ROLLING A DICE TOWARDS DISORDER

Developing outreach materials for the CATMAT project

Jade Doody[1] Jaime-Marie Price[1], Elizabeth Driscoll[2], Peter Slater[1]

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 of my project was to create outreach materials for the CATMAT project, including producing new content for the Behind the Labs Specs video series.

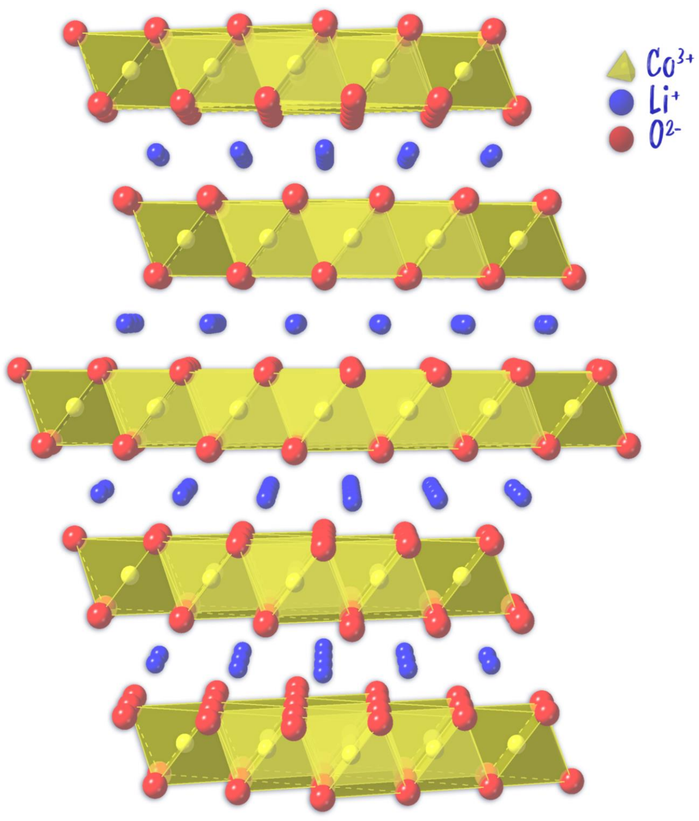
The CATMAT project research focus is on developing the next generation of cathode materials, which includes the replacement of cobalt from current technologies and identifying novel chemistries. One area of interest is disordered rock salts systems (DRS), and so educational resources to explore this topic were produced. The use of DRS can give very high capacities and help to eliminate Co.[2]

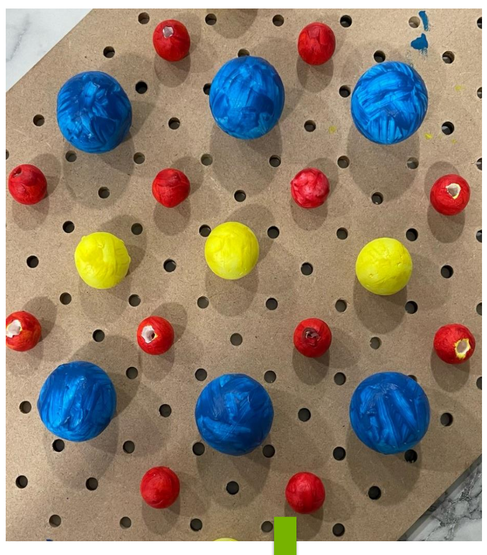
MOTIVATION

- Learn more about the battery sector and develop outreach activities, to inspire the next generation and to make current research accessible.
- Develop a tactile model to explore complex structures and defects.

OUTREACH MATERIALS
PEGBOARD MODEL

Building on the use of a pegboard model, used previously to explore defects[3] within crystal structures, this internship focused on using this simple model to explain DRS structures. The starting model replicates the layered structure found in $LiCoO_2$. The introduction of disorder into the structure was dictated by the roll of a dice. Depending on the returned value either no structural changes were made, or the lithium and transition metal ions exchanged positions, hence generating disorder.

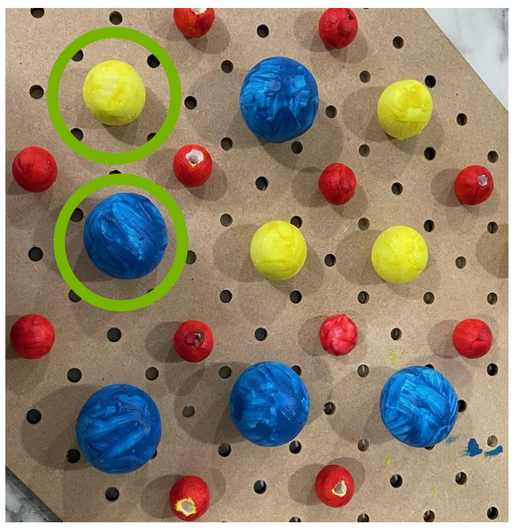




Layered $LiCoO_2$

If the dice's value after rolling was between 1 or 3, the lithium ion is swapped with the corresponding ion in the next layer (not oxygen).

If the dice lands on 4-6, the lithium ion doesn't move.



Disordered $LiCoO_2$

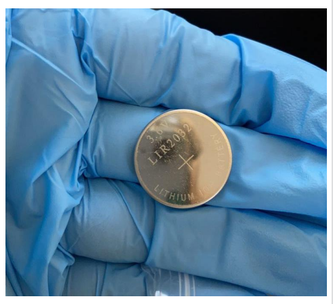
BATTERY INTERN DEVELOPMENT

During my placement, I was involved in the production of "Behind the Lab Specs" videos for: Diamond Lightsource Ltd., DLG Autoservices and Ecobat – these videos will be available later this year. I learnt a lot during these visits from how beamlines work and how they're used to study new materials and structures, to why insurance companies are interested in how electric vehicles work and how to recycle/repair lithium ion batteries.

I also had the opportunity to learn more about the battery field, with hands on lab work, which involved the fabrication of Li half coin cell along with lithium titanate.

Site visit to Ecobat

Outreach at the Think Tank



The coin cell I made in the labs

UNIVERSITY OF BIRMINGHAM
Behind the Lab Specs

DLG AUTO SERVICES

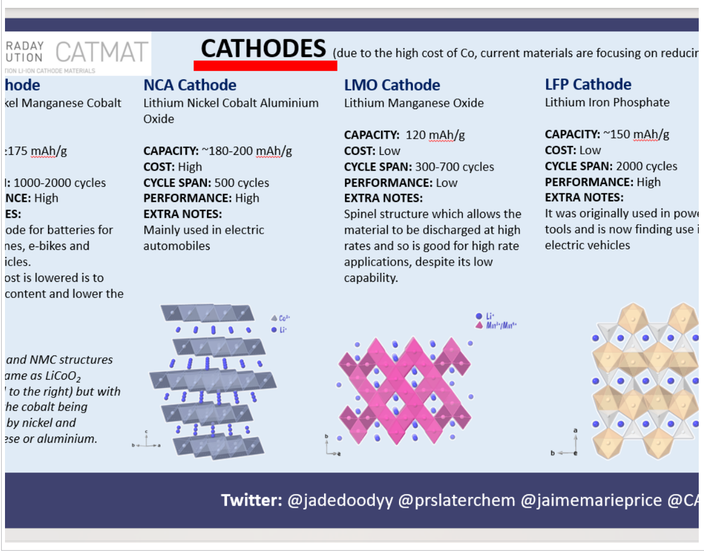
diamond

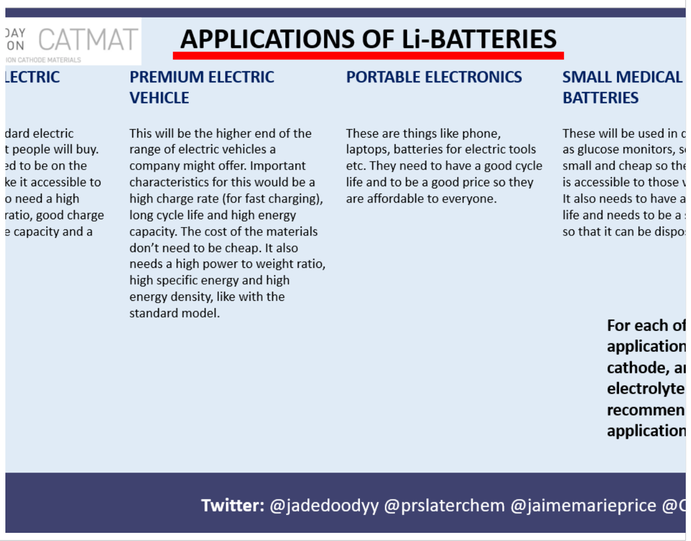
IMPACT / NEXT STEPS

- Turn the pegboard model into a fully 'working' battery which will help to explain how a lithium ion battery charges and discharges.
- The videos will be uploaded to the 'Birmingham Battery Bunch' YouTube channel under the 'Behind the Lab Specs' series.

APPLICATIONS ACTIVITY

I made an activity about the Applications of Lithium Ion Batteries. In this there is a page with different examples cathodes, as well as one for anodes and electrolytes. The reader is then posed with 4 different scenarios, and they have to pick a cathode, anode and electrolyte that is right for each application to make a tailored Lithium Ion Battery. There is also information about research into future materials, including disordered rocksalt structured cathodes and different types of solid state electrolytes (oxide and sulphide).





REFERENCES

- [1] E. H. Driscoll, E. C. Hayward, R. Patchett, P. A. Anderson and P. R. Slater, *Journal of Chemical Education*, 2020, **97 (8)**, 2231-2237
- [2] R. J. Clement, Z. Lun and G. Ceder, *Energy Environ. Sci.*, 2020, **13**, 345
- [3] Making Defects Tactile: Frenkel Defects https://www.youtube.com/watch?v=n3r853BySc0&list=PL5rEn4asarXFcrvNBEBDs4FuHdQ-FHjLx (date accessed 02/09/2022)

INTERN BIO

Jade is studying Chemistry at University of Birmingham. She has just finished her second year and is going into her third year of her integrated masters course.
I am interested in the research into battery technology and the alternatives to fossil fuels, i.e. hydrogen fueled and electric vehicles. I am aspiring to get my PhD in a battery technology related field and then I hope to go into research.

LinkedIn: Jade Doody
Twitter: jadedoodyy
Click the icons to be taken to these pages

THE FARADAY INSTITUTION CATMAT
NEXT GENERATION LI-ION CATHODE MATERIALS

UNIVERSITY OF BIRMINGHAM

UK Research and Innovation