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Estimation of Mica as silicate by gravimetric analysis of Micro and Nano crystalline Mica medicinal product –Abhrak Bhasm and its SEM analysis

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Abstract

Micas are a group of minerals whose outstanding physical characteristic is that individual mica crystals can easily be split into extremely thin elastic plates. This characteristic is described as perfect basal cleavage. Mica is common in igneous and metamorphic rock and is occasionally found as small flakes in sedimentary rock. It is particularly prominent in many granites, pegmatites, and schists, and books (large individual crystals) of mica several feet across have been found in some pegmatites. Micas are used in products such as drywalls, paints, fillers, especially in parts for automobiles, roofing and shingles, as well as in electronics. The mineral is used in cosmetics to add shimmer or frost. Ayurveda, the Hindu system of ancient medicine prevalent in India, includes the purification and processing of mica in preparing Abhraka bhasma, which is claimed as a treatment for diseases of the respiratory and digestive tracts.

Present study deals with estimation of mica as silicate by gravimetric analysis of micro and nanocrystalline mica medicinal product – Abhrak Bhasm. Paper also deals with Scanning Electron Microscope (SEM) analysis of Abhrak Bhasm. This research, along with better regulation and reporting, will enable consumers to choose products with confidence. This in turn will allow companies to benefit from these novel technologies in the long term while retaining customer confidence.

Keywords: Mica, Abhrak Bhasma, Gravimetric Analysis, Silica, SEM Analysis

1. Introduction

Mica

Micas are a group of minerals whose outstanding physical characteristic is that individual mica crystals can easily be split into extremely thin elastic plates. This characteristic is described as perfect basal cleavage. Mica is common in igneous and metamorphic rock and is occasionally found as small flakes in sedimentary rock[1]. It is particularly prominent in many granites, pegmatites, and schists, [2] and books (large individual crystals) of mica several feet across have been found in some pegmatites [3].

Micas are used in products such as drywalls, paints, fillers, especially in parts for automobiles, roofing and shingles, as well as in electronics. The mineral is used in cosmetics to add shimmer or frost.

The mica group is composed of 37 phyllosilicate minerals. All crystallize in the monoclinic system, with a tendency towards pseudohexagonal crystals, and are similar in structure but vary in chemical composition. Micas are translucent to opaque with a distinct vitreous or pearly luster, and different mica minerals display colors ranging from white to green or red to black. Deposits of mica tend to have a flaky or platy appearance [6].

The crystal structure of mica is described as TOT-c, meaning that it is composed of parallel TOT layers weakly bonded to each other by cations (c). The TOT layers in turn consist of two tetrahedral sheets (T) strongly bonded to the two faces of a single octahedral sheet (O). It is the relatively weak ionic bonding between TOT layers that gives mica its perfect basal cleavage.[7]

The tetrahedral sheets consist of silica tetrahedra, which are silicon ions surrounded by four oxygen ions. In most micas, one in four silicon ions is replaced by an aluminium ion, while half the silicon ions are replaced by aluminium ions in brittle micas. The tetrahedra each share three of their four oxygen ions with neighboring tetrahedra to produce a hexagonal sheet. The remaining oxygen ion (the apical oxygen ion) is available to bond with the octahedral sheet.[8]

The octahedral sheet can be dioctahedral or trioctahedral. A trioctahedral sheet has the structure of a sheet of the mineral brucite, with magnesium or ferrous iron being the most common cation. A dioctahedral sheet has the structure and (typically) the composition of gibbsite sheet, with aluminium being the cation. Apical oxygens take the place of some of the hydroxyl ions that would be present in a brucite or gibbsite sheet, bonding the tetrahedral sheets tightly to the octahedral sheet.[9]

Tetrahedral sheets have a strong negative charge, since their bulk composition is $AlSi_3O_{10}^{5-}$. The octahedral sheet has a positive charge, since its bulk composition is $Al(OH)^{2+}$ (for a dioctahedral sheet with the apical sites vacant) or $M_3(OH)_2^{4+}$ (for a trioctahedral site with the apical sites vacant; M represents a divalent ion such as ferrous iron or magnesium) The combined TOT layer has a residual negative charge, since its bulk composition is $Al_2(AlSi_3O_{10})(OH)_2^-$ or $M_3(AlSi_3O_{10})(OH)_2^-$. The remaining negative charge of the TOT layer is neutralized by the inter layer cations (typically sodium, potassium, or calcium ions).[10]

Because the hexagons in the T and O sheets are slightly different in size, the sheets are slightly distorted when they bond into a TOT layer. This breaks the hexagonal symmetry and reduces it to mono clinic symmetry. However, the original hexahedral symmetry is discernible in the pseudo hexagonal character of mica crystals.

Chemically, micas can be given the general formula $X_2 Y_{4-6} Z_8 O_{20} (OH, F)_4$ in which X is K, Na, or Ca or less commonly Ba, Rb, or Cs; Y is Al, Mg, or Fe or less commonly Mn, Cr, Ti, Li, etc.; Z is chiefly Si or Al, but also may include Fe^{3+} or Ti. Structurally, micas can be classed as dioctahedral (Y = 4) and trioctahedral (Y = 6). If the X ion is K or Na, the mica is a common mica, whereas if the X ion is Ca, the mica is classed as a brittle mica. [18]

Ayurveda, the Hindu system of ancient medicine prevalent in India, includes the purification and processing of mica in preparing Abhraka bhasma, which is claimed as a treatment for diseases of the respiratory and digestive tracts. [19, 20].

Abhrak Bhasma

There has been a constant surge in the demand for the traditional medicine like ayurvedic preparations. Abhrak Bhasma is a type of ayurvedic preparation prepared from repeated incineration of mica mineral with decoction of various medicinal herbs. Traditionally, it has been used in the treatment of asthma, bronchitis, bleeding disorders, cough, cold, urinary disorders, diabetes, anemia, skin diseases, splenic disorders etc. It has also been considered to have anti-aging as well as anti-infertility properties and therefore used in various rejuvenating preparations. Despite their wide range of applications, these products are rarely validated at par with the modern medicines. There is also a paucity of literature that describes mode of action of these products at physiological and molecular level.

Abhrak Bhasma is like a heavenly medicine, and it destroys pitta (fire), vata (air), and disease ksaya (phthisis). Abhrak Bhasma is widely used in pernicious anaemia, sickle cell anaemia, Bell's palsy, hepatic dysfunction, leukaemia, sex debility, azoospermia, cystic fibrosis, post encephalic dysfunction, and cervical dysplasia. Since ancient times, Abhrak Bhasma was used as Ayurvedic medicine to cure various diseases such as asthma, tuberculosis, cancer, hepatic dysfunction, diabetes, and so on.

Ayurveda, the holistic science of herbal remedies has extensively mentioned the use of this time-tested compound multiple times in several ayurvedic scriptures and journals and has indicated its use in the following conditions including Rasayani (rejuvenates the whole body), Medhya (improves intelligence), Balya (improves muscle strength), Deepana (enhances stomach fire), Pachana (helps in digestion), Rochana (stimulates appetite), Vamana (prevents nausea and vomiting), Vayasthapana (prevents ageing), Jvara (useful in fever), Anulomana (improves breathing), Kasahara (Relieves cough, Shwasha (relieves breathing difficulties), Amahara (treats indigestion), Gulmajit (useful in abdominal tumours), Kantya (relieves sore throat), Chakushya (treats eye problems), Garbhaprada (treats infertility), Vamanopaga (treats emesis), Sangrahini (treats diarrhoea), and Kustha (treats skin disorders).

Abhrak Bhasma is usually prepared via the calcination process which is termed as 'Puta' in ayurveda. The number of putas or calcination process defines the quality and therapeutic efficacy of abhrak bhasma. In case of abhrak bhasma, number of putas vary from 7 to 1000, often taking an entire year to finish the calcination process. The purified abhrak is triturated with the different types of plant saps, herbal juice and decoctions. After trituration, shape the remnant abhrak in the form of a disc-shaped cake. Subject the cake to high temperature of about 800 – 900 °C. This entire process is one Puta. Keep doing this process again and again until you obtain Shataputi Abhrak Bhasma i.e. super-fine powdered bhasma. Lastly put the Shataputi Abhrak Bhasma under direct sunlight to remove any remaining moisture particles.Store it in amber-coloured, glass bottles for future use.

Health Benefits of Abhrak Bhasma

- Abhrak Bhasma induces the secretion of insulin from the pancreas. Therefore, it is used in the management of type 1 diabetes mellitus.
- Abhrak Bhasma has shown anti-cancer activity mostly in cases of breast cancer and leukaemia.
- Abhrak Bhasma is also used as a nerve tonic to manage psychiatric illness.
- Abhrak rehabilitates the tissue precisely and aids in the healing of impaired nervous tissues.
- Abhrak Bhasma has androgen increasing properties. Hence, it can be prescribed as an aphrodisiac.
- It has beneficial properties, enough to suffice as an anti-impotency drug for males.
- Abhrak Bhasma has been used in the treatment of helminthiasis.
- Abhrak Bhasma is a well-known hematinic, which has the tendency to increase the red blood cells count, which in turn enhances the oxygen-carrying capacity of the blood.
- Abhrak Bhasma has been used to manage chronic diarrhoea, stroke, and paralysis of one side of facial muscle.
- Abhrak Bhasma has also been used in dealing with hepatic dysfunction, bone marrow depletion, tuberculosis and myocardial ischaemia.

- It has shown benefits in managing sexual impotency, erectile dysfunction, splenic and urinary disorders, and increasing the sperm count.
- Abhrak Bhasma has been used in the treatment of immunodeficiency diseases such as human herpesvirus 4 and human immunodeficiency virus.

Although this herbo-mineral formulation has been studied and researched extensively and is extremely beneficial in treating umpteen health conditions, it is still necessary to consume the formulation in the prescribed amount as suggested by the ayurvedic practitioner or doctor. An excess of it can lead to contraindications including acute bleeding disorders, ulcerative conditions, increase in heart rate etc. It is also strictly suggested for children, pregnant women and lactating mothers to avoid consuming this medication without doctor's supervision. [21-25].

Various micro and nanocrystalline Mica skin care products and their applications, with a particular focus on Giordani gold bronzing pearls is done which also deals with Scanning Electron Microscope (SEM) images, Transmission Electron Microscope (TEM) images and FTIR spectra of Giordani gold bronzing pearls. [26]

Present study deals with estimation of mica as silicate by gravimetric analysis of micro and nanocrystalline mica medicinal product – Abhrak Bhasm. Paper also deals with Scanning Electron Microscope (SEM) analysis of Abhrak Bhasm. This research, along with better regulation and reporting, will enable consumers to choose products with confidence. This in turn will allow companies to benefit from these novel technologies in the long term while retaining customer confidence.

2. Materials and Method

Estimation of Mica as Silicate by Gravimetric Analysis of Micro and Nanocrystalline Mica Medicinal Product – Abhrak Bhasm

Ammonium chloride is mixed with sample of Abhrak Bhasm. And it is hydrolysed with hydrochloric acid, and the solution is then digested on water bath for 30 minutes, an accurate determination of Silica can be made. 0.5 gm of Abhrak Bhasma was taken in 100ml of beaker then 0.5 gm of ammonium chloride was added and to it 5 ml concentrated hydrochloric acid was added. It was then heated in water bath for 30 minutes. During digestion solution was stirred occassionaly. Then solution was filtered through Whatmann No. 40 filter paper. Complete precipitate was transferred by using policeman. Then precipitate was washed using hot water till the washings are free from chloride ions (Washings was tested with $AgNO_3$ solution. Precipitate should not form). Filter paper along with precipitate was dried in hot air oven and it is then incinerated in crucible and weighed.

SEM Analysis of Abhrak Bhasm

The Electron Microscope is an essential component for scientific analysis of a variety of materials. Scanning Electron Microscope (SEM) comprises a powerful tool in studying (cell and molecular biology, anatomy, microbiology, pathology and forensic science) biological specimens, food stuffs and several other areas of material sciences (electronics, metallurgy, polymer and surface science).

Morphological graphs of the Abhrak Bhasm sample is provided by scanning electron microscopy (Digital Scanning Electron Microscope - JSM 6100 - JEOL) with a Link analytical system operating at 10 KV (acceleration voltage).

Scanning Electron Microscope (SEM) - Digital Scanning Electron Microscope - JSM 6100 (JEOL)

SEM facilitates the observation of very fine details (high resolution) of biological materials and good focus over a wide range of specimen surface (large depth of field). It also produces clear image of specimen ranging from object visible to the naked eye to a structure spanning few nanometers. Besides its use in studying soils, sedimentary particles and rock materials, it also helps to elucidate the architecture and evolution of microfossils.

Digital Scanning Electron Microscope - JSM 6100 (JEOL) is used with a digital image processor. It has a large specimen chamber that allows observation of the entire surface of a specimen upto 150 mm and a tilt of -5 to 90°. A special feature of this SEM is a cryostage

attached to it to study the low melting point specimens.

The image processing function permits image averaging and storage, filling of acquired still images and comparison of two/four images displayed simultaneously on the 12-inch CRT. This function makes it possible to observe specimens without causing damage to them.

Other features of this microscope are:

- Resolution: 4.0 nm at 8mm working distance
- Working distance: 6 to 48 mm
- Accelerating Voltage: 0.3 to 30 KV
- Magnification: x10 to x300,000
- Image Recording: on 120 B&W Roll Film (100 ASA) or 35mm B &W roll (25 ASA)
- Instant Print: an instant print is also possible on a Thermal Video Printer (8x10.5)

3. Results and Discussion

Estimation of Mica as Silicate by Gravimetric Analysis of Micro And nano-crystalline Mica Medicinal Product – Abhrak Bhasm

Constant Weight of empty crucible = 16.200
Constant Weight of crucible with precipitate = 16.363
Weight of Silica = 16.363 - 16.200 = 0.163

SEM Analysis of Abhrak Bhasm

Scanning Electron Microscope images of Abhrak Bhasm shows that the material mainly consisted of sperical and Dumb-bell shape with 1-3µm in diameter and has a smaller aggregated particle size.

Sr. No	Chemical Present	Percentage
1	Silica	20-30%
2	Alumina	33-37%
3	Ferric Oxide	30-35%
4	Calcium Oxide	10-15%
5	Potash	8 to 12%
6	Magnesia	5 to 6%
7	Titanium dioxide	2 to 2.5%
8	Sodium oxide	NLT 0.5%
9	Phosphate	NLT 0.5%
10	Sulphur	NLT 0.5%

(A) **(B)**

Figure 1. (A) Rock of Mica [4], (B) Dark mica from eastern Ontario [5]

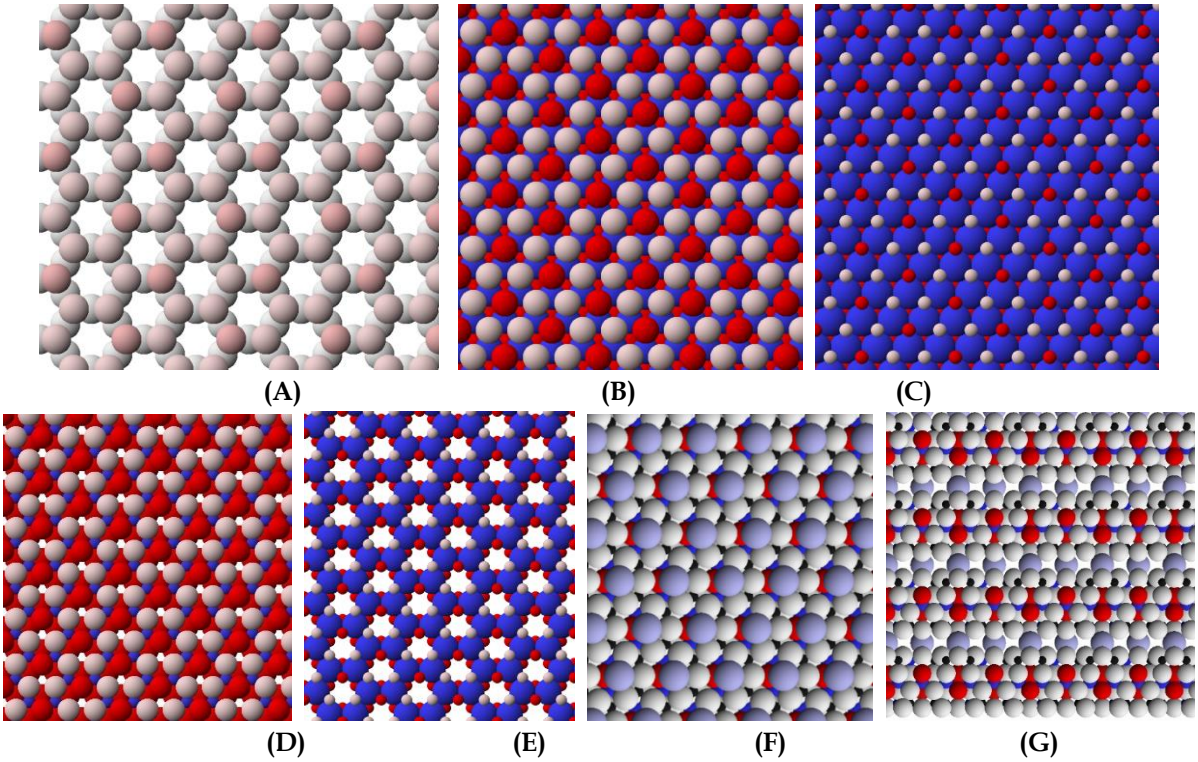

Figure 2.(A) View of tetrahedral sheet structure of mica. The apical oxygen ions are tinted pink.[11] (B) View of trioctahedral sheet structure of mica. The binding sites for apical oxygen are shown as white spheres. [12] (C) View of trioctahedral sheet structure of mica emphasizing octahedral sites [13] (D) View of dioctahedral sheet structure of mica. The binding sites for apical oxygen are shown as white spheres. [14] (E) View of dioctahedral sheet structure of mica emphasizing octahedral sites [15] (F) View of trioctahedral mica structure looking at surface of a single layer [16] (G) View of trioctahedral mica structure looking along sheets [17]

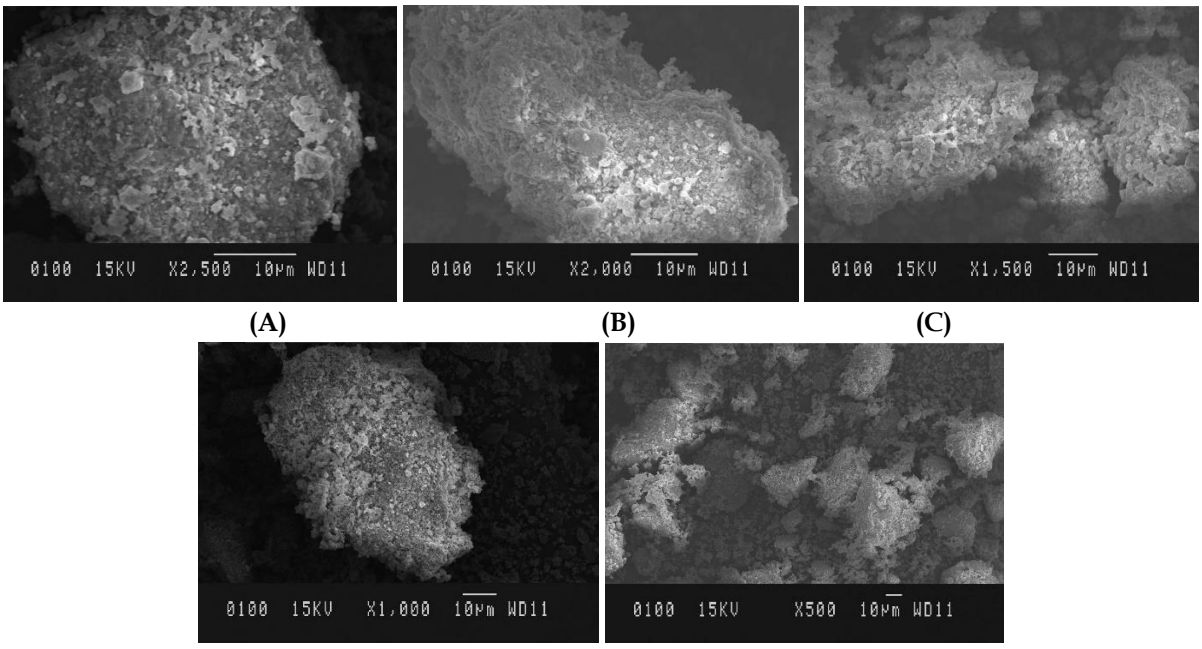

Figure 4. (A)- (E) Scanning Electron Microscope images of Abhrak Bhasm

4. Conclusion

0.163 gm Silica (SiO_2) was found in 0.5 gm sample of Abhrak Bhasm. Scanning Electron Microscope images of Abhrak Bhasm shows that the material mainly consisted of sperical and Dumb-bell shape with 1-3µm in diameter and has a smaller aggregated particle size.

Conflicts of interest: The author stated that no conflicts of interest.

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