국내 자연산 점토광물을 활용한 새로운 자외선차단 소재의 특성연구

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The Study on the Characteristic of Novel UV-protection Materials using Domestic Natural Clay Mineral

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Introduction

The mineral illite named Grim is a common soil component in temperate to cold region [1]. It is a non-expanding, clay-sized 2:1 layered mineral with potassium as the interlayer cation. Illite has been used to the oriental medicine from 2,000 years ago and classified as clay mineral similar structurally such as mica, talc, and sericite of a mica group. It was reported the results as functional mineral with deodorization, absorption and antibiotic [2]. Also, Illite has properties to be superior to moisture care, spreadability on the skin and resistance against UV rays. Illite was introduced as one of substitute materials of talc after detecting the asbestos from cosmetics and medicine in 2009. Because of this reason, there has been carried out a lot of researches related with alternative material of talc. Among them, many researchers in cosmetic companies have been searched and studied about new materials to able to supersede talc to be well used as cosmetic powder. Especially It is urgent for cosmetic area to find out new substitutes of the past TiO_2/Talc for UV protection.

Traditionally, two most common ingredients in sun block, titanium dioxide (TiO_2) and zinc oxide (ZnO). TiO_2 and ZnO have been used in sunscreens because of their ability to filter ultraviolet (UV) A and UVB light [3]. Furthermore, in the past few years, titania-based materials are widely used in water treatment, air treatment, clean energy production, and photocatalytic properties. Transparent micro fine titanium dioxide (TiO_2) nanoparticles gained popularity as inorganic sunscreen due to their efficacy and their counterparts with larger particle size [4-5]. Several types of cosmetics contain particulate TiO_2 as a UV absorber or scatter. TiO_2 is protects the skin from UV radiation by scattering, reflecting and absorbing most of the UVB and UVA radiation from the sun and also does not undergo any chemical decomposition. In recently years, manufacturers have started the nanosized TiO_2 in place of bulk forms. This new formulation has occurred in the problems of the unsightly white film and created the permeate into the skin more easily [6].

Consequently, we have been studied about hybrid materials formed from 10%-50% impregnated TiO_2 on the illite to overcome TiO_2 faults such as agglomerate and whiteness turbidity of TiO_2 used widely as sun block.

Experimental

We are prepared TiO2/illite hybrid materials with illite in 10-15㎛ and TiO_2 nanosize in 40-45nm as starting precursors. Firstly, it stirred mixture of ethanol and distilled water(ratio 1:1) and add 100g illite. After that, TiO_2 into mixed solution was dropped from 10 to 50wt%. Particularly, TiO_2 solution is dispersed homogeneously using the supersonic. Finally, after 12 hr reaction, solids product are dried in the oven 75°C for 12hr.

Results and Discussion

The XRD patterns of raw illite and TiO_2 10wt% - 50wt% impregnated solid product on the illite are shown in Fig. 1. As can be seen in Fig. 1, the hybrids were observed the transformation sequence as a function of TiO_2 contents. According to Fig. 1, in the increasing TiO_2 contents, a new the peak are shown at 2θ=27.4°. It is expected to increase the contents of TiO_2 impregnated on the illite.

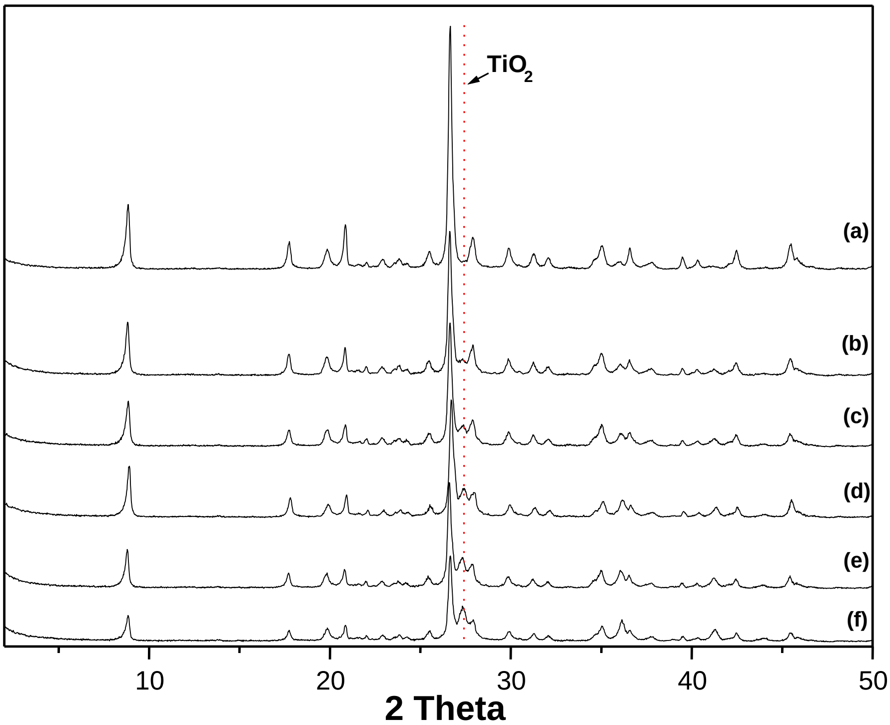

Fig. 1. Powder X-ray diffraction patterns of TiO_2 10%-50% impregnated on the illite and raw illite: (a) raw illite, (b) 10wt% TiO_2, (c) 20wt% TiO_2, (d) 30wt% TiO_2, (e) 40wt% TiO_2, (f) 50wt% TiO_2.

FT-R spectrum of the raw illite and TiO_2 10wt% - 50wt% impregnated on the illite is shown in Fig. 2. The absorption bands between 1200 and 400 cm^{-1} are attributed to OH^- bending vibrations, Si-O vibrations and Al-O vibrations. In the first region, bands arising at 475 cm^{-1} refer to the bending mode of Si-O-Al vibration and were assigned as T-O bending mode. In the second region, the observed band at 1026 ㎝$^{-1}$ refer to the asymmetric stretching mode of Si-O-Si vibration and is assigned as T-O stretching mode. The band center at 803 ㎝$^{-1}$ in the spectrum correspond to OH-bending vibrations[7]. Illite is characterized by the bands of Si-O-Si vibrations located 803㎝$^{-1}$, whereas the band characteristic of carbonate appears at 1464 ㎝$^{-1}$. Bands in the region of 1600-3700 ㎝$^{-1}$ can be assigned to the presence of water. A band arising at ~1624 ㎝$^{-1}$ is due to the usual bending vibrations of water [8].

A new absorption band is found in TiO_2-illite comparing with the raw one. The band covers a range from 945 to 905 cm^{-1} corresponding to the stretching vibration of Ti-O-Si and Ti-O-Al. The infrared ray ranging from 400 to 350 cm^{-1} is mostly reflecting the bond torsions. When the TiO_2 are combined with illite via Ti-O-Si or Ti-O-Al, the torsions of Ti-O- are restricted by the solid surface bonding. Thus, the energy of the torsion vibration of such bonds becomes weaker. Based on these results, we conclude that during the synthesis process a certain amount of TiO_2 has reacted with the surface-OH of raw illite, and created the new bonds like Ti-O-Si and Ti-O-Al. The bond stress is strong enough to keep the TiO_2 caught on the illite.

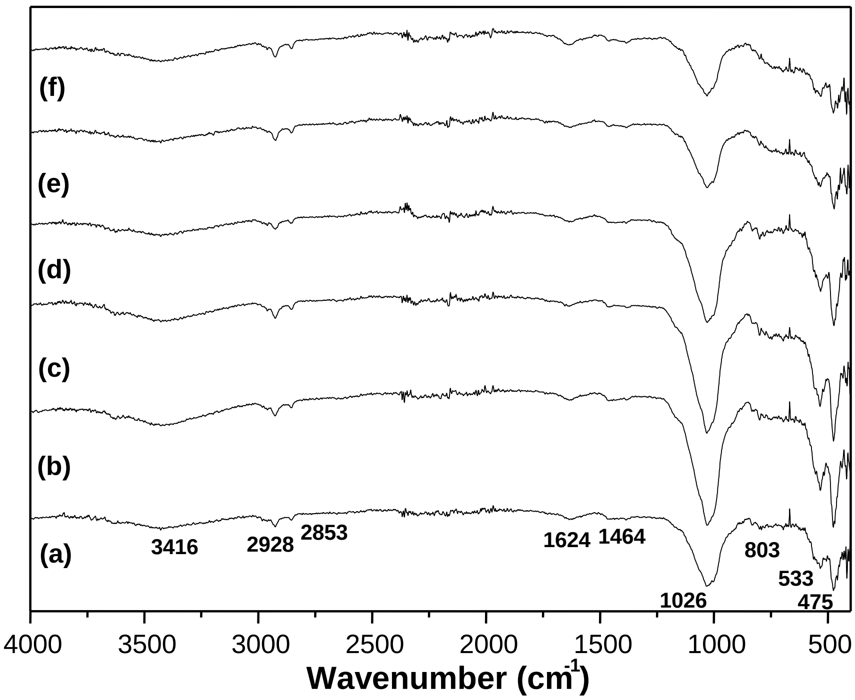

Fig. 2. SEM of solid product obtained from TiO_2 10wt% - 50wt% impregnated on the illite and raw illite: (a) raw illite, (b) TiO_2 10wt %, (c) TiO_2 20wt %, (d) TiO_2 30wt %, (e) TiO_2 40wt %, (f) TiO_2 50wt %.

Conclusion

We are increased contents 10 wt % - 50 wt % to impregnate titanium dioxide on the illite. Consequently, The reflection appeared at 8.8˚ (2theta) with a d_{001}-spacing of 10.0 Å and a new the peak are shown at 2θ=27.4°. Therefore it was consider formed a new peak due to increase the contents of TiO_2 impregnated on the illite. In FT-IR spectrum, the band from 945 to 905 cm^{-1} corresponds to the stretching vibration of Ti-O-Si and Ti-O-Al.

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