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"A NATURAL EUROPEAN MICA ENSURING SOFTNESS, COHESION AND LONG LASTING EFFECT"

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1. Introduction

Mica refers to a group of naturally occurring phyllosilicate minerals known for their layered structure, excellent chemical stability, and unique reflective and refractive properties. These characteristics make mica an essential raw material across various industries, particularly in cosmetics, where it is valued for its ability to impart shimmer, transparency, and smooth skin feel in a wide range of formulations.

In the cosmetics sector, mica is mainly used in products such as foundations, eyeshadows, and lipsticks, where both visual performance and skin compatibility are critical. Under the INCI name "mica" used for the cosmetic industry, we can find several types of muscovites coming from pegmatites, granites or from the alteration of feldspars. Although the chemistry of muscovite is unchanged from one rock to another, mica crystals were not formed in the same conditions that impact the properties in application.

Pegmatite favors the development of big crystals of mica. It can be found in specific geographical locations such as India or Latin America however, it is not abundant. It tends to offer pure and large sheets of micas easy to process and used most of the time when high shiny effect is expected.

In opposition, granite is found in abundance on all continents. In that rock, mica is found as little flakes associated with other minerals like feldspath, quartz and kaolin. In that case, the production process is key to optimise the physico-chemical parameters of the mica to procure the ideal properties of the expected application. In this study for example, the micas of granite origin come from France.

Sericite is another type of mica which is characterized by its very fine granulometry. It can be found in association with other minerals like kaolin or feldspath. From Latin sericus, meaning "silken" in reference to the location from which silk was first utilized. Its fineness gives it a silky feel.

The selection of an appropriate mica grade is therefore crucial for achieving the desired aesthetic, functional, and regulatory outcomes in personal care formulations in general and pressed powders in particular. This paper provides an overview of the different grades of mica available for cosmetic use on the market, examining their mineralogical characteristics, processing methods, and how these influence their performance in pressed powders formulation. Our study shows that only one type of mica is optimized for pressed powder as a soft, cohesive and long lasting agent in pressed powders. Special attention is given to the relationship between particle morphology, visual effect, and sensory profile.

2. Materials and Methods

A representative set of mica samples was selected to encompass a range of mineralogical types and geological origins. The study include Sericite, two different micas from Granite and one mica from Pegmatite.

Table 1: Description of samples studied

	Sericite 1	Sericite 2	Mica 1 (from granite)	Mica 2 (from granite)	Mica 3 (from pegmatite)
Origin	China	USA	France	France	Brazil

X-rays diffraction

Malvern Panalytical Empyrean X-ray diffraction is used to identify and quantify crystalline phases of mica and therefore, its purity. A Cu X-ray source at a wavelength of 1,54A is used at angles from 3 to 65 degrees during 24.56 minutes.

SEM images

Mica samples were prepared for electron microscopy following a standard protocol adapted for layered silicate minerals. A small amount of sample was evenly dispersed onto a carbon adhesive tab mounted on an aluminum SEM stub. The samples were metalized with platinum to avoid electrons accumulating on the surface prior to imaging.

Photomicrographs were collected using the secondary electron (SE) mode of a Schottky Field Emission gun-scanning electron microscope (FE-SEM) Jeol JSM IT800. The acquisition parameters are 5kV accelerating voltage, a working distance of 10 mm, and a resolution of 5120 × 3840 pixels.

Aspect ratio measurement

The aspect ratio of a particle is the ratio of its sizes in different dimensions. This methodology, only used for particles having a platelike structure, uses conductivity and density. Particles are suspended and left to equilibrate, then separated using a centrifuge. Each dispersion is measured with FiveEasy Plus FP30 conductivity meter according to the method described by Weber & all in Clay Minerals, (2014) 49, 17–26.

Oil absorption

It corresponds to the quantity of oil (tests carried out with linseed oil) added to 4 grams of mineral to obtain a stiff, homogeneous, smooth paste. The oil absorption value (ml/100g) assesses a mineral's capacity to absorb oil and organic components. It is measured according to standard ISO 787-5:1980.

Formulation of pressed powder

Pressed powder is a very technical formulation that has to be cohesive enough to resist the drops but also very soft and easy to pick-up. This cohesion has to be brought by a component with a lamellar morphology, the only one easy to press, to be compacted and very resistant. Muscovite is an ideal candidate for this galenic.

Table 2: Pressed powder formulation

Phase	Ingredient	Function	%
A	Muscovite base	Cohesive agent	74.2
	Zinc stearate	Compacting agent	10
B	Iron oxides	Pigment	6.8
C	Dicaprylyl carbonate	Binder	7.2
	Isostearyl Isostearate	Binder	1.8

Drop tests of pressed powder

Cosmatic drop test equipment is an automatic equipment used to count how many drop the pressed powders formulations containing 74.2% of mineral base they resist. This test is made three times on three different pressed powders of the same composition.

Panel test on pressed powders

To measure the optical and sensorial effect of the pressed powders containing different mineral bases, a sensory analysis was conducted with 18 texture experts according to NF EN ISO 13299. Volunteers assessed different criteria : the softness, the transparency on the skin, the mat effect and the homogeneity of the various powder formulations on a scale of 0 to 10.

Evaluation of mica's sebum resistance

USkin™ technology is used to measure the shine of the skin before, during and after sebum secretion. For this test, only one mica has been tested: Mica 2. 5mg of powder is applied on a skin model mimicking human skin. Sebum secretions are pulsed at regular intervals, representing 3.9µL. Gloss variation (ΔGloss) is expressed by the difference between gloss measured after 3 pulses (correlated with 24h in vivo secretion) versus gloss after 1 pulse. If

ΔG is between -0.01 and 0.01, there is a gloss control. If ΔG is above 0.01 it means that there is a gloss increase that produces a shiny effect on the skin.

3. Results

Table 3 : X-rays diffraction results

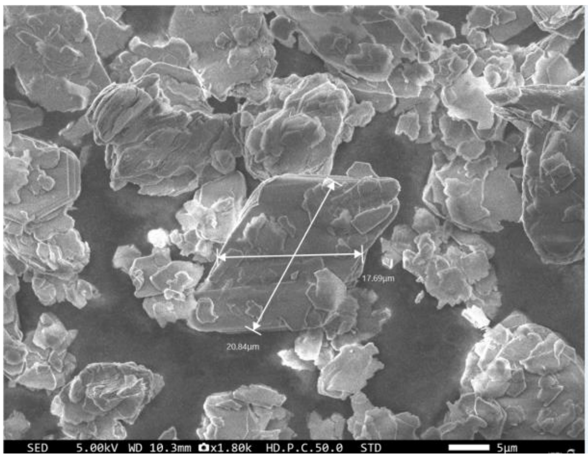
	Sericite 1	Sericite 2	Mica 1 (from granite)	Mica 2 (from granite)	Mica 3 (from pegmatite)
Muscovite	Main phase	Main phase	Main phase	Main phase	Main phase
Quartz	0	0	5%	0	0

This analytical measurement confirms that whatever the origin is, all the products have more or less the same composition based on muscovite. The main difference is based on the process used. Contrary to Mica 3 which is extracted under extremely pure mica sheet form, Mica 1 and Mica 2 coming from granite and Sericites need purification steps.

Table 4 : Aspect ratio measurement of muscovites

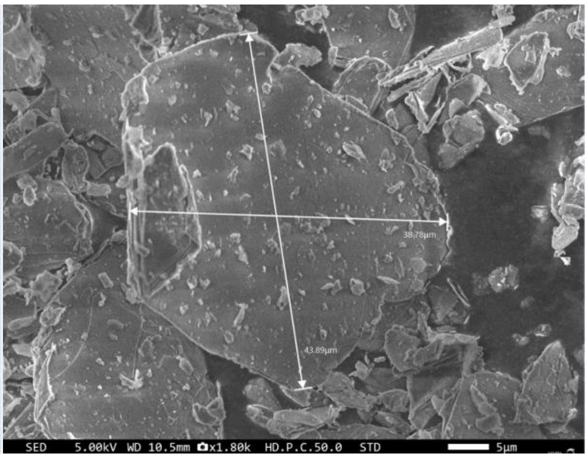
	Sericite 1	Sericite 2	Mica 1 (from granite)	Mica 2 (from granite)	Mica 3 (from pegmatite)
Aspect ratio	10.1	11.4	18.1	20.5	35.0

This aspect ratio helps to differentiate a sericite from other muscovites, as it is a naturally fine powder, it is characterized by a low aspect ratio. Micas have a larger plate shape. We can see also with SEM images below that Mica 3 has the largest platelets at the same magnification.



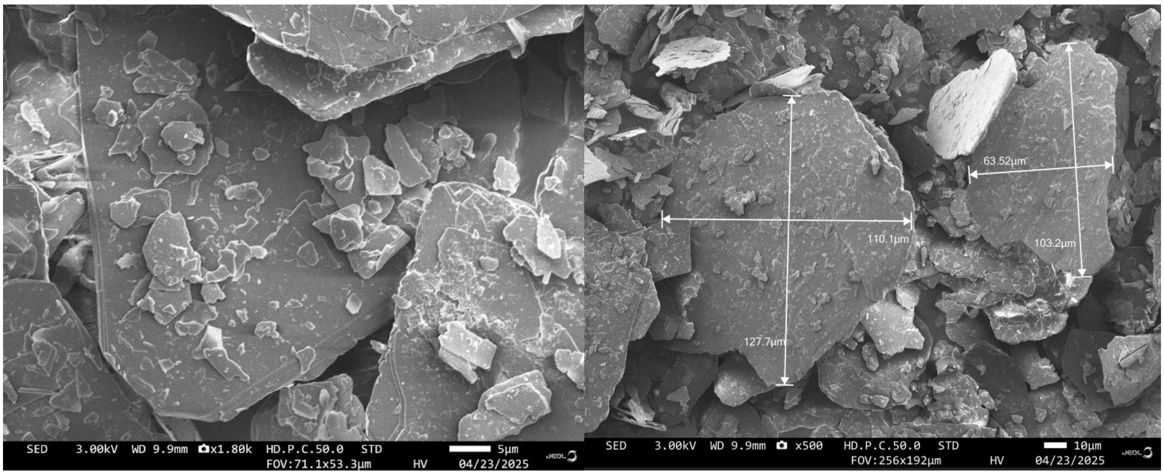
(a) X1800

*particle size 21µm*18µm*



(b) X1800

*particle size 39µm*44µm*



(c) X1800 ***(c) X500***

*particle size 64µm*100µm*

Figure 1: Scanning electron microscopy images of Sericite 1(a), Mica 1 (b), Mica 3 (c)

Table 5 : Drop tests of pressed powders

	Sericite 1	**Sericite 2**	**Mica 1 (from granite)**	**Mica 2 (from granite)**	**Mica 3 (from pegmatite)**
Drops needed to break the powder	6	5	9	10	3
Standard deviation	1	2	1	1	2

Sericites show an interesting level of drops resistance but Mica 1 & 2 are demonstrating a superior cohesion. However Mica 3 is less performing. Despite the lamellar structure of the mica that favors cohesion, all micas present different levels of resistance to the drop tests.

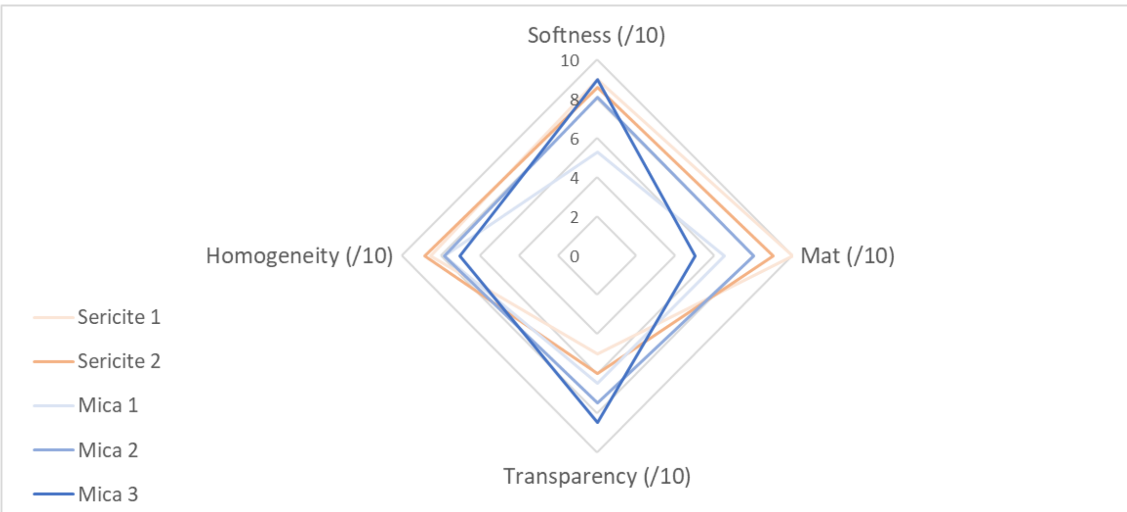


Figure 2 : Panel test evaluation of pressed powders

This panel test highlights that the sericite family can be differentiated from other micas in terms of optical properties by an ultra mat effect and less transparency on the skin than micas. It can be noted that Mica 3 is the most shiny mica according to the panel. For a pressed powder foundation, mica with mat effect will be more suitable than a shiny one.

Table 6 : Oil absorption capacity

	Sericite 1	Sericite 2	Mica 1 (from granite)	Mica 2 (from granite)	Mica 3 (from pegmatite)
Oil absorption (ml/100g)	60	45	90	120	70
Standard deviation	10	8	10	11	9

We note a superior oil absorption capacity for the Mica 2 that can be linked to its origin (granite from France), its purity (no quartz) and particle size.

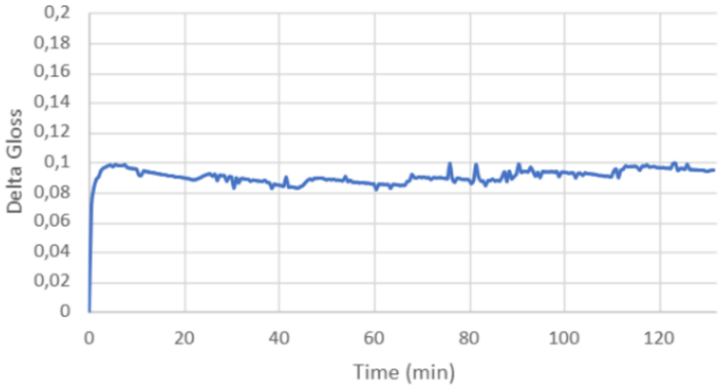


Figure 3 : Gloss variation profile over the time of Mica 2

For this test, only the mica with the highest oil absorption capacity has been tested: Mica 2. The figure 3 indicates that there is not an important variation of the gloss despite the addition of sebum secretion that correspond to 24h secretion.

ΔGloss 24h = ΔGloss end 3rd pulse - ΔGloss end 1st pulse

ΔGloss 24h = -0.004

ΔGloss value is under 0,01. This result indicates that there is a control of the gloss. Mica 2 allows a control of skin mattness along the day despite the regular sebum secretion. Introduced at high percentage in the pressed powder, this mica can provide a long lasting effect of the make-up powder.

4. Discussion

The characterization of mica samples from diverse mineralogical types and geological origins revealed significant variations in structural properties, which translated into perceptible differences in cosmetic performance as assessed through panel testing.

1. Mineralogical influence on sensorial & optical properties

XRD analysis confirm the presence of muscovite in the majority of the samples, meaning that this analysis is not sufficient to distinguish a sericite from a mica. However this cristallography analysis allows us to measure the presence of quartz. It is correlated to the softness of the material perceived by the panel test if we compare Mica 1 & 2 from the same origin.
With a Mohs hardness of 7, that corresponds to the hardness and the abrasivity of the material, quartz is degrading the softness of the product because Mica has a Mohs hardness of 2,5. The importance of removing quartz by using a mechanical process is key.

SEM micrographs further illustrate how particle morphology impact optical properties on the skin during panel testing. Samples with large lamellae are perceived shiner because they are reflecting more light.

2. Cohesion performance explained by the morphology

Several studies have shown that platelet-like particles tend to compact better than spherical or irregular particles. This is due to their ability to align and stack more efficiently during compression. So, lamellar morphology is essential.
However, the aspect ratio of the particles has to be considered in order to optimize this cohesion performance. If the aspect ratio is too low (Sericites) cohesion can not be ensured due to the small surface of particles that reduces the cohesion between particles. However a very high aspect ratio doesn't prove either a good resistance of the powder to the drops. Indeed, if we look at the figure 4 below, during compaction, there is a creation of bonds between hydrogen atoms of mica and oxygen atoms from binders such as esters (RCOOR') and from other micas. The multiplication of these hydrogen bonds help to the cohesion. Aspect ratio of Mica 2 is considered as optimum according to the excellent results obtained in drop tests.

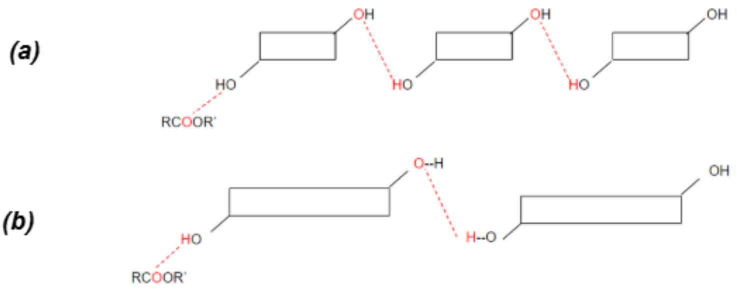


Figure 4 : Cohesion mechanism of Mica 2 (a) and Mica 3 (b)

3. Long lasting performance ideal for make-up application

Providing an additional property like a long lasting performance is key for the make-up market. Knowing that Micas have a more pronounced lamellar structure than sericites, it is supposed that this structure creates more spaces between the layers, allowing for better oil retention. Moreover, the influence of origin is key. An oil absorption capacity above 100 ml/100g reached by the Mica 2 is unconventional for a mica and make it unique. It allows to provide a gloss control during 24h.

5. Conclusion

This study demonstrate that mica's mineralogical type and geological origin significantly influence its structural properties and its manufacturing process that directly affect performance in cosmetic formulations for pressed powders. It reinforces the importance of tailoring mica selection not only to technical specifications but also to desired sensorial and marketing outcomes. Mica 2 offers the best compromise for a mineral base powder for pressed powder by combining high cohesion, softness and long lasting effect.

Future research will further explore surface functionalization of mica particles with a third party to enhance dispersion, compatibility with emulsions, or improve skin adhesion as well as quantitative correlation models between analytical parameters (e.g., particle size, type of coating) and sensory feedback scores to better predict performance during formulation development.
These directions aim to deepen the understanding of mica's functional role in cosmetics while supporting responsible sourcing and innovation aligned with industry trends and consumer expectations.

References

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