Developing Methods for Preparation and Imaging of Nafion® Filled Nano-pore Arrays in Anodiscs®

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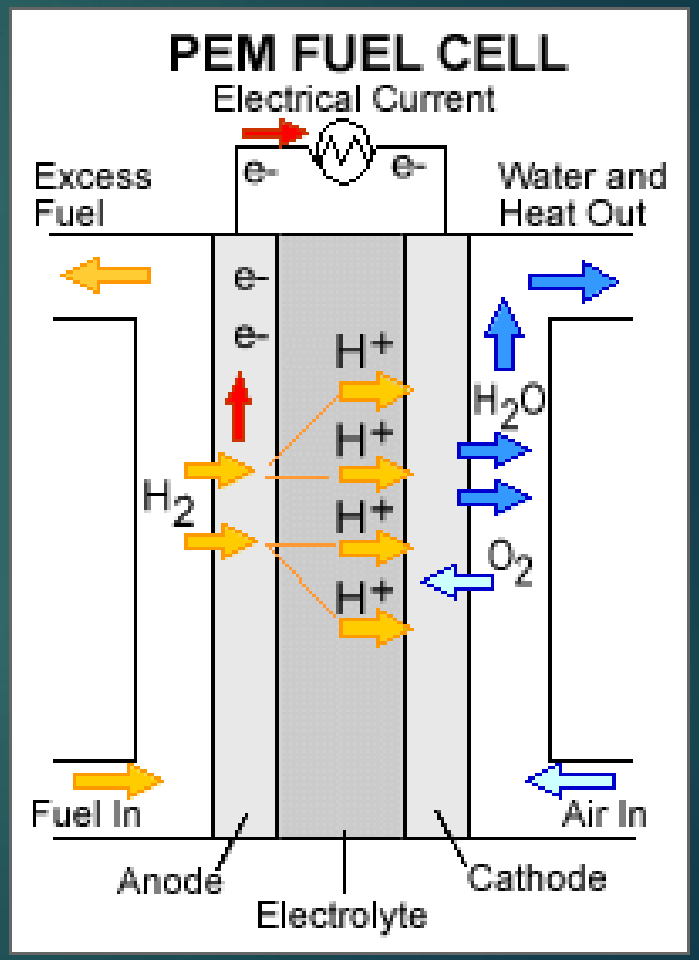
Fuel Cells

- $2H_2 \rightarrow 4H^+ + 4e^-$
- $4H^+ + 4e^- + O_2 \rightarrow 2H_2O$

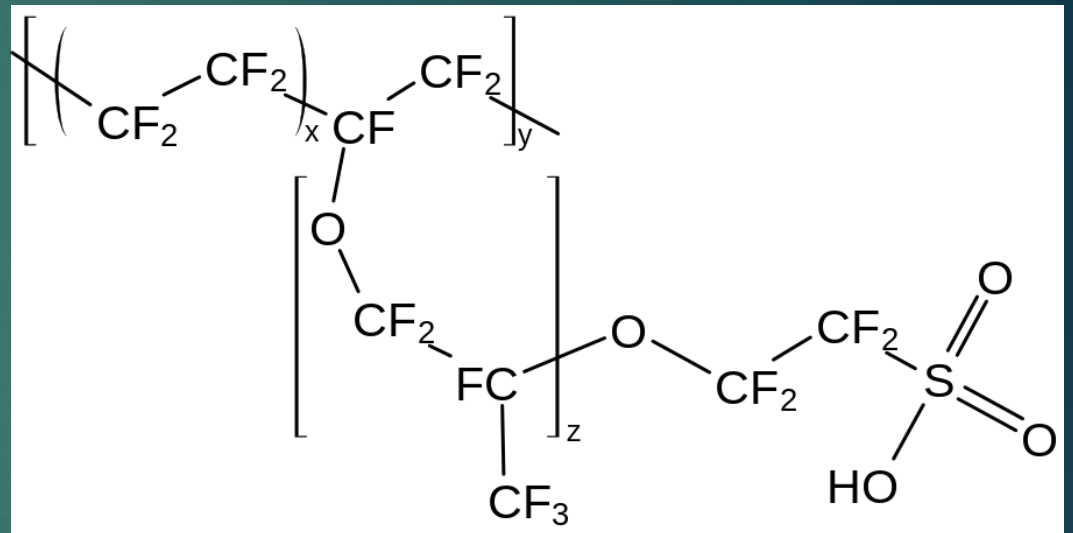
- More efficient

- Proton exchange membranes (PEMs)



Nafion ®

- Ionomer
- Parallel water channels
- Both hydrophobic and hydrophilic
- Phase segregation



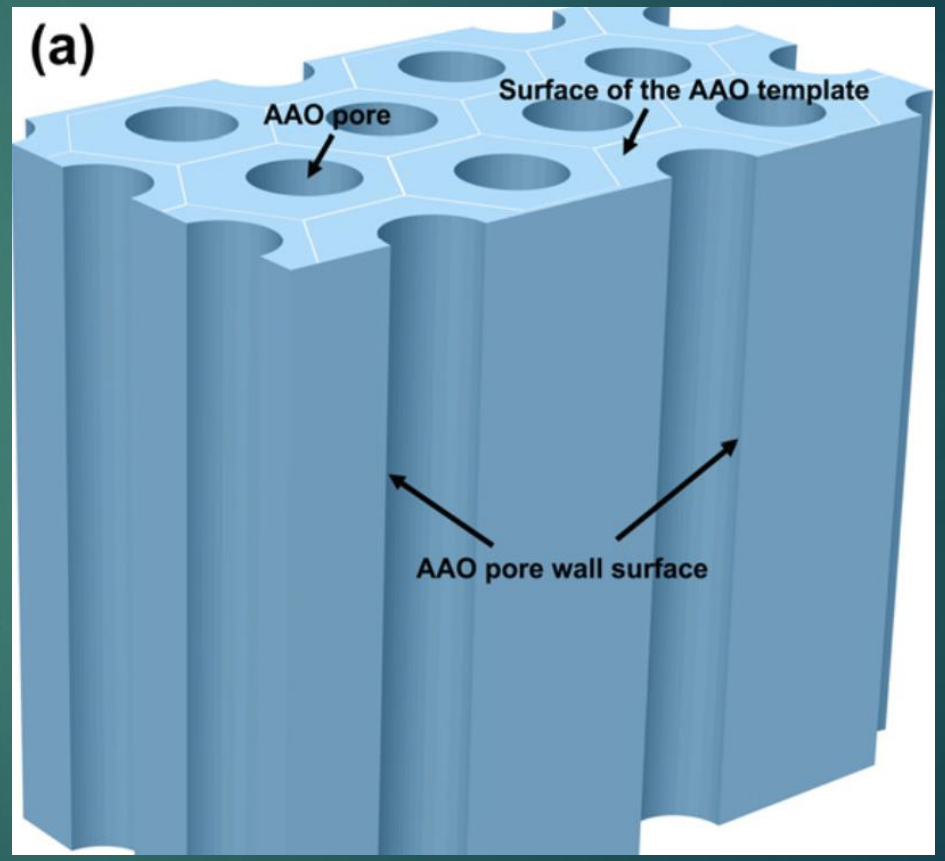
Chemical structure of Nafion

Motivation

- Lack of consensus about the morphology
- Alignment of the Nafion structures
- Block copolymer alignment

Anodisc ®

- Created by Whatman
- 60 µm thick
- 200nm diameter pores
- 25%-50% porosity



Isometric view of Anodisc structure

Literature Review Results

Pressure

- 42% filled
- 10 μm penetration

Spray

- Mostly filled
- Penetration untested

Objectives

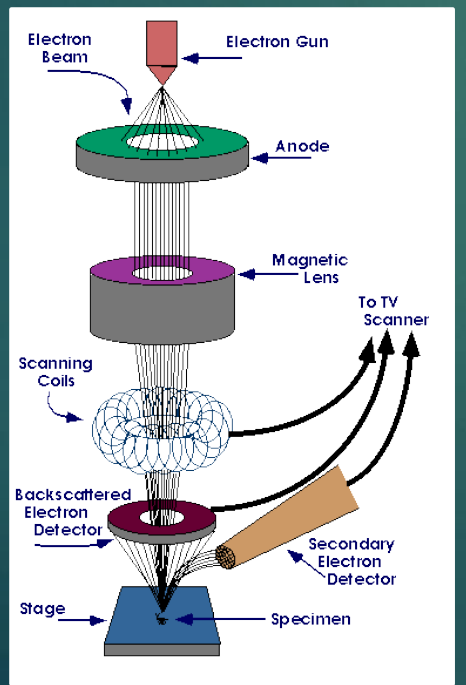
- Simplify Nafion loading procedures
- Image Nafion and nanopores
- Differentiate between the Nafion and the nanopores
- Characterize Nafion location

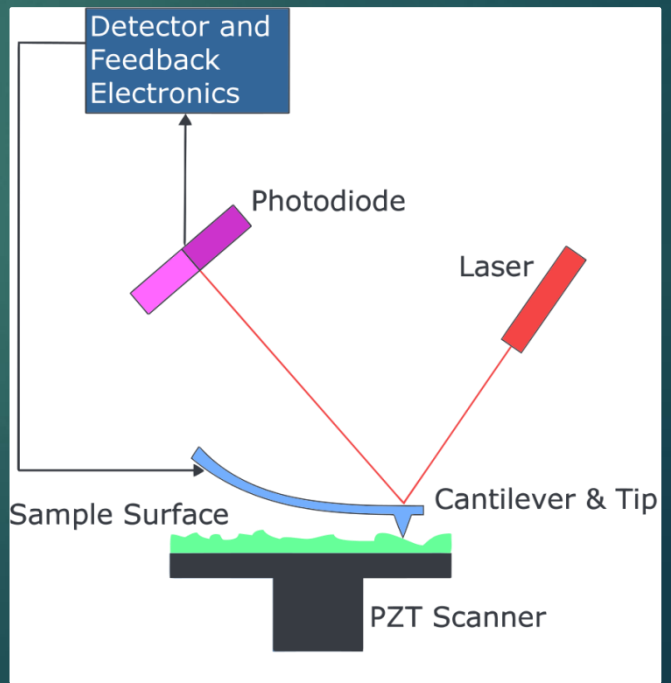
Simplified Preparation Method

- Break off a piece of an anodisc
- Drop Nafion on the anodisc
- Let it dry

Imaging Instruments

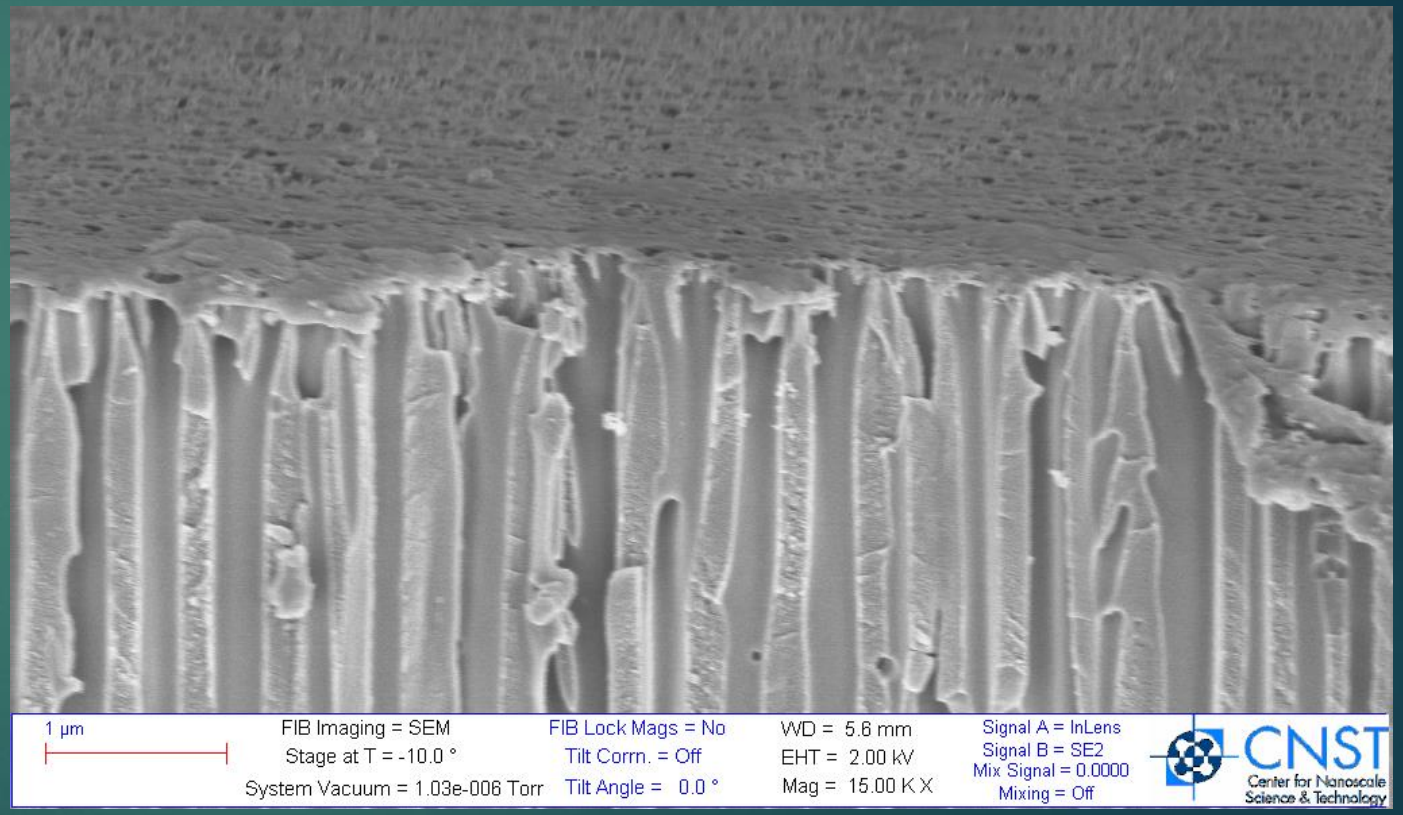
- Zeiss NVision 40 Cross Beam Microscope
- Asylum Cypher High Resolution Atomic Force Microscope





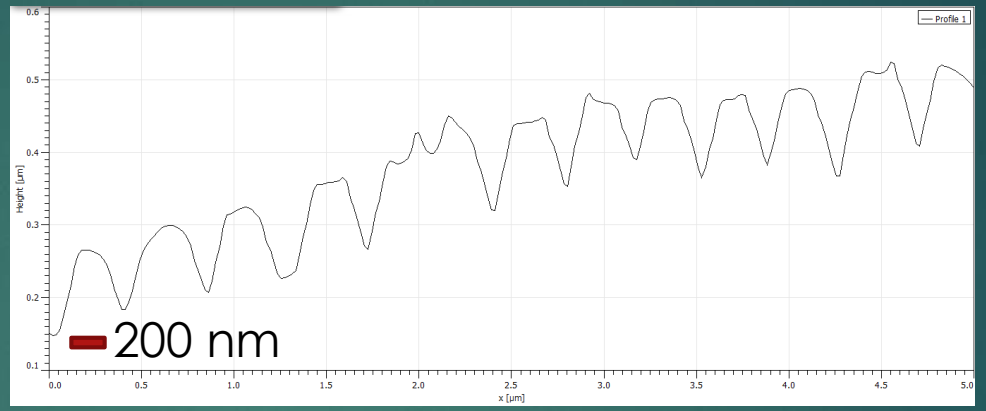
Bare Section

- 15,000X magnification
- Clean surface
- Broken pores



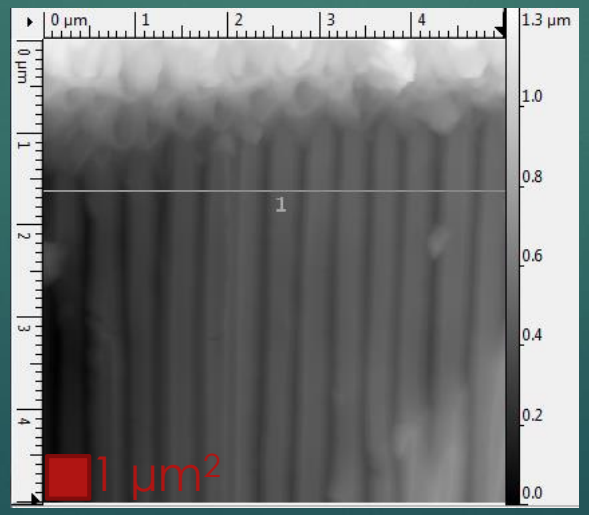
Bare Section

- Smooth pores
- Similar pores
- Periodic

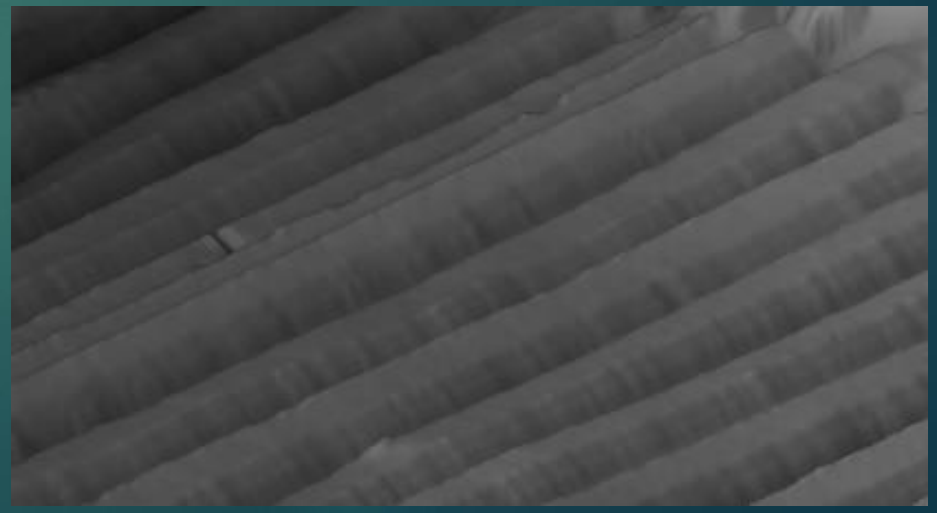


Height graph of the line on the bottom left image

Height map where shade represents the height

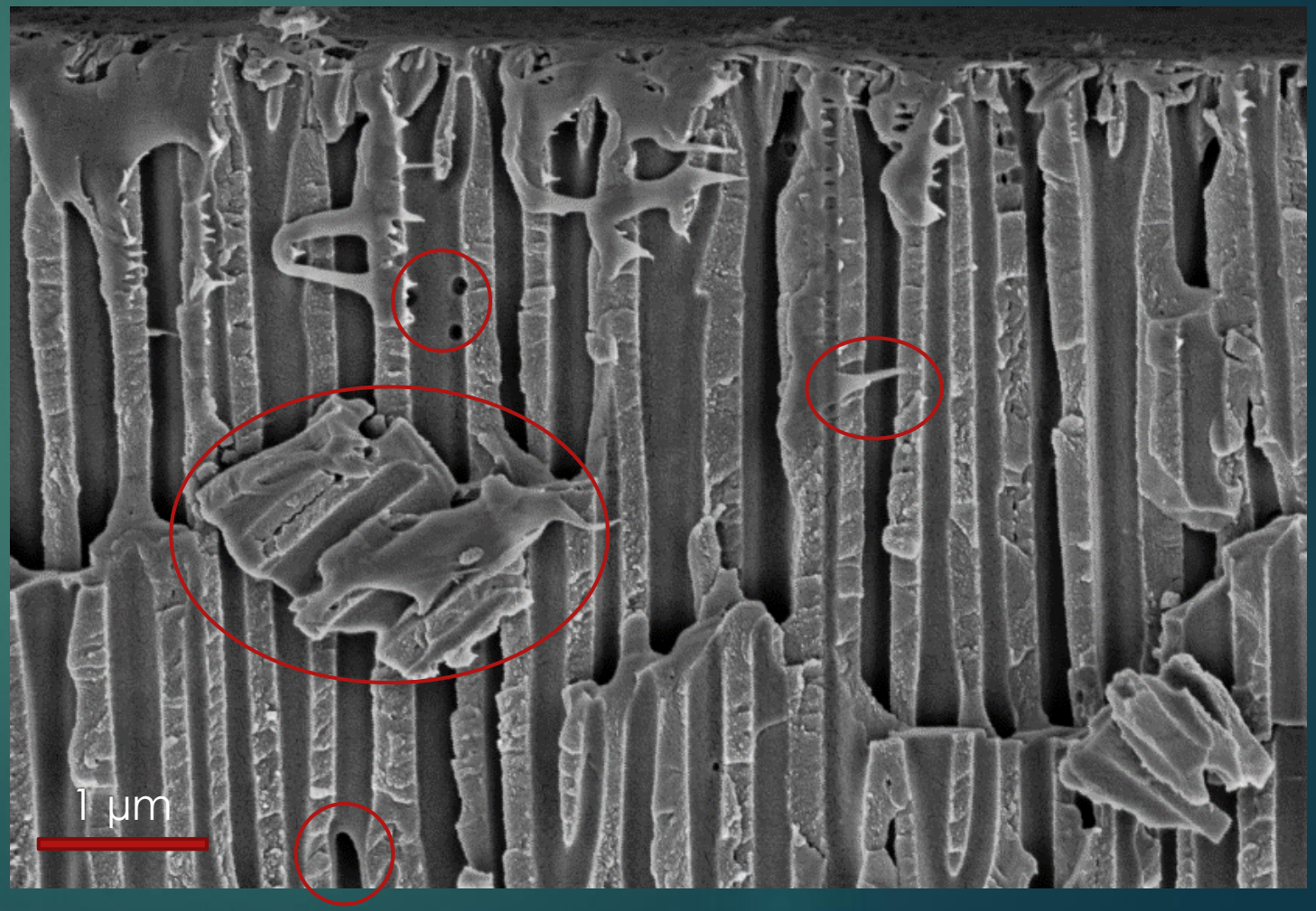


Isometric view



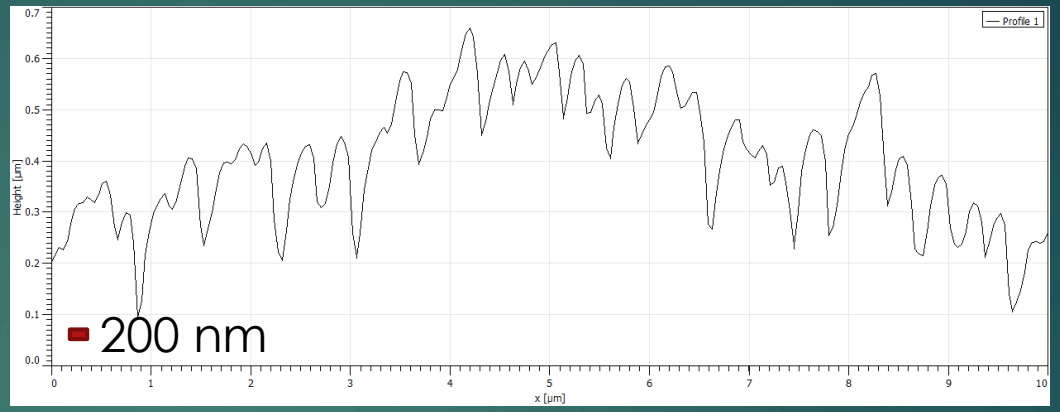
Filled Section

- 15,000X magnification
- Surface coated
- Unusual structures
- Low penetration



Filled Section

- Jagged Pores
- Bridging
- Irregular pores
- Not periodic



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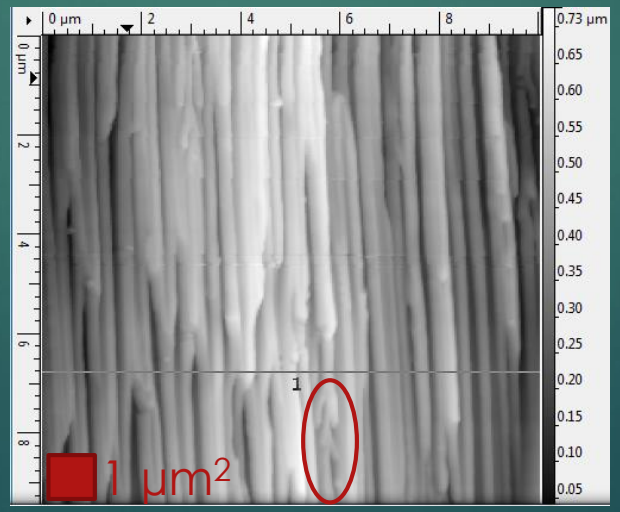
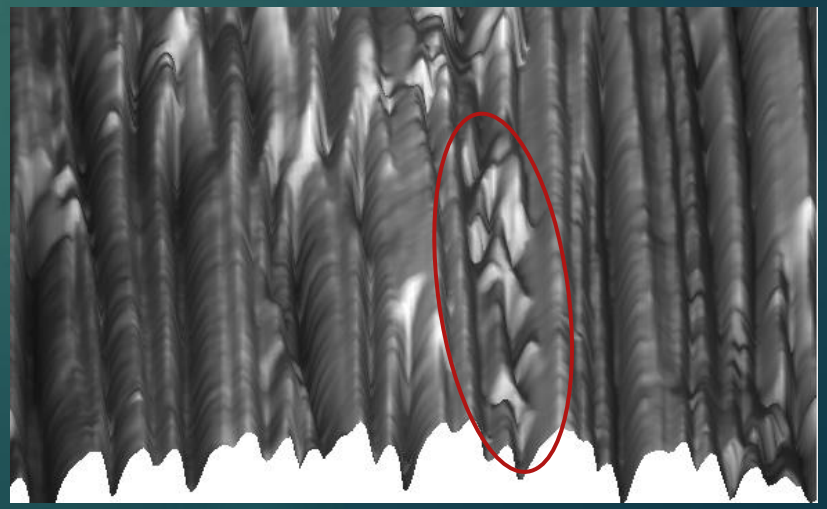
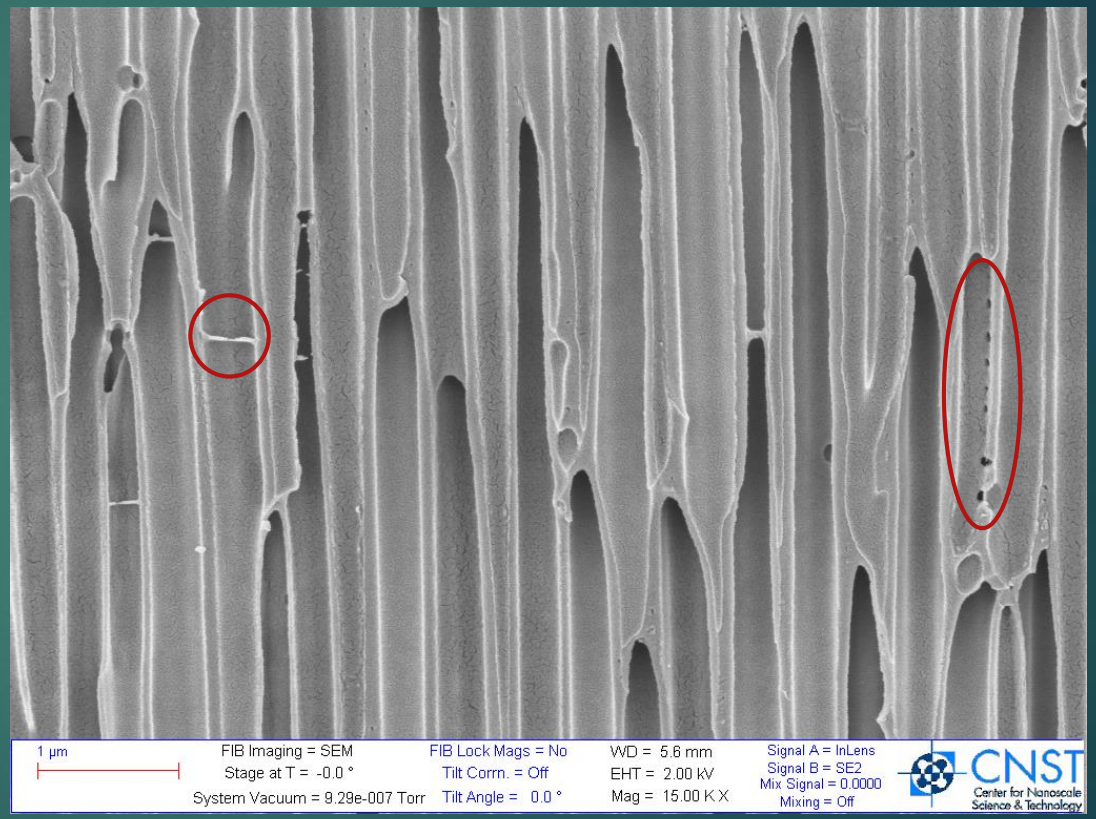


Isometric view



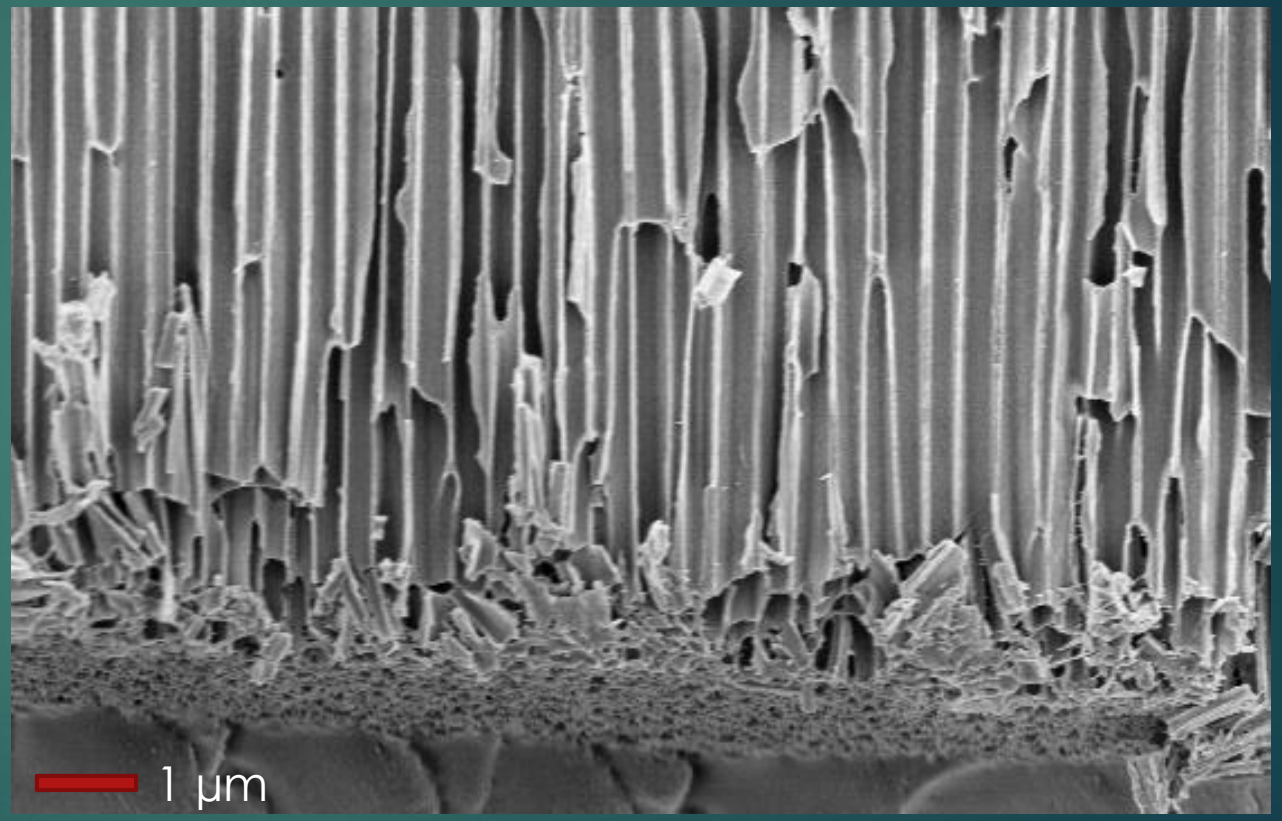
Filled Section

- 15,000X magnification
- Center
- Bridges and bubbles



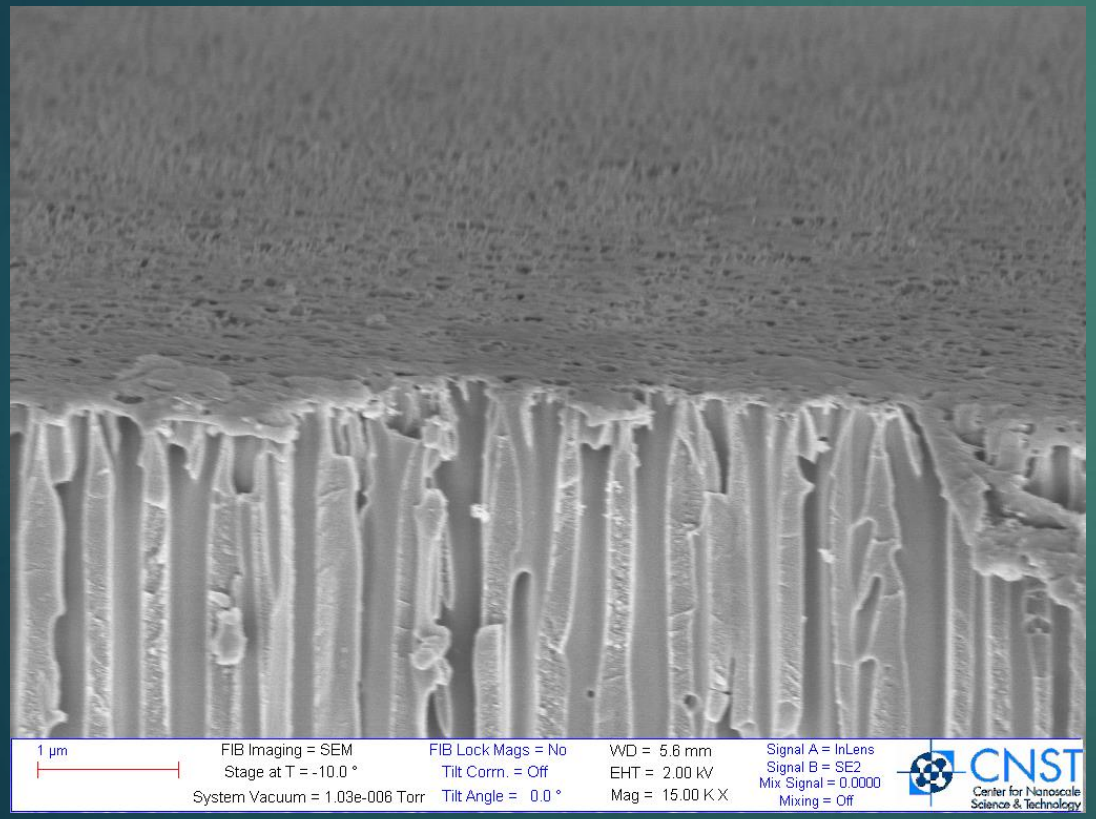
Filled Section

- 5,000X magnification
- Other side
- No Nafion

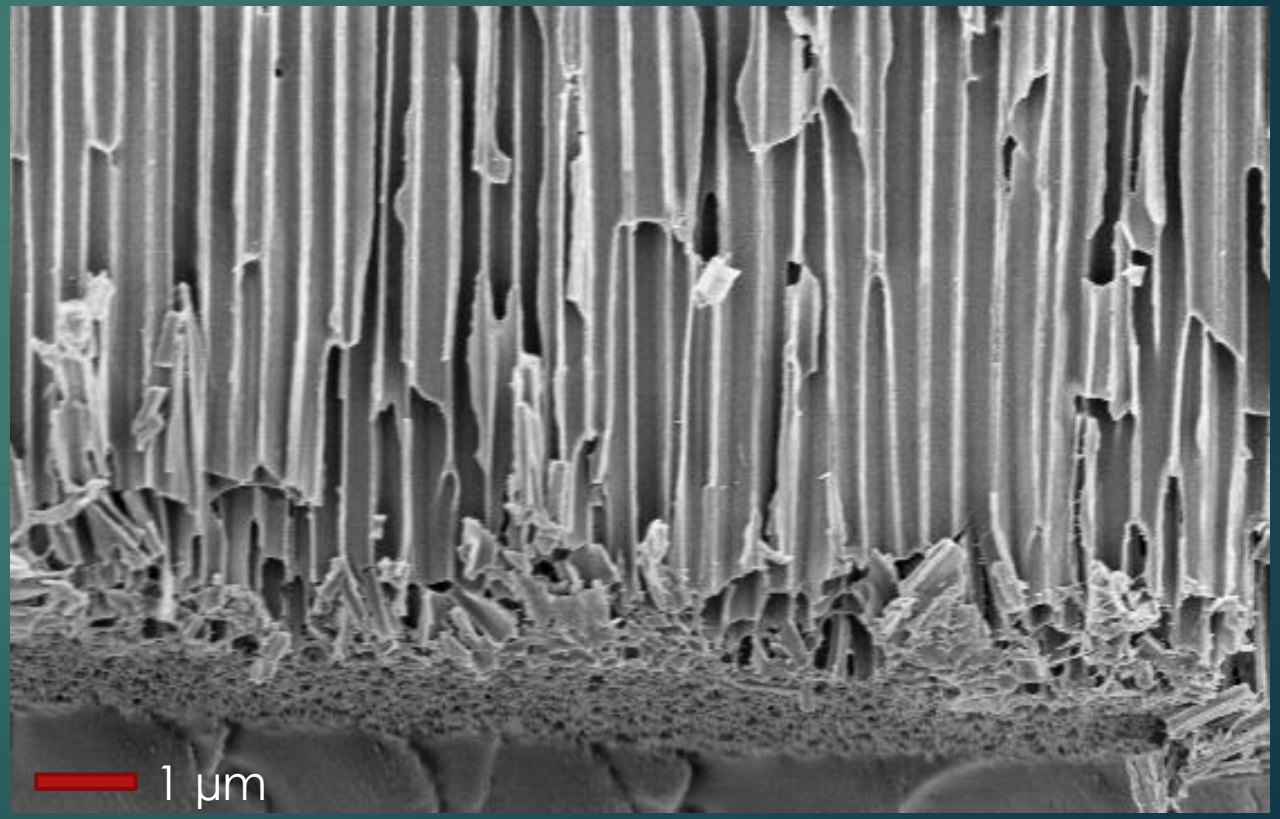


Filled Section

Bare



Filled



Conclusion

- Distinguishable in scanning electron microscope
- Coated only the walls
- Left a film on the surface
- Moderate penetration

Acknowledgements

- Advisors:
  - Joseph Dura
  - Kathryn Krycka
- NCNR SHIP Coordinators:
  - Yamali Hernandez
  - Julie Borchers
- CNST NanoFab Faculty:
  - Kerry Siebein
  - Vincent Luciani