Master's Thesis Engineering Technology

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Innovative setup to measure bulk conductivity in battery electrodes

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Introduction

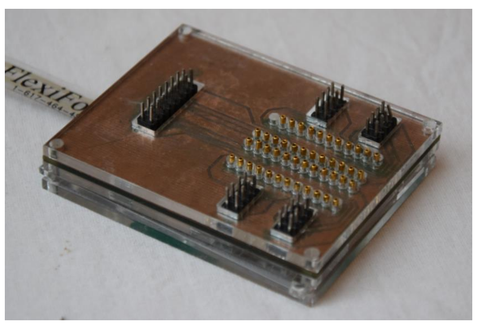
- A Lithium-ion battery's (LIB) performance is affected by its transport properties (ionic conductivity & electronic conductivity).
- The electrode microstructure of a LIB is the most important factor that determines these properties and is influenced by both the composition (non-uniformities) of the electrode components of the LIB and the manufacturing process.
- They can cause local variations in the electrode microstructure.

Objectives

- Gain insight into the limiting factors that result in battery performance deterioration
- Measuring the **local electronic conductivity variations**
- Build a **bulk conductivity** measurement setup, which gives the through plane resistance

Setup 1

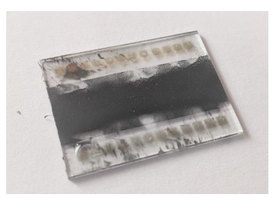
Pogo Pin Probe



- Pogo Pins contacting a glass sample substrate
- Sample has a gold sputtered probe pattern

Results 1

- **Fragile probe pattern** prone to braking
- **Shadows** in probe pattern give short circuits between probe lines
- **Long** preparation time



Damaged sample

Surface resistance of Pogo Probe compared to 4PP

Surface resistance (Ω)	Ossila 4PP	Pogo Probe
AVG	2.5875529	6.5169382

Setup 2

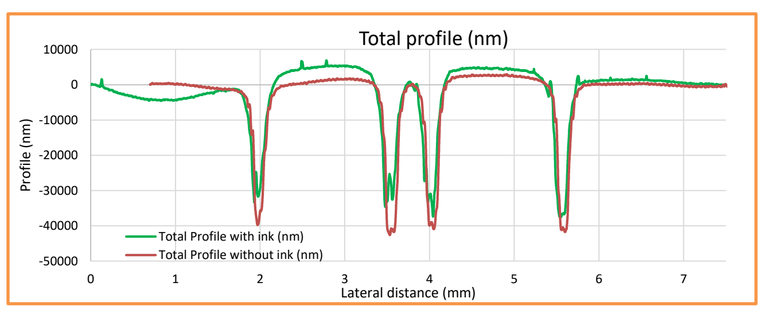
3D Printed Probe

- 3D Printed top and bottom probes
- Screen printed probe pattern with silver ink

Results 2

- **Broken** screen printing **mask**
  - No decent probing pattern
- Ink does settle into micro lines
- No measurements possible

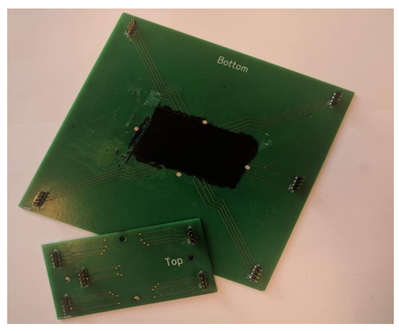
Broken printing mask



Profile of 3D Probe micro lines before and after ink screen printing

Setup 3

PCB Probe



- PCB top and bottom probes
- Exposed copper traced as probe patterns

Results 3

- **Detection** of regional resistance differences **possible**
- **Connection difficulties** between top and bottom probe for **bulk** measurements
- **Easy** usage and repeatability

Surface resistance of different regions of a coat, compared to Van der Pauw method

Surface resistance (Ω)	PCB Probe	Van der Pauw method
Top Left	63.8	
Top Right	39.19	
Middle	37.29	
Bottom Left	43.4	
Bottom Right	52.84	
AVG	47.30	450

Bulk resistance of middle probe (sufficient pressure applied)

Bulk resistance (Ω)	PCB Probe
Middle	25,85

Conclusion

- The Pogo Pin Probe could be improved by using less destructive pogo pins (less spring force), but it does not outweigh the disadvantages of the preparation time and the fragile nature of the gold sputtered probing pattern.
- The 3D Printed Probe is a promising method as the topography of the probe is the least non-destructive. Extra tests need to be conducted with a better, more rigid mask before measurements can be made to check the viability of this method
- The PCB Probe gives the best results and is able to show spatial differences in a battery electrode coating. It is easy to use and reusable. Extra research is needed to see if the measured resistance compares to that measured with existing setups. Improving the topography of the micro lines will result in a less destructive probe and improve results.

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