

Producing educational resources about electrode manufacturing

Using a board game to explain electrode production and cell assembly



Tabitha Seymour¹, Pengcheng Zhu², Elizabeth Driscoll², Peter Slater¹

1. School of Chemistry, University of Birmingham, Edgbaston, B15 2TT, UK

2. School of Metallurgy and Materials, University of Birmingham, Edgbaston, B15 2TT, UK

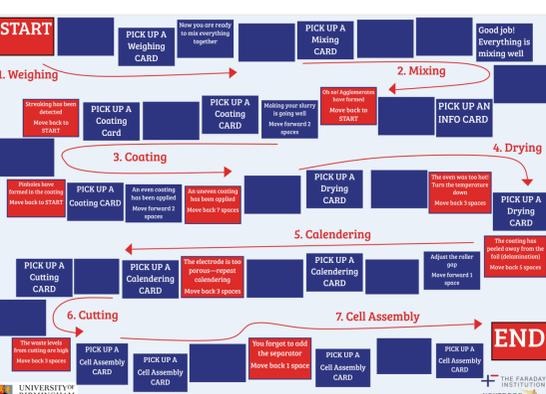
ABSTRACT

The aim was to produce educational resources for students, allowing them to understand and engage with the process of making electrodes and batteries.

- A battery board game, infographics and TikTok videos outlining the 'try-at-home' activity were created
- As part of the 'Behind the Lab Specs' series, two interviews with post-doctoral researchers at ISIS Neutron and Muon source were filmed and edited.

BATTERY BOARD GAME

- The board game is designed to guide students through the seven main stages of electrode manufacturing
- 'Info' cards contain detailed information and QR code links to infographics, videos and websites
- 'Action' cards have true or false and multiple-choice questions that allow the students to test their knowledge as they move around the board
- The red squares on the board are defect squares, including defects such as uneven coatings. Landing on these squares incurs penalties, such as moving back spaces or even moving back to the start.



INFO
Weighing involves measuring out the required proportions of each ingredient
The standard percentages used are often-
Active material = 96%
Conductive carbon = 2%
Binder = 2%
Solvent is also added to make an ink that is coated onto either Al or Cu foil (current collector)

ACTION
Making your electrode is going well, spin again to move forward more spaces

ACTION
Scan this QR code to learn more about ADDITIVE MANUFACTURING a new method that is being used to make electrodes

INFO
There are 3 different stages of drying
1. Solvent evaporation from the surface and film shrinkage
2. Removal of solvent from deeper within the coating through capillary action and diffusion to the surface
3. Gaseous removal of the final solvent
Drying oven

INFO
A. Schematic diagram of a low porosity electrode
B. Schematic diagram of a high porosity electrode

MOTIVATION

Science can often be confusing and inaccessible to younger students, so the opportunity to develop inventive new educational materials will ensure students of all abilities can engage with the content. ¹. The board game allows students to interact with their peers, learn about the electrode manufacturing process and test their understanding by answering the quick-fire questions added to the playing cards.

ADDITIVE MANUFACTURING OF ELECTRODES

Also known as 3D Printing!
There are many methods used in additive manufacturing, the most common being Direct Ink Writing (DIW)
This is very similar to piping icing onto a cake

Slurry casting is a conventional manufacturing process for Li-ion battery electrodes, which has low controllability over electrode architecture and geometry
3D printing is a more versatile technique that can produce electrodes with highly controlled architecture and geometry

Images of the slurry coating process

Images of the 3D printer used in the lab

The electrode slurry comes out of the nozzle
The nozzle is attached to machinery that can move it up and down the coating plate, allowing different shapes and patterns to be made

3D printing can also help to reduce waste, making the process more sustainable than slurry casting

Scan to find out more about an activity where you can make your own structured electrode!

A - Schematic illustration of 3D printed self-supported LFP electrodes
B - SEM images of three types of 3D printed LFP electrodes

Twitter handles: @t_seymour5, @PengchengZhu8, @EHDriscoll, @prslaterchem, @emjwils, @energymatbham

STRUCTURED ELECTRODES

Try '3D printing' yourself!

EQUIPMENT

- Buttercream style icing
- Piping bags
- Small hole piping nozzle / scissors
- Tinfoil
- Spoon
- Pen

METHOD

- 1) Either add the piping nozzle to the bag or cut the tip off the bag so there is a small hole
- 2) Fill the piping bags with the icing
- 3) Draw an outline of the pattern you would like to pipe onto the tinfoil
- 4) Begin to pipe the icing onto the foil
- 5) Experiment with how easy it is to make different shapes and patterns
- 6) Layer over the icing and see how lattice and layered structures can be made

Scan this QR code to watch a TikTok video demonstrating the process!
In this activity, you are mimicking the process of direct ink writing of electrodes in Li-ion batteries

As you can see, piping the icing onto the foil does allow much greater control of the shapes and patterns you create, however it is much slower than spreading the icing onto the foil using the back of the spoon. This is a disadvantage for industry where the coating needs to be applied quickly on a large scale

Twitter handles: @t_seymour5, @PengchengZhu8, @ZoeHeppibah, @EHDriscoll, @prslaterchem, @energymatbham

INFOGRAPHICS AND STRUCTURED ELECTRODES

- The infographics focussed on the advances being made in electrode manufacturing, such as optimisation of thick electrodes, using templating to control porosity and additive manufacturing to make structured electrodes²

Scan to view the 'Structured Electrodes' infographic



Scan to watch the TikTok video demonstrating the activity



CONCLUSIONS

The game was played with undergraduate students and a non-scientific audience; players commented that the game was fun and informative. It was promising that players of all ages were able to answer the questions correctly, proving the educational aspect of the game.

REFERENCES

- 1 - R.Y. Bayeck, *Project Management Journal*. 2020;51(4):86-100
- 2 - R.Gonçalves, S.Lanceros-Méndez, C.M.Costa, *Electrochemistry Communications*, **135**, 107210,1388-2481, 2022

NEXT STEPS

- Test the game in a classroom environment with Year 9+ students
- Expand the board game to include the continued research being conducted by the Nextrode Project
- Relate the board game to the other Faraday projects

INTERN BIO

Tabitha Seymour has just finished her first year studying Chemistry at the University of Birmingham. She is interested in synthetic chemistry and aspires to work in academia to continue the research towards creating a more sustainable future.

