Mica

Mica is invaluable in the electrical industry because of its unique combination of physical, chemical and thermal properties, low power loss factor, dielectric constant and dielectric strength.

The History Says

In Latin it is known as micare which mean to shine or to glitter or the Latin mica is a crumb or grain.

The Present Scenario

Nowadays mica is finding increasing use in equipment that encounters very high temperatures like rockets, missiles and jet engine ignition system. It is reported that in the manufacture of Telestar transmission satellites by teh USA, good use of mica has been made.

A group of minerals having perfect basal cleavage and capable of splitting into thin laminae is called mica. Chemically they contain complex silicate of aluminium and alkalies with hydroxyl. They crystallize in monoclinic system. Some varieties may contain iron, magnesium, lithium and rearely fluorine, barium, manganese and vandium. There are seven important mica minerals:

- Muscovite or potassium mica

  $H_2KAl_3(SiO_4)_3$

- Paragonite or sodium mica

  $H_2NaAl_3(SiO_4)_3$

- Lepidolite or lithium mica

  $KLiAl(OH,F)_2Al(SiO_4)_3$

- Phlogopite or magnesium mica

$H_2KMg_3Al(SiO_4)_3$

- Biotite or magnesium iron mica

$(H_2K)(Mg, Fe)_3Al(SiO_4)_3$

- Zinnwaldite or lithium iron mica

$Li_2K_2Fe_2Al_4Si_7O_{24}$

- Lepidomelane or iron mica

$(H, K)_2(Fe, Al)_4(SiO_4)_5$

Muscovite is the commonest of all and whenever the word mica is used it is understood to mean muscovite.

Other names of Mica

- Cat-gold
- Cat-silver
- Glimmer
- Glist
- Katen-silber
- Katzen-silber
- Katzengold
- Or des chats
- Rhomboidal Mica

Mode of Occurrence

Mica is found in pegmatites intruding mica schists. It is found to occur in book form in the pegmatites. The mode of formation of mica which is found in the form of small flakes to big slabs cleavable into the fine laminae is still the subject of active research.

One thing has been clearly established is the degree of presence or absence of orthoclase felspar indicates the possibility of finding mica in the pegmatite is indicative of the presence of more mica. This establishes that mica forms at the expense of orthoclase felspar.

The presence of tourmaline crystals and decomposed felspar in the pegmatites shows the possibility of finding good quantity of mica.

Mica pegmatite consists of quartz core with felspar on the sides adjoining the country rock, mica-schists. In the quartz and felspar zones, which usually form the core, the formation of mica is sparsely found and also the flakes are not big in size.

Mica pegmatites have been found to occur in various shapes and sizes mostly occuring as lenses. They may occur as parallel veins, pipes or in massive form. It is difficult to ascertain when the vein will pinch out and hence the mining of mica is regarded as quite speculative. Also, the abrupt decrease in degree of mineralization and disappearence of mica from the working face is quite common. Pipe mica veins have been worked upto a maximum depth of 200 metres.

Properties

Mica is invaluable in the electrical industry because of its unique combination of physical, chemical and thermal properties, low power loss factor, dielectric constant and dielectric strength. Dieletric strength is the ability to withstand high voltage without puncturing.

Common specifications are 1000 volts and even 1500 volts per millimetre of thickness without puncturing, and mica provides a high factor of safety at these figures. Dielectric constant may be defined as the capacity for momentarily storing electrostatic energy. The properties like low power loss factor and dielectric constant make mica ideal for use in condensers, the basic function of which is to store electrostatic energy in the dielectric field momentarily perhaps one-millionth part of a second and then to re-deliver it with the minimum possible loss.

No other natural substance has been found to possess the properties equal to those of mica. Muscovite mica can be split into flexible and transparent films as thin as 0.00025 inch, which gives added advantage in making built-up mica, tapes and films that can be used in any shape and size and punched films that can be used in any shape and size and punched instruments and appliances.

Of all the known varieties of mica only muscovite and phlogopite are of commercial importance and valued in the electrical industry. Muscovite finds the largest use while phlogopite has a limited application. Phlogopite does not posses the splitability and flexibility of muscovite. On the other hand phlogopite is superior to muscovite in heat resistance. Muscovite can withstand temperatures up to 700ºC, and phlogopite up to about 1000ºC. Phlogopite is, therefore, preferred where a high temperature is required. Other mica have no use except for lepidolite which is a source of lithium.

The quality of mica for commercial purposes depends largely on the amount of staining, air inclusions, the degree of flatness, and the colour. The staining is caused by mineral inclusions which occur intergrown with muscovite or between cleavage planes. The most common minerals which occur as inclusions are biotite, quartz, magnetite, hematite, garnet, plagioclase, apatite, clay minerals and the alteration products of biotite and iron oxides.

Muscovite which does not split up into even cleavage has a lower market value. It can be sold only as scrap mica. Such mica is called buckled mica. Buckling effect in mica results from post-pegmatite movement.

Other features possessed by muscovte, which greatly lower its value are A-structure and wedge-structure. Such structures originated at the time of crystallization. A-structure refers to cleavage imperfections called reeves or ridges that intersect at an angle of about 60º. This feature results from the twinning phenomenon. crystals with A-structure which are thicker at one end than at the other are said to possess a wedge-structure.

The presence of A or wedge structure greatly reduces the yield of sheet mica. Normally most of the muscovite in an individual body is of one habit; it either does or does not possess these structures.

Prospecting, Mining and Dressing

Prospecting of mica is still a matter of trial and error as no scientific method has so far been evolved for determining with certainty the occurrence of paying mica pegmatite. All the discoveries of mica-pegmatites so far are thanks to that devoted band of labourers who go in the field with chisel and hammer from vein to vein to find out paying pegmatite veins. Mines are developed following the veins.

The Room and Pillar method is adopted in mining. The mica obtained from the mine is called crude mica. It requires a little dressing to remove associated pegmatite dirt as well as defective portions such as buckled, wrinkled and wavy mica. They are rifted away with sickel.

Book-mica, split into a size atleast covering an area of 2?x 1½? and about 1/8 inch thick is called block mica. Block mica split into thin films of thickness 0.004-0.0012 inch is claled mica-film and less than 0.0012 inch thick as splitting.

The laboureres engaged in mica mines and factories where mica is hand-dressed are experts in dressing the crude mica into block, films and splittings. They do it by visual aid only. During the course of processing a considerable portion of mica goea waste. It is termed as scrap mica. The ratio of scrap mica to crude may vary from 60 to 80% depending on the defective portion in the crude mica.

For commercial purposes, mica is graded according to the quality e.g. superfine, clear, stained, fairly stained, good stained, heavily stained and densely stained; and according to sizes as given below:

figures in sq. inches

Over extra extra special	Over 80
Extra extra special	Between 64 to 80
Extra special	Between 48 to 64

Special	Between 36 to 48
No. 1	Between 24 to 36
No. 2	Between 15 to 24
No. 3	Between 10 to 15

No. 4	Between 6 to 10
No. 5	Between 3 to 6
No. 5½	Between 2½ to 3
No. 6	Between 1 to 2½
No. 7	Below 1

Industrial Applications

Sheet mica is used in a number of electrical and electronic appliances in different shapes and sizes. As an insulating material it is used in equipment like condensers, transformers, sheostats, radio and electronic tubes and radar circuits. It is used in the form of washers, discs, tubes and plates.

Nowadays mica is finding increasing use in equipment that encounters very high temperatures like rockets, missiles and jet engine ignition system. It is reported that in the manufacture of Telestar transmission satellites by teh USA, good use of mica has been made. The success of space research both in the USA and the USSR is to some extent due sto the usefulness of mica in the fields of communication and insulation. Phlogopite is used in spark plugs. Sheet mica, however, is not always available in required size as demanded by the industry.

Great progress has been achieved in making built-up mica called micanite. Mica films are placed with alternate layers of binding materials like shellac, alkyl, or silicon resin and then pressed and baked. Micanite is in common use now. It is convenient to cut or punch micanite according to requirements.

In the electronic-field, natural mica is mainly used in the manufacture of capacitors such as bridge-spacers in electronic valves and as panel-board where heat-resistance and low-loss peoperties at high frequencies are required. In such delicate equipment, mica of thinness varying from 0.015 inch and below are used. The mica of thickness in the range of 0.007" to 0.015" is used in bridge-spacers. Even thinner films, between 0.004" to 0.006", are used as backing plates for capacitors and further thinner films in the range of 0.0007" to 0.002" as dielectric. The splittings of such fine thickness are made with the help of pin and knife only.

The scrap mica obtained during the processing of crude mica and in the factories while punching is utilized in the manufacture of mica bricks for heat insulation, mica powder for use as filler in rubber goods, plant, lubricant and to some extent in plastic industries. It is also used in the manufacture of roofing material, welding rod, wall-paper, lamp chimneys, shades etc.

Waste or scrap mica is used invariably in the form of ground mica. The uses of ground mica depend largely upon its appearance and lubricating properties. Both of these characteristics are affected by the methods of grinding as well as teh purity and nature of the scrap.

Methods of Grinding

Scrap mica is ground by three processes, namely dry grinding, wet grinding and micronising. The marketed product is classified according to the grinding process which indicates quality and properties like colour, mesh size and bulk density. Dry mica powder is prepared by grinding in high speed hammer mills. The edges of the flakes get crushed and powdered mica is produced which gives the appearance of flour. Wet-ground mica is produced by grinding in water involving preferential delamination of flakes. Churn mills, with large wheels or rollers rotating on horizontal shafts are used for this purpose.

Substitute

A continuous research is being carried out to substitute mica, especially in the manufacture of roll type condensers. Synthetic materials like polyetyrene, polyethylene terphthalate (Mylar), polytetra fluoroethylene, ceramics and glass are some of the recent advancements which have partly replaced existing varieties of capacitors such as mica and paper.

In many applications wher high temperatures are not encountered as in domestic radio receivers, polyetyrene capacitors are replacing the mica capacitors. Ceramic capacitors are replacing to a certain extent both mica and paper capacitors. Ceramic capacitors have been developed having different temperature co-efficients and capacity, and high dielectric constants. Synthetic materials have an advantage of being produced on mass scale, in uniform quality and any size. However, it has not been possible to completely discard or replace mica by synthetic products bacause of its unique propety of heat resistance and stable chemical composition. Synthetic products have not been found suitable under high temperatures when compared to natural mica.

In the stove manufacturing industry, mica is being replaced by refractory glass, Pyrex and lena, owing to the fact that while mica sheet cracks under heat, pyrex does not. In the electrical equipment industry numerous substitutes, usually made of plastics e.g., teflon, nylon, stratified fibres and araldite or silicon varnishes, are coming into use. Mica is, however, still in use in precision work where substitutes have so far failed.

The USA, and France have made considerable progress in utilizing mica-scrap for the manufacture of different types of reconstituted sheet-like mica products called 'samica' and synthetic mica, mica-mat and integrated mica. Fluorinated mica is produced by replacing hydroxyl ion of phlogopite with fluorine ion at atmospheric pressure. Fluorinated mica has the unique property of binding itself under heat and pressure. This has given rise to new products under the mica family.

Sheet-like mica products are manufactured by a process similar to the manufacture of paper. Mica pulp is made and treated through a paper-making machine. Silicon resins are added to the pulp as bonding agents. In the preparation of integrated sheet-mica the natural adhesive property of their freshly split flakes is used to advantage in binding the small flakes under pressure arranged on the belt. To overcome is fragility, it is dipped in a solution of silicon resin. Integrated mica has the same properties as natural mica. Mica, paper, integrated mica etc., are used for rolled products for use in capacitors. A common mica product in use is called 'Mycalex'. It is manufactured by the General Electric Co., of USA.

'Mycalex' is a ceramic-like product made of glass bonded mica flakes that possess a combination of properties found in no other insulating material. It is prepared from ground mica and lead borate heated together to the softening point of the borate and compressed while still plastic. A part of the mica combines to form a lead borosilicate giving the product greater insolubility.