CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH

Indium (III) oxide (In$_2$O$_3$), indium tin oxide (ITO), tin (II) oxide (SnO), doped zinc oxide (ZnO) and indium zinc oxide (IZO) are examples of the traditional n-type materials. The application of transparent conducting oxide (TCO) is commonly made from the indium tin oxide, ITO since it is optically transparent and has ability to conduct electricity. However, ITO have some drawbacks, which is toxicity, low stability and very costly (A. Ismail et al., 2007). An alternative way to overcome the disadvantages is by selecting ZNO instead of ITO since ZNO have high potential in many optoelectronic applications and better optical, electrical and also mechanical properties (Zhang et al., 2015).

Some of the physical properties of zinc oxide are insoluble in water and appears white in colour and exist in form of powder. ZnO is one example of the inorganic compound with n-type conduction due to presence of interstitial zinc and oxygen deficiency. It is known that producing p-type ZnO is difficult because of its tendency to be n-type. ZnO is generally used in everyday life as an additive in most products and materials, such as in paints, foods, fire retardants, glass, batteries and many more.

ZnO is naturally occurs as mineral zincite, however most of ZNO are produced synthetically. Properties of ZnO that is stable in chemical structure, cheap in price, non-toxic and do not harm the environment and also having transparent behavior makes ZnO very special (Gupta et al., 2010).
Some applications involving ZnO is bipolar junction transistors, gas sensor, coatings in solar cells, photo-detection and light emitting diode (Gómez-Pozos et al., 2016). Another special characteristic of ZnO semiconductor is having 3.37 eV band gap which is wide enough with large exciton binding energy of 60 meV (Aoun et al., 2015).

Previously, many of the researchers did an extensive study on the effect of the metal doping for zinc oxide to thin film in order to improve the physical performance. There are various dopants like Cr, Cu, Ga, Al, Ag and the other metals have been doped using a various method in the previous years. However, it is reported that Ag as a good candidate for various photocatalytic and optical applications because it has shallow acceptor level for ZnO (Kumar et al., 2016). In previous study, lithium (Li), sodium (Na) and potassium (K) were selected as candidate for p-type doping in the alkali metals (IA) group. K was selected as the best candidate (Gupta et al., 2011) amongst all of three because the radius size of Li and Na is very small and have tendency to be interstitially incorporated into ZnO. In other side, there is more attention focused for the study of doping with IB group which involving copper (Cu), silver (Ag) and gold (Au) and Ag is the most suitable candidate for p-type doping (Volnianska et al., 2009).

There are many methods of synthesizing zinc oxide thin film, for example spray pyrolysis, chemical vapor deposition, sol-gel synthesis, sputtering and atomic layer deposition. However, sol-gel method would be the most promising method because of simple preparation, low cost, easy to control the chemical composition and suitable for the laboratory scale synthesize.

Hence, in this research, ZnO doped with Ag using sol-gel method followed by spin coating technique at various layers will be synthesized. It is believed that the doping of Ag will improve the optical and structural properties of the thin films.
1.2 PROBLEM STATEMENT

There are various methods that can be used to prepare the zinc oxide thin films such as chemical vapor deposition, sputtering, spray pyrolysis, pulsed laser deposition and sol-gel spin coating. Based on the previous study by Bougrine et al., (2003), advantages of using spray pyrolysis method are low in cost and simple technique. Moreover, they are also advanced in technology compared to other techniques. However, it is only suitable for the larger scale production of thin films meanwhile for sputtering method, the process is critical and very sensitive because the microstructure of films are influenced by the argon (Ar) gas pressure (Song et al., 2002).

Another technique used in previous study is using chemical vapor deposition (CVD) (Hu and Gordon, 1991). This technique produces the crystalline structure at high growth rates and suitable for surface coating for the larger scale, however there are some drawbacks of using CVD technique since this process prefers higher temperature, higher than 900 °C and involving complex process.

Amongst all of the methods mentioned above, sol-gel method is the most beneficial and selected method in preparing the thin film due to simple deposition equipment and easy for controlling the chemical component. Other than that, the fabrication of thin films also can be done at low budget and most important thing is suitability for fabricating at small amount of laboratory scale and research purposes.

In the previous study by Xian et al., (2013), Ag-doped ZnO thin film was synthesized by sol–gel method. Then, successfully prepared ZnO precursor was doped with 2 % and 4 % of Ag. The samples were then tested for thin film application. On the other hand, in this research, pure ZnO and Ag-doped ZnO will be synthesized using sol-gel method followed by spin coating technique and deposited on the glass substrate. The deposition layer varied from 3 to 11 and characterized using XRD, UV-Vis and FESEM. It is believed that the doping of Ag would improve the crystalline structure of ZnO and the transmittance also would be better. Meanwhile, the doping of Ag to ZnO is assumed to yield uniform surface morphology and finer grain size.