Michigan Pre-College & Youth Outreach Conference

November 14, 2017

Providing Access:

The Junior Science & Humanities Symposium

WAYNE STATE College of Education

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Michigan Youth & Pre-College Conference

What is the Junior Science & Humanities Symposium?

The Junior Science & Humanities Symposium (JSHS) is designed to challenge, engage, and publicly recognize high school students (Grades 9-12) who are conducting research in the sciences, technology, engineering, or mathematics (STEM).

Individual students compete for scholarships and recognition by presenting the results of their original research efforts before a panel of judges and an audience of their peers.

Program of the AEOP, supported by the Army, Navy, Air Force, and Academy of Applied Sciences, and the regional institution:

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What is the Junior Science & Humanities Symposium?

THE 53RD ANNUAL MICHIGAN REGIONAL JUNIOR SCIENCE & HUMANITIES SYMPOSIUM

WILL TAKE PLACE:

March 10, 2017
at
Wayne State University,
McGregor Conference Center

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What is the Junior Science & Humanities Symposium?

Participation in JSHS provides Opportunities for:

- Career/College exploration-
  - Participate in a forum honoring individual achievement in STEM
  - Develop & practice skills to help prepare for future pursuits in STEM fields
  - Hear nationally renowned scientists speak on their work
  - Research lab visits
  - Qualify for significant scholarships and other recognition

- Peer discussions and networking-
  - Conversations with peers who have similar interests
  - Hear research presentations by other students
  - Possibility to advance to the National Symposium

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- Students who present their research at the Symposium have the opportunity to receive *significant scholarships*
  (Payable on matriculation to the University of their Choice)
  - ***Regional Symposium***

    -The Academy of Applied Sciences will distribute $4,500 in academic scholarships to the top three regional finalists:
    - **$2,000** to first place
    - **$1,500** to second place
    - **$1,000** to third place

    -An ALL-EXPENSE-PAID trip to the ***National JSHS*** awarded to five finalists at each regional symposium ***(2017- San Diego, CA)***

    -A **$500 award to the teacher of the 1st place finalist**, honoring that teacher's and their school's contributions to advancing student participation in research

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- ***National Symposium*:**

  - The Academy of Applied Sciences in cooperation with the AEOP distributes awards to the top 3 finalists in the **National Research Paper Competition,** in each of the divisional categories from among all 48 regions:
    - 1st Place: **$12,000**
    - 2nd Place: **$8,000**
    - 3rd Place: **$4,000**

  - Tri-service sponsored awards for excellence are also presented to students who participate with **Poster Presentations** of their research in each category**:**
    - 1st place: **$1,000**
    - 2nd place: **$800**
    - 3rd place: **$600**

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How to participate in the JSHS

Visit: http://coe.wayne.edu/ted/science/jshs

- **Click on the tab *How to Participate* , and then click *Start Here***

  - **Access the linked information, resources, and guidelines for applying to participate in JSHS- including format & submission of:**
    - **abstract,**
    - **research paper**
    - **poster**

  - **Electronic registration procedures for permission & approvals from:**
    - **parent**
    - **sponsoring teacher**
    - **research mentor**

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Judging Categories:

- Biology- Genetics, Medicine, Bio-chemistry
- Chemistry- nanotechnology, materials
- Physics- biophysics applications, astronomy
- Mathematics
- Engineering- applied science

Paper Topics of Finalists from Past Symposia:

- *The Longevity of Carbon, Graphite, and Silver Based Strain Gauges*
- *Effect of Cucumber Fruit Peel Extracts on Inhibition of Phytophthora Capsici growth and Infection*
- *Interaction Between CD47 and EGF Receptors in Breast Cancer Stem Cells*

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The Longevity of Carbon, Graphite, and Silver Based Screen Printed Strain Gauges

by

[redacted]

Abstract

The purpose of the research was to discover the effect of repetitive strain on carbon, graphite, and silver based screen printed strain gauges. Three sensors of each type of ink were printed and each sensor was either subject to 10,000 cycles at either one , three, or five mm. The data was captured through a custom LabView program and read from a precision LCR machine. The force was applied via a Mark-10 motorized test stand. The data was then evaluated by a custom java program run in the Eclipse text editor (program available in paper) that determined the resistance at the both the point of highest and lowest force. The data was then graphed in order to determine how the sensors responded to repetitive loading and unloading. At the end of the research it was concluded that silver shows an increase in resistance for the same amount of force after repetitive strain and graphite and carbon both show a decrease in resistance after repetitive strain. The greater the net amount force applied to the sensor , the greater the difference in resistance after 10,000 cycles.

Introduction

Strain gauges measure the strain applied to a surface by examining the change in resistance of a conductive wire on the sensor (Hay, 2007). Primarily strain gauges are solid silicone based devices that provide both accuracy and durability; however they are expensive unless ordered in large amounts. Also due to the nature of their silicone substrate they do not have a large amount of capacity to bend. Printed strain gauges on flexible substrates have the ability to act as a low cost alternative to solid silicon based sensors while also providing a higher degree of utility (White, 1997).

Printed strain gauges are produced through a process known as screen printing. Screen printing is an old technology used in the mass production of printed material but has only been used relatively recently in the application of printed electronics. The screen printing of electronics requires a conductive ink to be printed onto a non-conducting substrate. The actual process of screen printing relies on the placement of ink onto a screen with a predrilled template; the ink is then pushed into the holes leaving the sensor on the substrate (White, 1997). Through screen printing a sensor component of no smaller than 50µm can be consistently created, this is significantly larger than that of a silicon based sensor and so the complexity of circuits that can be created through this process is significantly lower.

Another advantage of screen printed over solid strain gauges is the wide variety of applications that they can be applied in due to the many types of inks and substrates that a strain gauge can be printed on. The use of these different inks and substrates gives different innate properties to the sensor allowing it to excel in different circumstances (Merilampi, 2010). While the ability to use many different inks and substrates gives screen printed strain gauges many advantages it is also makes it impossible to determine the properties of each type of sensor. This research hopes to examine the longevity of carbon, graphite, and silver based inks on a PET substrate.

Methods

1. Attach small nonflexible wires to the strain gauge to act as a anchors later on for other wires by dipping the ends in epoxy resin and then placing it onto the conductive pads at the bottom of the strain gauge before firing in the furnace for twenty minutes.
2. The sensor is placed printed side facing up onto the bar attachment for the mark-10 ESM301 test stand (see figure 1).
3. Wires are attached to the soldered wires on the strain gauge (see figure 3) and are led away from the test stand to a stable location, lots of slack is left in the wire to allow for free movement and to guarantee no external force acts upon the sensor.
4. Using alligator clips the wires are then connected to the Agilent e4982a precision LCR meter (see figure 2).
5. The Agilent e4982a precision LCR meter is then connected to a PC via USB.
6. Data from the Agilent e4982a precision LCR meter is read from the PC using a custom LabView program and is written to a custom .txt document for later evaluation.
7. After the 10,000 cycles have been repeated the LabView program is ended stopping data collection.
8. In the event that the LabView program is not ended at the same time that the 10,000 cycles have ended it is necessary to look at the data and find where it stops, this is visible by looking for a stream of data that is all the same or close to the same value, remove that section of the data and continue.
9. A custom java program compiled in the Eclipse text editor is then run on the data , change constant values until a smooth curve is achieved.

Data Acquisition

Figure 1: mark-10 ESM301

Figure 2: mark-10 ESM301

Figure 3: Pc

Results

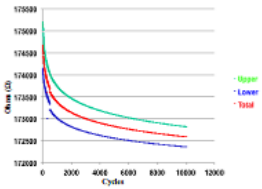

Figure 4a: Carbon 1mm

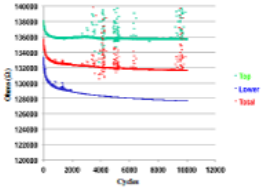

Figure 4b: Carbon 3mm

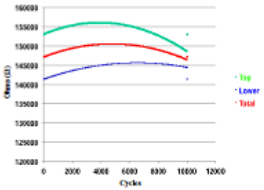

Figure 4c: Carbon 5mm

Figure 4: The three different tests for carbon

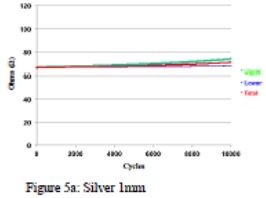

Figure 5a: Silver 1mm

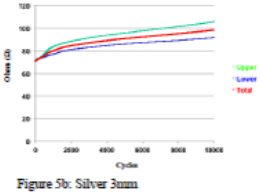

Figure 5b: Silver 3mm

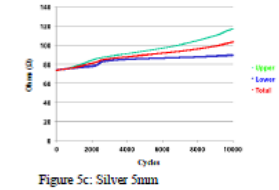

Figure 5c: Silver 5mm

Figure 5r: The three different tests for Silver

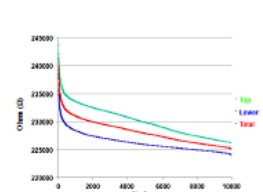

Figure 6a: Graphite 1mm

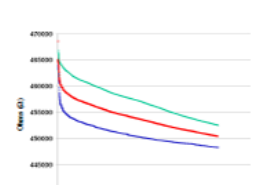

Figure 6b: Graphite 3mm

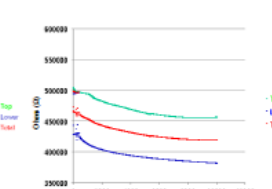

Figure 6c: Graphite 5mm

Figure 6: The three different tests for carbon Graphite

Conclusions

Three different inks were used to print three sets of stain gauges that were then tested for 10,000 cycles at three different lengths one three and five mm. Silver experienced an upward trend over time with the 5 mm test experiencing the greatest level of change in resistance from the start of the test to the end, this was to be expected as the strain gauge experienced the greatest amount of force over the course of the test. Carbon experienced a downward trend in all three cases, the graph in figure 4a appears to be steeper than the ones in either 4b or in 4c but that is because it is on a much smaller scale. While proportionally to the rest of the graph the change was allot more pronounced than in either of the other tests in relation to the total resistance changed it was not the greatest. Figure 4c shows the data from the 5mm test, it appears to have an upward ark that then begins to turn down, this could be caused due to movement in the sensor while testing or an imperfection in the strain gauge. In the unanalyzed graph for the test (available in paper) there is very little change in the beginning part of the graph, it is only in the latter portion of the graph that any trend becomes truly apparent and it becomes clear that there is a downward trend. The fact that the graphs in the figures only look at data taken when the sensor was at its highest and lowest applied force means that in some graphs such as figure 4c there is an apparent trend where there is none. Graphite also had a downward trend for all of the graphs with the steepest descent being at the beginning and then becoming more shallow as the graph goes on. The upper and the lower bound begin to become closer as meaning that the sensors precision at picking up differences in force is diminished. All three types of ink showed an increase or a decrease in resistance as the test continued, the difference in the start resistance and the end resistance was more pronounced when larger amounts of force were applied.

References

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•Lastly, I would like to thank my parents for supporting me and providing rides to and from research meetings.

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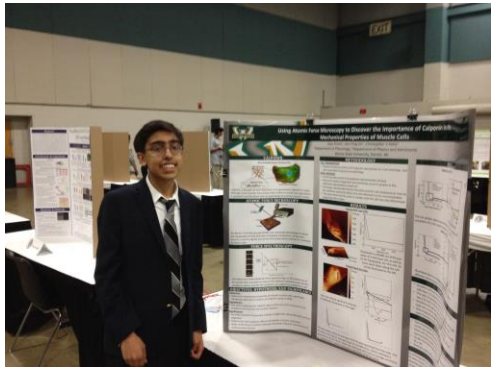
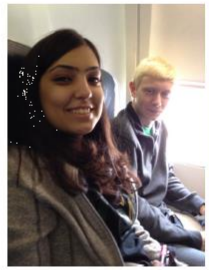


Finalist Presentation

National JSHS Tour of Walter Reed Army Institute of Research

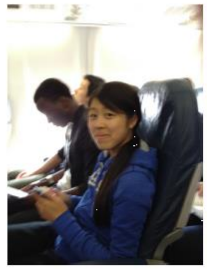


Flight to BWI

Finalists at National Awards Banquet

2015 Finalists on National Mall

Isabel Hsu Finalist Presentation



Isabel on Airline

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Walter Reed Army Institute of Research, Baltimore, MD (2015)
Wright-Patterson AFB, Dayton, OH (2016);
Point Loma Naval Research Center, San Diego, CA (2017)

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- **The deadline for submission of student research papers and application materials is January 15, 2017**
  - The Symposium is a valuable resource for students who plan to participate in this year's Science Fair and/or Science Olympiad.
  - All the application forms, guidelines and other information are available at:

http://coe.wayne.edu/ted/science/jshs

For additional information **contact:**

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