CHAPTER I
INTRODUCTION

Lithium-ion batteries (LIBs) are growing in popularity and widely used in electric vehicles (EVs), hybrid-electric vehicles (HEVs) and portable applications such as digital cameras, laptops, mobile phones, etc. Because they supply relatively high energy-to-weight ratios, long life with low self-discharge rate, lack of memory effect and also environmental benignity. The first generation of anode materials is metallic lithium. However, the commonly problem found in this type is the operational safety problem related to the dendrite growth on metallic lithium anodes during charge/discharge cycling which also leads to short circuits. The growth of dendrite lithium can be inhibited by providing free space for lithium ion insertion and extraction during charge/discharge process. Hence, the required properties of materials continue to attract attention with the goal of developing anode materials capable of absorbing lithium reversibly in order to replace metallic lithium anodes. The usage of lithium insertion compounds like carbonaceous materials are gained more favor to use as anode intercalation materials due to their natural structure that consists of layers, which allow ease of intercalation and deintercalation of Li^+ ions. Nevertheless, they have limited available of a theoretical capacity of 372 $mAhg^{-1}$ and low Li^+ ion diffusion between carbon layers.

Unfortunately, almost anode materials suffer from the formation of solid electrolyte intherphase (SEI). It is irreversible structure transformation which comes from electrolyte decomposition and electrode degradation. Some Li-ions will be blocked by this insulating layer resulting in capacity fading after several cycles and tremendous volume variation.

Consequently, numerous of strategies are employed to develop alternative anode materials which are nano-structured transition metal oxides such as WO_3, MoO_3, TiO_2, SnO_2 and Fe_2O_3 which gain higher lithium intercalation and deintercalation potential and the lower formation of dendrite lithium. These metal oxides exhibit their remarkable characteristic of extended cycle life due to the formation of a Li_2O buffering or favorable crystal structure for lithium intercalation and deintercalation. Among these potential anode materials, titanium oxides have been extensively studied due to their structural characteristics, low cost, wide availability, safety, and especially the higher lithium intercalation potential to avoid the deposition of metallic lithium. TiO_2 has various polymorphs including anatase, rutile and brookite. Only anatase is considerably the most electroactive structure which gives satisfactory results of a cell expansion (or volume change) less than 3% upon intercalation and deintercalation of lithium ion during charge/discharge process when compared to silicon and tin (200-400%). This prolongs cycle life of lithium ion batteries. The lithium intercalation and deintercalation on TiO_2 anatase proceeds according to the following reaction:

$$TiO_2 + xLi^+ + xe^- \quad \rightarrow \quad Li_xTiO_2$$

The weak point of TiO_2 owing to its poor electronic conductivity and low lithium diffusion rate can be restrained by electrospinning technique to produce it with the features that consist of extremely long fiber length, high surface area, and high porosities. These features lead to attain a large amount of active sites, more lithium storage capability and reduce charge transport pathways for both Li^+ ions and electrons diffusion. Moreover, the conductivity can be considerably improved by introducing of metal nanoparticles (e.g. Ag, Au, Zn) into the TiO_2 nanofibers (Nam *et al.*, 2010)

Therefore, the present work will focus on the structural modification of nanofibers to improve their efficiency as anode for high-power lithium-ion batteries. Accordingly, the hollow ZnO-TiO_2 and Ag_2O-TiO_2 composite hollow fibers will be prepared via coaxial electrospinning of the colloidal solution comprised of titanium (IV) isopropoxide/ Poly (vinyl acetate)/zinc (Zn) particles and silver (Ag) particles in case of Ag_2O-TiO_2 composite hollow fibers, followed by calcination in air to produce the ZnO and Ag_2O particles embedded TiO_2 hollow fibers. These particles were utilized as nuclei for outgrowing their crystals. Then, the hydrothermal treatment is employed to outgrow ZnO and Ag_2O crystals on the TiO_2 surface. The obtained products will be able to use as anode materials for improving the performance of lithium-ion batteries.