Chapter 1

Introduction

1.1 Research Motivation

Modern communication systems require low cost and high reliability packaging structures which provide good enough electrical performance at high frequency. Flip-chip offers very significant advantages over wire bonding, such as better electrical performance and fully automatically assembly process. These advantages make way for low production costs and high production volume for the products.

To further reduce the production cost, three approaches are proposed in this dissertation. The first one is to apply dry film photo-resist as the thick film photo-resist for masking for the wafer level packaging. It has several advantages over the traditional photo-resist, such as high process speed, excellent thickness uniformity, low exposure energy and low cost. Although there are some problems with dry film processes, but these problems can be overcame by properly tuning the process parameters. The goal of this part is to demonstrate the feasibility of using dry film for high frequency flip chip packaging applications. The second one is the bump material. Copper bumps are utilized to replace gold bumps. To avoid the oxidation problem of the copper bumps, novel cladding metal fabrication process is proposed. The third one is the bumps

layout on a transmission line. Novel four bumps layout is proposed to provide an alternative to the traditional six bumps layout.

1.2 Chapter Outlines

The arrangement of this dissertation is described as following:

In Chapter 1, motivation of this dissertation is introduced. Outlines of chapter 1 to chapter 6 are introduced.

In chapter 2, basic concepts of the packaging techniques are described. Development of electronic packaging is briefly discussed. Specifically, published literature of the millimeter wave wafer level packaging in the past decade is reviewed to address the noticeable issues.

In chapter 3, features of the dry film photo-resist are studied including the development and characteristics, structure and composition, reaction mechanism and process procedures. Some major concerns during process are pointed out. Sets of experiments are done to find solutions of those concerns mentioned above. Optimized process parameters are proposed. Results show the feasibility of using dry film as the thick photo-resist on a wafer.

In chapter 4, application of the dry film photo-resist in high frequency flip-chip packaging process is described. First, the basic theory and the structure of the coplanar wave guide are discussed. Second, theory and process procedure of electroplating are introduced. After that, flip-chip bonding process is mentioned. Finally, experiments flows are described in detail.

In chapter 5, results and discussions are demonstrated. Simulation and measurement results are compared and discussed. Figures including optical microscopy and secondary electronic microscopy are shown. Energy dispersive X-ray material analysis is conducted to prove the feasibility of the proposed processes. Mechanical reliability is also investigated.

Finally, conclusions are drawn in chapter 6.