# UNIVERSITI TEKNOLOGI MARA

# EFFECT OF MODIFIED $SIO_2$ FILLERS ON PROPERTIES OF PMMA/ENR 50 BLENDS ELECTROLYTES

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# ABSTRACT

The polymethyl methacrylate/50 % epoxidized natural rubber (PMMA/ENR 50) blend film was not a homogeneous blend. Therefore in this study, 15 nm (S15) and 20 nm (S20) silicon dioxide ($SiO_2$) fillers were added to improve the homogeneity and enhance the ionic conductivity of the nanocomposite polymer electrolytes. It was found that the phase separation and the ionic conductivity of the PMMA/ENR 50 blend have been improved when $SiO_2$ fillers were added. This indicated that $SiO_2$ fillers played an important role in producing homogenous and improving ionic conductivity nanocomposite polymer electrolytes film. The highest ionic conductivity of $5.26x10^{-6}$ $Scm^{-1}$ was obtained when 5 % of S15 was added into lithium tetrafluoroborate ($LiBF_4$) doped PMMA/ENR 50 (PEL155) blend system. Therefore PEL155 film was suggested as the best film in this study. However, $SiO_2$ agglomerates can be spotted on the surface of the PEL155 film due to the formation of hydrogen bonding between the silanol (Si-OH) group of the $SiO_2$ filler with the surrounding moisture. Therefore, S15 was treated with various concentration HCl solutions. In was found that HCl modified S15 (MS15) fillers filled $LiBF_4$ doped PMMA/ENR 50 electrolyte (PELM155) films exhibit better morphology with minimum filler agglomeration than the PEL155 film. However, their ionic conductivities were lower than the PEL155 film. This indicates that Si-OH group of the $SiO_2$ filler is crutial for helping dissociation of $LiBF_4$ salt and needed in forming $SiO_2$ linkages that provide conducting pathway for the ion tranport in the system.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 BACKGROUND OF STUDIES

Today, most human activities such as working, communicating and traveling involved the use of electronic devices such as cell phones, laptops, cameras and global positioning systems (GPSs). These technologies produced smaller and portable devices hence it needs a smaller and lightweight battery that can power these electronic devices. Therefore, the performance of the battery needs to be improved so that it may last longer and stable at wide temperature range, can be recharged at reasonable rate, non-toxic and low in cost (Goodenough and Kim, 2011). There are several types of rechargeable batteries that has been developed such as $Li^+$ ion battery (Wu et al., 2017), $Mg^{2+}$ ion battery (Wang et al., 2017) and $Na^+$ ion battery (Guerfi et al., 2016). Amongst them $Li^+$ ion battery has been extensively researched due to stable cycling, high energy density, high voltage, and environmentally-friendly (Wu et al., 2017).

A $Li^+$ ion battery consists of anode, cathode and electrolyte that are assembled together to form a battery system (Zhou et al., 2010). The performance of a battery was determined by the type of materials utilized. Thus, the development of new materials for battery components is crucial in order to obtain desired battery performances (Scrosati & Garche, 2010, Goodenough & Kim, 2010). Most development of battery focusses on obtaining an electrolyte material that has high energy density, good charge/discharge cyclic stability as well as high safety (Wang et al., 2014). Polymeric materials has been extensively chosen in developing electrolyte for $Li^+$ ion battery because it is able to give reasonable conductivity, high mechanical strength and stable at a wide range of temperature (Krejza et al., 2008). The idea of using polymer as electrolyte has been started in 1970s by Feton and co-workers (1973) and followed by Wright (Wright, 1975, Wright, 1998). However, its potential as electrolyte material in electrochemical devices has only been realized by Armand et al., (1979) in which a non-conducting polymer of poly(ethyleneoxide) (PEO) was able to conduct electricity when inorganic salt (Wright, 1998) was added into the polymer matrix. This new class of polymer is called polymer electrolytes.