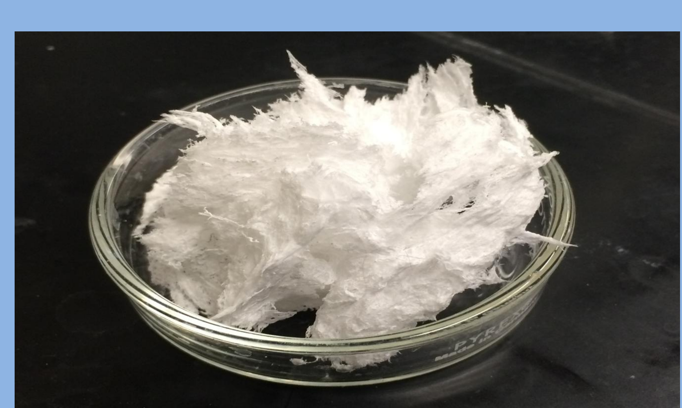
Eco-Friendly Electronics

Canada
Syncrude
ISEST
UNIVERSITY OF ALBERTA

Department of Chemical and Materials Engineering
Kaylin Lynett,, Preetam Anbukarasu, Michelle Hoang, Dr. Anastasia Elias

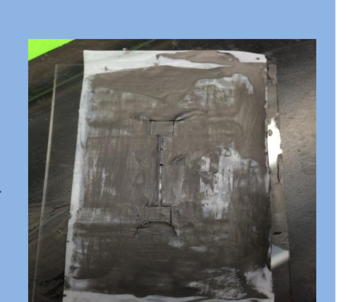
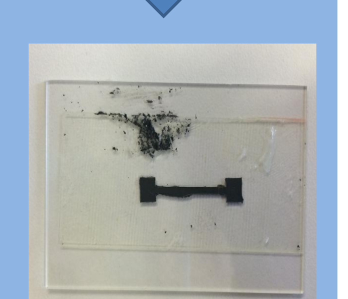
Introduction

- Approximately 40 million metric tons of electronic waste (e-waste) are disposed globally each year. Only about 13% of that e-waste gets recycled. Most of the e-waste gets exported illegally from developed countries into developing ones, where e-waste is burned, releasing toxins into the air and soil.
- Most plastics aren't biodegradable, therefore disposing of them is another major problem. However, we worked with a biodegradable polymer (plastic), which is produced naturally by bacteria.
- The thinnest and smallest material known to man is graphene. It is the two-dimensional form of carbon. It has one of the best electrical conductivity of any material.
- By combining an eco-friendly polymer and graphene, a biodegradable conductor was created.




Methods

1. Dissolved the polymer in chloroform and added various concentrations of graphene. Then poured the solution into molds made of Polytetrafluoroethylene (Teflon), and tested their resistance.
2. Used a sonic dismembrator (sonicator), to see if it would help the graphene be more evenly distributed.
3. Used a different solvent to dissolve the polymer. Therefore instead of using chloroform we used acetic acid.
4. Did degradation testing, using an enzyme.

http://www.tm.mahidol.ac.th/en/tmcl/tmcl_equip2.htm

Results

WHAT IS ELECTRICAL RESISTANCE?

- Resistance is a materials' opposition to the flow of electrical current. Therefore a high resistance means that it is harder for electrons to travel through the material. We want a low resistance in our composites.

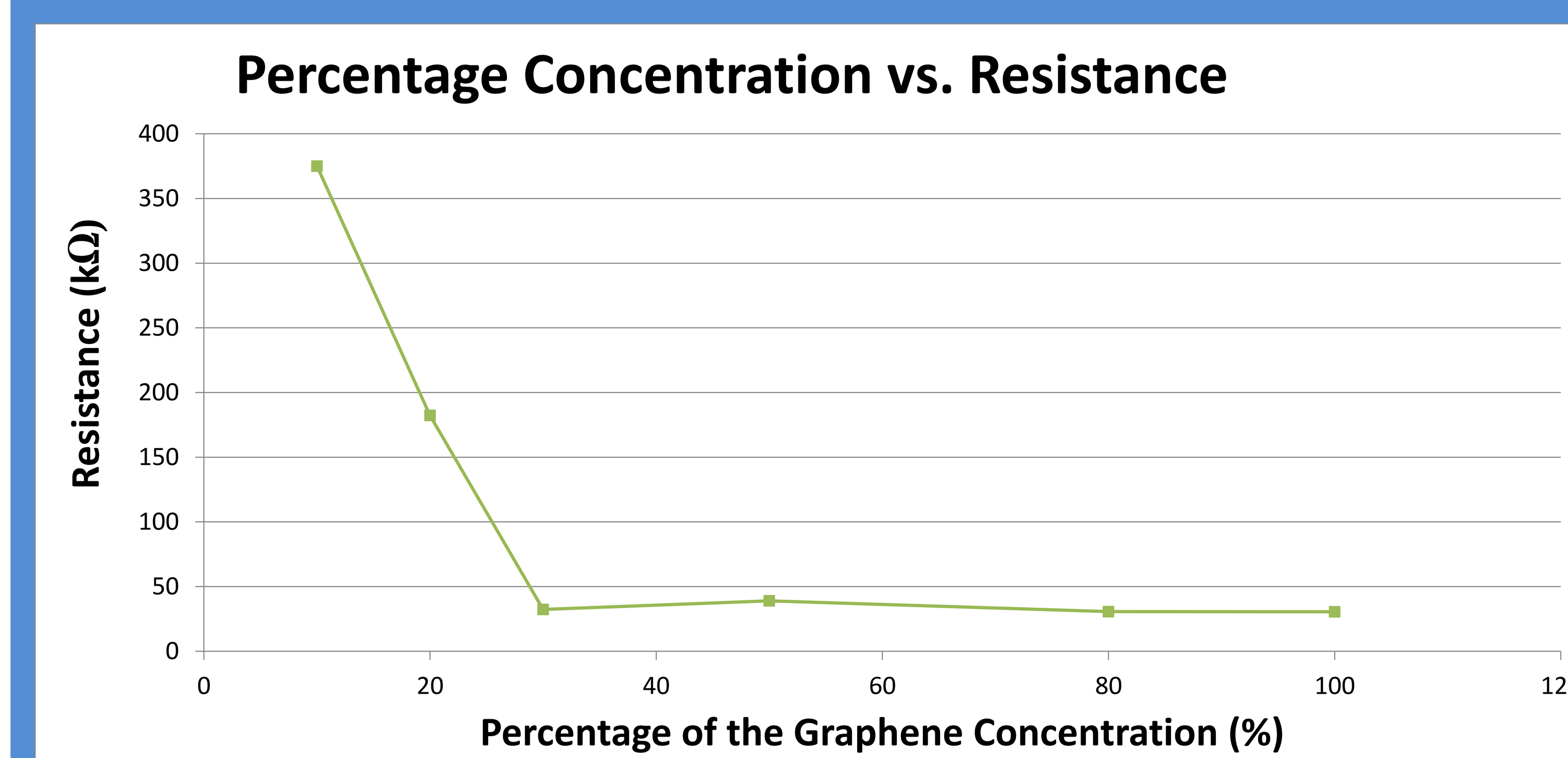


Figure 1.1 The higher the concentration of graphene the more conductive the channel. Above 30% graphene, the resistance stays constant.

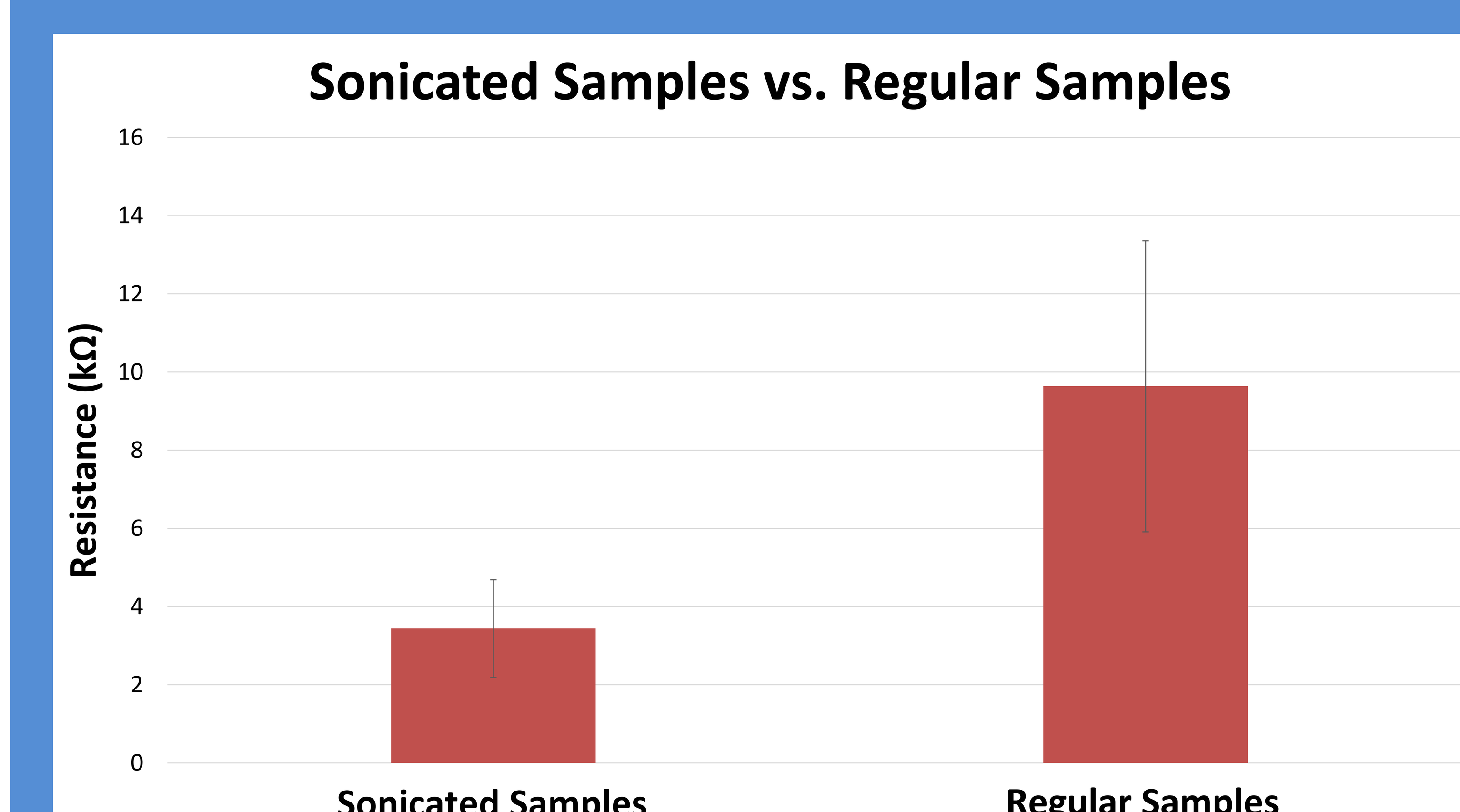


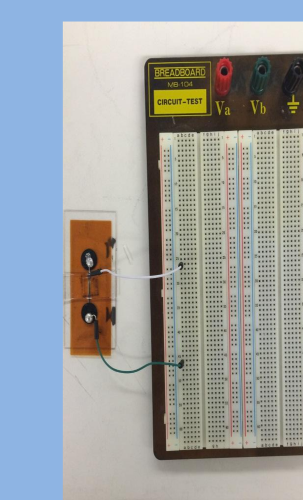
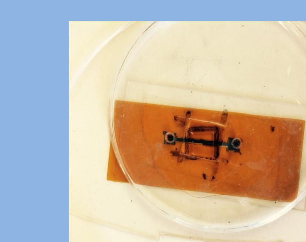
Figure 1.2 Using the sonicator we found that the overall resistance of the samples was lower, suggesting that the graphene was better dispersed.

- Two different samples with 30% graphene were made, one with chloroform as the solvent and the second with acetic acid.
- The results were comparable, the resistance of the sample with chloroform had an average of 76 kΩ, and the average resistance for the acetic acid samples was 100 kΩ.

Results Cont'd

DEGRADATION TEST

- Surrounded the sample with Kapton (the orange material in the pictures), and then placed a polydimethylsiloxane (PDMS; a silicon-based organic polymer) sample on it, which contained a slot so we could pour the enzyme on.

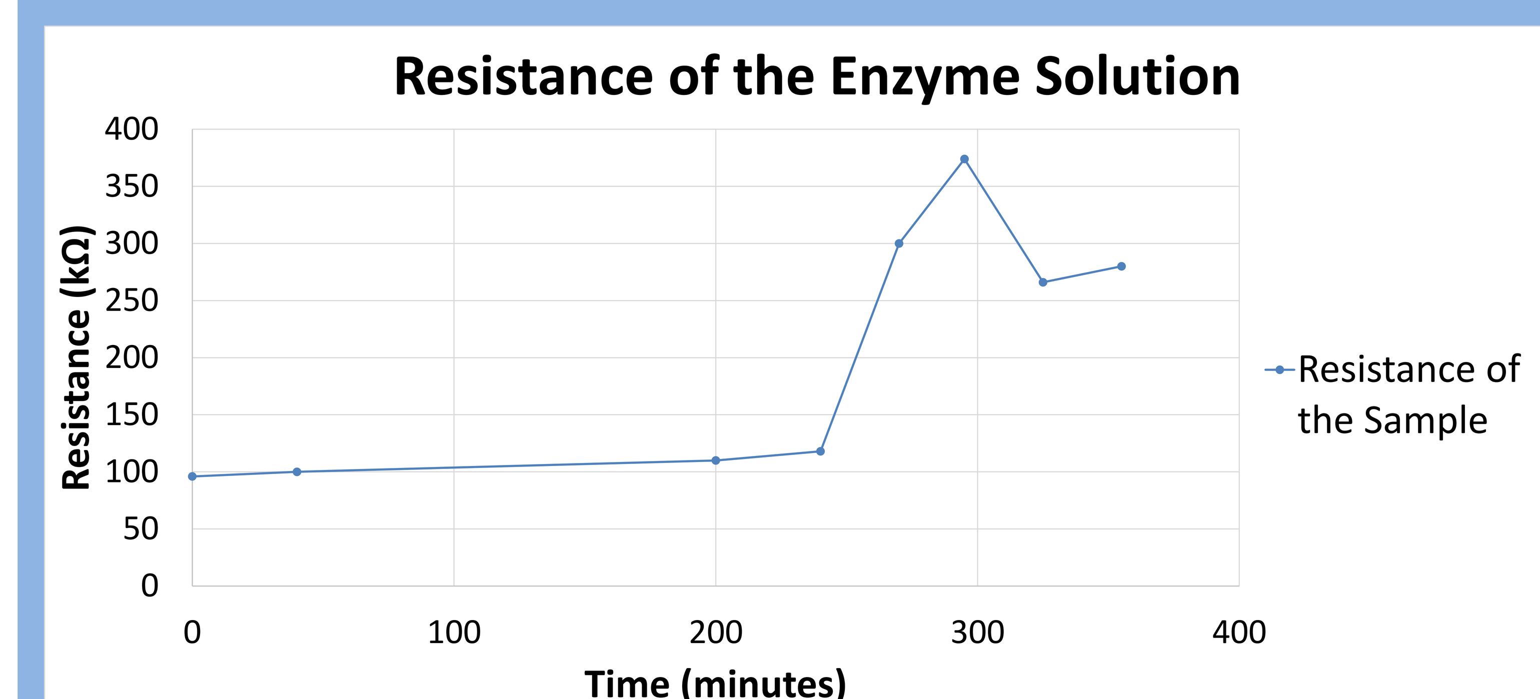



Figure 1.3 Demonstrates how the resistance changed the longer the enzyme was on the sample.

Conclusion

- These results represent that after reaching 30% concentration of graphene, the resistance remains almost constant.
- Sonicating the graphene/polymer mixture before casting reduces resistivity.
- The enzyme used is produced naturally by bacteria and could be found at electronic dump sites. Therefore, the degradation testing is proof that the channel will biodegrade.
- Therefore, this channel could potentially be integrated into everyday electronics to make them more eco-friendly.

References

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