CHAPTER I

INTRODUCTION

Flexible polyimide (PI) films have been widely applied in soft electronics and microelectronics packages. It is used as base materials of flexible printed circuits (FPC) and other soft electronics because polyimide has high thermal and chemical stability, low dielectric constant (Strunskus et al., 1996; Stephans et al., 2000) and it is easy for planarization and patterning. The ability to generate high-resolution metal patterns on polyimide surface is increasingly required in these applications, because of the miniaturization of the large-scale integrated (LSI) circuits and printed circuit boards (PCBs), which is essential in the downsizing of electronic devices. It is expected that flexible micro electro mechanical (MEMS) and semiconductor devices, as well as flexible displays, can be fabricated on flexible substrate films for use in various applications. For such flexible applications, metals such as gold, silver, copper, nickel, rhodium or cobalt are widely used as patterns on polymeric substrates in printed circuits.

However, adhesion between polyimide and metal is notoriously poor. Many methods have been developed to increase adhesion of polyimide such as plasma treatment (Heilmann and Werner 1998; Heilmann et al., 1999), laser irradiation use of ion beams, inverse chemical vapor deposition and surface modification treatment. Most of these methods require high vacuum equipment, while the productivity is often low. Therefore, they are not economically feasible. These methods may also introduce foreign materials and undesirable modified layers into the interfaces, resulting in possible reliability failure (Ramos 2002). The suitable method is surface modification by hydrolysis from alkaline because of the simplicity and low cost (Acevedo and Harris 1994). Nevertheless, the optimal conditions for the hydrolysis of polyimide and the most efficient way for metal patterning on a selected area of PI have yet to be determined.

Fabrication of the metallic thin films and/or patterns on the polyimide surface was previously achieved through chemical reduction using $NaBH_4$ aqueous solution (Coowar et al., 2008), thermal treatment (Wu et al., 2005; Shim et al., 2008) and ultraviolet (UV) induced photochemical reduction of the adsorbed metal ions using preadsorbed TiO_2 nanocrystals as a photocatalyst. Although these processes allow the surface of polyimide to be directly metalized, patterned formation of metallic thin films is only achieved through the use of photo resist or catalyst, and it is difficult to control the interfacial structure between metal thin films and the underlying polyimide. It has been suggested that diffusion of metal ions during the reduction process plays a key role in determining the metal/polyimide interfacial structures. (Akamatsu et al., 2003).

In this research modification of polyimide surface is prepared by hydrolysis reaction, of which modification time, temperature and concentration of KOH aqueous solution are investigated factors. The focus of this research is the determination of factors affecting the modification of polyimide surface for the growth of ultrafine silver nanoparticles on polyimide surface by 3 UV irradiation procedures i.e. conventional irradiation, water-assisted irradiation and cycle irradiation, in order to improve adhesion properties (between silver and polyimide) and chemical resistance (to base solution during the subsequent electroless plating process). The scope of this study includes the investigation of the following effects:

1. Effects of modifying time (1, 3 and 5 min), modifying temperature (50, 60 and 70 °C) in surface modification step.
2. Effects of time in impregnation of silver ion and irradiation time in UV irradiation step.
3. Effect of heat treatment.
4. Effects of amount of water for assisted ultraviolet irradiation.
5. Effect of immersion in KOH aqueous solution after irradiation (cycle irradiation).
6. Effect of reduction by $NaBH_4$.
7. Effect of copper electroless plating.

This thesis is divided into five parts. The first three parts describe general information about the study, while the following two parts emphasize on the results and discussion from the present study. The introduction is presented in Chapter I. Chapter II consists of background information, while the experimental systems and procedures used in this study are shown in Chapter III. The experimental results, including an expanded discussion, are given in Chapter IV. Finally, in the last chapter, the overall conclusion from the results and some recommendations for future work are presented.