MICROSTRUCTURAL EVALUATION OF Sn3.0Ag0.5Cu SOLDER ALLOY FABRICATED VIA POWDER METALLURGY METHOD

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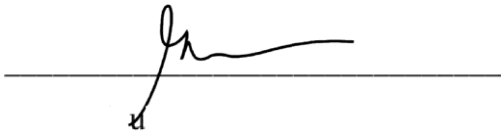
We hereby declare that We have checked this thesis and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.



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ABSTRAK

Selama beberapa dekad, proses pembuatan industri adalah kaedah yang sering digunakan dalam pembuatan aloi pateri dan memperkasakan sifat aloi pateri. Walau bagaimanapun, teknik pengadukan atau mengacau cecair logam yang biasa digunakan dalam kaedah Casting perlu diberi perhatian untuk perbincangan lebih lanjut. Menurut kajian literatur, teknik Casting telah menunjukkan permasalahan dari segi kualiti sifat aloi pateri iaitu kesamarataan taburan unsur dalam aloi pateri. Oleh itu, suatu Teknologi Hijau yang dikenali sebagai kaedah Powder Metallurgy (PM) telah dipilih kerana fungsi pemprosesan bahannya yang dapat membantu mewujudkan tahap kesamarataan taburan unsur dalam aloi pateri. Ia mempunyai dua prosedur asas iaitu mengisar dan memadat. Ini berfungsi untuk pembuatan aloi pateri yang lebih baik di mana ia hanya menggunakan suhu bilik dalam menyatukan bahan yang berbeza sekaligus. Lebih-lebih lagi, persekitaran kerja yang bersih dan lebih selamat dalam praktiknya dan memerlukan satu cetakan untuk menghasilkan puluhan produk yang menjimatkan kos yang besar. Kajian ini dilakukan untuk mencari jurang yang terdapat dalam tinjauan literatur mengenai isu kesamarataan taburan unsur aloi pateri. Oleh itu, penyelidikan ini dijalankan untuk mengkaji sifat-sifat aloi pateri Sn3.0Ag0.5Cu yang disediakan dengan kaedah PM. Pemilihan bahan yang melibatkan ukuran dan bentuk bahan mentah adalah faktor penting semasa mempraktikkan kaedah PM kerana akan mempengaruhi hasil akhir. Oleh itu, empat jangka masa pengisaran yang berbeza iaitu 2, 4, 6 dan 8 jam dijadikan pemboleh ubah untuk mencapai campuran homogen di dalam aloi. Campuran ini kemudian dipadatkan dengan mesin pemadatan hidraulik untuk 1, 3, 5, 7 dan 9 tan. Langkah ini adalah untuk memastikan campuran akan dapat digunakan untuk meneruskan prosedur ujian *reflow*(kecairan) dan juga ujian *microhardness*. Melalui ujian *reflow*, terdapat empat topik utama yang akan dibincangkan termasuk hasil ujian *reflow*, ujian *wettability*, pembentukan IMC dan ketebalan IMC. Semua sampel disejukkan melalui proses penyejukan perlahan. Hasil kajian menunjukkan bahawa ada kaedah PM boleh dijadikan kaedah alternatif yang lebih baik dari kaedah Casting dalam pembuatan paduan pateri. Ini disebabkan oleh taburan unsur yang berbeza dilihat lebih baik selepas proses mengisar telah disahkan oleh analisis SEM dan EDX, manakala tahap *wettability* juga tinggi bagi semua sampel yang mana berada di bawah 90 °. SEM dan EDX juga memperlihatkan bentuk IMC Cu_6Sn_5 yang wujud pada perantaraan aloi pateri dan matriks pateri. Ketebalan IMC menggambarkan nilai yang cukup tinggi kerana masa penyejukan yang lebih lama. Kesimpulannya, kaedah PM adalah pilihan pembuatan aloi pateri yang lebih baik untuk mempraktikkan Teknologi Hijau dan sesuai dengan pengeluaran kos rendah serta persekitaran yang lebih selamat. Campuran aloi pateri yang dihasilkan dengan kaedah ini juga sesuai dalam menghasilkan sifat aloi pateri yang sangat baik.

ABSTRACT

For decades, casting has been the most influential industrial manufacturing process to fabricate and promote higher properties of solder alloy. However, stirring technique which is commonly applies in casting method has brought some attentions for further discussions. According to literatures, the stir casting technique has showed quality issue towards solder alloy property of elementary particles distribution. Thus, concerning the issue, a green technology known as Powder Metallurgy(PM) method is selected due to its material processing function which can also offer particle distribution deals. It is basically having two basic procedures which are milling and compacting. These works for better solder alloy production where it only uses room temperature to consolidate different materials at once. Moreover, a clean and safer working environment is in practice and it takes one mould to produce dozens of products which is a big cost saving. This study is conducted to seek out the gap found in the literature reviews on the homogeneity issue of the solder alloy's elemental distributions. Thus, this research is carried out to study the properties of Sn3.0Ag0.5Cu solder alloy prepared by PM method. The selection of materials involving size and shape of the raw materials are important factors whilst practising PM method due to the end up result of milling. Therefore, four different milling durations listing 2, 4, 6 and 8 hours which became the variables to reach off a homogenize granulated mixture inside the alloy. These mixtures were then compacted with a hydraulic press machine for 1, 3, 5, 7 and 9 ton of compaction loads. This step is to ensure the mixture will be in handable form to move on into reflow test procedure as well as the microhardness test. Through the reflow test, there are four major topics to be discussed on including the behaviour of solder pallet by reflow test, wettability test, formation of IMC and the thickness of IMC. All samples are cooled down by the slow cooling process. Results showed that there is high possibility to utilize PM method in solder alloy fabrication due to high distribution of different elements after milling process as being confirmed by the SEM and EDX analyses, high degree of wettability by all samples which lined below 90°. The SEM and EDX also displayed scallop IMC of Cu_6Sn_5 existed at the solder joint and matrix. The IMC thickness depicted quite high values due to longer cooling time. In conclusion, PM method is a better option of solder alloy fabrication to practice Green Technology plus fits the low-cost production and safer environment. The produced solder alloy by this method also fits the excellent solder alloy properties.

TABLE OF CONTENT

DECLARATION

TITLE PAGE

ACKNOWLEDGEMENTS **ii**

ABSTRAK **iii**

ABSTRACT **iv**

TABLE OF CONTENT **v**

LIST OF TABLES **viii**

LIST OF FIGURES **ix**

LIST OF SYMBOLS **xiii**

LIST OF ABBREVIATIONS **xiv**

CHAPTER 1 INTRODUCTION 1

1.1 Homogeneity of Alloy 1

1.2 Problem Statement 3

1.3 Objective of Research 4

1.4 Scopes of Research 4

1.5 Overview of Thesis 5

CHAPTER 2 LITERATURE REVIEW 6

2.1 Introduction 6

2.2 Electronic Packaging 6

2.3 Material Selection 6

2.4 Fabrication Process of Solder Alloy 10

2.5 Soldering 21

2.6 Wettability 24

2.7 Interfacial Reaction between Lead-Free solder and Cu substrate 26

2.8 Summary 33

CHAPTER 3 METHODOLOGY 35

3.1 Introduction 35

3.2 Research Framework 35

3.3 Raw Materials 37

3.4 Calculation to Obtain the Sample 39

3.5 Powder Metallurgy Method 40

3.6 Sample Preparation 42

CHAPTER 4 RESULTS AND DISCUSSION 49

4.1 Introduction 49

4.2 Powder Metallurgy (PM) methods 49

4.3 Microhardness 68

4.4 Reflow Process Results 70

4.5 Wettability 75

4.6 Formation of Intermetallic Compound(IMC) 83

4.7 Thickness of the Intermetallic Compound(IMC) 93

CHAPTER 5 CONCLUSION 101

5.1 Introduction 101

5.2 Conclusion 101

5.3 Recommendations 102

REFERENCES **103**

APPENDIX **115**

LIST OF TABLES

Table 2.1	Thermal Reflow Soldering Profile for current works	7
Table 2.2	The summarized findings on the homogeneity of mixture prepared by mechanical mixing of PM method	20
Table 2.3	Thermal Reflow Soldering Profile for current works	23
Table 2.4	Wettability degree which indicated by wetting(contact) angle	25
Table 3.1	Properties of tin(Sn), copper(Cu) and silver(Ag)	38
Table 3.2	Calculated weight percentage of predicted IMCs	48
Table 4.1	Summary of the physical properties of Sn3.0Ag0.5Cu pre-alloy after completely milled according to their respective duration	57
Table 4.2	SEM images with a weight percentage of selected milling durations at grain boundaries for; (a) 4 hours at 50μm and (b) 8 hours at 30μm	68
Table 4.3	The average value of the wetting contact angle according to milling duration and compaction load.	82
Table 4.4	Morphology analyses on the interfacial IMC-Cu substrate/solder joint for all samples according to their compaction loads upon their milling duration respectively; initial CL represents compaction load and both represent scallop and sharp edge	91
Table 4.5	The average of IMC thickness value according to milling duration and compaction load for every sample	96
Table 4.6	The thresholded images as of morphology and of the mean area fractions of the IMCs at the solder joint for (a)2, (b)4, (c)6 and (d)8 hour of milling duration	97

LIST OF FIGURES

Figure 1.1	The differences of heterogeneous and homogeneous structures of a material	1
Figure 2.1	The phase diagram of ternary SnAgCu	10
Figure 2.2	The aggregates of elongated and tubular found in this study	13
Figure 2.3	Situation of raw materials inside the ceramic jar:(a) at rest, (b) while it was planetary rotating by counter-clockwise and mixing (top view), (c) the raw materials were hitting the wall and crushed into irregular size and shape while mixing (side view)	14
Figure 2.4	Krumbein-Sloss chart	17
Figure 2.5	Reflow Profile Recommendation	23
Figure 2.6	The spreading of molten solder alloy on Cu substrate	25
Figure 2.7	Surface tension and internal pressure of gravity experienced by molten molecules	26
Figure 2.8	The cross-section image of compacted Sn3.0Ag0.5Cu pre-alloy granule; the yellow line is as an indicator	28
Figure 2.9	The schematic illustrations of IMC formation during interdiffusion	29
Figure 2.10	The changes of IMC growth due to increasing temperature	32
Figure 2.11	The scallop shape of IMC on top of the Cu substrate	32
Figure 3.1	Flowchart of the research	36
Figure 3.2	Images of raw materials captured by SEM Sn, Ag, Cu	37
Figure 3.3	The graphs of particle size distribution for the as-received powder: Sn, Ag, Cu	38
Figure 3.4	Image (a) shows the planetary ball mill machine used to mill the pre-mixture of Sn3.0Ag0.5Cu and Figure (b) the inner part	41
Figure 3.5	Image (a) and (b) show the mixture of Sn3.0Ag0.5Cu before and after the milling process	42
Figure 3.6	Image (a) until (d) displays the procedure to produce a solid, smooth and symmetrical solder pellet from 1.5 g of Sn3.0Ag0.5Cu mixture	42

Figure 3.7	Figure (a) and (b) are the illustrations to position the solder alloy pellet according to their characterization test	43
Figure 3.8	Illustrations of indentations marking on solder alloy pellet for microhardness test	44
Figure 3.9	The cut-out solder alloy pellet is illustrated as in (a) and Cu board(b)	45
Figure 3.10	Image (a) is an illustration of assembling the 1/8 of cut out solder alloy pellet, image (b) is the table-top furnace and image (c) is the enlarge display screen	45
Figure 3.11	Illustration of how to position the method B sample	46
Figure 3.12	The different between;(a)large and (b)small wetting angle and the way of the angle is taken for each sample	47
Figure 3.13	Calculation of IMC using weight percentage	48
Figure 4.1	The images of low and high magnification of the milled powder of Sn3.0Ag0.5Cu	51
Figure 4.2	Images of (a), (b), (c) and (d) show the weight percentage of area on milled powder as analysed by SEM and EDX according to milling hour	52
Figure 4.3	Graphs of particle size distribution analyses for the Sn3.0Ag0.5Cu milled powder according to their milling duration; (a)2 hour, (b)4 hour, (c)6 hour and (d)8 hour	54
Figure 4.4	Average mean value for sphericity, roundness and particle size for 2 hour sample	58
Figure 4.5	XRD analyss on milled powder of Sn3.0Ag0.5Cu solder alloy for 6 hour of milling duration	63
Figure 4.6	Images of top view of compacted solder alloy bulk after sample preparation procedure and the method of measuring the diameter of each sample; representing (a)2 hours (b)4 hours (c) 6 hours and (d) 8 hours as each of image is compacted with 5 tons	65
Figure 4.7	Average of compacted solder alloy particle diameter as according to the respective compaction load	66

Figure 4.8	Element map images for; (a) 2 hours, (b) 4 hours, (c) 6 hours, (d) 8 hours	66
Figure 4.9	Images show the SEM and EDX analyses of random spots for compacted Sn3.0Ag0.5Cu milled powder and the weight percentage according to milling duration	68
Figure 4.10	Graph of average microhardness values according to compaction load upon the milling durations respectively	70
Figure 4.11	The pre-test of the sample size used to melt on the Cu board	72
Figure 4.12	The compacted solder bulk after the reflow process for wettability analysis	73
Figure 4.13	Illustration of heat flow distribution of free to compacted milled powder; (a) within zero compaction load, (b) within compaction load	75
Figure 4.14	Illustration of heat distribution to irregular sizes and shapes of granules upon the cross-section of compacted milled powder on Cu board during the reflow process	76
Figure 4.15	The melted solder, the unmelted and the small amount of melted solder on top of unmelted after reflow soldering the Sn3.0Ag0.5Cu milled powder	77
Figure 4.16	Images of wetting angle(contact angle) which has been measured accordingly; 2 hour milling duration	78
Figure 4.17	Images of wetting angle(contact angle) which has been measured accordingly; 4 hour milling duration	79
Figure 4.18	Images of wetting angle(contact angle) which has been measured accordingly; 6 hour milling duration	80
Figure 4.19	Images of wetting angle(contact angle) which has been measured accordingly; 8 hour milling duration	81
Figure 4.20	Graph of average wetting angle based on compaction loads upon milling durations	83
Figure 4.21	The XRD result on the formed IMC at the solder joint	84
Figure 4.22	The illustration of IMC structures and the interface of IMC-solid substrate	85

Figure 4.23	Cross-section of Sn3.0Ag0.5Cu solder alloy by 2 hours of milling duration;(a)1, (b)3, (c)5, (d)7, (e)9 ton of compaction loads	98
Figure 4.24	Cross-section of Sn3.0Ag0.5Cu solder alloy by 4 hours of milling duration;(a)1, (b)3, (c)5, (d)7, (e)9 ton of compaction loads	100
Figure 4.25	Cross-section of Sn3.0Ag0.5Cu solder alloy by 6 hours of milling duration;(a)1, (b)3, (c)5, (d)7, (e)9 ton of compaction loads	101
Figure 4.26	Cross-section of Sn3.0Ag0.5Cu solder alloy by 8 hours of milling duration;(a)1, (b)3, (c)5, (d)7, (e)9 ton of compaction loads	102
Figure 4.27	The illustration of IMC-solder matrix bulk interface	92
Figure 4.28	The average of IMC thickness value by according to milling durations upon compaction load respectively	95
Figure 4.29	The mean area fraction value of formed IMCs at the solder joint by according to milling durations upon compaction load respectively	100

LIST OF SYMBOLS

Cu_3Sn	$Copper_3$ Tin
Cu_6Sn_5	$Copper_6$ Tin_5
°	degree
℃	Degree Celcius
℃/s	Degree celcius per second
g	gram
Hv	Hardness value
kg	kilogram
μm	micrometer
%	percent
s	second
wt	weight

LIST OF ABBREVIATIONS

ASTM	American Standard
Cu	Copper
HAp	hydroxyapatite
IMC	Intermetallic Compound
Pb	Lead
Mg	Magnesium
PRT	Peak-Reflow-Temperature
PM	Powder Metallurgy
PCB	Printed Circuit Board
rpm	Rotation per minute
Ag	Silver
SMT	surface mount technology
THT	through-hole technology
Sn	Tin
XRD	X-Ray Diffraction
Zn	Zinc

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