PIN TRANSFER OF EPOXY RESIN (GLYCERIN) ON THE LED HOUSING

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DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed………………………………………… (GAJJHENTHRA A/L RICHARD RAJ)

Date……………………………………………

Statement 1

This journal is the result of my own investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. Bibliography/ references are appended.

Signed………………………………………… (GAJJHENTHRA A/L RICHARD RAJ)

Date……………………………………………

Witnessed by supervisor

Signed………………………………………… (DR. MOHAMAD AIZAT ABAS)

Date…………………………………………

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LIST OF ABBREVIATIONS

FSI	Fluid Structure Interaction/ Fluid Solid Interface
PIV	Particle Image Velocimetry
LED	Light-Emitting Diode
CFD	Computational Fluid Dynamic
STL	Standard Triangle Language
3D	3 Dimensional

ABSTRAK

Teknologi LED telah diguna dalam pelbagai aplikasi harian dan masih sedang cuba untuk diimprovasi dalam pelbagai aspek. Ciri utama yang menyebabkan LED berfungsi adalah komponen-komponen yang merangkumi LED tersebut. Pelbagai masalah yang berkaitan dengan komponen-komponen LED sentiasa muncul dan kerap dikaji oleh seseorang penyelidik. Motif utama dalam kajian saya ialah untuk menyelesaikan masalah pemindahan epoksi ke atas rangka LED. Masalah yang kerap berlaku dalam industri ialah epoksi berbentuk hemisphera timbul di atas permukaan rangka LED apabila proses pemindahan dilakukan yang akan merosakkan rangka LED tersebut. Jadi, simulasi menggunakan ANSYS Fluid Structural Interaction (FSI) dilaksanakan dah juga Eksperimen pemindahan pin dijalankan. Hasil dan data yang didapati akan digunakan untuk sahkan kedua-dua cara tersebut. Data yang akan diperoleh daripada simulasi ANSYS adalah kontur halaju dan kontur tekanan. Selain itu, daripada eksperimen, pemindahan epoksi ke atas rangka LED boleh diteliti. Motif saya adalah untuk mendapatkan hanya satu lapisan epoksi yang nipis di atas rangka LED selepas proses pemindahan dan sahkannya dengan keputusan simulasi.

ABSTRACT

LED Technology has been implemented in so many daily applications and is still being improvised in so many aspects. The key feature in a complete working LED model is the whole LED setup within itself. A lot of problems are arising and being studied regarding the LED setup. The main aim of my research is to solve the epoxy transfer on to the LED Housing. The problem faced in the industry is that a hemispherical shaped epoxy is formed on the LED Housing after the transfer which damages the housing. Thus, simulation using ANSYS Fluid Structural Interaction (FSI) is carried done along with pin transfer experiment to validate each other's result. The results obtained from the ANSYS simulation would be velocity contour and pressure contour and from the experiment, the transfer of the epoxy from the pin to the LED Housing can be witnessed. My motive is to achieve a thin layer epoxy on the LED Housing after the transfer and see if it agrees with the simulation results.

CHAPTER ONE

INTRODUCTION

1.1 Research Background

In recent years, the application of light-emitting diodes (LED) in electronic devices such as smartphones, digital watched and television have increased. LED are semiconductor devices that emits light as electric current is passed through it. The contact between the current carrying particles and the semiconductor material produces light. The complete set up of a LED will consist of the semiconductor material, epoxy, heat sink, lens and an outer package to hold the set up.

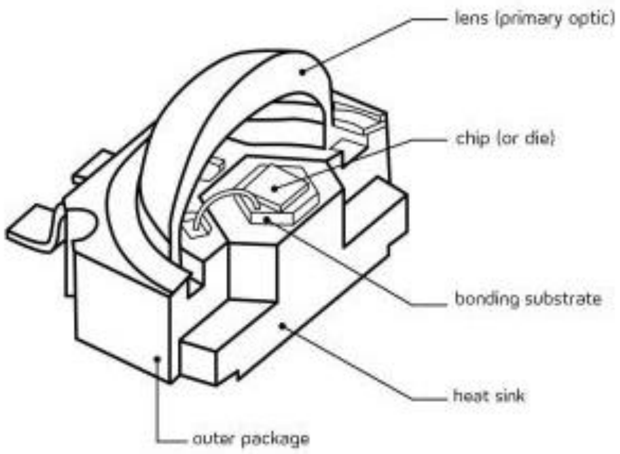

Figure 1. 1: A complete LED package

Epoxy plays an important role in binding the lens onto the LED Housing (Outer Package) and must be chosen wisely according to its viscosity, surface tension and angle of contact. However, after application, the final shape of the epoxy will usually be a hemisphere. This must be avoided to prevent spillage of excess epoxy onto the LED Housing when placing the lens on it.

Recently, studies show that the lens placement on the epoxy causes the epoxy to overflow and damage the LED Housing. The shape of the epoxy applied onto the base depends on the viscosity, surface tension and contact angle of the epoxy. The type of material that will be used to replicate epoxy resin in this project will be glycerin. Thus, changes in glycerin characteristics must be done and tested by using simulation and pin transfer experiment. This is to ensure only a thin layer of is transferred onto the LED Housing.

A brief description of the pin transfer will be given in this paragraph. An example of this application is in the semiconductor industry where it will be used for the transfer of solder paste on to the Printed Circuit Board (PCB). Pin transfer is a process involving hard tooling consisting an array of pins or pin heads corresponding to the positions on the Printed Circuit Board (PCB) where components to be attached is fabricated. The pin arrays are then dipped into a tray containing the solder paste and suspended drops of solder paste will be attached when the pin arrays are removed from the tray. The array of pins will then be transferred from one point to another onto the Printed Circuit Board (PCB). The pin arrays will be lowered onto the PCB and the solder paste will be transferred to preselected areas. The design of the pin tip and its diameter is important to avoid any distortion in the solder paste droplets. This similar concept will be used in conducting my pin transfer experiment using epoxy resin.

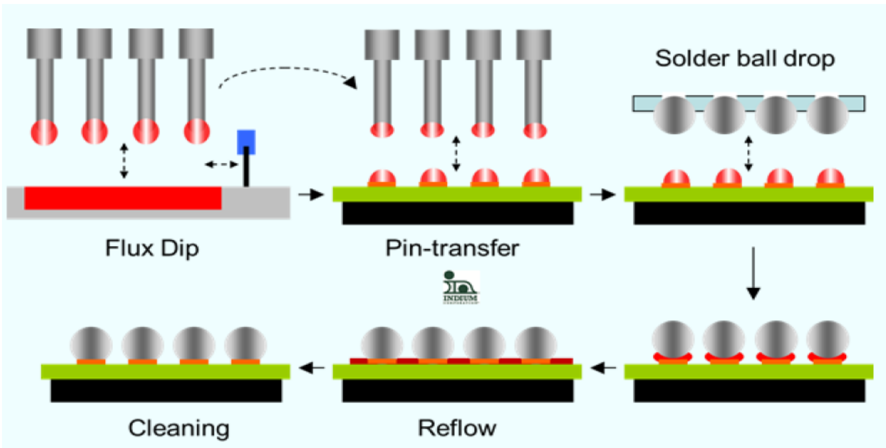

Figure 1. 2: The Schematic Diagram for pin transfer Technology

1.2 Problem Statement

Previous technology on the epoxy application on the LED Housing has caused the epoxy to form a hemispherical shape. It was said that the viscosity and surface tension of epoxy used played a vital role in the epoxy transfer. An epoxy with a high viscosity will tend to adhere well and have a slow transfer rate from the pin on to the LED Housing. This makes the time given for the pin transfer to occur to short and is insufficient for the epoxy to be completely transferred. Surface tension varies for different fluids and this applies for different epoxies as well. When the surface tension is too high or low, the shape of the applied fluid on a surface would not be as how we needed. It might not stay in shape at all or will rather just collapse and not adhere well on the applied surface. Thus, for the problem that I am working on, due to inappropriate viscosity, surface tension and contact angle used, a hemispherical shaped epoxy is formed on the LED Housing after transfer. A hemispherical shaped epoxy indicates there is an excess amount of epoxy which would not be used to hold the lens in place. Hence, the excess epoxy will only damage the outer package by flowing out of the base.

1.3 Objective

- To simulate a working model and conduct pin transfer experiment to see the application of a thin layer of epoxy resin onto the housing.
- To determine the appropriate epoxy resin viscosity, surface tension and contact angle to be used during the pin transfer experiment.
- To eliminate completely the formation of hemispherical shape during the application of epoxy resin on the LED Housing.

1.4 Scope of Research

My Final Year Project research is limited to the simulation of the LED Housing with the epoxy resin and conducting a pin transfer experiment to obtain the experimental results based on the transfer of the epoxy resin. The movement of the epoxy resin will be recorded using a camera and images of it will be captured. My research scope only covers on the application of the epoxy resin onto the LED Housing. The lens placing on the epoxy resin and complete set up of the LED will be done separately by other party. This is because the main issue that we are trying to solve is only on the epoxy resin application and its characteristics. As mentioned before, the material used to replicate the epoxy resin in my project is glycerine.

1.5 Thesis Organisation

This thesis is on the six degree of freedom simulation and the pin transfer experiment on the application of the epoxy resin on the base of the LED housing. The organization of the thesis is as follows.

Chapter One introduces my Final Year Project title and a thorough explanation on the purpose of conducting this research is given. A brief explanation on how to conduct the research which is by simulation and pin transfer experiment have been described.

In Chapter Two, a complete research and case studies have been summarized for each parameter that are involved in this project. Every simulation setup and pin transfer experimental setup are first reviewed and studied before being conducted. Each of the research and case studies will be summarised and explained in this chapter.

Chapter Three provides a detailed review on the methodology of my research. Explanation of each step taken when conducting the simulation and pin transfer experiment are described.

Chapter Four is where analysis will be done on the results that have been obtained for my research and I will discuss the obtained results. In the discussion, all the results will be clearly reasoned and explained.

Finally, in Chapter 5, the whole thesis will be concluded and to identify if the mentioned objectives are met. Recommendations will also be included in this chapter for future work or studies to further improvise my Final Year Project research.

CHAPTER TWO

LITERATURE REVIEW

Overview

In this era of fast developing technologies, the implementation of Light Emitting Diode (LED) has increased and there are many types of LEDs that are being produced according to different types of usage. Recent cases have shown that the type of epoxy used is affecting application on to the base of the LED housing. In this chapter, the techniques and type of epoxy used in my research to see the changes in epoxy characteristics are reviewed. From the review of the epoxy, it was understood that the viscosity, surface tension and contact angle of the epoxy affects the application on the base of the LED housing. Besides the type of epoxy, the testing mechanism for the epoxy by simulation and pin transfer experiment is also another subject of interest. In this literature review, the testing mechanism used by previous researches are reviewed and an appropriate setup for the simulation and pin transfer experiment are chosen. The material chosen to replicate an epoxy in my project is glycerin. In this Chapter Two, the type and properties of epoxy resin are investigated based on previous researches.

2.1 Epoxy Resin

Epoxy was first founded by Prileschajew in 1909 (Lee, 2012) and was then commercially debuted in 1947. Polypol was the first to be produced which was done by Devoe-Raynolds Company. It was the preparation of synthetic drying oil. (May, 2018). The word epoxy resin came into use and was used on both prepolymers and cured resin. Reactive groups in the would have reacted in cured resin but are still called as epoxy resin even after they no longer contain epoxy groups. Due to rapid changes in technology in this era, the epoxy resins have further been improvised to meet certain characteristics and are produced by varying the ratios of the components. (Today, 2012). Reaction between epoxy resin and hardeners are done to cure the epoxy resin. A rigid three-dimensional network will be formed from this reaction. (Ellis, 1993). Epoxy resins in general are known for their chemical resistance, good electrical properties, low moisture absorption and high strength.

2.2 Types of Epoxy Resin

There are different types of epoxies produced throughout the world to carter different needs. Every epoxy type produced vary from others by their specific characteristics. Different epoxies will also have different methods of producing them. Some of the different epoxy types will be explained below.

Bispenol-A (BPA) also known as diglycidyl ether of bisphenol-A (DGEBA) is produced by adding bispenol-A and epichlorohydrin together with the presence of catalyst. This epoxy will be liquid form when it contains low-molecular-weight molecules and will be more viscous liquid or solid when it contains higher-molecular-weight molecules. (Jin et al., 2011; Jin and Park, 2006). BPA is widely used in the consumer industry where it'll be used to produce products such as plastic bottles and act as protective lining on the inside of some metal-based food and beverage cans.

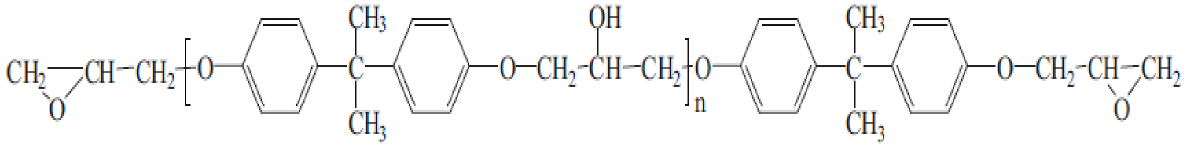

Figure 2. 1: The structure of Diglycidyl Ether of Bisphenol-A (DGEBA) (Jin et al., 2015)

Cycloaliphatic epoxy resin (CAE) is produced by reacting 30-cyclohexenylmethyl 3-cyclohexenecarboxylate with peracetic acid. This synthesis then produces 30,40-epoxycyclohexyl- methyl 3,4-epoxycyclohexanecarboxylate (CAE). Good electrical properties, good weatherability, high UV stability and good thermal stability is caused by an aliphatic backbone and a fully saturated molecular structure. (Yoo et al., 2010; Liu and Wang, 2011). This epoxy is used to in the electrical industry to make good insulators.

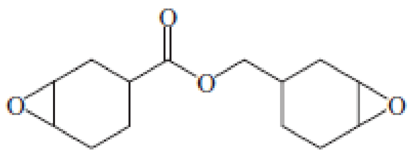

Figure 2. 2: Chemical structure of Cycloaliphatic epoxy resin (CAE) (Jin et al., 2015)

Tetrafunctional epoxy resins are usually used in high temperature due to its high epoxy functionality and high crosslinking densities. Cured epoxy has a high thermal stability, modulus, chemical resistance and UV blocking. Tetrafunctional epoxy resin is a formed by reacting 1,3- diaminobenzene or 4,40-aminodiphenyl methane with epichloro-hydrin. (Park et al., 2004; Lee et al., 1996). Tetrafunctional epoxy resin will usually be used in the aerospace industry. It is used as high-temperature adhesives and encapsulation materials.

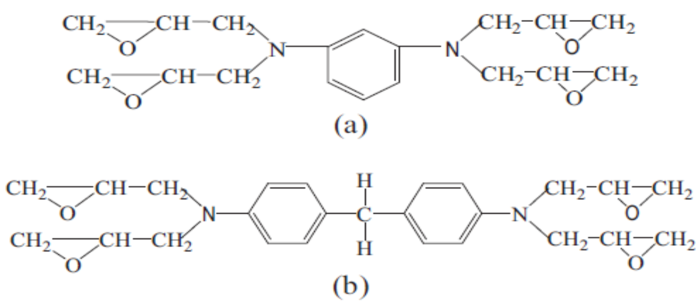

Figure 2. 3: Chemical structure of Tetrafuntional epoxy resin (Jin et al., 2015)

Novolac epoxy also known as glycidyl ethers of phenolic novolac resins. This epoxy is synthesized by reacting phenolic novolac resin with epichlorohydrin.

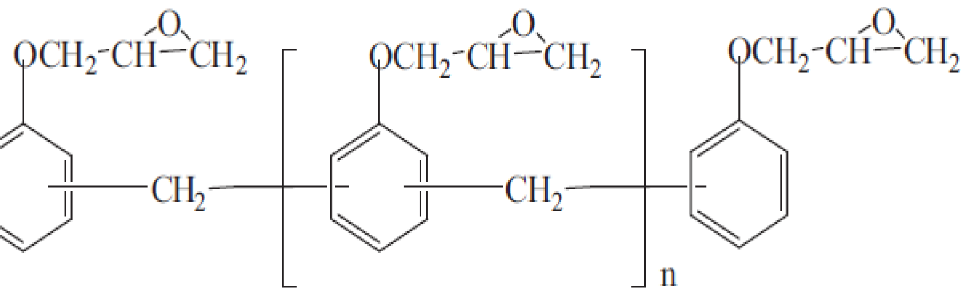

Figure 2. 4: Chemical structure of Novolac epoxy resin (Jin et al., 2015)

High cross-linking densities properties of this epoxy due to the multiple epoxide groups in novolac epoxy resins that increases thermal, chemical, solvent-resistant properties. (Park et al., 2000; Guo et al., 2003). Novolac epoxy is ideal for harsh chemical and solvent resistant applications. It is used as a troweled mortar, slurry binder, and coating for concrete and steel in extremely corrosive areas where resistance of about 98% against sulfuric acid or other strong caustics is necessary.

2.3 Applications of Epoxy Resin

The vast development of technology aiding the formulation to produce epoxy resin has greatly which increased the application of epoxy resin. The mechanical, electrical and other properties of epoxy resin have significantly increased as well. (Dakin, 1974).

Vacuum Impregnation

- The epoxy impregnation of REBCO coils and cables. REBCO tapes are utilized for high temperature semiconductors (HTS) under high mechanical loads. Thus, these tapes must be mechanically stabilized by impregnating it with epoxy resin. The impregnation fills the voids in the tape structure and prevents distortion. This allows for uniform mechanical distribution. Epoxy resin is chosen for impregnation because of its high mechanical strength and good resistance to temperature changes. (Barth, 2013).

- In fusion reactors, massive superconducting electromagnets are used which requires a large amount epoxy resin for electrical insulation as well as improve mechanical and thermal strengths. The magnets are made from a bundle of superconducting cables wrapped in dry glass. Vacuum-assisted resin transfer molding will then be done to the entire magnet. (Madhukar, 2015).
- Fusion devices need large, superconducting, resistive or capital-intensive magnets. The production of this magnets must be cost-efficient and reliable. Thus, these magnets will be insulated with epoxy resin. The epoxy resin used will be cost efficient and also high insulation from electricity. Good mechanical properties can be achieved at magnet operating temperatures as well. (Fabian et al., 2002).

Epoxy resins are used in paint and coatings as an anti-corrosion coating. This is because of certain properties such as high chemical resistance, safe, good solvent, low shrinking on cure, mechanical and corrosion resistance. Acidic food substances tend to corrode the walls of the containers and lead to rust, thus epoxy resin is applied to prevent rusting. (Hao et al., 2013; Guo et al., 2003; Gergely et al., 2013).

Figure 2. 5: The Anti-Corrosion Coated Paint Used to Paint a Wall (Jin et al., 2015)

The current development in aerospace technology and increase in the number planes have led to many changes and modification in the aerospace industries. Aeroplanes are made to be lighter for better fuel economy and to reduce the service cost as well. These efforts are taken into consideration for sustainability purposes and reduce operational cost. The use of epoxy resin in the aerospace industry will have a high demand in the future. (Committee, 2018). The main reason epoxy resin is used in aerospace industry is due to the high adhesive properties and it is cost efficient. Usually, these epoxies would be reinforced with Kevlar, carbon, high strength glass or boron fibres before being applied in the aerospace industry. (Azeez et al., 2013; Kandare et al., 2013).

Epoxy resin does not only play a role in engineering-based applications but also is applied in the medical field. Such application can be seen in biomedical systems. Some of the application are like wound dressings, vascular grafts, and aortic heart valves which uses collagen-based materials. (Zeeman et al., 1999). Epoxy resin are preferably used in biomedical system due to the extreme hardness, outstanding chemical inertness, low electrical and high thermal conductivities and optical transparency. (You et al., 2013; Zhang et al., 2011). Usually, epoxy resin will be implemented to reusable or disposable instruments. Processes such as coating, bonding and sealing in a surgery procedure will make use of epoxy resin. Time factor plays a big role as well because epoxy resin can cure at a fast rate and will be more efficient. Epoxy resins can further be improved by mixing them with hardeners to carter the needs of different medical requirements. (Frick, 2014).

2.4 Properties of Glycerin

The right properties of epoxy resin play an important role in the pin transfer experiment. Specific surface tension, viscosity and contact angle of epoxy resin will be needed to have a complete transfer of epoxy resin onto the LED Housing and forming only a thin layer epoxy resin instead of a hemispherical drop of epoxy resin.

Surface tension is the amount of force needed to increase the surface area due to intermolecular forces. Surface tension is not the same for all the liquids and differs because of the difference in intermolecular forces of each liquid. In a liquid, two different types of molecules exist which are known as interior and exterior molecules. The interior molecules would be attracted to the molecules around it and the exterior molecules will only be attracted to the surface molecules and molecules beneath it. This causes the energy level of the interior molecules to be lower relative the energy level of the exterior molecules. Thus, a lower surface area is needed to maintain a lower energy level. This phenomena is known as surface tension. (LibreText, 2019)

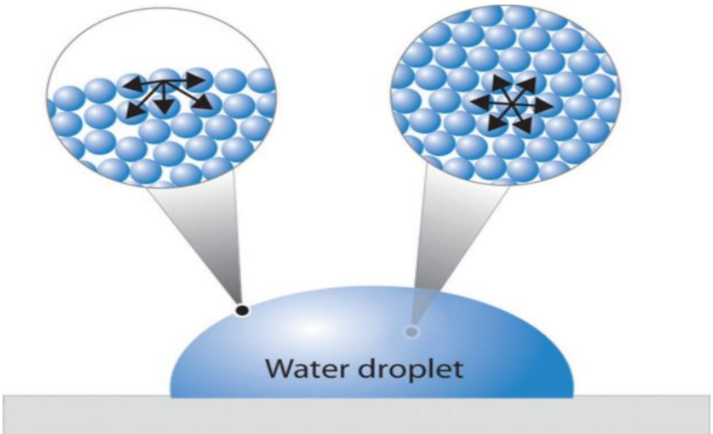

Figure 2. 6: The interaction of the interior molecules and exterior molecules of water droplet (LibreText, 2019)

The molecules are attracted to each other due to the polar property of water. The water molecule consists of two hydrogen atom and one oxygen atom. The positive ends of hydrogen molecule will attract the negative end of the oxygen atom. This creates the intermolecular forces, thus the stronger the intermolecular forces and surface tension are, the higher the surface tension will be. This causes more energy to be required in order to break the strong bond. (LibreText, 2019). There are two main forces that play a main role in affecting the surface tension. They are known as cohesive and adhesive forces. Cohesive force functions to attract and hold the body of a liquid together with minimal surface area. Adhesive forces on the other hand functions to spread or disperse a body of liquid. Thus, increasing the cohesive forces aids to maintain the shape or body of a liquid but if the adhesive force is higher than the cohesive forces, then the liquid will spread even more while increasing the surface area. The increase in adhesive force can be done by adding a wetting agent to the liquid which will increase the surface area. (LibreText, 2019).

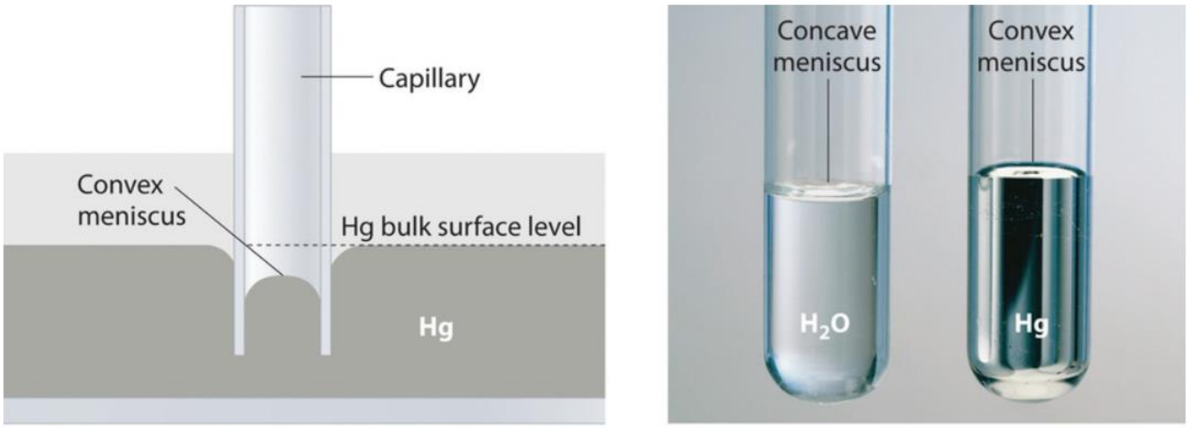

Figure 2. 7: Both images shows the adhesive forces effect on liquids (LibreText, 2019)

The effect of temperature and volume concentration on the surface tension is quite significant. Sodium dodecyl benzene sulfonate was used as the surfactant for stable suspension of graphene. When tested, the surface tension of the graphene-water nanofluid decreases with the increase in temperature and volume concentration. The effect of volume concentration on the surface tension is due to the adsorption of nanoparticles at the liquid and gaseous interphase because of the hydrophobic nature of graphene. As for the temperature, it affects surface tension because as the temperature increases, the strong intermolecular forces become weakened which then reduces surface tension. (Ahammed et al., 2016).

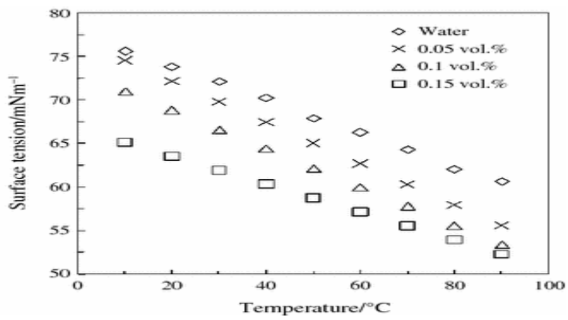

Figure 2. 8: Variation in surface tension with temperature for graphene–water nanofluids (Ahammed et al., 2016)

Figure 2.8 above shows the variation in surface tension with temperature for temperature readings. It clearly shows that the surface tension decreases with increase in temperature. The values of the surface tension of the nanofluid at 10 °C and 90 °C are 65.07 and 52.27 N m^{-1} respectively for 0.15 % volume concentration, which are lower by 13.82 and 13.75 % when compared with deionized water. This is because when temperature increases, the surface tension of the liquid decreases. (Ahammed et al., 2016).

In general, viscosity is the resistance of fluid to flow. Viscosity is the interaction between different molecules in a fluid. (RheoSense, 2019). Viscosity is also the ratio of shearing stress to the velocity gradient. (Elert, 1998-2019)

$$\eta = \frac{\bar{F}/A}{\Delta v_x/\Delta z}$$

where;

F/A is the shearing stress and $\Delta v_x/\Delta z$ is the velocity gradient.

According Newton's Law, shear of fluid is directly proportional to the force applied and inversely proportional to the viscosity. The SI unit of viscosity is square meter per second (m^2/s). The Newton's equation is as below;

$$\frac{\bar{F}}{A} = \eta \frac{\Delta v_x}{\Delta z} \quad \Leftrightarrow \quad \bar{F} = m \frac{\Delta v}{\Delta t}$$

There are usually three types of viscosity known as dynamic viscosity, absolute viscosity and simple viscosity. Kinematic viscosity is the measure of ratio of the viscosity of a fluid to its density. The instrument used to measure kinematic viscosity is capillary viscometer. In simple words, if two liquids of same volume with different viscosities are placed in individual capillary viscometer, the liquid under the influence of gravitational force will move downwards. From this, it can be observed that the more viscous liquid takes a longer time to flow down the tube compared to the less viscous liquid. (Elert, 1998-2019). Usually, the pressure does not affect the viscosity of liquid unless they are subjected to extremely high pressure. Then the viscosity of the liquid will increase. Normal pressure does not affect the viscosity because of the incompressibility behaviour of the liquid. (Elert, 1998-2019).

The wettability of a surface is measured using contact angle. During wetting, the deposited liquid on a surface will spread due to the weak intermolecular forces between the particles. Hence, when the contact angle is smaller, the wettability will increase. Usually, a contact angle of 90° is formed by a wetting liquid whereas a non-wetting liquid forms an angle of 90° and 180°. (Dwivedi et al., 2017).

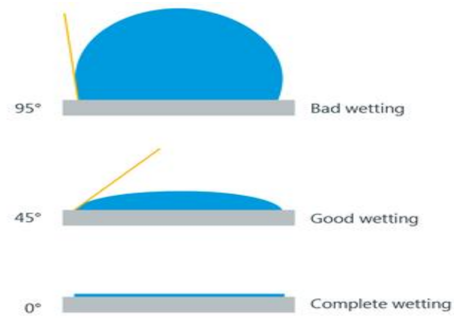

Figure 2. 9: The Wettability and Contact Angle on Different Materials (Kruss, 2019)

The contact angle of a liquid can be measured by using a few methods. Wilhelmy-balance tensiometry (WBT), tilting-plate goniometry (TPG) and captive-drop goniometry (CDG) are some of the methods to measure contact angle of a liquid. (Krishnan et al., 2005).

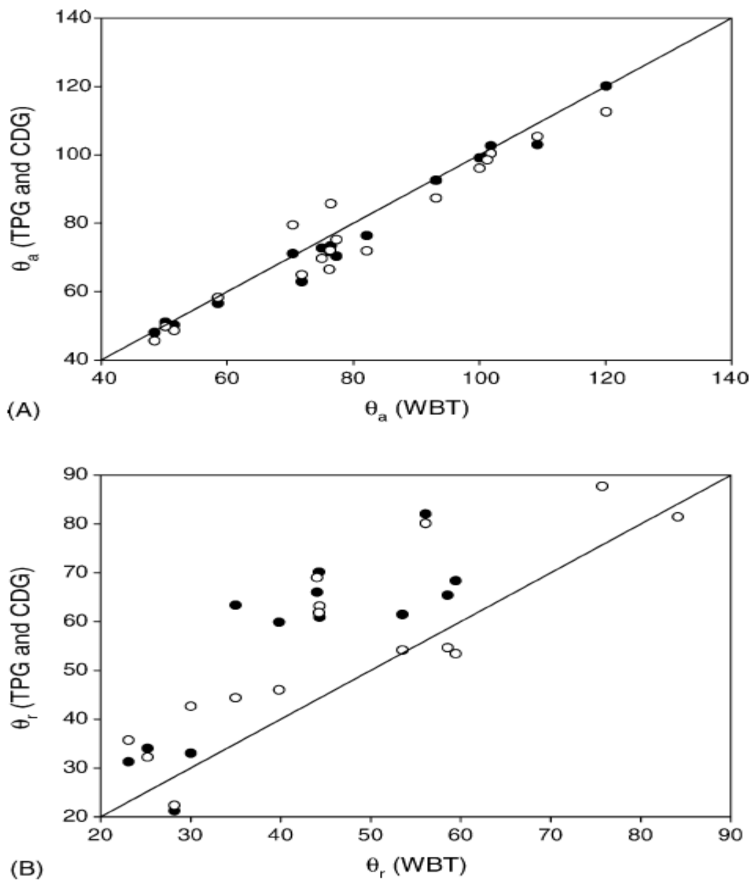

Figure 2. 10: Comparison of advancing (θ_a, panel A) and receding (θ_r, panel B) contact angles from goniometric techniques, tilting-plate (TPG, closed circles) and captive-drop (CDG, open circles), to Wilhelmy-balance tensiometry (WBT) (Krishnan et al., 2005)

Every contact angle is not accurate and does not determine the exact same wettability of the surface. The advancing angle (θ_a) should be at maximum and the receding angle (θ_r) should be minimal and a proper contact angle between the surface and the liquid should be determined in order to get the wettability of a surface. When the methods are compared, the results obtained for advancing angle (θ_a) using tilting-plate goniometry (TPG) and captive-drop goniometry (CDG) to Wilhelmy-balance tensiometry is acceptable. On the other hand, for receding angle (θ_r), measurement by tilting-plate goniometry (TPG) and captive-drop goniometry (CDG) were offset from the Wilhelmy-balance tensiometry (WBT) and the variation were big. (Martin and Vogler, 1991; VOGLER, 1993; Lander et al., 1993).

2.5 Design Optimization

A three-dimensional (3D) model able to present a complex and micro-scale product in bigger scale. The 3D models can provide completely functional components to be tested for various applications for instant biomedical devices, sensors, actuators, micro-structures or thermal electronics. (Sanjuán et al., 2007; Miyamoto et al., 2005).

A 3D model can be used to replicate the exact model that need to be tested which it can be either smaller or bigger in actual reality. By having a 3D model, we would also be able to test the model designed in many software to meet different purposes. Different types of information and data can usually be obtained for our model such as fluid flow, velocity, viscosity, pressure, density and so on.

Hence, it is vital to make sure that the parameters of the 3D model designed is accurate and is relatable with the actual model that needs to be tested. This is to ensure the results obtained is accurate with the actual experimental results while the percentage difference being always not more than 10% to 15%.

2.6 Computational Simulation

In this era, computational simulation technology has become a vital tool for most researches and in the industry. The effectiveness such a tool is the ability to simulate the problem and see the results that would be significantly same with the actual experimental results that is going to solve the problem. (Giuliano, 2011). The development of efficient numerical algorithms and the emergence of new parallel computing architectures through computational modelling has also contributed in the fame that this tool has gained. Even with well-developed algorithms for numerical solution of single-physics problems existing, the efficient solution of multi-physics problems still represents a considerable challenge and computational simulation is expected to solve the problem. (School of Computer Science, 2019).

In this paper, a bolted joint in a structure is tested. Previous studies on this was on the extraction of stiffness for the joint region and determination of contact stress through Finite Element Method (FEM). (Gould and Mikic, 1972; Schiffner, 1997; Wileman et al., 1991). During the finite element analysis, two main components pretension and a mating part contact of the bolted joint. Pretention could be modelled using a thermal deformation, a constraint equation, or an initial strain. (Kim et al., 2007). For thermal deformation, the pretention is found by generating virtual different temperatures and thermal expansion on the bolt and flange. (Kim et al., 2007). Constraint equation can be used to monitor the behaviour of the nodes and for this the pretension will be a special form of coupling. (Kim et al., 2007). For initial strain, the initial displacement is assumed to be a portion of the pretension on the structure with the bolted joint. This is considered as a more direct approach. (Kim et al., 2007).

For the Finite Volume Method, a paper by Jungwoo Kim (Kim et al., 2001) have studied two different methods in simulating complex flow which were unstructured grid method and immersed-boundary method. A body in a flow field is assumed to be a forced momentum in the Navier-Stokes equation rather than a real body. Thus, flow over a complex geometry can be simply handled with orthogonal grids that do not coincide with the body surface. Few of the advantages of immersed-boundary method are CPU and memory savings and easy grid generation than unstructured grid. When flows over cylinder and sphere are simulated with the immersed-boundary method, it can be seen that without introducing the mass source/sink near the immersed boundary a nonphysical solution was obtained near stagnation point of flow and numerical solution deteriorates more with increasing Reynolds number.

2.7 Pin transfer

From a patent by Russell E. Blette and John O. Roeser (Blette and Roeser, 1993), a pin is used to deposit a specific small amount of liquid material onto an object. The liquid material mentioned can be of any sought. In an automated solder paste dot applicators, a whole system includes a reservoir and tube to direct the molten solder paste onto the workpiece. Using the current technology available, the tube or needle can also be placed on a 3-axis robot to place the solder onto multiple workpieces. In a pin transfer applicator, multiple pins are arranged vertically according to the parts to be soldered onto the circuit board. A frame consisting all the pin heads are slightly dipped into the solder paste and moved to the circuit board. The ends of the pin are then lowered dispelling the molten solder from the pin head onto the designated positions on the circuit board. The pin will be attached to an applicator and will extend and retract in order to apply the solder paste on the workpiece (Blette and Roeser, 1993). Thus, this concept will be applied for my pin transfer experiment on the transfer of epoxy resin on to the LED Housing.

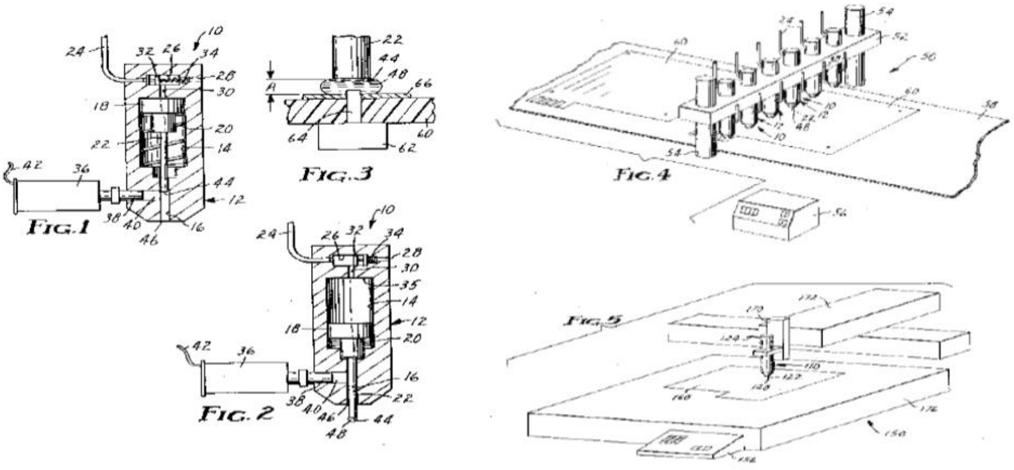

Figure 2. 11: Schematic diagrams of the pin transfer setup (Blette and Roeser, 1993)

From a patent by Masayoshi Koyama, Norihito Tsukahara and Daido Komyoji (Koyama et al., 2015) states that Japanese Patent Laid-Open No. 2006-320795 discloses a discharge device for discharging small droplets of specific diameters into a solution. This device was considered usable in the application of paste for mounting electronic equipment. The pin is attached to a slider and moved up and down where it was configured to reach the discharge opening so to not drip the paste from the discharge opening when it approaches the target object and transfers the paste by moving the pin away from the discharge opening.

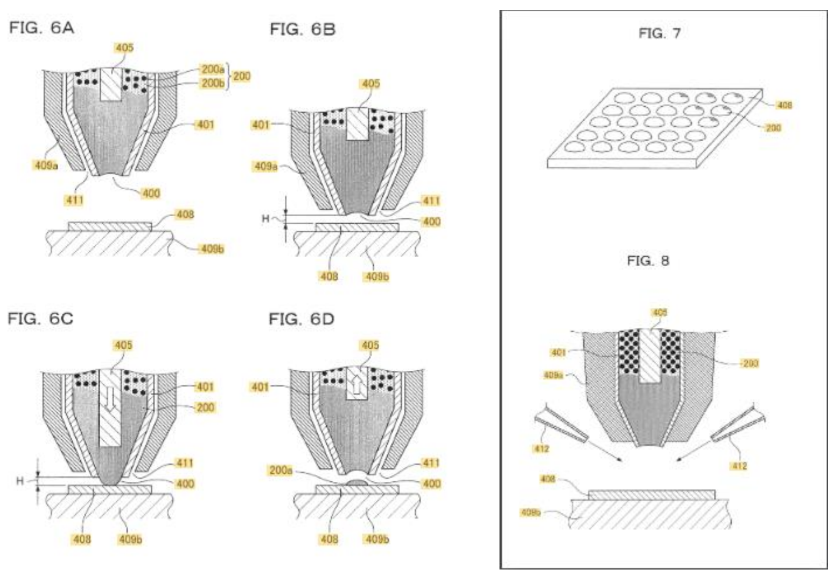

Figure 2. 12: The pin transfer technology proposed (Koyama et al., 2015)

Summary

To summarize my literature review, many of the technology nowadays are using LED technology and major problem like the application of epoxy should be solved to carter the current demands. In terms of numerical solution, CFD Simulation in ANSYS is the best approach to get and study the possible outcomes. Besides that, pin transfer experiment is the most suitable to observe the transfer of epoxy resin on to the LED Housing from the pin.

From the literature review, it is understood that the study for CFD Simulation in ANSYS and pin transfer experiment are limited. Only a few papers have been on the idea of starting up such projects. This would be a breakthrough where both simulation and pin transfer experiment will be conducted to observe the transfer of epoxy resin onto the pin housing.

CHAPTER THREE

METHODOLOGY

Overview

This research is focused on the determining the appropriate glycerin as an epoxy replicate and the application onto the LED housing. Thus, this research will involve conceptual designing of the model using SolidWorks, CFD simulation of the setup and finally conducting a pin transfer experiment in order to observe the movement of the epoxy when applying to the LED housing. The results of the simulation and the experiment will then be compared for validation.

3.1 Flow Chart

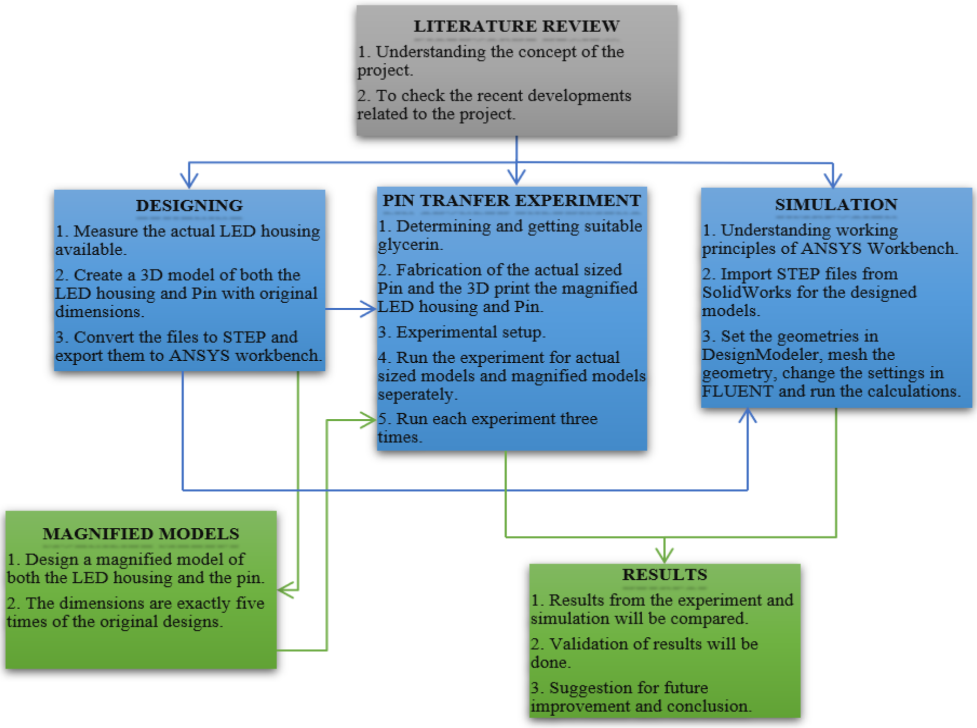

Figure 3. 1: Flow chart showing the progress and steps in completing this project

3.2 Designing of the 3D Model

The real housing of the LED was obtained before conducting the project. For me to proceed with the CFD simulation in ANSYS and make renderings with original design, a 3D model with exact dimensions had to be designed to be implemented into the CFD simulation. Hence, appropriate steps were taken for me to obtain the most accurate rate possible at the end.

The Parameters and Dimensions

Before carrying out any 3D designing of the model, the parameters and dimensions of the LED Housing should be obtained. Since this is the first Malaysia based LED and OSRAM didn’t provide me with any dimensions for this project, the dimensions have to be manually obtained. The initial method used was 3D scanning to get a 3D model of the LED Housing and transferring it to SolidWorks to get the dimensions. Unfortunately, it was said the model was too small for the machine to scan and the 3D model obtained would not be accurate.

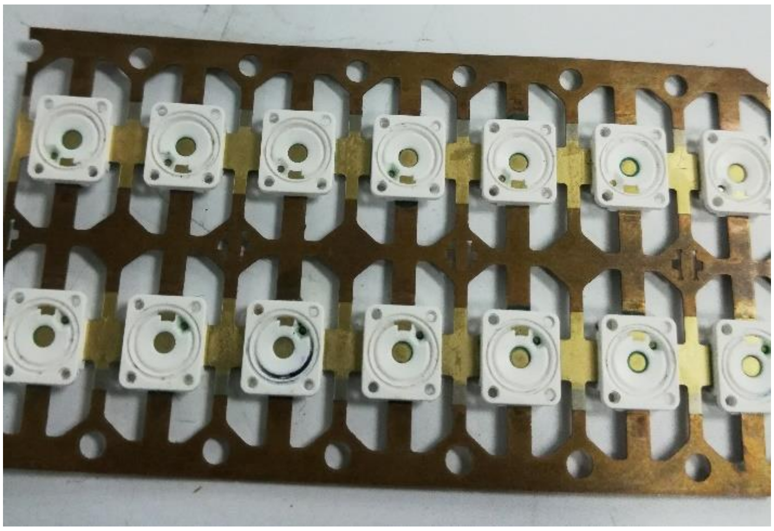

Figure 3. 2: The arranged Light Emitting Diode (LED) housings

Then, another alternative was used. Alicona machine was used to measure and record the dimensions. This machine was used because of its ability to zoom and focus in detail. Traceable measurement results in a high repeatability and a vertical resolution of up to 10nm was achieved in this machine. Hence, this was the best option to get the dimensions of the small LED Housing model that I had. Other small dimensions such as the height, width and length were measured using a Vernier calliper.

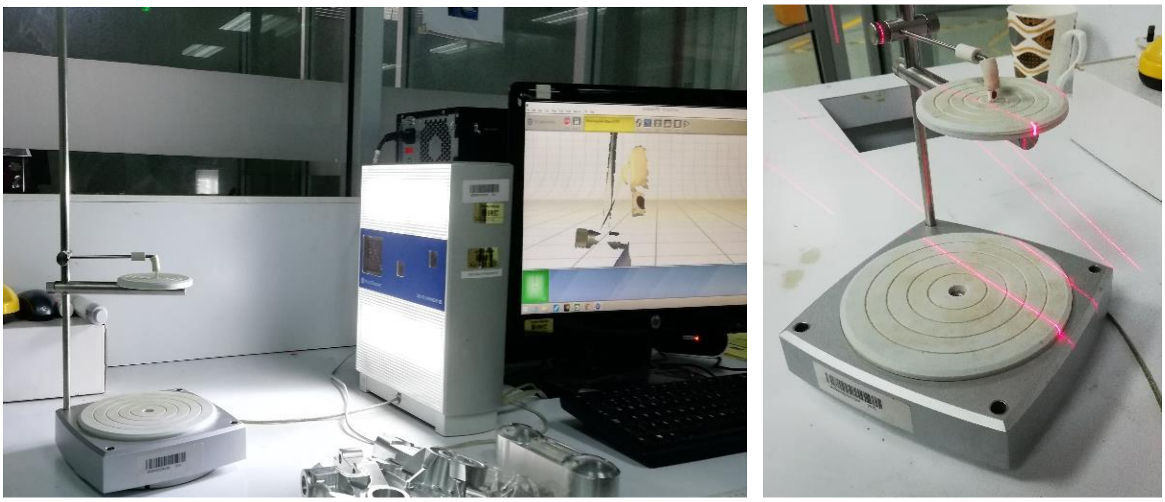

Figure 3. 3: The 3D scanning process of the LED housing

Figure 3.3 shows the dimensions that have been obtained from the Alicona machine. Some of the dimensions that were measured using this machine were the diameter of each circle and distance between two points.