UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF COVERLAY ADHESION BY EPOXY – BASED ADHESIVE ON COPPER – POLYIMIDE LAMINATE FOR FLEXIBLE PRINTED CIRCUIT

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

by

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ABSTRACT

This research is an investigation to study the condition of cureness and evenness of pressure distribution in double - sided flexible circuit. This study will examine and analyses 45 samples of five different region in 3 selected layers top, middle and bottom of double sided Flexible Printed Circuit (FPC) with standard epoxy – based adhesive thickness of 25 micron meter and polyimide of 25 micron meter thick. This FPC consists of polyimide, copper clad laminate and epoxy – based adhesive as the main material that undergoes lamination process**.** This project purpose to identify the overall level thickness of coverlay adhesion by epoxy- based adhesive toward lamination layer distribution and to study on degree of degradation of adhesive in Flexible Printed Circuit (FPC) by using Thermogravitmetric Analysis (TGA).The investigation are focusing on potential of delamination that occurs on the FPC after the lamination. Two methods of testing that are used in this study to examine the cureness and distribution of pressure which are the cross- sectional observation method and TGA Analysis. Both methods are complying to gain the results data in graph and image formed. From results, there were found that there are no delamination occurred. But, there are more potential for the FPC to experience delamination.

ABSTRAK

Penyelidikan ini adalah satu penyiasatan untuk mengkaji keadaan kekerasan dan ketepatan pengedaran tekanan dalam litar fleksibel dua sisi. Kajian ini akan mengkaji dan menganalisis 45 sampel lima rantau yang berlainan di 3 lapisan terpilih iaitu atas, bahagian tengah dan bawah litar bercetak Fleksibel Fleksibel (FPC) dengan ketebalan pelekat berasaskan epoksi bersaiz ketebalan "standard" 25 mikron dan polyimide berketebalan 25 mikron. FPC ini terdiri daripada "poliyimide", "copper – clad laminate" dan pelekat berasaskan epoksi sebagai bahan utama yang mengalami proses laminasi. Tujuan projek ini untuk mengenal pasti ketebalan peringkat keseluruhan pelekat penutup pelekat oleh pelekat berasaskan epoksi ke atas pengedaran lapisan laminasi dan untuk mengkaji tahap penguraian pelekat dalam Litar Bercetak Fleksibel (FPC) dengan menggunakan Analisis Thermogravitmetric (TGA). Penyiasatan ini memberi tumpuan kepada potensi penyimpangan yang berlaku pada FPC selepas salapan. Dua kaedah ujian yang digunakan dalam kajian ini untuk mengkaji kekasaran dan pengedaran tekanan yang merupakan kaedah pemerhatian keratan rentas dan analisis TGA. Kedua-dua kaedah mematuhi untuk mendapatkan data hasil dalam graf dan imej yang terbentuk.Berdasarkan hasil dapatan kajian, tiada sebarang delaminasi berlaku.Namun, terdapat potensi untuk terjadinya delaminasi terhadap FPC.

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering Technology (Product Design) with Honours. The member of the supervisory is as follow:

Signature: …….

Supervisor : Dr.Lau Kok Tee

Date : …….

DECLARATION

I hereby, declared this report entitled INVESTIGATION OF COVERLAY ADHESION BY EPOXY – BASED ADHESIVE ON COPPER – POLYIMIDE LAMINATE FOR FLEXIBLE PRINTED CIRCUIT is the results of my own research except as cited in references.

Signature: ……

Author : NURIZZATUL ZAHIRAH BINTI ABDUL LATIFF

Date : ……...

DEDICATION

A very special dedication to my beloved parents, Mr Abdul Latiff Bin Harun and Mrs Norhayati Bt Mohd Ghazali for their continuous moral support and pray. Also my deepest appreciation towards my supervisor Dr Lau Kok Tee for his guidance and advises through all this investigation. I would also like to express my gratitude to my co-supervisor Mr. Hairul Effendy Bin Ab Maulod for the guidance and advices. To my Industrial Supervisor Ms Nurhazirah Binti Rosli, big thank for your guidance and cooperation in making this investigation run well. I also want to thank MFS Technology (M) Sdn. Bhd for giving me opportunity and trust to me to perform this study.

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l	-	Length
w	-	Width
h	-	Height
m	-	Mass
ρ	-	Rho
V	-	Volume

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will explain the overview of the study and the purpose of this study. The chapter includes the background of the study, problem statement, objectives and that is expected to be achieved and the scope of project.

1.2 Research Background

Flexible Printed Circuit (FPC) has been use widely throughout the world as the electrical components that help in providing most of technology to work successfully. The applications of this kind of circuit are used in so many fields. Flexible printed circuit (FPC) boards are refer to a type of flexing circuit board with high wiring density, light weight, thinness and the freedom to bend and fold features(Wang, 2016). The raw materials of FPC include a flexible copper clad laminate (FCCL) and two different adhesives which are epoxy or acrylic coverlay, in which the copper foil and epoxy or acrylic resin were both bonded with the polyimide (PI) film. The bonding methods of copper foil in FCCLs are both physical and chemical. The bond of the FCCL and coverlay is by either one of adhesive using lamination press process

In this study, the role of lamination process is to combine the coverlay and the copper clad laminate (CCL) with adhesives using hot hydraulic press laminate machine. The conductor of the finished flexible circuit is protected and enhances the flexibility by the coverlay. CCL in flexible printed circuit consist of two types of thermosets that are polyimide and polyester. The adhesives used in lamination are acrylic-based adhesive and epoxy-based adhesive. Typically, a laminate is done by bonding together a base material, an adhesive and a metal foil. The stack is then exposed under pressure and heat in a hot press laminate machine to create a permanently bonded metal polymer laminate.

1.3 Problem Statement

Flexible Printed Circuit (FPC) has widely been used in the industry of electrical interconnectivity field. The FPC production is very high due to large value request of customers.

There are so many processes in FPC that has been developing in order to improve the quality and properties of the board. One of the important processes used in manufacturing the FPC is lamination process. The structure of laminate layers consist of copper clad laminate (CCL) and coverlay with adhesive; epoxy and this layers are bond together under specific heat and pressure value with interval time. In order to create the desired pattern of conducting traces, the copper layer are etched and the adhesive of the adjacent insulating layers fills the spaces after the copper was removed.

Coverlay is used to protect the circuit of the finished FPC. But, there are possibilities for coverlay delamination occurrence happen after the lamination process.

The delamination is caused by “underfill”condition of epoxy adhesive that is when filling the gap between the undersides of a components and coverlay. The delamination may occur during the soldering process, particularly with lead- free solders which need higher reflow temperatures than leaded solders. Bending during installation, service and repair can also cause FPC to delaminate.

For so many years, the inspection of flexible printed circuit in MFS Technology has been done by random observations and visual inspections. There is no such technology that can help to confirm those epoxy adhesives are perfectly stacked and cure between the copper plate and polyimide. Plus, confirmation cannot be made that the epoxy adhesive is evenly distribute while being pressed during lamination press process. If delamination occurred, bubble air might appear on FPC. This condition can cause delamination if the FPC undergoes process with high temperature rate. Due to this, it will be a failure for the FPC.

This issue becomes ever important when MFS is facing more stringent requirements for FPC in automobile application. Until recently, curing mechanism and cureness on layer for lamination process has not been investigated.

1.4 Research Objectives

This study embarks on the following objective:

i. To identify the overall level thickness of coverlay adhesion by epoxy- based adhesive toward lamination layer distribution.

ii. To study on degree of degradation of adhesive in Flexible Printed Circuit (FPC) by using Thermogravitmetric Analysis (TGA).

1.5 Scope of Research

The study on this topic may bring benefits to the industry of FPC manufacturing. In this study, double - sided flexible printed circuit (FPC) with epoxy - based adhesive polyimide coverlay that has undergone the lamination process are used for research. The scopes of this project are more focusing on the pressure distribution and evenness of epoxy – based adhesive and the curing condition after the lamination process. The parameters used for this lamination process are fixed to pressure of 140 bar (P), temperature of 195 ° Celsius (C) and running time of 2 hours and 30 minutes time each process. The lamination process is done by hot press lamination method. The single panel layout with dimension of 19 .7" × 24" is used. The samples for this study are taken from the 25 micron meter thickness FPC.

The findings will be further supported by the micro cross- sectional method test according to IPC- TM-650 Test Method Manual and TGA Analysis.

1.6 Organization of Research Study

This project is divided into five chapters that briefly describe the analytical and experimental research performed. This dissertation shows the defect occurred after the lamination hot press process in flexible printed circuit production. The cause regarding the delamination with copper clad lamination has been studied, in search of improvements on their physical and mechanical properties. The first chapter is introduction to the study that brief on problem statement, objectives, significant of study and scopes of project.

As for the second chapter explain on the literature background of this study. It discusses on the Flexible printed circuit (FPC) overview in world industry, types of FPC, manufacturing process of FPC including the material use, stack up material, lamination, curing process and lamination delamination. The highlight element that included in this chapter is about the lamination process of coverlay with copper clad laminate (CCL) and the defects occurred after curing phase.

Chapter 3 provides details explanations on the methodology used for overall research work, raw materials that involved, and procedure of running analysis that had been done. In this chapter, instead of investigation of distribution of evenness of pressure and temperature lamination distribution, also want to understand the correlation of adhesive bonding with epoxy-based adhesive with copper polyimide after curing process in Flexible Printed Circuit (FPC).

In chapter 4, concludes the overall results that were obtained from this research. In this chapter, it explains how the results are obtained and followed by the discussion of each data gained.

For the last chapter, conclusion of overall results and the successful of achieving the objectives are stated. Also, the recommendations of future are suggested.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

On this portion, it will explain about the previous research that has been writing from the numerous of the journalist and researcher which come from the internet, journals, article and books about the topic that is related to this final year project study. This chapter also explains about the overview of the flexible printed circuit and the delamination occurred in flexible circuit production.

2.2 Overview of Flexible Printed Circuit in the World industry

Flexible printed circuits (FPC) are broadly utilized as a part of purchaser gadgets, especially for applications where the gathering is required to flex in ordinary activity (Yan et al., 2016). As alluded to Tasaki, et al. (2015), the progress of remote interchanges and advancements is significantly advancing with the market development exceptional of innovation hardware data, for example, cell phones and tablets. The generation of Electrical and Electronic Equipment (EEE) is one of the quickest developing parts of assembling industry on the planet. The age rate of Waste Electrical and Electronic Equipment (WEEE) is high worldwide and keeps on expanding, being one of the rapidest and most developing waste stream.