

## Adhesion Properties of Copper/Polyimide Film Modified by Reactive Ion Etching(RIE)

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### Abstract.

Surface modification of polyimide(PI) films was treated with oxygen RIE by varying ion doses from  $1 \times 10^{16}$  to  $1 \times 10^{18}$  ions/cm<sup>2</sup> at an ion beam energy of 250 eV. Following the modification of PI surface, metal films consisting of NiCr/Cu and Cu were deposited on modified PI films by D.C. magnetron sputtering and electroplating, respectively. The surface modified PI film was characterized by XPS, AFM, SEM and contact angle measurement, respectively. The water contact angle of PI film decreased significantly from 64° to 4.4° with an increase of ion dose, indicating that the surface energy of PI film increased. The XPS spectrum showed that functional group, particularly C-O bonding, on modified PI surface was significantly increased by interaction between scissored unstable chains and reactive ions. The modified PI film surfaces by oxygen RIE showed significant improvement in adhesion to a overcoated metal film of NiCr/Cu.

### Introduction

PI/metal film have wide application in the manufacture of flexible circuits, PCB(printed circuit board) and cable assemble. Technical concern for the PI/metal system lies in the improvement of interfacial adhesion of metal to PI films. Various surface modification techniques such as ion-beam bombardment(IB), ion implantation and plasma treatment have been used to improve the adhesion[1-5]. It has been reported that surface modification of polymers leads to improve the adhesion between metal and polymer by the increase of the surface energy resulting from the formation of hydrophilic group and the surface roughening.

In this study, surface of polyimide(PI) film was modified by oxygen RIE at various ion doses and subsequently NiCr/Cu metal films were deposited on the modified PI films. The effects of oxygen RIE on the characteristic of PI film surface and the adhesion property of NiCr/Cu metal film on the modified PI film were reported.

### Experimental Procedure

Commercially available Upilex-S PMDA-ODA polyimide(PI) film with a thickness of 25 μm was used in this study. An oxygen RIE of the PI film was carried out by varying ion doses from  $1 \times 10^{16}$  to  $1 \times 10^{18}$  ions/cm<sup>2</sup> at an ion beam energy of 250 eV. Ion beam was generated from RF ion source with a beam diameter of 6 cm at grid face. The wettability of the PI surface was measured by contact angle meter(GBX Model : D-1) using both DI water and ethylene glycol. The average value of contact angle was taken from the measured values of three drops at different places. The change of surface roughness was observed by Atomic Force Microscopy(AFM). X-ray Photoelectron Spectroscopy(XPS) was performed to identify chemical bonding state for the PI surface. XPS data were obtained with monochromatic AlKα x-ray( $h\nu=1486.6$  eV).

Following the surface modification of PI film by oxygen RIE, in-situ deposition of NiCr/Cu was performed on the modified PI film. The 100 Å thick NiCr tie layer and 2000 Å thick Cu seed layer were deposited by D.C magnetron sputtering at a working pressure of 2 mTorr. Subsequently, Cu