CHAPTER 1

Introduction and Research Objective

1.1 Introduction

Nowadays, the energy resources of fossil fuels (petroleum, coal and natural gas) present an important problem as limited non-renewable energy resources. The conversion of sunlight into electricity by solar energy devices is an alternative energy source to solve this problem [1]. More than 85% of the current solar cell production involves crystalline silicon technologies, which have high cost and limited silicon feedstock [2]. An approach which undertake a significant cost reduction is for thin film solar cells based on hydrogenated amorphous silicon (a-Si:H) and microcrystalline silicon (μc-Si:H) [3]. In addition, dye-sensitize solar cells have been developed and have low cost and simple production [4]. An major part of these devices are the transparent conducting layers used as a front electrode and as part of the rear reflector. When applied at the front side, transparent conducting layers have to possess a high transparency in the visible range and have high electrical conductivity [5-7]. These films have also been used as transparent electrodes in many other optoelectronic devices such as in organic light emitting diodes, flat panel displays and electrochromic devices [5-7].

Optimum properties are that the resistivity of transparent conducting films should be as low as 10^{-4} Ω.cm, the extinction coefficient in the optical visible region should be lower than 0.0001 and the optical band gap (E_g) should be greater than 3 eV [8-9]. Transparent conducting films have been prepared from oxide-based materials such as indium oxide (In_2O_3), tin oxide (SnO_2), cadmium oxide (CdO), zinc oxide (ZnO) [10, 11], tin and titanium doped indium oxide (ITO and ITiO) [5,12-13], antimony and fluorine doped tin oxide (ATO, FTO) [14-16], tin and aluminium doped cadmium oxide (CdO: Sn and CdO: Al) [11] and aluminium and gallium doped zinc oxide (AZO and GZO) [7,17-19]. Chemical vapour deposition (CVD), evaporation, RF and DC

sputtering, sol-gel, pulsed laser ablation and spray pyrolysis are some preparation processes currently used to produce transparent conducting films [20-22].

The focus of this work is on transparent conducting films for electrode of solar cells. The best technique for growth of films for this application is spray pyrolysis because this technique can be used in large scale with low cost production compared to growth other films techniques [20-22]. Furthermore, spray pyrolysis has the other advantage of being a continuous, chemically homogeneous and low pressure preparation [20-21]. Modification of the spray pyrolysis technique by using an ultrasonic frequency vibrating nozzle will be used in this work. The droplets from this nozzle can be controlled to be very small, in the micron region. The films can then be homogenous, without pin holes and with grain size in the nano scale [22].

In this work, we will prepare transparent conducting films from oxide-based materials on microscope glass substrate at high temperature in air by using ultrasonic spray pyrolysis technique and subsequently investigate the physical, optical and electrical properties of these films for solar cell applications.

1.2 Research objectives

The objectives of this study are as follows:

1.2.1 To fabricate and investigate the properties of transparent conducting films from oxide-based materials by using ultrasonic spray pyrolysis.

1.2.2 To study the effect of processing parameter such as substrate temperature and doping condition on physical, optical and electrical properties of transparent conducting films from oxide-based materials.

1.2.3 To investigate the optimum conditions for preparing transparent conducting films from oxide-based materials by using spray pyrolysis technique.

1.3 Usefulness of the research

The main education advantages of this work are:

1.3.1 To obtain knowledge for the transparent conducting films.

1.3.2 To obtain new methods for improvement of optical and electrical properties of In_2O_3 and ZnO films.

1.3.3 To obtain high performance properties of the transparent conducting films for the solar cell applications.