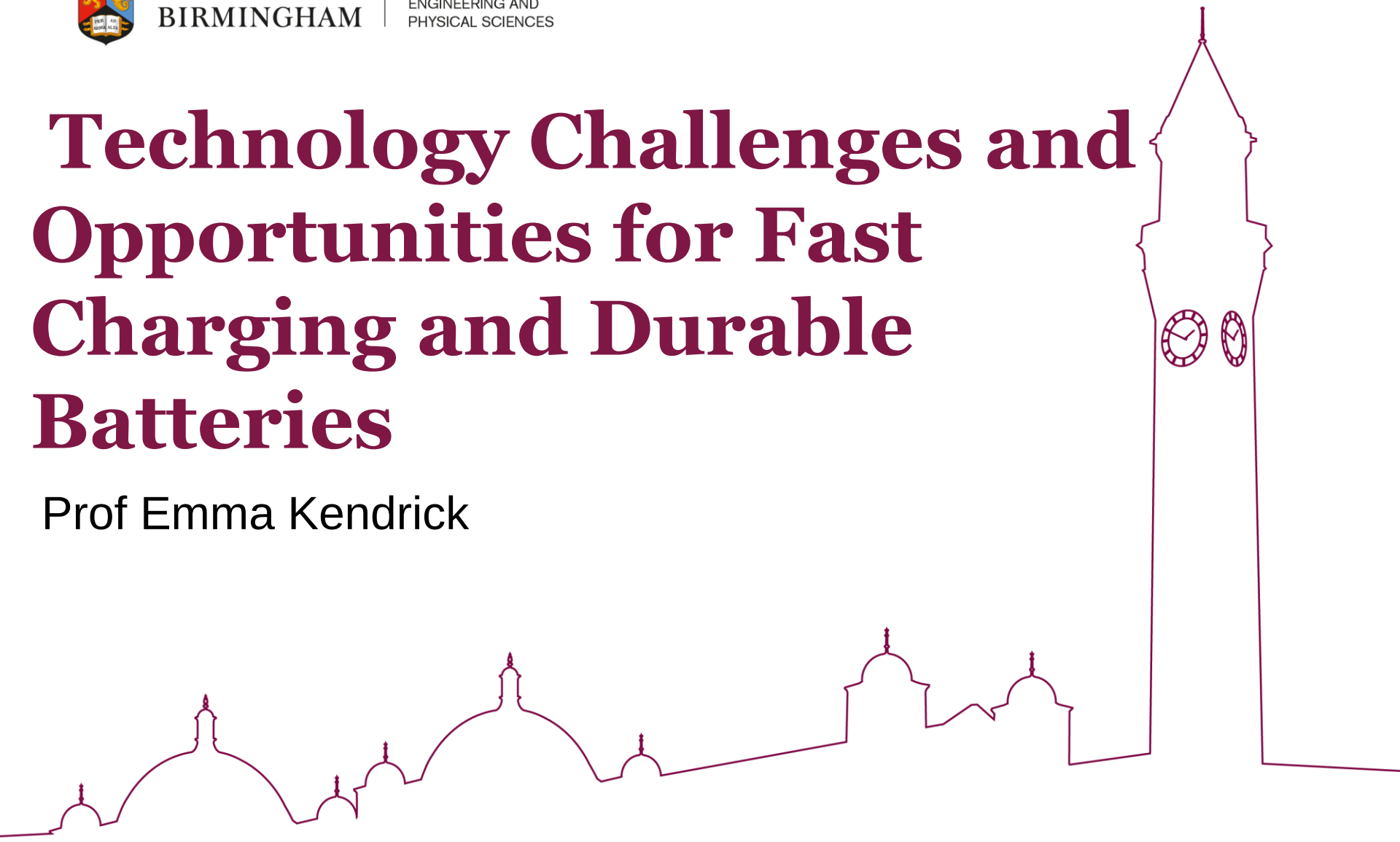
UNIVERSITY OF BIRMINGHAM | COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES

Technology Challenges and Opportunities for Fast Charging and Durable Batteries

Prof Emma Kendrick



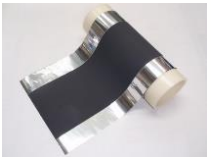
Integrated - Energy Storage Research
‘Circular Economy’

Raw materials

Materials and Electrochemistry

Testing and Validation
Forensics and Diagnostics
Modelling

Cell Components

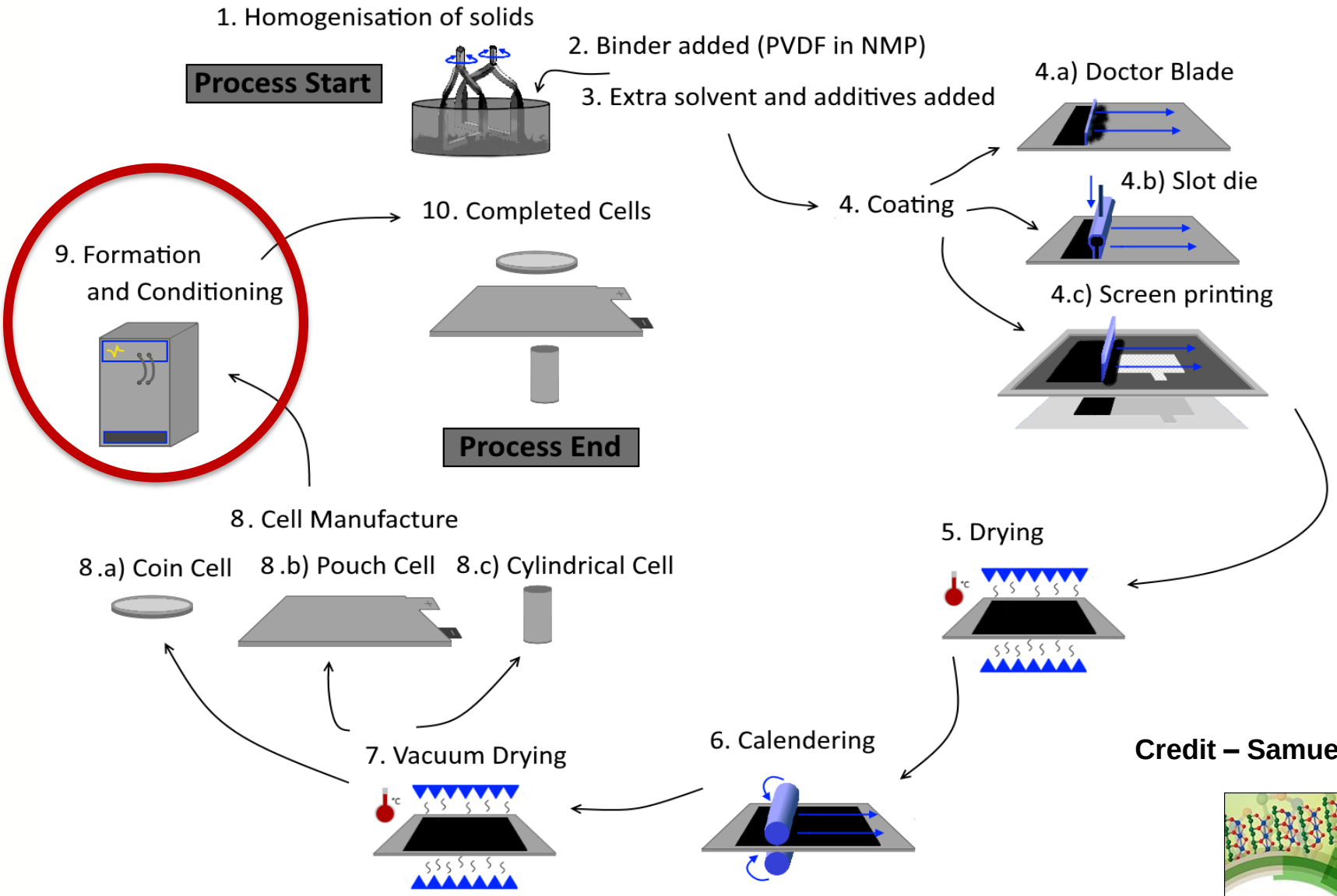


Cells and Cell Manufacture

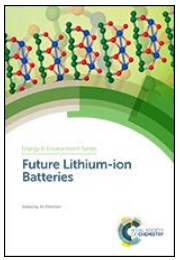
Module, Pack and BMS

Application Integration

Recycling / 2nd Life



Credit – Samuel Roberts

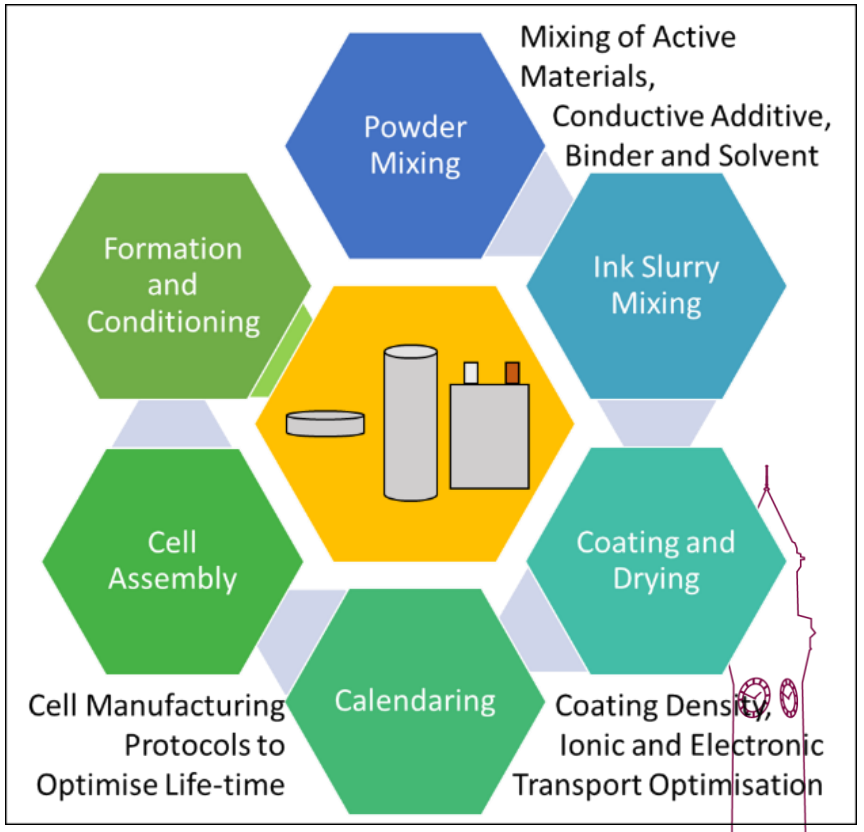


Book: Future Lithium ion batteries. Chapter 11, Emma Kendrick 'Advanced Manufacturing' April 2019. https://doi.org/10.1039/9781788016124-00262

Battery Properties for Optimisation

- Cycle Life / Calendar Life
- Cost
- Energy / Power
- Safety

Manufacturing Processes



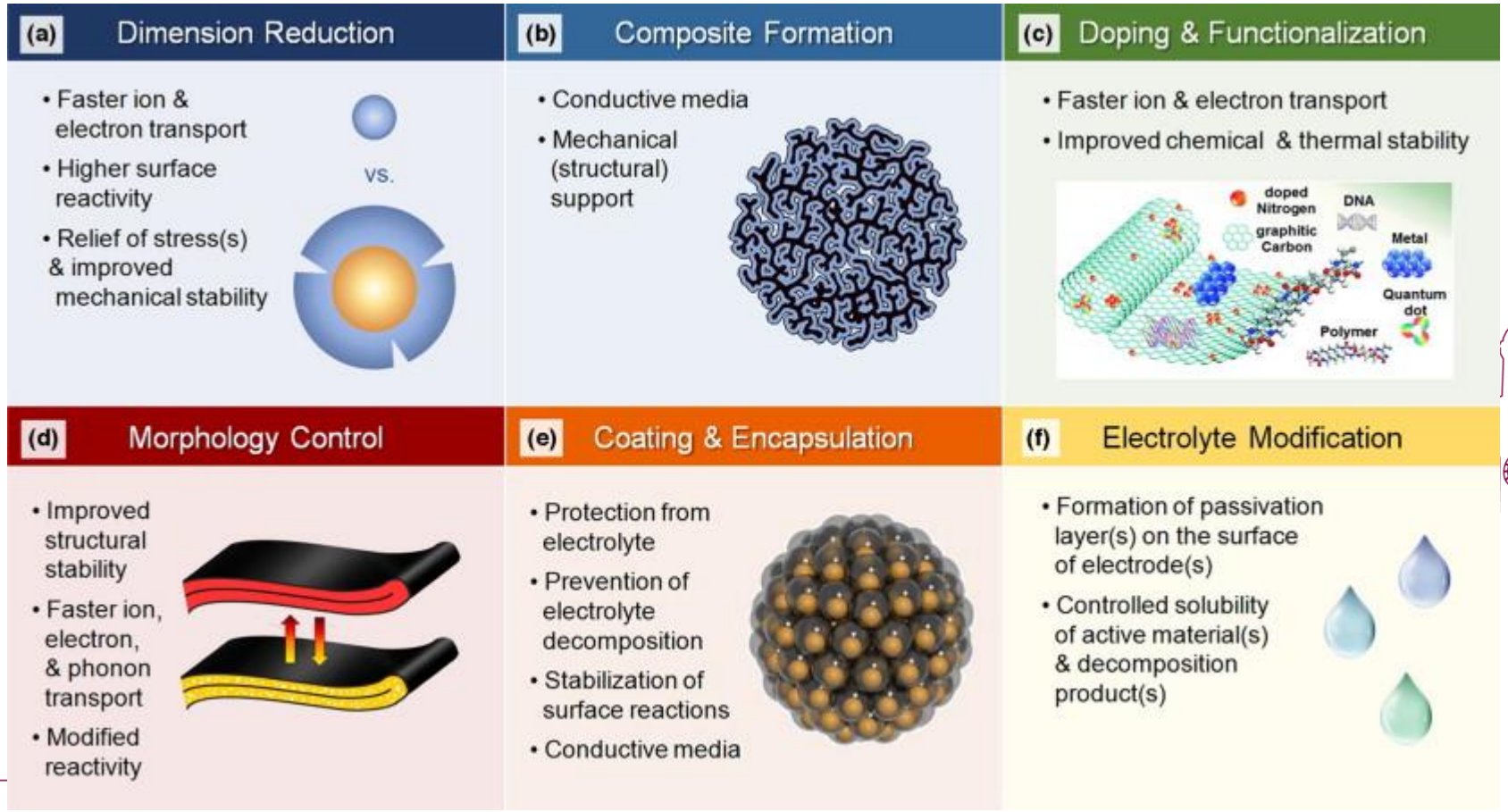
Li-ion battery materials: present and future

Naoki Nitta[1,3], Feixiang Wu[1,2,3], Jung Tae Lee[1,3] and Gleb Yushin[1,*]

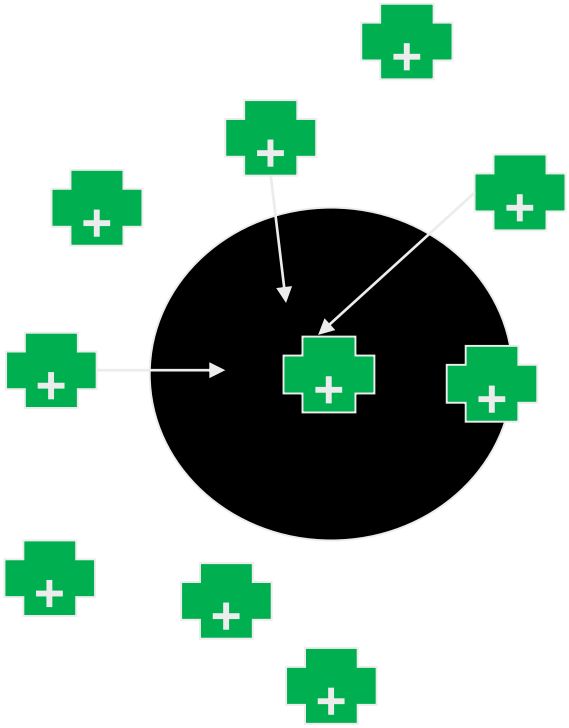
Materials Today • Volume 18, Number 5 • June 2015

Material Design Principals - 1

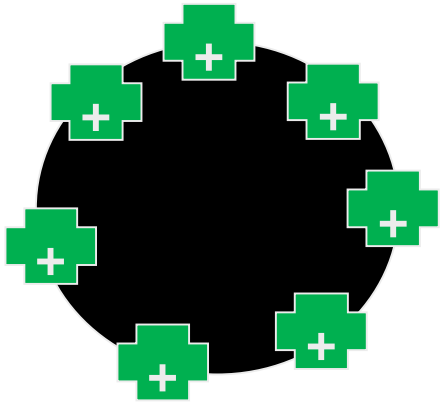
- Power is Current X Voltage = Watts



Electrolyte

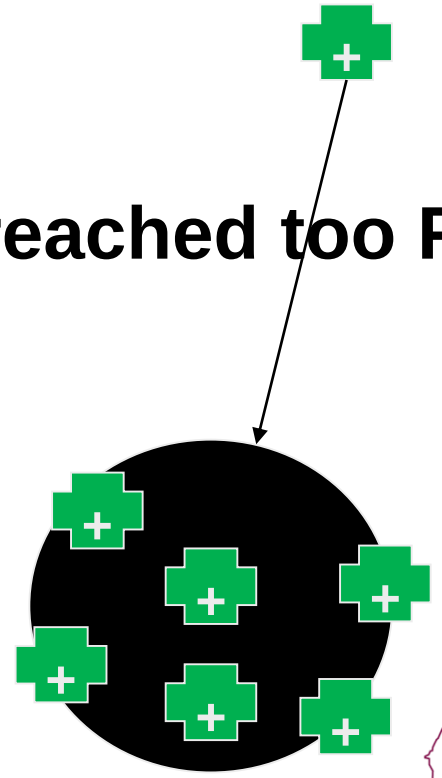


Low Rate and Equilibrium



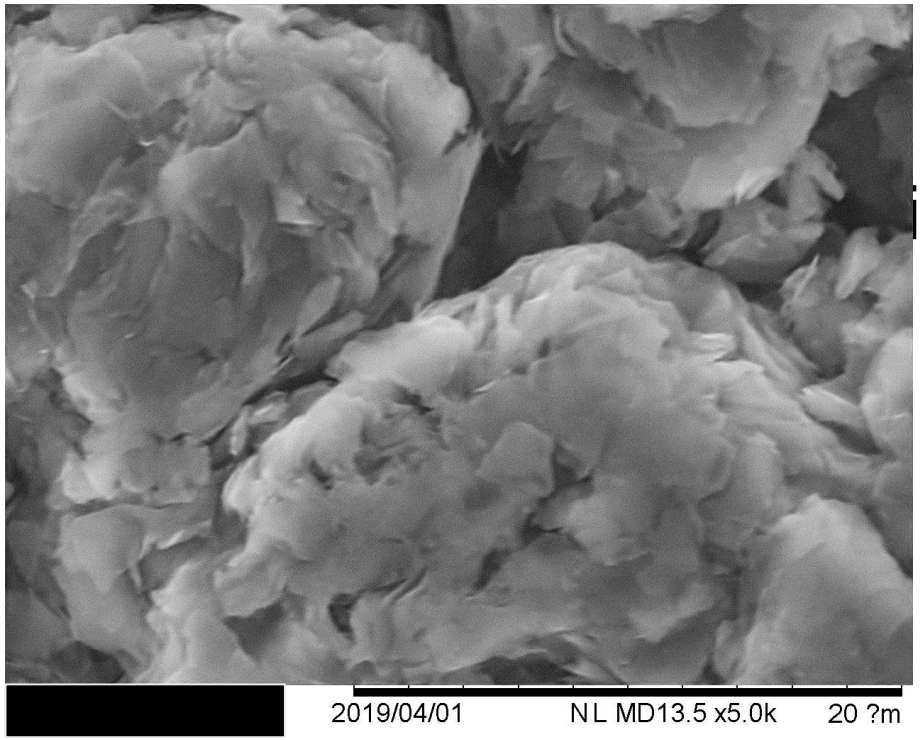
Surface super concentrated Voltage reached early

Voltage Cut-off reached too Fast

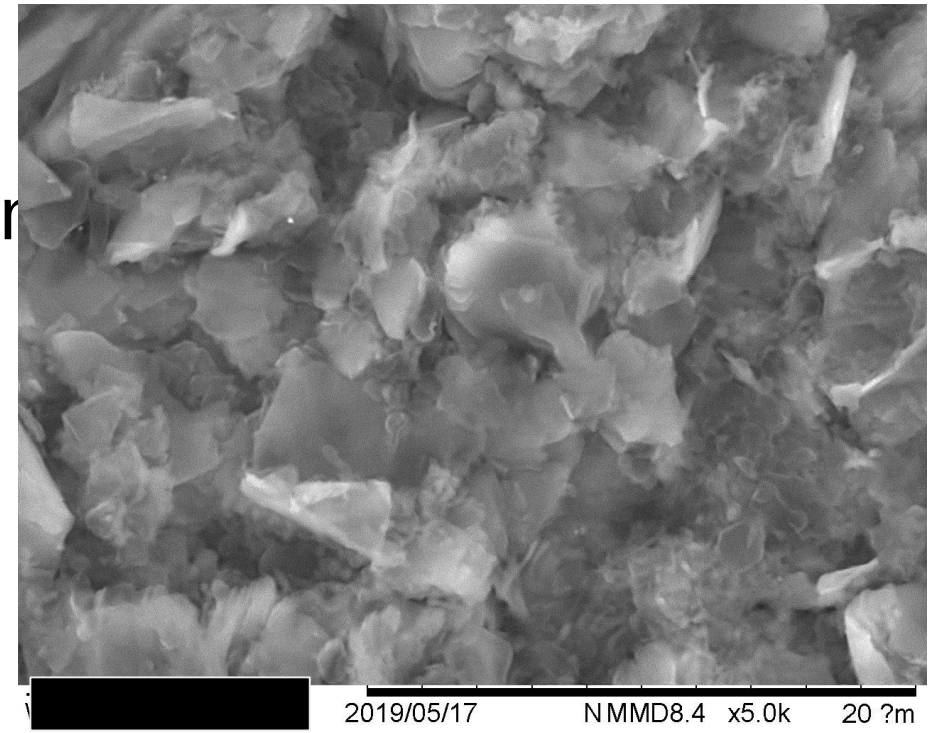


Electrolyte Depletion

Anode : Graphite after pulsing



Original electrode



After 5000 pulse sequences

Anode : Dendrites

Opportunities in Materials and Cell Designs of High Power

- Active Materials development
  - Higher ionic and electronic conductivities
  - Smaller Particle Sizes, Hierarchical Particles
- Electrode Designs for Fast Ionic Transport
  - Higher electronic and ionic conductivities
  - Reduced Impedance
- Electrolyte
  - Improved Wettability of electrode
  - Faster ionic Conductivity
- Separator
  - Thinner and lower resistance separators