THE EFFECT OF FREE VIBRATION ENERGY ON CONDUCTIVE INK

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DECLARATION

I declare that this project report entitled "The Effect of Free Vibration Energy on Conductive Ink" is the result of my own work except as cited in the references.

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APPROVAL

I hereby declare that I have read this project report and in my opinion, this report is sufficient in term in terms of scope and the quality for the award of the degree of Bachelor of Mechanical Engineering.

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ABSTRACT

There is now a new technology that is well developed, which has the potential to conduct electricity through the use of ink utility. This technology is called conductive ink and has recently been launched with the introduction of various materials. In most cases, the conductive ink formulation uses materials such as silver, carbon and other conductive materials as a filler. There is also a substance that is still fresh in the carbon black conductive ink industry. Carbon black is a modern treasure dubbed "wonder material" with outstanding electricity conduction properties. In ink formulation, the use of carbon black as a conductive material can offer many advantages, but certain factors affect carbon black's efficiency during the conduction of electricity. One of the variables is carbon black's properties and behaviors, which may influence the threshold of the ink and its percolation. Such variables are a new thing that is still being explored by researchers, as the use of carbon black is still new in conductive ink technology. Based on the existing formulation of conductive ink, which is carbon black as a filler, a study on the effect of free vibration energy on conductive ink has been conducted. Four different forms have been patterned into ink samples, which are a straight line, zigzag, curve, and square pattern. Their separate widths are printed out for each pattern, which is 1 mm, 2 mm, and 3 mm. Three experiments will be performed in this research to achieve the targets, which are sheet resistivity test using a four-point probe, hardness test using nanoindentation with the effect with and without vibration, and studies using a scanning electron microscope on the presence of fatigue or crack. Based on this research, it can be concluded that the curve is a better pattern followed by the straight line, whereas vice versa with zigzag, and 1 mm samples are less effective in conducting electricity compared to 3 mm samples based on distance. In the future, the results of this study will be used to improve the efficiency of carbon in conductive ink technology.

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LIST OF ABBREVIATIONS

GnP	-	Graphene Nanoparticles
TPU	-	Thermoplastic Polyurethane
SEM	-	Scanning Electron Microscopy
CB	-	Carbon Black

LIST OF SYMBOLS

C	-	Carbon
O	-	Oxygen
R	-	Resistance
ρ	-	Sheet resistivity
Ag	-	Silver
Cu	-	Copper
Au	-	Gold
C	-	Carbon
Gpa	-	Gigapascal
mV	-	Millivolt
ηm	-	Nanometre
μm	-	Micrometre
mm	-	Millimetre

CHAPTER 1

INTRODUCTION

1.0 Introduction

This section offers details about background of the study, problem statement and objective. Scope and limitation are also provided in this chapter.

1.1 Background of the research

To become more high-end and complex, electronic devices and semiconductor area are being built, but they are mostly still rigid and inflexible. In order or develop novel devices such as e-textiles, embedded electronics, wireless sensors, foldable display panels and transparent photodetectors, researchers have studies a new electronic interface framework that is versatile, transparent and can be intergrated between electronic devices and semiconductor components (Barbaro et al., 2010).

Conductive ink is a type of ink that by infusing the ink with a conductive material, can conduct electricity to allow electrical conduction and can be printed directly on a substratum or any flexible surface via a normal printing process. In order to vaporize the solvent and heat the conductive particles put together, the inks are normally added to the substrate and slightly heated up (Yang et al., 2016).Conductive ink is an important factor for any application, with extensive wearable electronics applications (Van den Brand et. Al., 2017), chemical sensors (Singh et al., 2017) and RFID chips (Huang et al., 2015) and is considered to be the next generation of electronic devices. Conductive ink can replace printed wiring and is particularly useful for small circuits requiring low-cost technique. Flexibility and expandability are featured in the stretchable conductive ink while retaining high conductivity levels.

In data transmission, wires are used for transferring signals. Wires are more sophisticated and high-end, but due to versatility, they are very weak. A new system of electronic devices that is versatile, transparent and can be incorporated between electronic devices and semiconductor components has been studied to develop new devices such as e-textiles, embedded electronics, wireless sensors and others. Conductive ink has been chosen because it meets the requirement that even when exposed to such conditions such as bending, twisting and vibration, it can retain its work. In this study, I have aimed to discuss and evaluate further about mechanical properties specialized in the effect of free vibration energy on conductive ink.

1.2 Problem statement.

There are an ever rising need for electronic device with modern features to be created and manufactured. The significant features of new electronics are for example low production costs, long term endurance, environmentally sound manufacturing method, recycling, lower consumption of energy and higher performance, and the inclusion of electronics as part of other initiatives buildings. New production methods have to be developed to address all these challenges.

Wires more high-end and complex but its very poor due to flexibility. We need new system or production of electronic devices that is flexible, transparent and can be incorporates between electronic devices and semiconductor component to produce novel devices such as e-textile, embedded electronics, wireless sensor and others. Conductive ink is chosen because its meet all the requirements such as low cost and able to sustain their function even when subjected with certain conditions.

1.3 Objectives

The objective of this research are as follows:

1. To investigate the relationship between the pattern of the conductive ink, resistivity and number of cycle.
2. To examine the hardness of the conductive ink and Elastic modulus.
3. To testing the fatigue of conductive ink on bending test rig.

1.4 Scope and limitations

In scope of this research are mainly focus on electrical and mechanical properties. In order to detect free vibration in the structure or buildings, conductive ink is placed on the structure such as rubber and many more. This is because it is unreliable and inflexible when only using wires to transfer data. In this study, we used conductive ink to detect the vibration and then record accurate data. The reading of the resistance are recorded using 4 patterns of conductive ink to find out the response to the different pattern, resistance and number of cycle. We concentrate on elastic modulus and the hardness of the conductive ink in this research. Elastic modulus is a test of a material's ability to tolerate changes in length when compression is under longitudinal stress. Hardness is the capacity of a material to resist deformation, calculated by a standard test where the resistance of the indentation surface is measured. The most widely used hardness tests are defined by the form or shape of the indents, the size and the amount of load applied. Furthermore, this research are focus on the fatigue of conductive ink. Material fatigue, when subjected to a cyclic load, is a phenomenon where structures fail. Even when the experienced stress range is well below the static material strength, this type is structural damage occurs. The most popular cause behind mechanical structure failures is fatigue.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In this chapter will deal about the previous research that related to conductive ink according to material background, pattern of conductive ink and how to blend the filler, binder and epoxy become conductive ink. The literature review will discuss the material characterization of the conductive ink until the objective of this project which is the effect of free vibration energy on conductive ink.

2.1 Material background

Conductive ink is an ink that results in a printed object which conducts electricity. It is usually produced by infusing graphite or other conductive material into ink. Compared to conventional industrial standards, such as etching copper from copper-plated substrates to form the same conductive traces on relevant substrates, conductive inks can be more efficient way to lay down modern conductive traces, as printing is a strictly additive method that creates little to no waste streams that need to be recovered or processed.

Today, conductive ink has many applications and is widely used in metallic structure printing. However, in its early days, in wearable technology and e-textile industries were the greatest push behind its growth. The most significant factor in printing of metallic structures is the conductive ink. To this end, many conductive materials, such as conductive polymers, carbon, organic or metallic compounds, metal precursors and metal NPs, maybe considered. The majority of conductive inks are based metal NPs (Sreenilayam and Sithara P et al., 2019)

The thin film of conductive inks is a blend of conductive material that can replace a thin film in one flexible and thin electronic device, traditional and rigid electronic devices become one. Conductive ink is a conductive polymer composite, which the insulating polymer is mixed with nanoparticle conductive filler until it reaches the percolation threshold due to continuous linkages of filler particles. Epoxy resin is one of the most versatile polymer and it can be rouped into thermosetting resin and thermoplastic resin (Roberson, David A., Ryan B. Wicker, Lawrence E. Murr, Ken Church, & Eric MacDonald., 2011. Microstructural and process characterization of conductive traces printed from Ag particulate inks).

In addition, depending on the finished product, epoxy resin can be shaped into any desired form. Requirements and requires, and by adding the heat it can be healed. Conductive in some situations the filler must have the ability and low resistivity to conduct electricity. Yet, compared to its pure state, filled composite has greater resistance. Significant factors leading to thin film mechanical properties other than the flexible substrate are also the use of epoxy resin and its curing application. To a certain degree, versatile and wearable electronic devices need to be able to withstand dynamic loading. The solid atoms move from their loading equilibrium state and in order to preserve the initial shape, the restored force is induced to oppose the incidence of deformation (Roberson, David A., Ryan B. Wicker, Lawrence E. Murr, Ken Church, & Eric MacDonald., 2011. Microstructural and process characterization of conductive traces printed from Ag particulate inks).

This phenomenon illustrates the mechanism of solid mechanical activity in reaction to mechanical stress. In order to alleviate the mechanical stress as the load increases, defect forming and propagation appear. The effect of low cyclic loading and bending deformation on GdBCO coated conductor (CC) tape, which has strong bending deformation strain tolerance, was studied by Shin (2015).

2.2 Carbon Black

Due to exceptional mechanical and electrical qualities, carbon black is extremely attractive for the creation of flexible electronics on paper. Wet transfer and printing processes are often used to pattern carbon black on paper. Printing, in example, is a simple technology that enables for large-area, low-cost and scalable production procedures such as carbon black. Carbon black have recently been utilised to generate conductive pathway on paper for various application.

Energy storage, energy harvesting, electrochemical sensors, and printed heaters are just a few of the applications for carbon black. This necessitates precise control of electrical properties specific to the application; ink composition is a key component (Santhiago, M.Correa, Bernardes and Oliveira, 2017. Flexible and foldable fully-printed carbon black conductive nanostructures. Applied materials and interfaces).

Carbon black is frequently referred to as a miracle substance. Carbon black research has demonstrated how good the material's characteristics are. Electrical conductivity is also high in carbon black. However, some experts have noted that creation and deployment of high-quality carbon black in large quantities is a challenging undertaking. The properties of carbon black will be affected by its dispersion. Some research has been done on the graphene formulation in order to create a robust composite that can effectively conduct electricity. Some study is being conducted on the pattern of carbon black-based composites, as the