

# **CHARACTERIZATION OF LOCALLY AVAILABLE MICA MINERALS FOR CAPACITOR APPLICATIONS**

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Department of Materials Science and Engineering

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MINERALS FOR CAPACITOR APPLICATIONS

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### Declaration

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institution of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the partial fulfilment of the requirements for the Degree of Master of Science in Materials Science and Engineering under my supervision.

Name of the supervisor: Prof. S U Adikary

Signature of the Supervisor:

Date:

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## Abstract

Mica is a group of minerals of the hydrated aluminosilicate of iron, magnesium, potassium, lithium and sodium etc. Commercially, the two most widely used micas in the electrical industry are the muscovite and phlogopite types. Phlogopite is the widely available mica type in Sri Lanka.

Micas from different mining locations (Mathale, Mailapitiya, Badulla and Kebethigollewa) in Sri Lanka were characterized using XRD and SEM methods. Two different methods, namely ceramic method and flake method were used to study the dielectric properties of locally available mica. Dielectric behaviour of mica characterized above has been investigated by measuring capacitance (C) and loss tangent (D) at selected frequencies, with a precision LCR meter in a controlled environment. Then the relative permittivity,  $\epsilon_r$  for each specimen was calculated and behaviour of  $\epsilon_r$  with frequency was studied. Five flake specimens each obtained from four different locations and five ceramic disc specimens each prepared with powdered mica of two different locations were used for the study. Size, shape and method of preparation of the specimens were kept constant throughout the experiment. Graphs between  $\epsilon_r$  and  $\log_{10}[\text{frequency}]$  of silvered mica flakes, and that of silvered mica discs were plotted separately. Accordingly, samples prepared by both methods have also been compared. Finally, average loss tangent  $D_{\text{avg}}$  values of silvered mica were plotted as a function of average relative permittivity,  $(\epsilon_r)_{\text{avg}}$  at defined frequencies and investigated location wise.

Scanning Electron Microscopic (SEM) analysis of Mathale and Mailapitiya samples confirmed that they have typical mica like flaky structures with layers. The XRDs of mica samples from different locations revealed different crystal structures & poly types. Sample from Mathale revealed two crystal structures Phlogopite 1 M and Phlogopite 3T, while Mailapitiya sample revealed two crystal structures Phlogopite 1 M and Biotite. Phlogopite 1 M and Hendricksite (Zinc-rich mica) were found fairly abundantly and Wustite ( $\text{Fe}_{0.92}\text{O}$ ) was found in small concentrations in Badulla sample, while Phlogopite 3T was found abundantly in Kebethigollewa sample.

Dielectric properties including dielectric constant ( $\epsilon_r$ ) and dielectric loss tangent (D) have been done in the frequency range from 1 kHz to 1MHz. The results showed that the dielectric constant ( $\epsilon_r$ ) and loss tangent (D) decrease with the increasing frequency at room temperature. As per the results, Kebethigollewa flake mica and sintered Mathale mica were the best types with higher  $\epsilon_r$  and lesser D, at low radio frequency ranges. However, flake mica showed comparatively higher  $\epsilon_r$  values than that of mica dielectrics obtained from the same source and manufactured by ceramic method. These results are also found compatible with the results of similar studies carried out by the researches in different countries.

Hence, it can be concluded that locally available mica can be applied as dielectrics for capacitors within low radio frequency range. Even though both methods can be used, flake method is more suitable for applications which require higher  $\epsilon_r$  values while ceramic method is better, where low capacitance applications are required. Ceramic method may be further developed by using other techniques such as slip casting method. Kebethigollewa and Mathale mica flakes are the best sources in terms of dielectric properties.

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