CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Worse environmental issue happened in the world because of excess greenhouse gases that causes depletion of ozone layer and global warming. Greenhouse gases are producing by some non-renewable energy. Petroleum, coal, natural gases are examples of non-renewable natural resources, will be used up in the next few years' time. Therefore, researchers are now focusing on alternate ways to decrease the dependency to the non-renewable energy sources. High efficiency, low cost and environmental friendly energy storage system is one of the most intense researches which carried out due to high demand (Aricò, A. S., 2005).

In ESS i.e., batteries, capacitors and supercapacitors two important parameters are taken into consideration viz., (i) energy density and (ii) power density. Energy density is total energy stored is measured in a system. Power density indicates speed of charge and discharge cycle of an energy storage device. Supercapacitors have ~~a~~ high power density (~5 kW kg^{-1}), fast charge and discharge time (0.3-30 s) and long cycle life (>100,000) (Jung, H. G., 2013). However, their energy density (1-10 Wh/kg) is between that of the batteries and capacitors (Faraji, S, 2015). Relationship between energy and power densities is explained using a Ragone plot as shown Figure 1.1.

Supercapacitor divided into electric double layer capacitors (EDLCs) and pseudocapacitors (PCs) according to ESS. (Zhi, M, 2012). Electric double layer capacitor operates using charges accumulation at an surface of a carbon-based electrode. However, working principle of PCs is based on rapid and reversible redox reaction and is a faradaic reaction.

Transition metal dichalcogenides (TMDs) are in single sheet layer with layer structures that is quite same with graphite because they are semiconductors with suitable bandgaps.Formula generally for layered TMDs is MX_2, where M is groups 4 to 10 of transition metal while X is a chalcogen .Application Of TMDs can be wider in few field such as storage of energy, catalysis and devices in eectronic. (Manish Chhowalla, 2013).

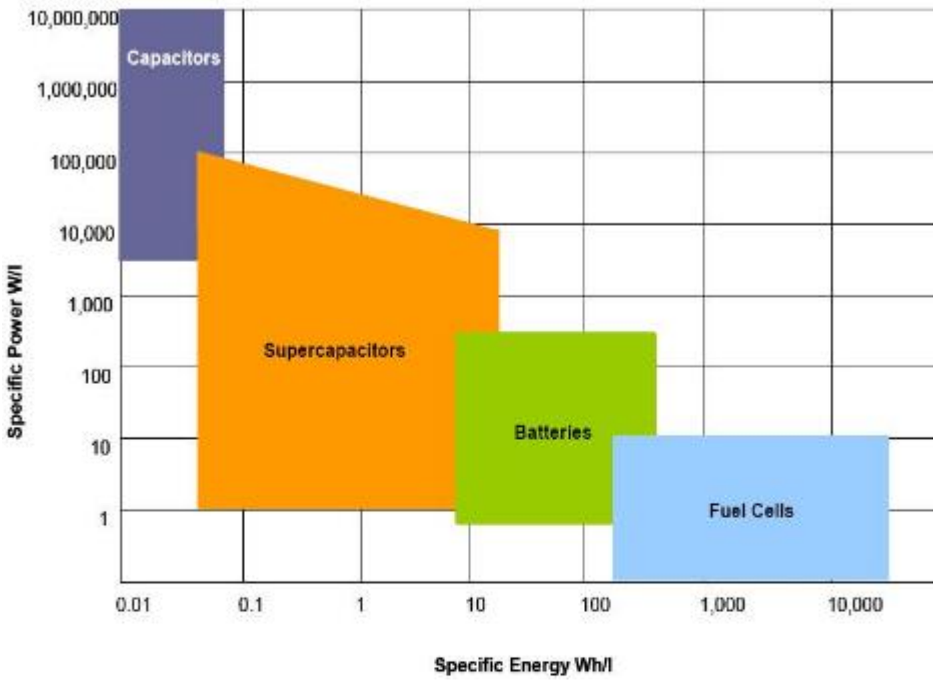

Figure 1.1. Ragone plot of energy storage for ESS devices
Adapted from: (Goodenough et al. ,2007)

1.2 PROBLEM STATEMENT

Exfoliation of transition metal dichalcogenides between layered structures of electrode materials have been demonstrated could yield high power and energy density of a supercapacitor. Two dimensionally TMDs have been promoted in a new and advanced material in certain electrochemical devices in this few years; which could be synthesized using hydrothermal method. However, there is still effort to investigate the relationship between before exfoliated and after exfoliated of transition metal dichalcogenides with efficiency of a supercapacitor.

1.3 OBJECTIVES OF THE RESEARCH

The objectives of this research are:

1. To synthesize transition metal dichalcogenides (MX_2) where M = Mo and W, and X = O, S, Se and Te using hydrothermal method, and fabricate MX_2 using exfoliation method.
2. To characterize the synthesized MX_2, and exfoliated MX_2 samples using physico-chemical technique.
3. To evaluate the electrochemical properties of the MX_2 and exfoliated MX_2 using potentiostat-galvanostat.

1.4 RESEARCH QUESTION

1. Would the hydrothermally-synthesized molybdenum dichalcogenide present two-dimensional layered morphology?
2. Would the exfoliation of MX_2 yielded layered MoX_2 structure?
3. Is exfoliation of MX_2 would yield different energy density and power density?