The 11th NEDO-CDTI Joint Workshop

"Technologies for Hydrogen Valley in Spain and Japan – Regional H2 Value Chain"

Recent Progress in Research and Development on Hydrogen and Fuel Cells at the University of Yamanashi

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University of Yamanashi

- ✓ One of the leading university in Japan in Hydrogen and Fuel Cells R&D
  - More than 40 years experiences in electrochemistry.
  - One of the top Japanese universities in patents and papers on HFCs.
  - Total 85 people are engaging for HFCs R&D activities
- ✓ Covers all key materials for fuel cells and water electrolysis
  - Catalysts, Supports, Membranes, GDLs, Separators, Ink coating process, etc.
  - All research from material preparation to performance evaluation and microscopic observation can be done in one place.

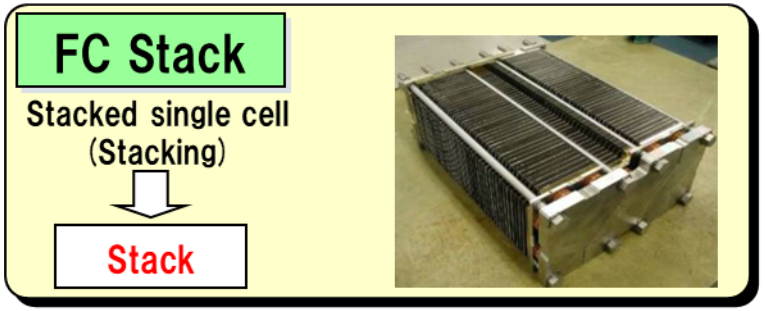
Lab. for FC Electrocatalysis
1978～2000

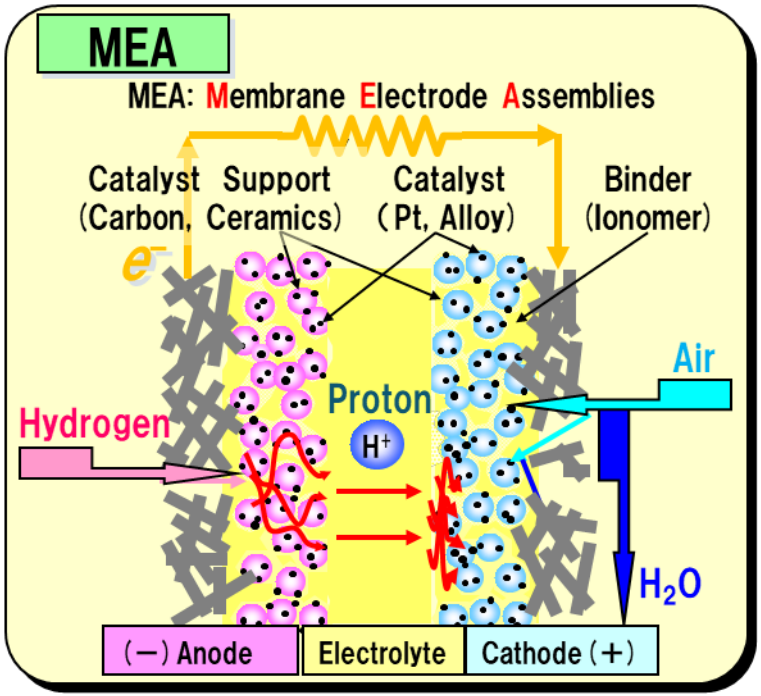
Clean Energy Research Center
2001～

Hydrogen and Fuel Cell Nanomaterials Center
2008～

Materials for Fuel Cells and Water Electrolysis

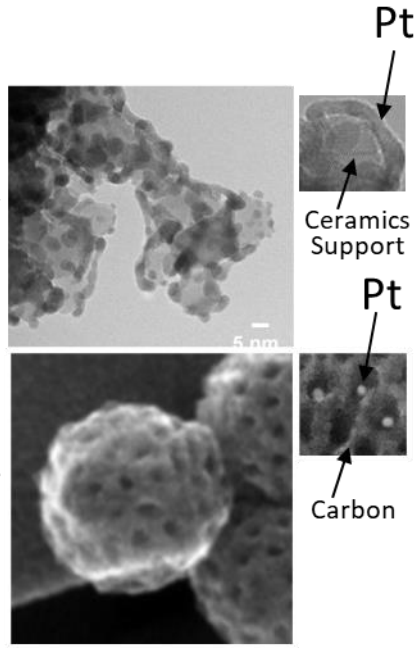
- ✓ Fuel Cells(FCs) and Water Electrolysis(WEs) have a similar stacked structure and use electrochemically compatible materials, i.e. catalyst, support, thin film electrolyte membrane, gas diffusion layer (GDL), and separators.
- ✓ University of Yamanashi focus on materials R&D for them.





Material research for future FCVs and WEs

- ✓ Catalysts
  - FCVs, HDVs:
    - Pt catalyst on electro-conductive ceramic support
    - Pt catalyst supported on ordered mesoporous carbon
  - WEs:
    - IrOx catalyst for PEMWEs
    - Highly active and durable Ni-based catalyst for AEMWEs



- ✓ Electrolyte Membranes
  - FCVs, HDVs:
    - Hydrocarbon type proton exchange membrane with high chemical and mechanical stability by reinforcement
  - WEs:
    - Hydrocarbon type anion exchange membrane with high durability and conductivity for AEMWEs

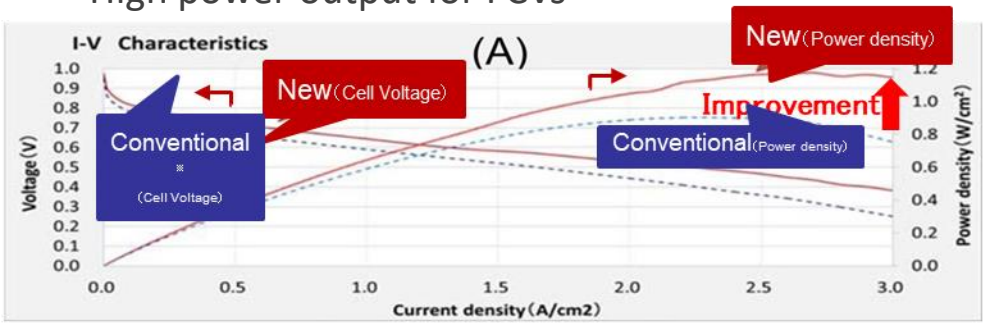
Source: https://www.nedo.go.jp/content/100950420.pdf

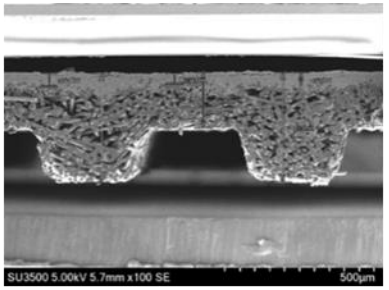
Material research for future FCVs and WEs

- ✓ Separator with Porous rib

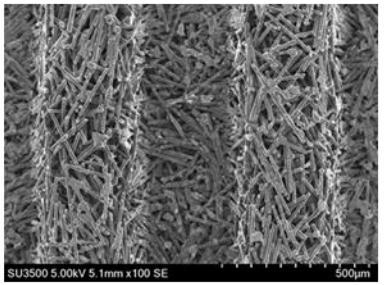
  Source： M. Watanabe et.al Journal of ECS, 166(7) F3210-3215(2019))

  - Flat separator integrated with GDL with flow channel
    - High power output for FCVs





(a) cross-section

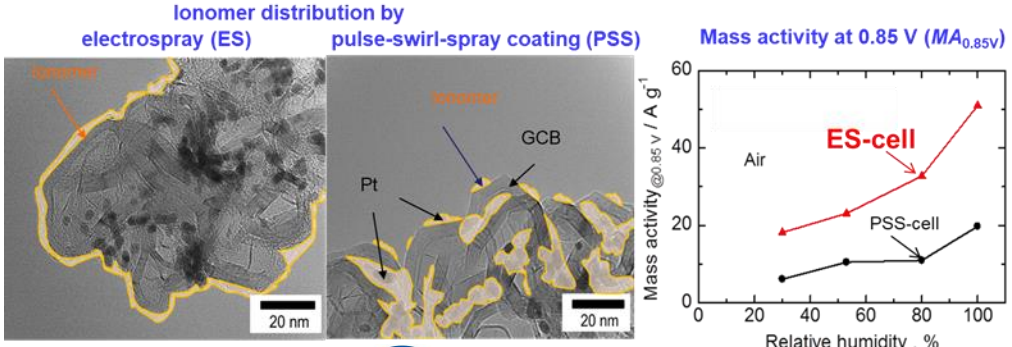


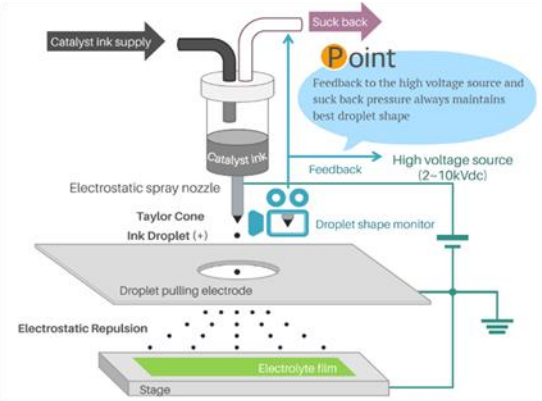
(b) upper surface

- ✓ Dry Ink coating process

  Source： K. Takahashi et.al Journal of ECS, 163(10) F1182-1188(2016))

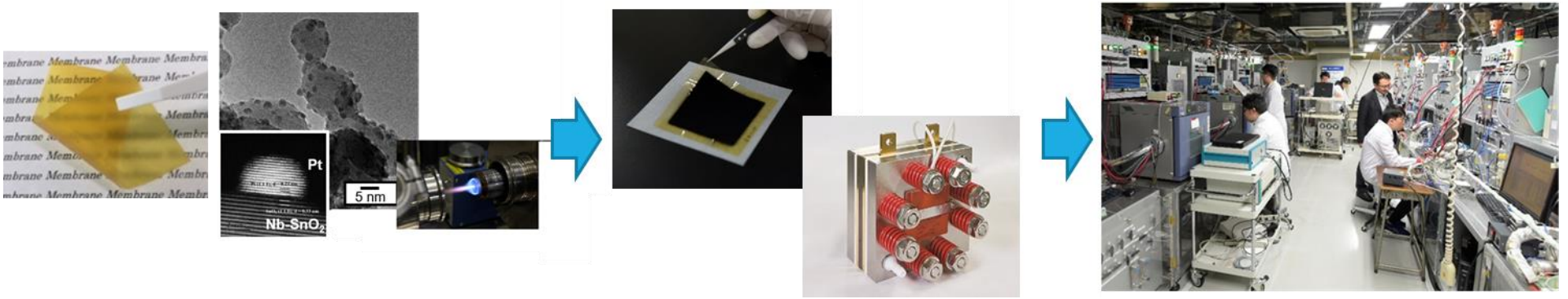
  - Electro-Spray method enable uniform ionomer coverage on catalysts results in higher catalytic activity.



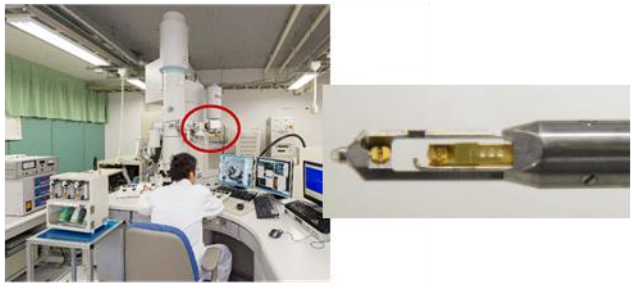


Unique capability for FCHs R&D

- ✓ High capability from material creation to fuel cell prototyping and evaluation

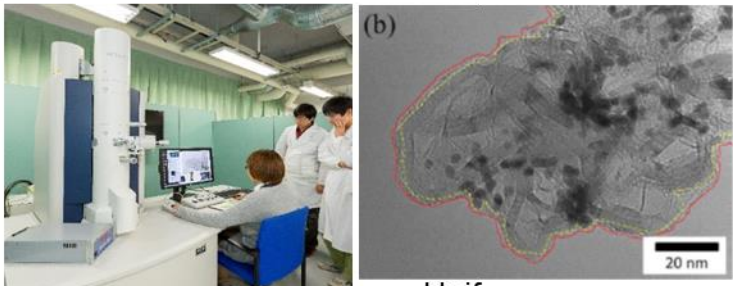


- ✓ Unique electronic microscopes developed with the manufacturer



Catalyst samples could be heated up to 1500 ℃ in various gas atmospheres

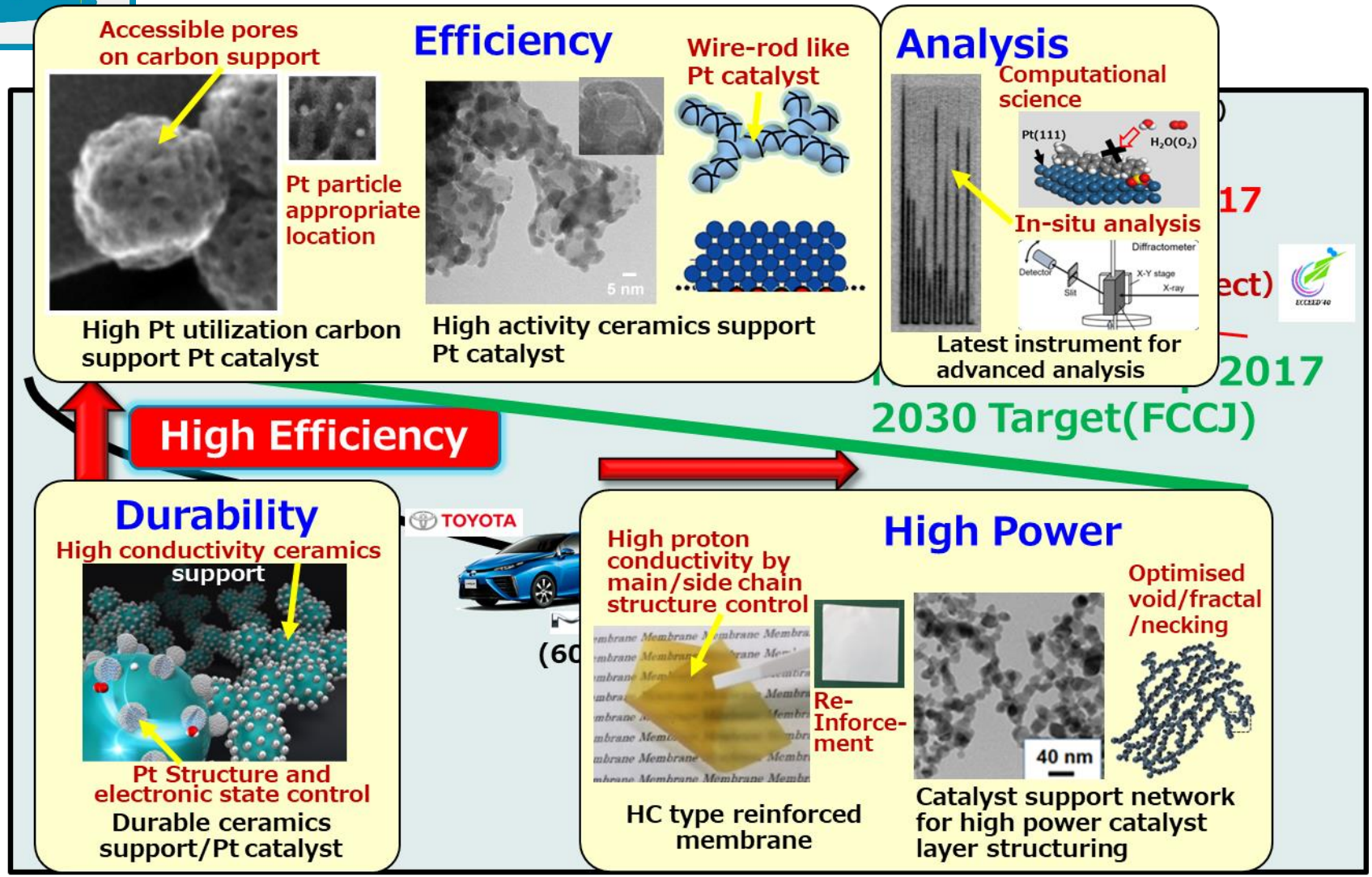
Atomic level high resolution STEM



Uniform coverage

Direct observation of electrolyte coverage without damage

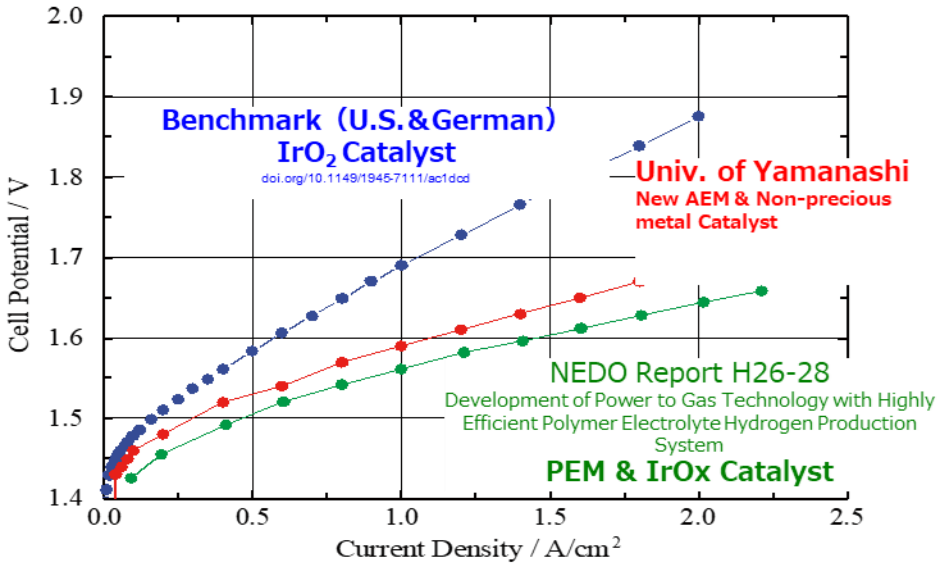
Main challenges and solutions for the future FCVs



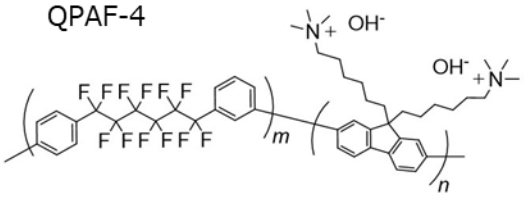
Source: https://www.nedo.go.jp/content/100950420.pdf, etc.

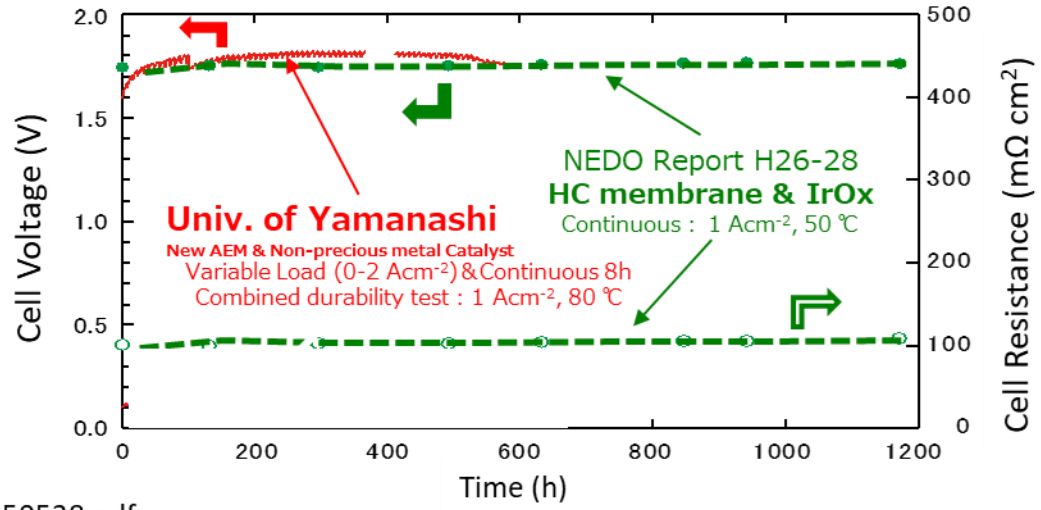
Main challenges and solutions for AEMWEs

- ✓ Catalyst Challenge
  - NiMO catalyst development



- ✓ Membrane Challenge
  - Durability improvement





Source: https://www.nedo.go.jp/content/100950538.pdf

Ideas for a Japan – Spain collaboration

- ✓ Academia-Academia, Academia-Industry collaboration should be promoted.
  - As a first step, it is important to deepen mutual understanding through human exchange.
  - Government support for encouraging above would be very effective.