CONTROL STRATEGY OF BURR FORMATION AT SAWING PROCESS FOR THE IMPROVEMENT OF SAWN PACKAGE

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering

(Department of Manufacturing Process)(Hons.)

By

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Sekian dimaklumkan. Terima kasih.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Process)(Hons.).

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ABSTRAK

Kajian dalam projek ini adalah masalah sebenar dari industri. Pertama sekali, pakej gergajian adalah proses pembangunan reka bentuk baru yang dinding sisi pakej bersalut dengan bahan NiP-Au. Adalah didapati bahawa burr timbul di pinggir tepi atas unit cip selepas proses menggergaji. Proses pemotongan mikro diperlukan untuk mengurangkan ketinggian. Tetapi penyingkiran berlaku selama 15 minit proses deburring kimia. Untuk mengelakkan pemisahan, proses deburring kimia perlu dikurangkan dari 15 minit hingga 30 saat. Tetapi, sementara proses deburring kimia menurun hingga 30 saat, ketinggian burr yang dihasilkan oleh penggerudian berkelajuan tinggi tidak dapat membersihkan untuk memenuhi spesifikasi yang ditetapkan iaitu kurang daripada 0.05mm. Oleh itu, matlamat dalam projek ini adalah untuk meminimumkan pembentukan burr pada unit cip untuk memenuhi spesifikasi yang ditetapkan kurang daripada 0.05mm. Objektif penyelidikan adalah untuk menyiasat kesan faktor penting ke arah pembentukan burr semasa proses gergaji dan untuk mengoptimumkan proses gergaji dengan menggunakan pendekatan DOE untuk memenuhi spesifikasi burr kurang daripada 0.05mm. Idea yang dicadangkan bagi kajian ini adalah untuk mengawal kelajuan pemotongan pemesinan, putaran spindel dan jenis bilah berlian. Reka bentuk Ujian dengan kaedah Taguchi dan analisis nisbah S / N digunakan dalam kajian ini. Hasil yang diperoleh adalah titik terima yang berjaya dicapai 95% yang mengalami peningkatan sebanyak 21.33% berbanding percubaan pertama. Sebagai kesimpulan, objektif projek ini dicapai. Kesan faktor-faktor yang signifikan terhadap pembentukan burr semasa proses gergaji telah diselidiki dan melihat proses telah dioptimumkan dengan menggunakan pendekatan DOE untuk memenuhi spesifikasi ketinggian burr yang kurang daripada 0.05mm.

ABSTRACT

The study in this project is a real problem from the industry. First of all, the sawn package is a new design development process which the side wall of the package is plated with the NiP-Au material. It is found that the burr arise on the edge of the top edge of chip unit after the sawing process. Micro-etching process is needed to be carry out to reduce the burr height. But delamination occurred during 15 minutes chemical deburring process. To avoid delamination, chemical deburring process need to reduce from 15 minutes to 30 seconds. But, while the chemical deburring process reduce to 30 seconds, burr height produced by high speed sawing no able to clean to meet defined specification which is less than 0.05mm. Hence, the aim in this project is to minimize the burr formation on the chip unit to meet the defined specification less than 0.05mm. The objectives of the research is to investigate the impact of the significant factors towards burr formation during the saw process and to optimize saw process by using DOE approach to fulfil burr defined specification less than 0.05mm. The proposed idea for this research is to control the machining cutting speed, spindle rotation and type of diamond blade. The Design of Experiment with Taguchi method and S/N ratio analysis is used in this research. The result of successful accepted points achieved 95% which had an improvement of 21.33% compared to the first trial run experiment. As a conclusion, the objectives of this project are achieved. The impact of the significant factors towards burr formation during the saw process had been investigated and saw process had been optimized by using DOE approach to fulfil burr height defined specification which is less than 0.05mm.

DEDICATION

Only

My beloved family.

My appreciated friends,

My supportive academic supervisor, industrial supervisor and engineer

For giving me moral support, cooperation, encouragement and also understandings.

Thank you so much to all of you

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I would like to express my special thanks of gratitude to my industrial supervisor Mr Goh Soon Lock who gave me the golden opportunity to do this industrial based project on the topic control strategy of burr formation at sawing process for the improvement of sawn package as my final year project title as well and thanks for your guidance throughout the project.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Sawn package run with high speed sawing which is 1st cut 100 mm/s and 2nd cut 300mm/s for unit per hour (UPH) improvement. Burr induced by high speed sawing will be cleaned by 15 minutes chemical deburring process to meet defined specification which is less than 0.05mm. But delamination observed during 15 minutes chemical deburring process. To avoid delamination, chemical deburring process reduces from 15 minutes to 30 seconds. By reduce to 30 seconds, chemical deburring process, the burr that produced by high speed sawing no able to clean to meet defined specification which is less than 0.05mm.

Burr is the common defect that occurs on the work piece after the machining process. The existence of burr on the machined work pieces are troublesome and complex problem (Dornfeld & Min, 2010). This is because the burr will cause damage to the part and it will make the product assembly complicated (Dornfeld & Min, 2010). Hence, the deburring process which is an additional finishing operations is needed to reduce the burr formation (Dornfeld & Min, 2010).

The strategy to prevent or minimize the burr in the first place is the better strategy to attempt to reduce the burr formation on the work piece (Dornfeld & Min, 2010). The facts is

that most burrs can be minimized or prevented by process control which is by carefully choice of tools, part design, work material or tool path and machining parameter (Dornfeld & Min, 2010).

In this project, the machining parameter for tape sawing process is being study to investigate the main factor of causing the burr formation during the sawing process on the package unit. The burr height on the package unit surface will be measure by Mitutoyo Quick Vision Pro Smart Scope after the sawing process.

1.2 Introduction

Infineon Technologies (Malaysia) Sdn. Bhd. is one of the shareholders of Infineon AG of Germany. Today it is the largest semiconductor manufacturers in Melaka. There have a number of department in the company. DS development department is the department which under the Development Center or also known as Research and Development Center. In DS development department, it is separate to a few group which is project management, Front of Line (FOL), End of Line (EOL) and etc. In the process development of EOL, the formation of the burr on the package is an undesirable result and it should be avoided or at least reduce.

The focus in this study is on the sawn package which is a new process development design that has the side wall plating. The side wall is plated with NiP-Au after tape saw process. It is observe that there have arise of the burr at the top edge of the chip unit. Microetching process which is the deburring process is carried out to reduce the burr formation on the work piece. The objective in this study is to investigate the impact of the significant factors towards burr formation during the tape saw process and to optimize tape saw process by using Design of Experiment (DOE) approach follow by Taguchi method to fulfil burr specification which is less than 0.05mm.

A burr is commonly an unwanted piece of material. It is a small piece or raised edge of material remaining attached to a workpiece after a machining process (Burr (edge), 2017). Aurich said that in cutting operations, the burr formation is impossible to avoid (Aurich, Sudermann, & Bil, 2005). K.Martinsen and G.Ringen stated that the robustness of the machining process which is about the handling and function of the parts is being affected by the existences of the burr (Martinsen & Ringen, 2016).

Burr formation is usually removed in the deburring process by using the deburring tool. The deburring process will result in higher consumed of the manufacturing cost. D.Dornfeld and S.Min said that a substantial cost is needed to remove the burr (Dornfeld & Min, 2010). Avinash A.Thakre and Shashank Soni said that for deburring process, it is estimated that approximately 20-30% of the manufacturing cost of the finished products is required. Hence, it is importance to minimize the burr formation on the workpiece in first stage of the process (Thakre & Soni, 2016).

Avinash A.Thakre and Shashank Soni stated that the effort to reduce the burr formation during machining is select the optimum tool geometry and process parameters (Thakre & Soni, 2016). In this project, the machining parameter for sawing process is being concern. The Design of Experiment (DOE) will use in this experiment and the Taguchi method is apply in the design of the experiment to optimize the experiment by reducing the variation and give a less number of runs for the experiment. After sawing process, the surface of the package is observed under the smart scope and the burr height on the package is measured and recorded. Signal to noise ratio is used in this experiment to analyse and investigate the significant factor which causing the burr formation.

1.3 Problem Statement

New process flow had been introduced for this new package with side wall plating. Side wall is plated with NiP-Au after tape sawing process. One of the problem observed after tape

sawing process is formation of burr. To solve this problem, microetching process is carry out before plating to remove the burr. But delamination occurred during 15 minutes chemical deburring process. To avoid delamination, chemical deburring process reduces from 15 minutes to 30 seconds. But, when chemical deburring process reduce to 30 seconds, burr height that produced by high speed sawing not able to clean to meet defined specification which is less than 0.05mm.

1.4 Objectives

The objectives of this study are:

(i) To investigate the impact of the significant factors towards burr formation during the tape saw process.

(ii) To optimize tape saw process by using Design of Experiment (DOE) approach follow by Taguchi method to fulfil burr defined specification which is less than 0.05mm.

1.5 Scope

This research is carried out at semiconductor industry that is Infineon Technologies (Malaysia) Sdn. Bhd, Melaka. This study focused on the significant factor cause the burr height at the surface of the chip unit. The process that used in this study is the tape sawing process by using the Dicing saw DFD 6362. The material of the lead frame is copper alloy EFTEC-64TC. The relationship between the process parameters setting which are sawing speed, spindle

rotational speed and type of diamond blade for this study will be investigate to analyse which factor is significant to burr height formation.

Design of Experiment (DOE) approach follow by Taguchi method is used in this study to optimize the process parameter setting with low number of experiment run. Signal-to-noise (S/N) ratio is used in this study to analyse the significant factor which cause the burr height formation in this study.

The Mitutoyo Quick Vision Pro which is a Japan based manufactured measuring scope is used to measure the burr height on the chip unit after the tape sawing process. The result of the burr height is recorded to inspect the main factor affecting on burr formation. Lastly, the S/N ratio analysis method is used in the Taguchi method as a measure of performance and to determine the optimal parameter for the tape saw process.

1.6 Significant/Important of study

The potential benefit after complete the project is the people who work in this project will have a deep knowledge about the mechanism of burr formation and the behaviour of burr formation through the investigation of the relationship between the process parameter settings.

The company will gain the benefit as reducing the burr height on the workpiece will reduce the total manufacturing cost and time by reducing the usage of deburring process. The surface quality will improve after complete the project.

1.7 Thesis Organization

The organization of this thesis is described simply from Chapter 1 until Chapter 5. Chapter 1 begin with background of study, problem statement for the study, objectives for this study, and scopes of study. Chapter 2 literature review comprised previous study or research about the burr formation on the workpiece after machining and the effect of the formation of burr on the workpiece while solderability. Chapter 3 of methodology identified which method or tool can used to solve this problem more effectively. Chapter 4 is about analysis on result of the study. The data collected after sawing process is used to analyse on relationship of different factors in the process. In Chapter 5, the conclusion and recommendation about this research are examined.

CHAPTER 2

LITERATURE REVIEW

2.0 Background and Definition of Burr Formation

Burr is the edge which differ from the desired geometry after machining (Biermann & Hartmann, 2012). Gillepie defined that the extended material beyond intersection of two theoretical plane during cutting or shearing is known as burr (Póka, Mátyási, & Németh, 2016). Gyorgy Poka defined that during the manufacturing process, a deviation in a small scale range from the contour and it is made inevitably and undesirably is called burr (Póka et al., 2016).

ISO 13715 standard defined that if a rest material extends beyond it that part consider has burred edge (Póka et al., 2016). Schafer is the person who made the first technical description of the burr, Schafer defined the raised edge which is made on the edge or surface outside the target geometry is called burr (Póka et al., 2016). Ko said that the undesirable result of deformation ductility during cutting and shearing process is because of the burr formation (Póka et al., 2016).

A circumstance similar to chip generation which is burr formation is a typical problem that occurs in several industrial sectors such as automobile sectors and aerospace (Niknam & Songmene, 2014).

Machined part quality and high productivity and automation will be endure the most troublesome impediments due to burr formation. Burr free and precise components with tight tolerances and better surface finish are demanded as to ensure competitiveness (Niknam & Songmene, 2014).

In machining the ductile material, the burr formation is one of the problematic aspect in the machining process (Persson, Agmell, Bushlya, & Ståhl, 2017). Gillespie said that the formation of burr produced due to machining and shearing is similar to the plastically deformed material at work piece edges which involve any material extending past the ideal edge line produced by the two surfaces surrounding the burr (Persson et al., 2017). The edge and chip bend forward instead of being sheared off to the work piece result from the lost of the necessary reaction forces from the work piece lead to plastic deformation which causing the burr formation.

2.0.1 The Importance of Reducing the Burr

Seyed said that the most familiar and unwanted phenomenon occurring in machining operations that decline assembly and machined part quality and it should be prevented or at least minimized is the burr formation on the work piece (Niknam & Songmene, 2014). This is because the dimensional accuracy and surface quality will decrease as the existence of burrs in components.

Other than that, the negative effects or even disastrous consequences will occurred due to burrs formation on the component (Kou, Wan, Cai, Liang, & Liu, 2015). The well-known problem in machining of metals is the presence of burrs as it interferes with production on many levels (Persson et al., 2017). The manufacturing process in aspect of technological, economical and worker safety is being affected from the formation of burr on the work piece (Persson et al., 2017). Part accuracy, disturbances to components and interfere with proper assembly is the technological problems occur when burrs on critical features (Persson et al., 2017).