Sustainable Electrodes for Advanced Redox Flow Batteries

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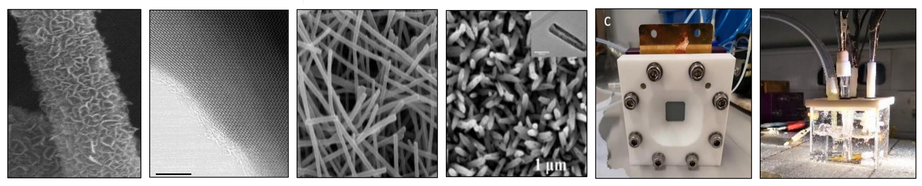
Who are we?

My research group at QMUL designs sustainable materials for energy conversion and storage applications.

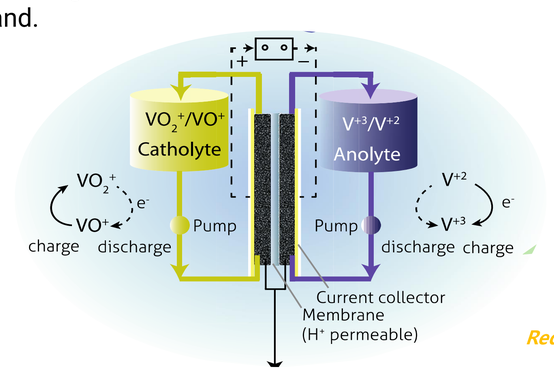
Key research areas:

- Lignin-derived carbons
- Freestanding fibre mats
- Electrospinning
- Redox flow batteries
- Solar Redox flow batteries



Why research this?

Context of my research – Global warming and climate change is a sad reality. The use of sustainable resources such as wind and solar energy are key to help decarbonise our higher than ever energy demand.



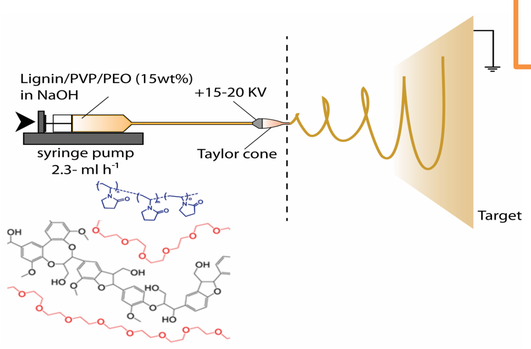
Redox Flow Batteries

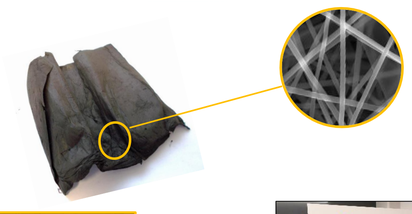
- There has been an increase in renewable energy capacity installed (from 20 GW to >150 GW in 10 years)
- However, the actual capacity to store that excess of energy produced from renewables has not increased that fast
- We need reliable sustainable ways to store energy from renewables, so we can use it when we need it
- This is vital to decarbonise our energy supply

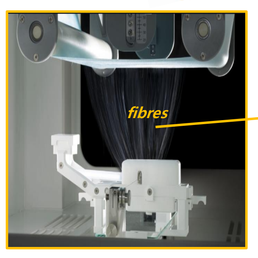
Our Vision

To design alternative electrode materials for redox flow batteries for grid-scale energy storage derived from biomass-waste with tailored 3D porous structure and surface chemistry.

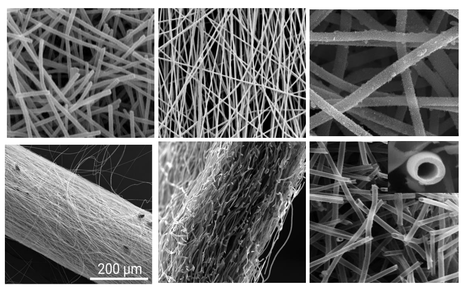
Electrospinning



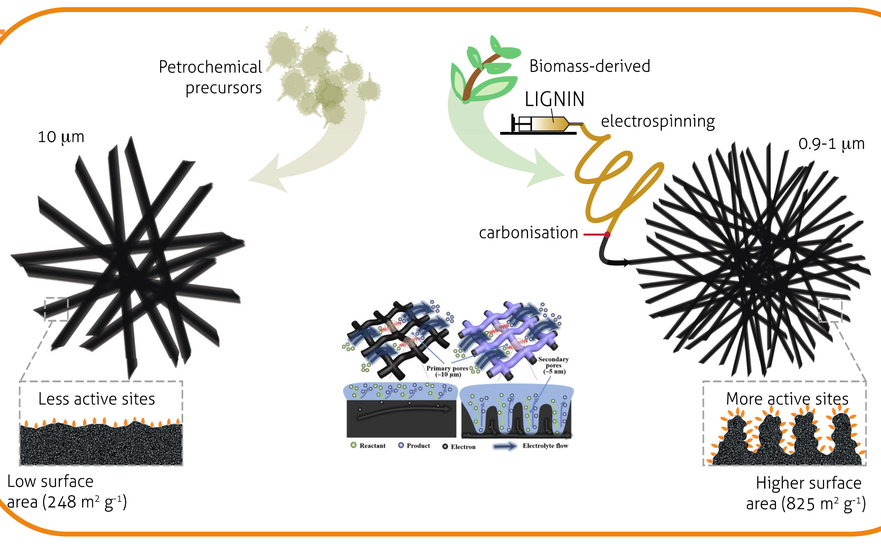




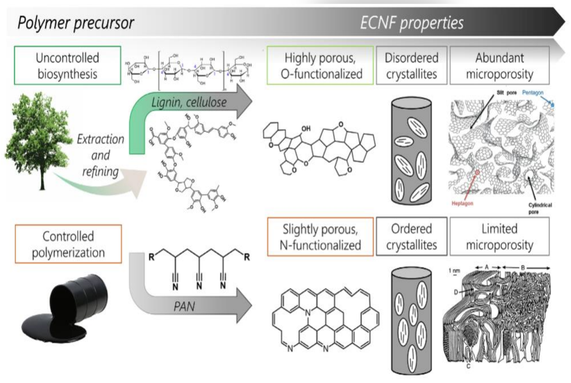
- Versatile, scalable technique
- Freestanding materials
- Fibre diameter 100- 900 nm
- Thicknesses 80-200 micron



Some examples of fibres we have obtained *via* electrospinning.

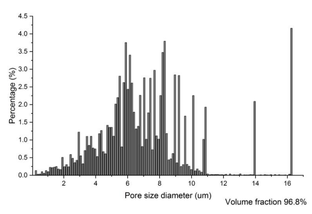


Biomass-waste

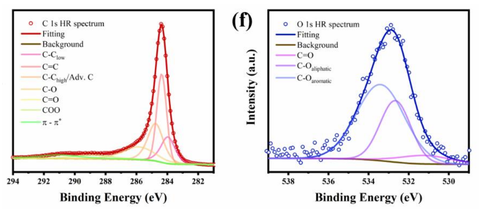


Structural Characterisation of electrospun lignin-derived carbon fibres

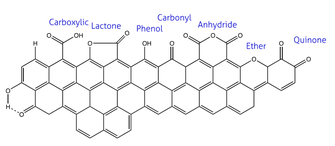
XCT



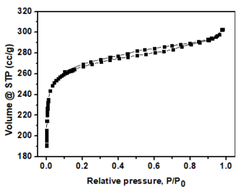
XPS



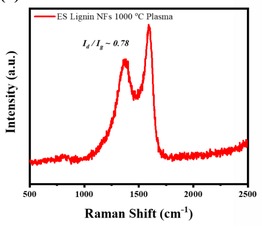
O-functionalities



BET

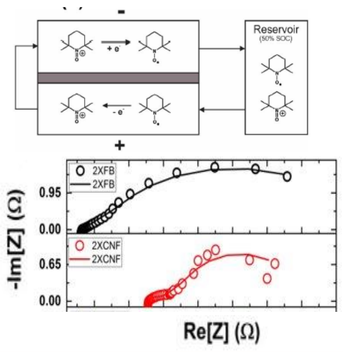


Raman



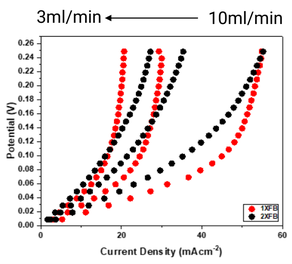
Electrochemical Characterisation of electrospun lignin-derived carbon fibres

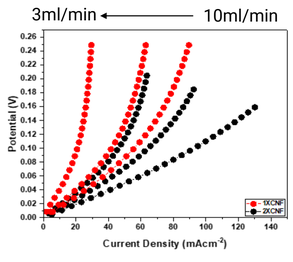
Single electrolyte set up



	10ml/min		5ml/min		3ml/min	
	1XFB	2XFB	1XFB	2XFB	1XFB	2XFB
R_Ω	1.76	0.78	1.17	0.80	1.18	0.80
R_{CT}	0.09	0.14	0.05	0.10	0.04	0.10
R_{MT}	0.76	1.04	1.37	1.69	1.98	2.37
Total	2.61	1.96	2.58	2.59	3.21	3.28

	10ml/min		5ml/min		3ml/min	
	1XCNF	2XCNF	1XCNF	2XCNF	1XCNF	2XCNF
R_Ω	1.43	1.76	1.45	1.80	1.48	1.79
R_{CT}	0.21	0.36	0.16	0.33	0.20	0.29
R_{MT}	0.59	0.13	0.91	0.38	1.90	0.67
Total	2.22	2.24	2.53	2.51	3.58	2.75





Conclusions and Outlook

- Electrospinning is a convenient manufacturing technique that enables the processing of a variety of materials into freestanding fibre-based materials of control thickness, composition and porosity and therefore better understanding of structure-property relationships.
- Biomass-waste derived carbon electrospun fibres hold great potential for replacing current stat-of-the-art PAN-derived carbon felts / papers, exhibiting lower charge transfer resistance.

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