POROSIMETRY EQUIPMENT FOR THE ELUCIDATION OF THE STRUCTURAL ARCHITECTURE OF NOVEL MATERIALS DEVELOPED FOR FUEL CELL TECHNOLOGIES

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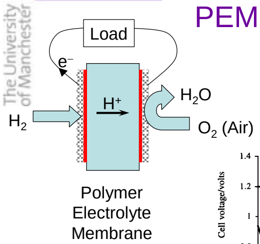
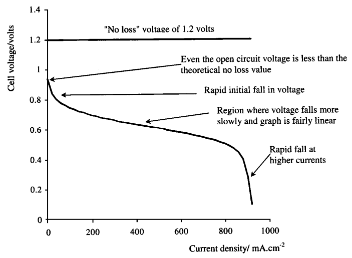
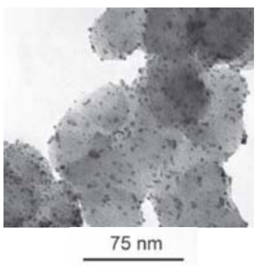
PEM Fuel cells



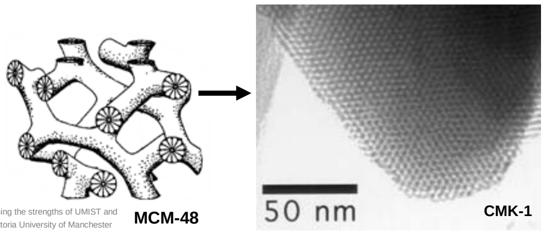


Conventional catalyst structure



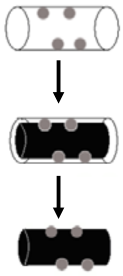
Plan

- Use templated carbons and catalyst.
- Improved connectivity, utilisation & reactant access
- e.g. mesoporous carbons
  R. Ryoo, S. H. Joo and S. Jun, *J. Phys. Chem. B*, 1999, **103**, 7743)

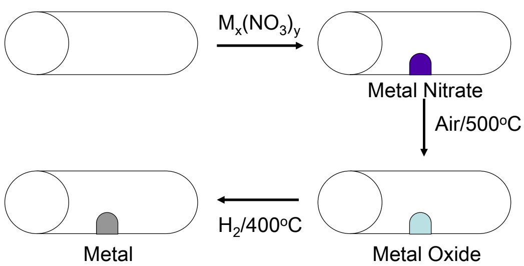


Plan

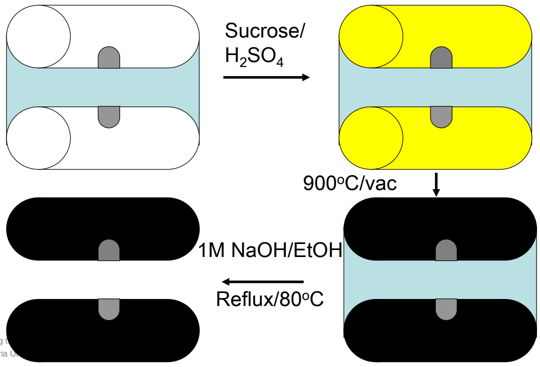
- Mesoporous silica
- Metal salt impregnation
- Metal Oxidation/reduction
- Impregnation with sucrose
- Carbonisation
- Leaching of Silica template



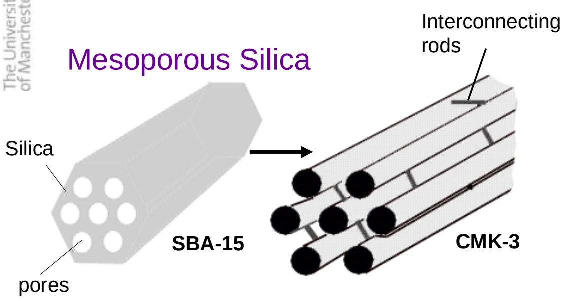
Metal Impregnation



Carbonisation



Mesoporous Silica

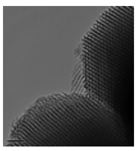


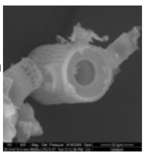
Synthesis of novel materials for fuel cell applications

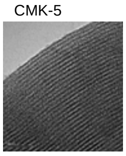
Template synthesis

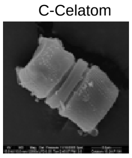
Mesoporous materials → SBA-15 → CMK-5

Bio-minerals → Diatomaceous earth → C-Celatom









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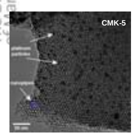
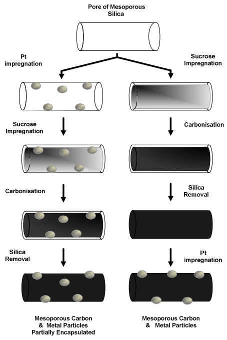
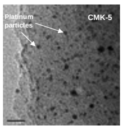
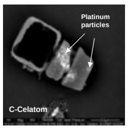
Metal impregnation into the nanostructures

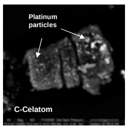
Two methods of metal impregnation were used: *before and after carbonisation











*S. M. Holmes, P. Foran, E. P. L. Roberts, and J. M. Newton,
"Encapsulation of metal particles within the wall structure of mesoporous carbons,"
Chemical Communications, 2005, pages 1912-1913

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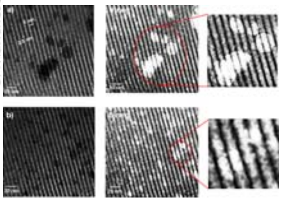
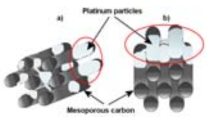
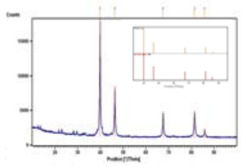
CMK-5 electrocatalyst



Pt particles follows the pore structure of the carbon support





Material	BET (m^2g^{-1})	Pore Diameter (nm)	Pore Volume (cm^3g^{-1})
Plain CMK-5	1581	3.00	1.2
13 wt%Pt/CMK-5	900	2.8	0.62
23 wt%Pt/CMK-5	290	3.00	0.22

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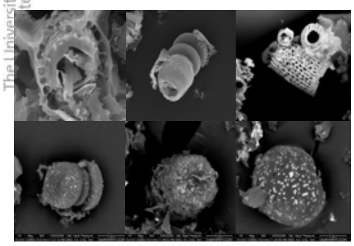
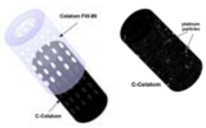
C-Celatom electrocatalyst



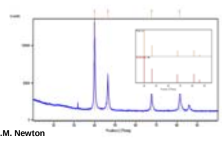
Carbon negative (C-Celatom)

Pt particles uniformly distributed throughout the novel carbon support



Material	BET (m^2g^{-1})
Plain C-Celatom	312
16 wt%Pt/C-Cela	252
28 wt%Pt/C-Cela	218

Vulcan XC-72 BET Surface Area 250 m^2g^{-1}



S. M. Holmes , B.E. Graniel-Garcia, P. Foran, P. Hill, E.P.L. Roberts, B. H. Sakakini and J.M. Newton
"A novel porous carbon based on diatomaceous earth"
Chemical Communications, 2006, pages 2662 - 2663

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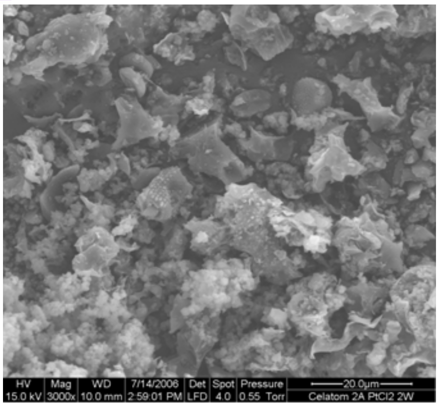

Combining the strengths of UMIST and The Victoria University of Manchester

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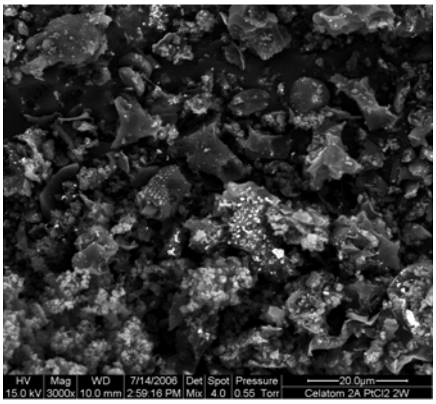

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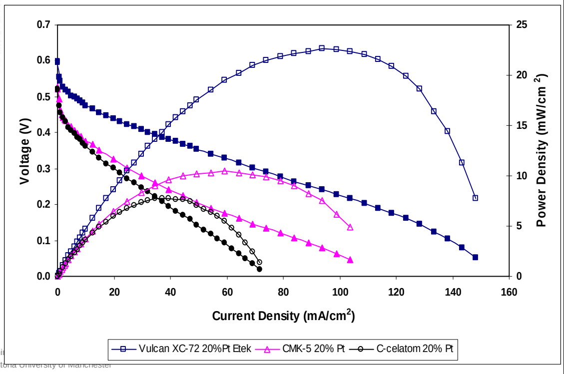
Fuel cell data



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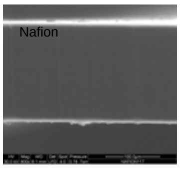
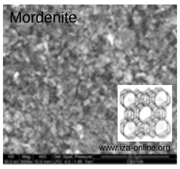
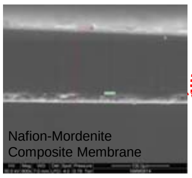
Sample	Vulcan XC-72 20%Pt	CMK-5 20% Pt	C-celatom 20% Pt
BET Surface area support only (N_2 ads)	250 m²/g	1581 m²/g	312 m²/g
Surface area platinum only (CO ads)	31 m²/g	8 m²/g	0.5 m²/g
Pt particle size	From TEM ~ 2 nm	From TEM ~ 3 nm	From SEM ~ 125 nm

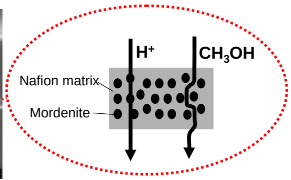
Nafion-Mordenite Composite Membrane for Direct Methanol Fuel Cell Application

To develop a membrane with lower methanol permeability in order to achieve a superior DMFC performance to Nafion

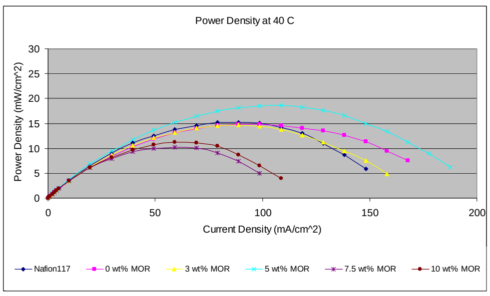








Effect of Mordenite Content in Membrane on DMFC Performance



Operating Condition

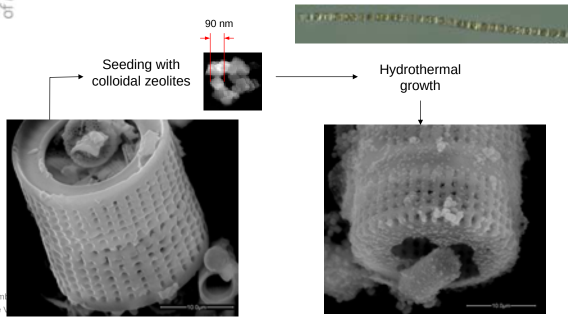
- Cell temperature 40 °C
- Air flowrate 1 l/min
- Methanol solution (4 M) flowrate 5 ml/min

MEA Characteristic

- 1 mg Pt/cm² on anode and cathode

A series of hierarchical porous structures have been synthesised using natural products as templates or scaffolds.

Initial work based around the growth of silicalite on to the surface of diatomaceous earth has been advanced by the development of the synthesis of zeolite Y, through a seeding / hydrothermal growth process

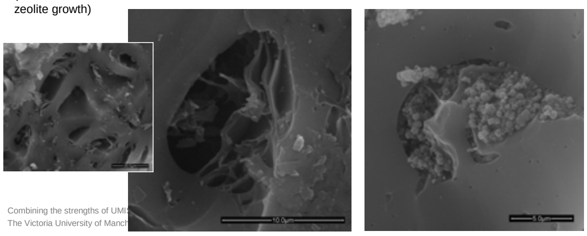


The growth of zeolite coatings using seeds prepared by ball milling of commercial zeolites opens up the production of these materials to a range of zeolitic structures which can be tailored for the ionic contaminant to be targeted.

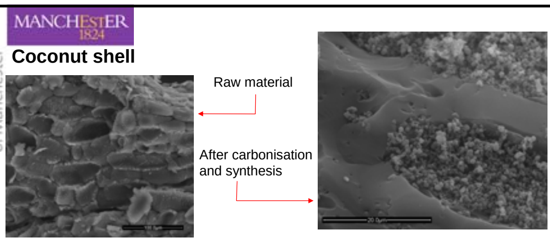
Carbonising natural structures offers a wide range of highly ordered supports with large contact areas. These materials show affinity for the growth of zeolites within their natural cavities.

Carbonised Olive pips

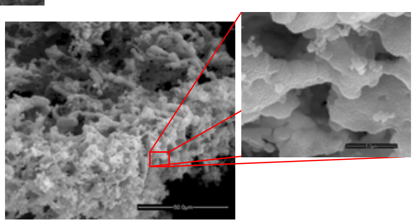
(before and after zeolite growth)



Coconut shell



Additionally, the carbon supports can be removed by calcination, producing negative structures of their porous system.



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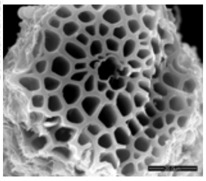
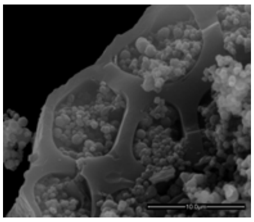
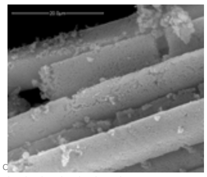
Coconut fibres



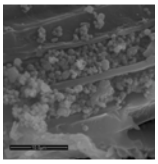
Coconut fibres are hierarchical structures with the highest surface area of all the tested materials





Zeolite crystals fill up the pores of the fibre

Once the carbon is removed, the crystals retain the cylindrical shape of the pore



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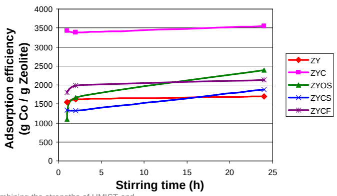
These materials have been demonstrated to be very effective in the removal of **cobalt** ions from aqueous solutions.

For the case of **arsenic**, the adsorbents have achieved a **complete removal** when working with concentrations commonly found in polluted streams.

Hg porosimetry will be a powerful aid to characterise the nature of the composites' surfaces, in order to explain the mechanics behind their adsorption capacities.



The alumino-silicate composition of the materials means that encapsulation of the cobalt ions is extremely effective when the material is vitrified to a glass at high temperature.

Leaching tests have proven that no ions are released even when exchangeable ions are present.

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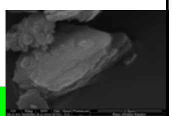
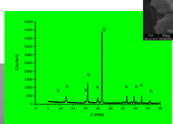
REFINEMENT OF AHOKO NIGERIAN KAOLIN FOR ZEOLITES SYNTHESIS : STUDY BY PASCAL 140/240 MERCURY POROSIMETRY



SEM image of Ahoko kaolin

Nigeria map showing location



XRD pattern of Ahoko kaolin

Representative sample of as-shipped Ahoko kaolin

COLLECTION OF REPRESENTATIVE SAMPLES OF AHOKO NIGERIAN KAOLIN FROM LOCATION IN NIGERIA AND ITS ANALYSIS BY XRD AND SEM

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Acknowledgements

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Thank you!

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