UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF MgI_2-$Mg_3(PO_4)_2$- Al_2O_3 ELECTROLYTE FOR MAGNESIUM BATTERY

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in the accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any academic institution or non-academic institution for any other degree of qualification

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ABSTRACT

The discovery of lithium iodide based solid electrolytes with high ambient electrical conductivity stimulates considerable attention on MgI_2-$Mg_3(PO_4)_2$ binary system and MgI_2-$Mg_3(PO_4)_2$ with Al_2O_3. Mg have formal valency of 2+ and it is expected that the mobility of the Mg^{2+} to be less than the smallest metal ion Li^+. Alumina has unique properties that able to enhance the ionic conductivity. All samples prepared by using ball milling method and sintering method. The sample are characterized by using physical and electrical spectroscopy in order to find the suitable inorganic solid electrolytes composition for fabrication of magnesium battery. Conductivity measurement by the AC impedance (EIS) technique shows that the binary system of MgI_2-$Mg_3(PO_4)_2$ exhibits the highest room temperature conductivity of 5.23E-04 Scm^{-1} for 30 weight percent of MgI_2 while the system MgI_2-$Mg_3(PO_4)_2$ with Al_2O_3 shows maximum conductivity of 1.08E-03 Scm^{-1} for the electrolyte with 4 weight percent of Al_2O_3. The increase in ionic conductivity is due to ion dissociation and decrease of value ionic conductivity is due to blocking effect. Temperature dependence showed the activation energy is lowered for the highest conducting sample. For MgI_2-$Mg_3(PO_4)_2$ the activation energy obtained is 0.29eV and MgI_2-$Mg_3(PO_4)_2$ with Al_2O_3 is 0.22eV. The temperature dependence conductivity follows Arhenius behaviour. Field Emission Scanning Electron Microscopy (FESEM) images show some changes in the morphology after introduce the MgI_2 and filler. The samples with filler shows nano flakes like structure with some space created allowing the Mg^{2+} cations to migrate that lead to enhanced conductivity. FTIR spectroscopy justified interaction and complexation in the both systems. The semicrystalline nature in the system reveals by XRD. The modulus formalism studies show that both system is ionic conductor with the value of transference number in the range of 0.8-0.96. The fabricated cell using electrolyte of 30 weight percent of MgI_2 with 4 wt.% of Al_2O_3 showed the better performance more than 100 hours by characterize using discharge characteristics of 1.5 μA of current and the value of open circuit voltage is 1.2V at room temperature.

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