

화장품분체들로 사용되는 일라이트, 운모, 활석, 견운모의 구조적 특성의 비교 연구

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A Comparative Study of Structural Characteristics of Illite, Mica, Talc, and Sericite using as Cosmetic Powders

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Introduction

The technological properties of clays are directly related to their colloidal size and crystalline structure in layers, meaning a high specific surface area, optimum rheological characteristics and/or excellent sorptive ability. The use of a clay mineral for any specific application depends on both its type of structure (1:1 or 2:1 layer type) and on its chemical composition. The different types of cations in the octahedral sheet and isomorphic substitutions in the octahedral and tetrahedral sheets result in net charge deficits, varying according to the sheet unit, and, ultimately, in different mineral phases giving rise to very varied technical behaviours. Textural differences between structurally and chemically identical minerals also affect their adsorptive and rheological properties [1,2,3].

In the field of health, certain clay minerals and clays are used in pharmaceutical technology and dermopharmacy as ideal excipients and as substances with suitable biological activity in the formulation of dosage forms that are either solid (tablets, capsules and powders), liquid (suspensions, emulsions) or semisolid (ointments, creams) [4,5].

Apart from being efficient in the pharmacological or cosmetic function for which they are chosen (as abrasives, absorbents, adsorbents, anticaking agents, glidants, coating agents, opacifying agents, viscosity-increasing agents, emulsion stabilizers, binders, suspending agents, therapeutic agents, tablets and capsule diluents or lubricants), clays should also be seen to comply with a number of chemical (1), physical (2), and toxicological requirements (3) (1: stability, purity, chemical inertia; 2: texture, water content, particle size; 3: atoxicity, safety and microbiological purity), for which there are specific technical specifications for each clay and its intended use.

A cosmetic product is any substance or preparation intended to be placed in contact with

the outside of the human body (epidermis, hair, lips, teeth, etc.) with the main, or exclusive aim of cleansing or perfuming it, changing its appearance or smell, as well as protecting and maintaining it. A medicinal product, however, is a substance or combination of substances administered to humans in order to treat or prevent illness, carry out a diagnosis or restore, correct or modify disturbed physiological functions. In general, Clay minerals using as the pharmacological or cosmetic function are illite, mica, talc, sericite, kaolinite, and smectite etc.. Among them, we selected four clay minerals, illite, mica, talc, and sericite to have been applied for a long time in the cosmetic areas.

This study attempts to characteristic comparison of structure and outer surface with correct concept about mineral, textural and physical-chemical identification of the different components used in formulations and correlate them with their biological effects.

Experimental

Sample preparation

The illite used in this study are was provided by Yongkung Illite Co. Ltd. with illite mine of Yongdong area in Korea and other samples were supplied with ChemiLand Co. Ltd.. All samples have been used as cosmetic powders.

The criteria used operational XRD definitions of clay mineral groups are based on the positions of 00 l reflections of samples in four different states: air-dry, saturated with ethylene glycol, and heated at 300 and 550 °C. Clay mineral groups are identified by applying one or any combination of these tests. Tri- and di-octahedral subgroups are differentiated using the position of the 06 reflection (the b_0 parameter is much larger for tri- than di-octahedral clay minerals and this difference manifests clearly at high 2θ angles).

Charaterisation

The structure of clays was investigated by X-ray diffraction with a Rigagu XRD-6000 diffractometer, using Cu-K α radiation ($\lambda=1.5418$), with Ni-filter. The XRD patterns were recorded in the 2θ scan range 2–60°, with a scan speed of 2°/min, using as calibrating material quartz powder. Operating power of the X-ray source was 40 kV at 30 mA intensity. The Fourier transformed infrared spectrometry (FTIR) was recorded in the 4000 to 400 cm^{-1} range on a BRUKER EQUINOX 55 spectrometer. The samples were prepared using the KBr pellet technique. The mixtures of the clays, and dried KBr(ratio 1:200) were subjected to a pressure of 10 ton cm^{-2} .

Results and Discussions

The coarse-crystalline minerals, characteristic of metamorphic environments, are identified in air-dry preparations by distinct 00 l spacings.

Illite is regarded as a species in the true (flexible) mica group. Illite is non-expandable and has fixed instead of exchangeable cations in the interlayer space. In reality, illites are exclusively dioctahedral and clay-size, while the charge of illite layers is 0.9/O $_{10}(\text{OH})_2$, but the overall charge is often lower than this because illite particles are very thin. The positions, shapes, and relative intensities of 00 l reflections of an illitic material often change slightly after glycol treatment, indicating some mixed-layering.

The most sensitive indicator of mixed-layering is based on the intensities, rather than the positions, of the 001 reflections :

$$I_r \frac{1}{4} (001=003 \text{ air-dry}) / (001=003 \text{ glycol})$$

where I_r denotes the intensity ratio of the 001 and 003 reflections from air-dry and glycolated samples.

A value of $I_r \frac{1}{4} 1 \pm 0.1$ is indicative of pure illite. The first three all have $d_{001} \frac{1}{4} 0.998-1.00$ nm. The presence of some iron species should be suspected if the 002 reflection is clearly weaker than in typical Al^{3+} -illites and an admixture of tri-octahedral micas can be ruled out.

In surface environments (weathering of ultra basic rocks, saline lakes) clay-size analogues of talc called kerolite or pimelite (Ni-rich species) can be found. Talc is characterized by a basal (d_{001}) spacing of 0.96 nm, but the 001 reflection is displaced to 1.0–1.01 nm because the particles are very thin. Thus, the distinction between illite and talc is based on higher order 001 reflections.

Mica has interplanar spacing d_{001} (base d_{001} one-layer mica cell) between 9.6 Å and 9.74. Talc clearly has a smaller spacing at 9.354, while wonesite is 9.574. The slightly smaller d_{001} of wonesite may result from the large number of interlayer vacancies.

Natural sericites were determined to contain one or two water-layer complexes. The shapes and positions of the reflections at about 5 Å and 3.33 Å are characteristic for these complexes. If the 12.5 Å (one water-layer) complex is present, the 5 Å reflection is broad, weak, and displaced toward smaller angles of 2θ from the illite peak position. The 3.33 Å reflection is sharp, strong, and displaced slightly toward larger angles. For the 15 Å (two water-layer) complex, the 5 Å reflection is strong, sharp, and not displaced, whereas the 3.33 Å reflection is diffuse and is displaced toward smaller angles.

The typical IR spectrum of phyllosilicates include a single band of the OH stretching vibration lying in the 3600–3700 cm^{-1} region, a less complete band or shoulder of the OH bending vibration lying in the 800–950 cm^{-1} region, inplane Si–O stretching vibrations usually resulting in two bands at 950–1100 cm^{-1} , and Si–O bending vibrations contributing to the strong absorptions in the 400–600 cm^{-1} region.

The IR absorption spectrum for samples is very similar to that of pyrophyllite due to their similar di-octahedral structure. However, a few apparent features can be used to discriminate the pure sericite phase from the original ore. The absorption band observed at 3629 cm^{-1} and 3670 cm^{-1} in the OH stretching region of the original ore was assigned to the hydroxyls of the pure sericite and pyrophyllite phase respectively. Additionally, partial substitution of Al for Si in the tetrahedral sheet of pure sericite generated an in-plane Al–O–Si absorption at 754 cm^{-1} , while the pyrophyllite did not show such absorption. The vibration band in the FT-IR spectrum difference between talc and illite is 3676 cm^{-1} for talc and 3620 cm^{-1} for illite. Mica and illite had too similar IR spectra and these two clay minerals are almost indistinguishable when common methods of identification by IR spectroscopy are used.

Conclusion

The minute structure difference of illite, mica, talc, and sericite which have been used as cosmetic powders could be affected to cosmetic formulation. Especially, in the preparation of the composition containing oils or functional materials addition on them, it has to be

considered their structural characteristics and properties observed from XRD data supplemented by diffractometer patterns and spacing-intensity measurements for identifying and differentiating the clay minerals

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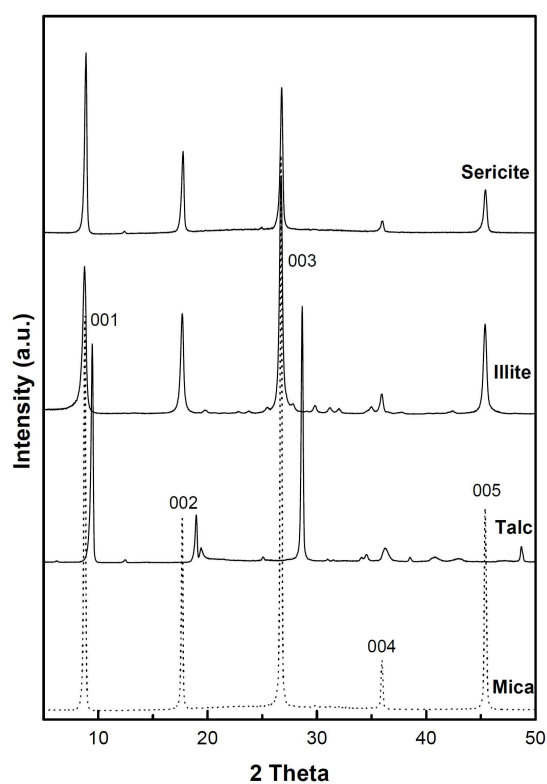


Figure 1. X-ray powder diffraction patterns of Illite, Mica, Talc, and Sericite.

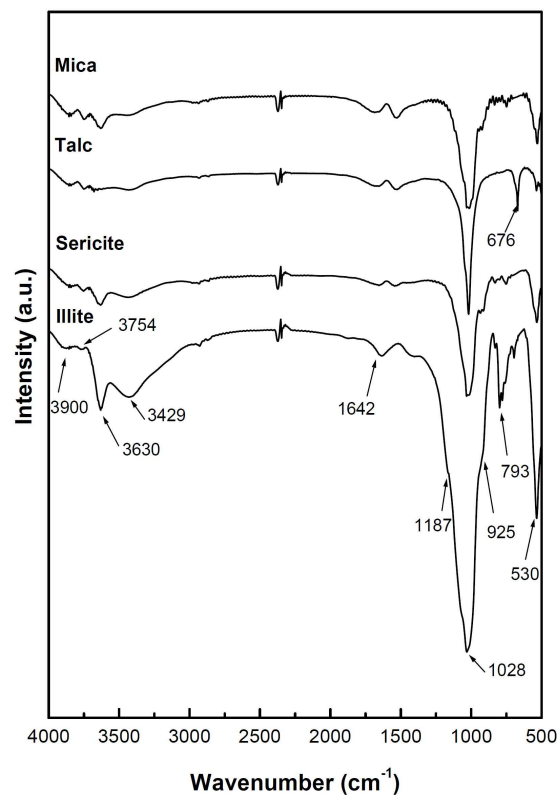


Figure 2. FT-IR spectrum of Illite, Mica, Talc, and Sericite.