectively