Large area deposition of printable electronics

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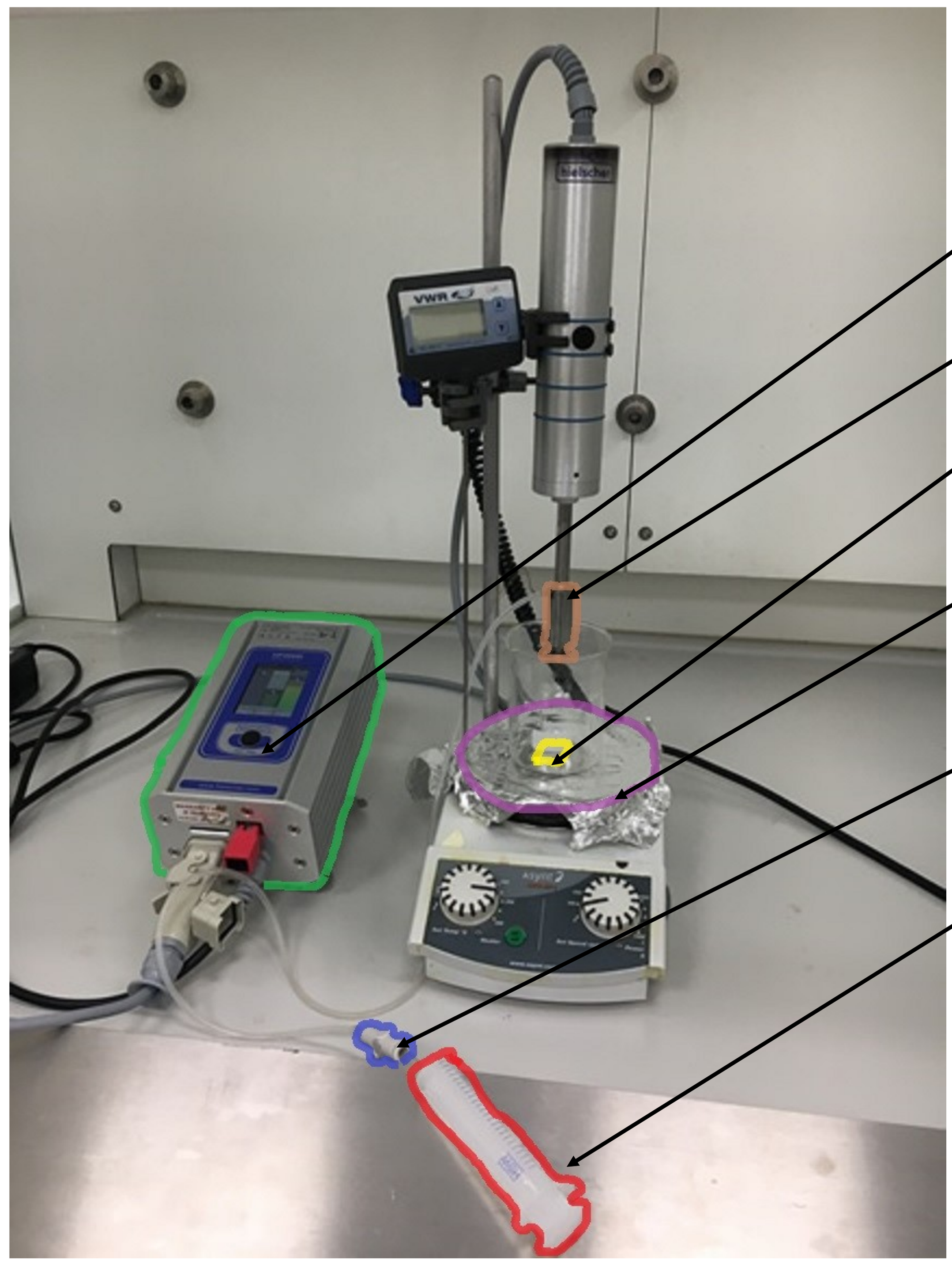
Background & Motivation

Printed electronics are a promising emerging technology with many applications such as flexible electronic devices, wearable electronics and biomedical devices. Inkjet printers are the most widely used type of printer due to the variety of useable substrates and a cost-effective system. The most common form of electronic device printing is inkjet, but spray printing, if properly implemented can achieve atomic precision for cheaper. Spray printing is a technique in which an ultrasonic pulse is used to vaporise particles which have been dissolved into a solution (such as deionized water) and then to spread them over a sample.

Project aims

- To create electronic device spray printer.
- Equip it with user interface for easy control.
- Test it by printing samples of graphene oxide.

The goal is to produce thin films of material with an even coating as this is the best for producing electronic devices.



Temporary setup:

Ultrasound generator/ control box

Spray head

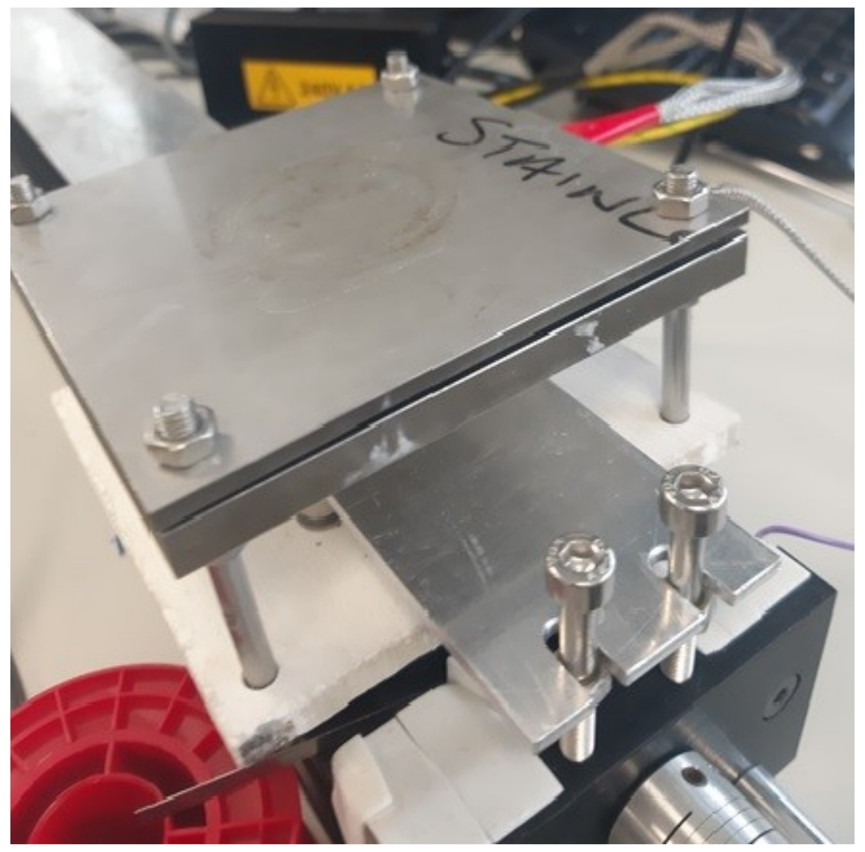
Sample

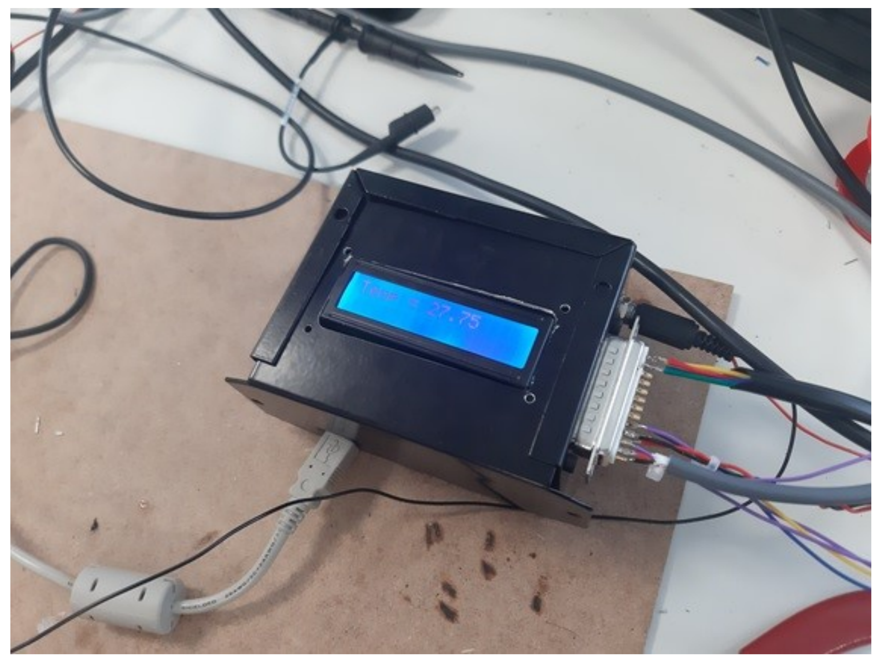
Temporary stationary hot plate

Flow controller/ limiter

Syringe used to supply flow

Final product





- User interface is simple to understand and use.
- Many parameters such as spray type and power can be easily customised.
- Comes equipped with a custom built hot plate for vapour control.
- All electronics are kept in a watertight container and controlled via a USB type A connection.
- Setup has been installed into a glove box so that it can be used to print with hazardous materials as well as graphene oxide.

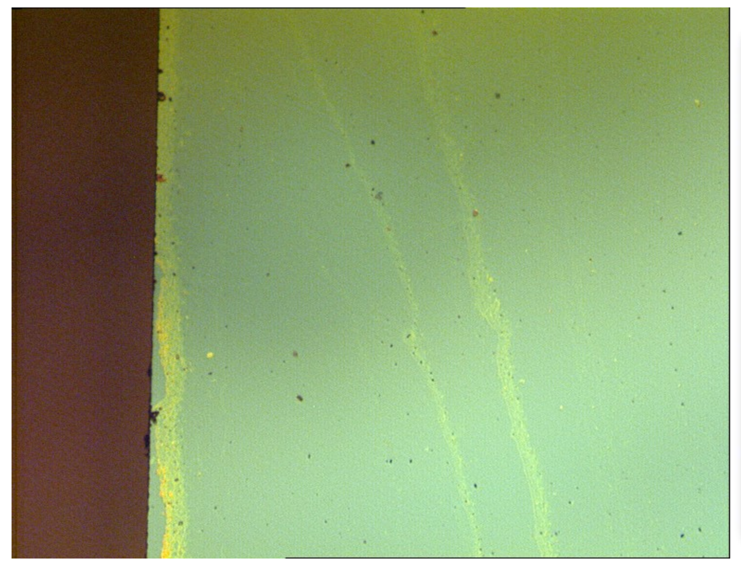
Results and explanations

Several samples of Graphene Oxide where successfully sprayed down and analysed. Graphene Oxide forms 2D monolayers (layers of 1 atom thickness). When being sprayed from water the graphene oxide will split into thin flakes and lay horizontally down on the surface. These flakes can be seen clearly in picture 2.

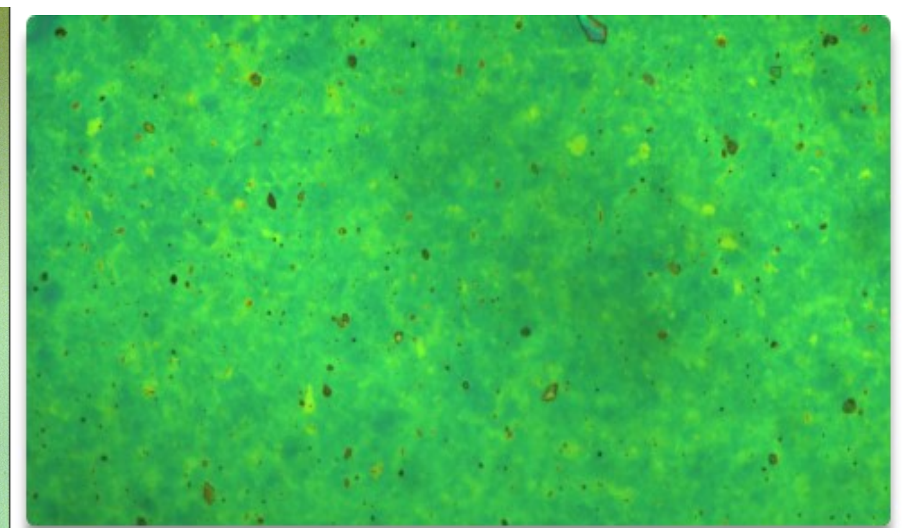
It can also been seen in picture 1 that the flakes will form an even layer with a "coffee ring" effect at the edges of the spray cone. This effect causes a lot of unevenness meaning it will reduce the effectiveness of a Graphene Oxide transistor.

Higher concentrations allowed for full coverage of the silicon base but also lead to a more uneven coverage.

This was remedied by having the sample pass under the spray head multiple time over a long period of time while the spray was operating with a fine mist and a low concentration of Graphene Oxide.



(1) Visible graphene layers



(2) High concentration experiment: 1ml of GO in 20 ml of deionized water

Conclusion

The goal of producing an automated electronic device spray printer was successfully fulfilled . In addition several samples where produced and analysed. The quality of these samples varied but through experimentation the technique was refined to produce thin films of a consistent quality. If I was to continue this project I would further refine my technique until I could produce a working graphene oxide transistor.

Acknowledgements

- I would like to thank Dr Toby Hallam & Dr Pablo Docampo for giving me the opportunity to grow my skills and network with experts in a field I am interested in.
- I would like to thank Andrea Dawson and Thomas Coulson for providing a space for me to work and assisting with technical details.
- I would also like to give a special thanks to Nathan Hill, a PhD. student who assisted me in various ways throughout the project.
- Finally I would like to thank Dr Joshua Karlsson for supervising me while I was conducting laboratory experiments.