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Design, Experimental Analysis and Optimization on Effect of Entry Material in PCB Manufacturing

Pawar Ajit Ramchanchandra[1], Patil Satish Hemant[2], Tilekar Rahul Rajendra[3], Suryawanshi Yogesh Ashok[4] Prof. Sangle.P.S[5]

Mechanical Department, Savitribai Phule Pune University, SCSCOE Rahuri Factory, Rahuri, India[1,2,3,4,5]

Abstract: Optimization of the metal drilling process requires creation of minimum amount of burrs and uniform appearance of the drilled holes. In this paper, an experimental investigation was performed on sheets of copper using different diameter drills. Cutting data, clamping conditions, and drill geometry were constant and we used different type of entry material like copper, aluminium, backlit and soft wood in order to increase heat transfer rate which produces in drilling process due a to friction of drill with workpiece to be optimize reach the desired quality. The results revealed possible reduction of burr occurrence on both the entry and exit side of the sheet, requiring no additional deburring. The demand on the uniform appearance of drilled holes was fulfilled as well as high productivity achieved. Such optimized process results in a noticeable decrement in job rejection and production cost reduction.

Keywords: Drilling, aluminium, burr minimizing, measurement, vacuum clamping.

INTRODUCTION

A Printed Circuit Board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be single sided (one copper layer), double sided (two copper layers) or Multi-layer (outer and inner layers). Multi-layer PCBs allow for much higher component density. Conductors on different layers are connected with plated-through holes called vias. Advanced PCBs may contain components- capacitors, resistors or active devices - embedded in the substrate. Glass epoxy is the primary insulating substrate upon which the vast majority of rigid PCBs are produced. A thin layer of copper foil is laminated to one or both sides of panel. Circuitry interconnections are etched into copper layers to produce printed circuit boards. Complex circuits are produced in multiple layers. Printed circuit boards are used in all but the simplest electronic products. Alternatives to PCBs include wire wrap and point-to-point construction. PCBs require the additional design effort to lay out the circuit, but manufacturing and assembly can be automated. Manufacturing circuits with PCBs is cheaper and faster than with other wiring methods as components are mounted and wired with one single part. Furthermore, operator wiring errors are eliminated.

REVIEW OF BOOK, JOURNAL & INTERNATIONAL PAPER

There were many works performed on the design of effect of entry material on PCB by different investigators using various mechanism or techniques. Present literature review gives the overview off the some researchers work on effect of entry material on PCB.Following are the research papers which are refer for a future purpose in order to study effect of entry material on PCB.

Lukas Pilny (it All) this paper describes the Optimization of the metal drilling process requires creation of minimum amount of burrs and uniform appearance of the drilled holes. In this paper, an experimental investigation was performed on 2 mm sheets of wrought aluminium alloy Al99.7Mg0.5Cu-H24, using 1.6 and 2 mm diameter drills. Cutting data, clamping conditions, and drill geometry were varied in order to optimize the process and reach the desired quality. The results revealed possible reduction of burr occurrence on both the entry and exit side of the sheet, requiring no additional deburring. The demand on the uniform appearance of drilled holes was fulfilled as well as high productivity achieved. Such optimized process results in a noticeable production cost reduction. [1]

Das(it All) this paper describes the best product dimensions and the minimization of time and cost of production has become a measure of concern. Drilling process takes care about 35% of all the machining processes and influences the acceptability of the products as the drilling process is at the most final processing stage in the production line. The burr, which is a plastically deformed material, generated during drilling is unnecessary output and often lowers the surface quality, reduces the product life and acceptability of the product. Total elimination of burrs during drilling process is a

difficult task, however, with proper selection of process parameters it can be minimized. In the present experimental study, analysis on burr formation has been carried out on the aluminum channel in drilling process. The drill bit diameter and spindle speed are found to be most effecting parameters in burr formation. Drilling of aluminum flat drilling has been done for comparison of result.[2]

Luis Miguel P. Durao (it All) this paper describes the characteristics of carbon fibre reinforced laminates have widened their use from aerospace to domestic appliances, and new possibilities for their usage emerge almost daily. In many of the possible applications, the laminates need to be drilled for assembly purposes. It is known that a drilling process that reduces the drill thrust force can decrease the risk of delamination. In this work, damage assessment methods based on data extracted from radiographic images are compared and correlated with mechanical test results—bearing test and delamination onset test—and analytical models. The results demonstrate the importance of an adequate selection of drilling tools and machining parameters to extend the life cycle of these laminates as a consequence of enhanced reliability. [3]

M. Henerichs (it All) this paper describes drilling Carbon Fibre Reinforced Plastics (CFRP) induces different material defects like delamination, burnt matrix material, rough bore channel surfaces, fibre pull-out and uncut fibres. Intensive research has been conducted to analyse the amount of defects caused, describing the surface and subsurface defects introduced by machining operations. Additionally, the mechanical strength of rivet joints has been analysed intensively. However, the mechanical performance of rivet joints includes many influencing factors as different materials prepared with various machining processes are being joined. The presented study introduces five newly developed test rigs to analyse the mechanical performance of single bores in relation to different drilling and loading conditions. The setups are designed to focus either on the mechanical strength of the bore channel or the drill entrance or exit. The developed test rigs expand the capability to describe the workpiece quality after a drilling operation. The test rigs facilitate an efficient quality evaluation of drilling processes as well as the development of adapted drilling tools. [4]

D. Chandramohan (it All) this paper says that an effort to utilize the advantages offered by renewable resources for the development of biocomposite materials based on biopolymers and natural fibers has been made through fabrication of Natural fiber powdered material (Sisal (Agave sisalana), Banana (Musa sepientum), and Roselle (Hibiscus sabdariffa)) reinforced polymer composite plate material by using bio epoxy resin. The present work focuses on the prediction of thrust force and torque of the natural fiber reinforced polymer composite materials, and the values, compared with the Regression model and the Scheme of Delamination factor / zone using machine vision system, also discussed with the help of Scanning Electron Microscope [SEM]. The Electron Dispersive X-Ray Thermo detector [EDX] machine Model was used to study the composition of the microstructure of composites specimens. [5]

V Santhanam (it All) this paper describes that Composite materials are used in many engineering applications due to their superior properties. Hybrid fibre composites are developed to provide the advantage of both natural fibre and synthetic fibre. Drilling is an inevitable task for component assembly. Studies on drilling performance of Banana-Glass fibre hybrid composite is reported in this article. Banana-Glass fibre reinforced Epoxy composites were prepared by using hand layup method. Drilling experiments were conducted on chopped fibre and laminated woven fibre composites using standard twist drill. Experiments were conducted by varying the feed rate and speed. The Effect of fibre volume fraction in chopped fibre and stacking sequence in woven fibre composite on the drilled hole quality was found. Optimum drilling parameters were determined for selected samples each from chopped fibre and woven fibre composite. Machine vision technology was used to measure quality of the drilled Hole. [6]

Lijuan Zheng (it All) this paper describes that in order to meet the requirements of electronic product miniaturisation, the use of thinner and smaller printed circuit boards (PCBs) will be required. To achieve this, many more micro-holes must be drilled in a smaller area than before. PCBs are anisotropic multi-material sheets consisting of a dielectric layer (resin/glass fibre cloth) and a high purity metal conductor (copper foil). It is difficult to achieve high machining precision, surface quality, drilling efficiency and long drill life when drilling PCB micro- holes. In this study, micro-drills with a diameter of 0.1 mm were used to drill the PCBs at rotational speeds of up to 300 krpm. The drilling process was digitally photographed. The chip morphology and the hole wall were observed. The quality of the hole wall, such as hole wall roughness and nail head and exit burr formation were observed and measured. The influence of drilling condition on the drilling process and hole quality were studied. It was found that the morphology of the chips and the hole wall surface depended on the material properties of the printed circuit board. Chips were formed normally as conical helical chips from the aluminium entry board, conical helical chips from the copper foil and discontinuous chips from the glass fibre and softened resin. The hole wall through the copper foil seemed much smoother than that of resin/glass fibre cloth layer. However, nail heads and burrs were formed at the copper foil layers, which decreased the hole quality. Chip morphology and hole quality were affected by feed rate, spindle speed and tool wear. The basic removal mechanism of the PCB micro-holes was analysed, and this study provided a firm foundation for further work in this area. [7]

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Yu-Chu Huang (it All) this paper describes that the growing demand for cell phones and other electronic devices in daily life has created a strong need for printed circuit boards (PCBs). The global PCB production value was $46.8 billion in 2010 and is expected to grow in the coming years. Drilling in PCB production cannot be avoided for either electro-connection among layers or fixing components. The formation of drilling burrs affects the PCB quality and results in necessity of a deburring process. The burrs produced from drilling processes can be hard to remove and the cost of deburring is always substantial. Minimizing the creation of burrs during the drilling process will reduce the effort and time needed to remove burrs. Therefore, the hole drilling and deburring process are considered opportunities to reduce energy use. In this paper, the burr formation mechanism for holes was studied. Since burr formation is strongly related to process conditions and drill geometry, experiments were carried out to develop a Drilling Burr Control Chart by varying feed, spindle speed and drill diameter. The Drilling Burr Control Chart serves as a tool to predict burr formation and is therefore extremely useful for industrial applications. This paper proposes several approaches to minimize drilling burrs and to green the PCB drilling process.[8]

Hardik B. Prajapati (it All) this paper describes growing world of technology miniaturization is a key word. Drilling is one of the most fundamental machining technologies and is moving toward high precision/high speed application for productivity enhancement. The drill tools play a critical role is increasing the productivity of a cutting process. Although the price of a cutting tool itself is relatively low, the costs caused by tool failures are considerably higher. Therefore, from the viewpoint of cost and productivity, modelling and optimization of drilling processes are micro drilled holes are utilized in many of today‘s fabrication processes. Precision production processes in industries are trending toward the use of smaller holes with higher aspect ratios, and higher speed operation for micro hole drilling .Experiment was conducted on FR-2 as a work piece material using carbide drill having 0.7 mm diameter.FR-2 sheet with copper foil lamination on one or both sides is widely used to build low-end consumer electronic equipment. In the present work, spindle speed and feed are chosen as machining parameter to see the effect of circularity and taper angle on workpiece. Usingtaguchi methodology, L27 orthogonal array has been chosen and experiment has been performed as per orthogonal array design. For validation of the predicted value and optimization result, confirmation experiments have been performed with optimum levels of machining parameters. It is experimentally found that spindle speed is more influencing parameter for hole quality in terms of circularity and taper angle.[9]

PROBLEM STATEMENT

i. Proper heat dissipation to avoid thermal expansion.
ii. To absorb hammering force and avoid dilamination of copper
iii. Proper hole quality with high precision

NECESSITY OF WORK

The main function of PCB is to transfer electricity and produce an opening through the board that will permit a subsequent process to form an electrical connection. For that purpose quality of hole should be good, Micro drilling required high speed and high force due to that top surface of PCB material get damaged. To avoid this damage protective entry material is used.

OBJECTIVE OF WORK

1. Analytical design of ―Effect of entry material on PCB.
2. Modelling and Simulation of ―Effect of entry material on PCB.
3. Preparation of Prototype sample of ―Effect of entry material on PCB.
4. Experimental workout of ―Effect of entry material on PCB.
5. Study of comparative result of ―Effect of entry material on PCB.

METHODOLOGY

Aim: Find out effective entry material for PCB with minimum cost and maximum reliability.Problem Defination: Wastage of entry material of high cost.

Existing problem: The entry material used in company is going to be wasted which is costly, so we have to search the material having low cost.

Solution: We are going to use following alternative materials- Copper, Back up, Aluminium, Bakelite

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RESULT ANALYSIS

The right entry material will improve drilled hole registration and lower the risk of drill bit breakage by minimizing drill deflection upon contact with the stack. In order for the entry material to function properly, it must be flat and free of pits, dents, and scratches. Warped or twisted material will result in increased extents of entry burrs and drill bit breakage. Surface imperfections and materials that are too hard contribute to drill deflection, resulting in decreased hole registration accuracy and breakage of small-diameter drills. Phenolic materials or phenolic composites (i.e., aluminum-clad phenolic) often warp and under most drilling conditions contaminate the hole wall, which results in problems with adherence of the plating because desmearing chemicals are not designed to remove phenolic resin. Solid aluminum materials of the correct composition and hardness that are not of an excessive thickness, yet are not too thin, may work satisfactorily with larger-diameter drill bits.

However, drilling with solid aluminum materials (0.008 in and thicker) may increase the risk of breakage of smaller-diameter drills. Aluminum-clad cellulose core materials provide a hard surface to prevent burrs yet minimize drill deflection and breakage associated with solid aluminium.

CONCLUSION

From the discussion so far it has been concluded that Aluminum is better entry material than copper, Bakelite or wooden material. Al will help in reduction in burr, plain surface finishing and better hole quality than other materials like copper, Bakelite, wood etc. Burr minimization techniques can be easily implemented in Al material. The overall conclusions from the investigations are:

- Burr reduction with increased speed.
- Burr reduction with reduced feed rate.
- Conical defect at hole entry can be eliminated by using high feed, short drill length, and drill point warranting good self-centering capability.
- Significant reduction of exit burr with properly constructed clamping system.

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