



VINGNANAM Research Conference

21st of July 2022



VRC-2022

Faculty of Science
University of Jaffna
Sri Lanka

Jointly Organized by

**Faculty of Science
University of Jaffna
Sri Lanka**



**Western Norway
University of
Applied Sciences**

Mixed conducting sodium montmorillonite suitable for battery cathodes

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Montmorillonite (MMT) is naturally found as a clay mineral in Sri Lanka. It is an aluminosilicate crystalline compound with a layered structure. In this structure, an octahedral sheet of aluminum-oxygen (Al – O) is sandwiched between two tetrahedral sheets of silicon-oxygen (Si – O). The MMT structure can accommodate various monovalent and divalent cations such as Li^+ , Na^+ , Mg^{2+} within interlayer spacings. Natural Li – MMT and Na – MMT are found in various parts of the world. The MMT structure has the ability to exchange interlayer cations with various other divalent cations. MMT with interlayer alkali cations show appreciable ionic conductivity. The Na – MMT was taken for the present research work. To improve the ionic conductivity of the MMT structure, the structure was further saturated with Na^+ ions. The concentration of Na^+ ion saturated Na – MMT was measured by Inductive Couple Plasma Mass Spectroscopy. The structural and electrical properties of Na rich MMT were investigated using XRD, SEM and Complex Impedance Spectroscopy. The bulk conductivity of Na – MMT was enhanced by saturation of Na^+ ions and was $3.41 \times 10^{-4} \text{ S cm}^{-1}$ at 30 °C. Na – MMT has negligible electronic conductivity, which is less than 0.001 %. For using Na – MMT as cathode materials in batteries appreciable electronic conductivity must be present in the materials. To enhance electronic conductivity of Na – MMT various concentration of carbon black was added. The electronic transference number of saturated Na – MMT pellets with graphite electrodes was determined by the DC polarization method. The electronic transference number of Na – MMT with 25 % carbon black and Na – MMT with 30 % carbon black was 81 % and 87 % respectively.

Keywords: Cation exchange, *Electrical conductivity*, *Intercalation cathode*, *Sodium montmorillonite*.