

# Conceptual design of stretching test rig for stretchable conductive ink

M.Z. Azmi<sup>1</sup>, N.H. Sobri<sup>1</sup>, M.A. Suhaimi<sup>1</sup>, N.S. Rozali<sup>1</sup>, and M.Z. Akop<sup>1,2,\*</sup>

<sup>1</sup>Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka,  
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

<sup>2</sup>Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka,  
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

\*Corresponding e-mail: zaid@utem.edu.my

**Keywords:** Conceptual design; stretchable conductive ink; stretchable test rig

**ABSTRACT** – With the growth of the usage of flexible and stretchable printed circuit using conductive ink in the industry, it is important to assess the reliability, performance and functionality of the flexible and stretchable printed circuit. Therefore, a stretchability test rig must be developed in order to test the stretchability of the stretchable printed circuit as well used in check the conductivity of the conductive ink when the stretchable printed circuit stretched. The stretchability test rig consist of three parts which is the main body, the secondary body and the holder. Attached to the main body is a handle which is connected with gear. The gear act as pinion for the rack which can adjust the length of the main body and the secondary body. Two holders will be used to clamp both end of the sample conductive printed circuit which then one holder will be attach to main body and another attached to secondary body.

## 1. INTRODUCTION

Conductive ink has a vary properties in which some of the conductive ink can be stretch, flex, bend, as well as other various properties [1]. With the various kind of usage of the products which use the conductive ink as well as the printed circuit, the need for performance and functionality of these conductive inks and printed circuit need to be conduct [2].

In this paper, the detail design of the stretchable test rig was made to perform the strain test on the stretchable printed circuit as well as the conductive ink. This stretchable test rig will allow the access on the performance of the printed circuit under strain test, which also include the conductivity of the conductive ink, the allowable of the four-point probe device to check the conductivity of the conductive ink and also the adhesion of the conductive ink on the stretchable circuit [3].

The objective of this paper is to design a stretchable test rig which will be used to determine the conductivity of the conductive ink under strain test of the stretchable printed circuit. The process involves in completing this paper are the detail designs of the stretchable test rig which also include the schematic diagram and 3D modeling.

## 2. RESEARCH METHODOLOGY

### 2.1 Product Design Specification (PDS)

In order to produce a product which satisfy the key requirement of the design functionality, PDS were made to ensure all the features need in the product design meet with all the requirements. Table 2.1 shows the PDS need in the stretchable test rig.

Table 2.1 PDS of stretchable test rig

Product design specification	
Stretchable test rig	
No.	Requirements
	Performance
1	1.1 Able to do stretchable motion
	1.2 Can allow four-point probe device to collect data on the circuit
	Dimension
2	2.1 Maximum height : 40mm
	2.2 Maximum width : 110mm
	2.3 Maximum length : 400mm
	Weight
3	3.1 Total weight : 0.07kg
	Material
4	4.1 Should be lightweight and corrosion resistance
	Safety
5	5.1 No sharp edge from the body of the test rig
	Ergonomic
6	6.1 Simple and easy to use
	Cost
7	7.1 Depend on the material cost
	7.2 Low maintainance cost

For the set up of the experiment, the stretchable printed circuit is attached with two holders from both two body. The holder is detachable from the body which allow ease of install the circuit with the holder. Figure 2.1 shows the set up of the circuit for testing.

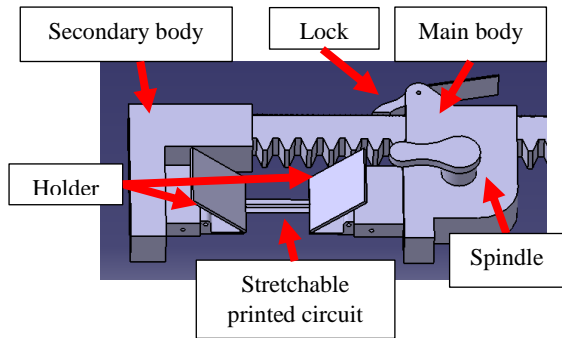


Figure 2.1 Set up of stretchable printed circuit for strain testing

During the testing, both holder will clamp both side of the circuit. When the spindle is turn, the main body will push the secondary body causing the printed circuit stretched. The lock mechanism will allow the test rig to hold the position when needed.

### 2.2 Detail Design of Test Rig

The test rig consists of three main part which is the main body, secondary body and holder.

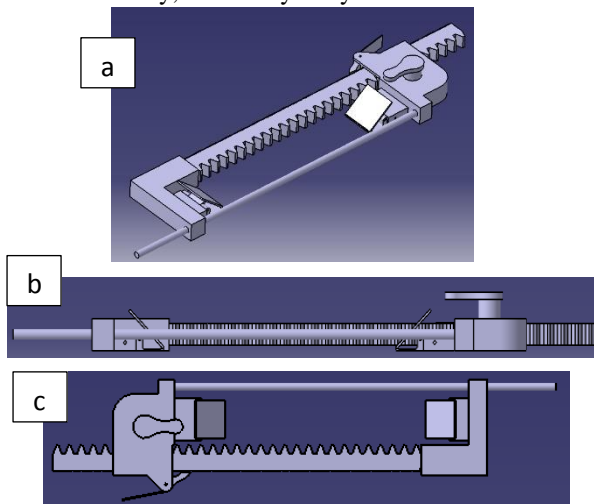


Figure 2.2 3D modeling of test rig (a) isometric view, (b) side view and (c) top view

Inside the main body, there are gear which attached with the spindle which allow the user to rotate. The gear is connected with the rack from secondary body where the body can push each other using the gear. A lock mechanism is used to hold down the rack from retract back the rig from the stretch from the circuit.

The secondary body only consist of rack, a slot for the holder and slot for a rod from main body. These rod function is to balance the rig when performing the strain test.

The holder function is straight forward where it will hold the circuit. It is detachable from the circuit for ease of install the circuit. When the suitable length

of the circuit obtains, the holder can be install to both body with a rod.

## 3. DESCRIPTION OF PROPOSED DESIGN

### 3.1 Advantages of Detail Test Rig

The stretchable test rig help in strain test as it is hard to constantly pull the circuit and maintain the length at same length. Without a proper tool, the data obtain cannot be consistent thus will lead to unreliable data.

The stretchable test rig is small and compact in size which easy to mobilize. The lock mechanism also important as it can hold the stretch of the circuit in the length needed.

## 4. SUMMARY

In this paper, the design of stretchable test rig was meant to be used for strain test on stretchable printed circuit and conductive ink to see whether there is conductivity change in the circuit when there is present of strain in the circuit. Ideally this test rig was designed to be used in a small and compact scale of circuit.

## REFERENCES

- [1] Tuomas, H. (2016). Reliability studies on printed conductors on flexible substrates under cyclic bending (Doctoral dissertation).
- [2] Norhidayah, A. A., Saad, A. A., Sharif, M. F. M., Ani, F. C., & Ali, M. Y. T. (2017). Stress Analysis of a Stretchable Electronic Circuit. *Procedia Engineering*, 184, 625–630.
- [3] Yu, X., Mahajan, B. K., Shou, W., & Pan, H. (2017). Materials , Mechanics , and Patterning Techniques for Elastomer-Based Stretchable Conductors, 22–31.