Faculty of Mechanical Engineering

EFFECT OF REFLOW TIME ON HARDNESS, ELECTRICAL RESISTIVITY AND WETTABILITY OF CNT IN SAC305

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DECLARATION

I hereby declare that this project report entitled "Effect of Reflow Time on Hardness, Electrical Resistivity and Wettability of CNT in SAC305" is the result of my own work except as cited in the references.

Signature : ……

Name : ……

Date : ……

APPROVAL

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

Signature : ……

Supervisor Name : ……

Date : ……

ABSTRACT

This project is about the study of effect of reflow time duration on the properties of solder alloy SAC305 with Carbon Nano-Tube (CNT). SAC305 with CNT solder alloy could help semiconductor industry to spend less manufacturing time, cost and saving environment in the future by using lead free material beside produce better performance products. This paper presents the result of defect, electrical resistivity, hardness and wettability when SAC305 added with 0.04 wt. % of CNT at different reflow durations. The solder paste was reflowed at 243 ºC with different reflow duration of 45, 60 and 75 seconds. The result in structure can be conclude as the reflow duration increased, the structure of the solder alloy had less defects appearances. Next, the resistivity result was improved as the reflow duration reduced from 0.45 to 0.36 mR/sq. Further, the solder alloy hardness becoming higher from 19.72 to 21.64 HV as the reflow duration increased. Lastly, the wettability of the solder alloy improved as the reflow duration was increased as contact angle decreased from 63.5º to 35.3º. As conclusion, these results and studies are expected to help improving solder paste SAC305 with CNT formulation and application.

ABSTRAK

Projek ini adalah satu penyelidikan mengenai kesan durasi masa keatas sifat aloi pateri SAC305 dengan campuran Carbon Nano-Tube (CNT). SAC305 dan CNT solder aloi mampu membantu industri semikonduktor untuk menjimatkan masa pembuatan, kos dan dapat menyelamatkan alam sekitar dimasa hadapan dengan mengunakan bahan bebas plumbum disamping menghasilkan produk berprestasi yang lebih baik. Kajian ini membentangkan hasil kajian mengenai kerosakan, kadar rintangan, tahap kekerasan dan kebolehbasahan apabila SAC305 ditambah dengan 0.04 wt. % kandungan CNT dengan durasi reflow yang berbeza. Pes pateri dipanaskan pada suhu 243 ºC dengan durasi reflow 45, 60 dan 75 saat. Hasil kajian mendapati semakin bertambah durasi reflow, semakin kurang kewujudan retakkan didalam struktur solder aloi. Seterusnya, kadar rintangan elektrik didapati menurun apabila durasi reflow semakin meningkat daripada 0.45 kepada 0.36 mR/sq. Selanjutnya, tahap kekerasan solder aloi menjadi semakin tinggi dengan nilai 19.72 kepada 21.64 HV apabila durasi reflow semakin lama. Terakhir, kebolehbasahan aloi pateri juga berubah semakin baik ketika durasi reflow bertambah lama apabila sudut darjah solder menurun daripada 63.5º kepada 35.3º. Kesimpulannya, kesemua hasil kajian dan pembelajaran ini adalah untuk membantu menambah baik formulasi dan aplikasi pes pateri SAC305 bersama CNT.

DEDICATION

To my beloved father Haji Ghazali Bin Said,

My beloved mother Hajah Noraini Binti Mohd Zain,

My beloved brothers,

Muhammad Nai'musyahmi, Muhammad Hisyamuddin, Muhammad Nazmiuddin

My supportive sister

Nurliayana Nabilah

And fiancé.

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LIST OF ABBREVIATIONS

PCB	Printed Circuit Board
SAC305	Sn (Tin 96.5%), Ag (Silver 3%) and Cu (Copper 0.5%)
CNT	Carbon Nanotube
SEM	Scanning Electron Microscope
SMT	Surface Mount Technology
PWB	Printed Wiring Board
TAL	Time-Above-Liquidous
CTE	Coefficient of Thermal Expansion
IMC	Intermetallic Compound
SWCNT	Single-Walled Carbon Nanotubes
wt. %	(Weight of solute / Weight of solvent) x 100
SiC	Silicon Carbide
UV	Ultraviolet
PCD	Polycrystalline Diamond
RPM	Round per minutes

LIST OF SYMBOLS

ºC	Temperature in Celsius
s	Time in seconds
mA	Current milliampere
mR	Resistance milliohm
cm^2	Area centimeter square
mbar	Pressure millibar
ml	Volume milliliter
mm	Scale millimeter
µm	Scale micrometer
%	Percentage

CHAPTER 1

INTRODUCTION

1.1. Background of Study

Soldering process of electronic component on Printed Circuit Board (PCB) had becoming more convenience and cheaper by using modern method of reflow soldering. Reflow soldering method is a process that use special solder paste (mixture of powdered solder and flux), that will be applied on the PCB contact pad. The solder paste will be subjected to controlled heat by using reflow oven, by certain range of temperature it will melt the solder paste and reflow them to join the electronic component with the PCB (Georgina Kearney, 2015).

Solder paste mixture of Sn (Tin 96.5%), Ag (Silver 3%) and Cu (Copper 0.5%) or known as SAC305 was widely used as medium for reflow soldering method to soldering electronics component on the PCB. SAC305 had high features such as; low cost, best solder joint reliability, all type flux compatible and excellent wetting. The most

important of SAC305 was its flexibility to be used by most of soldering equipment, existed processes method and solder flux (AIM Metals and Alloys LP, 2016).

Recently, the effort to improvise the solder paste was done by many researchers to see the effect of SAC305 properties in term of its mechanical and conductivity performance. Researchers had found that by adding low amount of Carbon Nanotube (CNT) into the SAC305 solder paste mixture, the characteristics of the solder paste will have positive change in term of its wetting, dispersion and reflow properties (K. Bukat, et al., 2012).

1.2. Problem Statement

Effective transition from SnPb soldering to lead-free soldering requires key implementation issues to be addressed in the electronic industry. One of the critical issue is the effect of reflow profile on the lead-free solder joint reliability since reflow profile would influence wetting in microstructure of the solder joint. Solder paste needs adequate reflow temperature to melt, wet and interact with the copper pad to form solder joint. The IMC, witch act as the bond, will form during the reflow in cooling process. Therefore, a suitable reflow profile is essential to form a good solder joint.

1.3. Objectives

The objective of this project are as follows:

i. To study the defect of SAC305 when add with 0.04 wt. % CNT at different reflow duration.
ii. To investigate the properties of wettability, hardness and electrical resistivity of SAC305 when added 0.04 wt. % CNT.

1.4. Scopes of Projects

The scope of these project are as follows:

i. The solder paste that will be used for this project is SAC305 with 0.04 wt. % CNT.
ii. The reflow process is by using reflow oven.
iii. Analysis of the defect by using Image Analyzer (AI).
iv. Study the electrical resistivity using Four-point probe.
v. Study the hardness using Nano-indentation.
vi. Study the wettability by using computer Image J software.

1.5. General Methodology

The explanations and details for methodology that will be execute in order to achieve the objectives in this project will be discuss. The flow of this project experiment will also be shown in this section.

1. Literature review

Collecting data through previous journals, website, articles and any related material about the project.

2. Material preparation.

Printed circuit board (PCB) and solder paste SAC305 with CNT will be prepare along with the measurement devices and tools to execute the experiment.

3. Experiment

The experiment will focusing on heat treatment of the SAC305 by applying variances time duration in the reflow oven with constant temperature setting.

4. Sample preparation

After cooling period, the SAC305 with CNT will be take out to be analysis.

5. Analysis

By using Four Point Probe to measure the conductivity properties of the SAC305 with CNT, the defect of the solder paste will be analyses by using Image Analyzer. Each data and observation will be recorded.

The methodology of this study is simplify in the flow chart as shown in Figure 1.1.

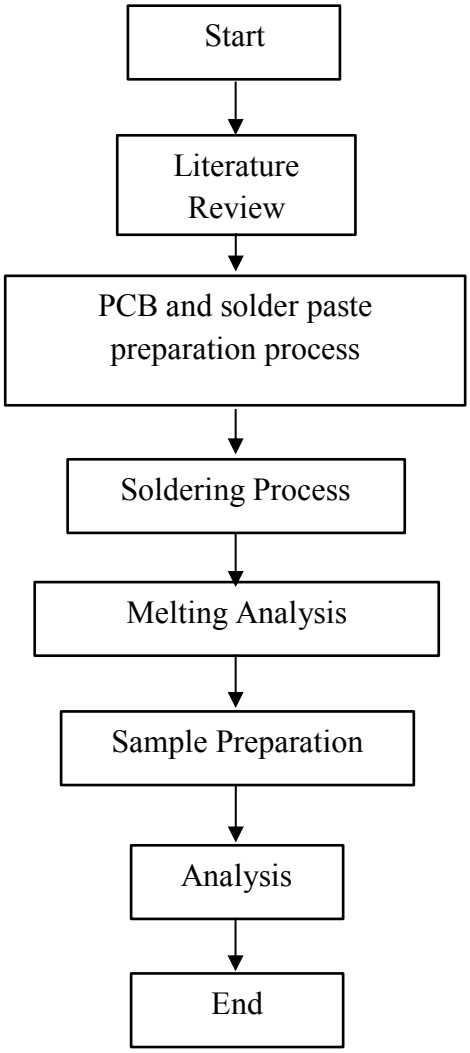

Figure 1.1: Flow chart of the methodology.

CHAPTER 2

LITERATURE REVIEW

2.1 Reflow Soldering System Introduction

The capability of reflow soldering to integrate with Surface Mount Technology (SMT) had expanded the reflow soldering method by study, refined and improvement. There are two main reason of the usage of the reflow soldering over other conventional methods.

The first reason is the advantage of the reflow soldering method which are usually had uniform solder joint effect with the electric component. The properties of this solder also usually more cleanliness during completed assembly make it more tidy and better quality. It have higher flexibility that make it to able to solder a large number of electronic component with minimum changeover of time thus increase production rate.

The second reason of the usage of reflow soldering method was because the process engineering included which it have low time above liquidus solder temperature

to minimize the solder grain growth allow it to become more durable solder joint. More, process overall have less pressure and damage applied on the PCB, thus reduce defect product. Plus, the process also have less movement of part make the component more neatly and tidy, refer to Figure 2.1. (Jim Bergenthal, 1995).

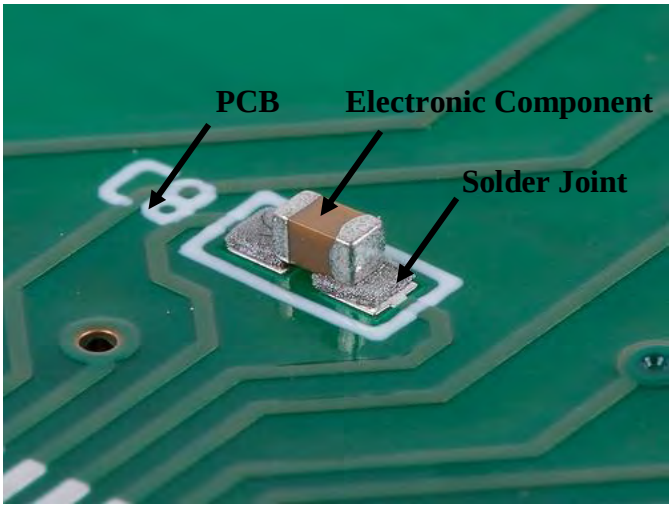

Figure 2.1: Reflow soldering product with electronic component soldered on PCB.

2.2 Reflow Soldering Process

The reflow soldering not only low cost to maintain it is also simpler process compare to the conventional soldering process. Basically, reflow soldering process required three important component from the solder paste preparation, electronics component placement and heat application or reflow soldering process. These process is important for reflow soldering to get a good result.