



FURTHER-FC

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Further Understanding Related to Transport limitations at High current density towards future ElectRodes for Fuel Cells

Importance of the Project from Industry Point of View

(Stéphane Cotte, Toyota Motor Europe)



Content of the presentation



1. Toyota Motor Europe
2. FC development history of Toyota
3. Progress of technologies in 2nd Gen. Mirai
4. Next action towards a sustainable progress
5. Importance of FURTHER-FC

1. Toyota Motor Europe



- Technical centre located in Belgium (Brussels)
- Material Engineering division
- Advanced Research for next generation FC & H2 storage
 - Material development
 - Innovative production method

2. FC development history of Toyota

'14

'20

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**Carbon
Neutral**



- High-speed production
- Lowering cost
- High Functionality
- Additional value



**99.7% reduction
of PM2.5**
(Toyota internal test)

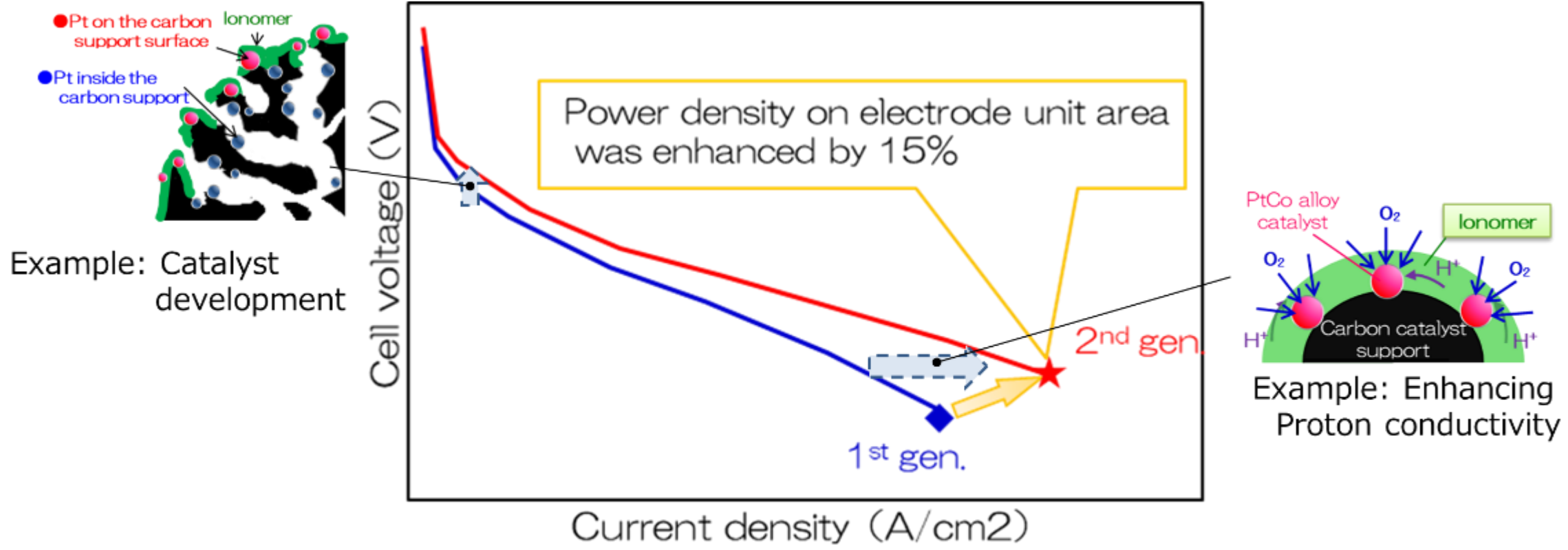
**Starting point toward
a sustainable future
and happiness**

3. Progress of technologies in 2nd Gen. Mirai

	1st Gen. MIRAI	New MIRAI
Size Weight	370 cells 33L/41kg	330 cells 24L/24kg
Max. Power	114kW	128kW
Volumetric Energy Density	3.5kW/L	5.4kW/L
Cruising range (Toyota internal test)	650km	850km

Overall improvement in **Electrode materials**, flow channel, production technologies

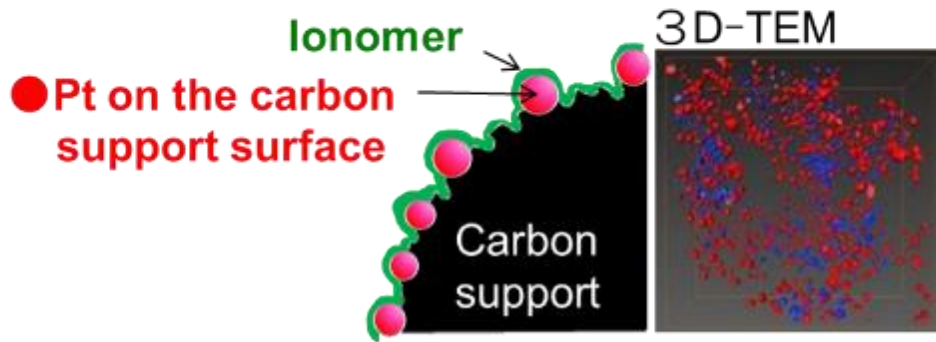
3. Progress of technologies in 2nd Gen. Mirai



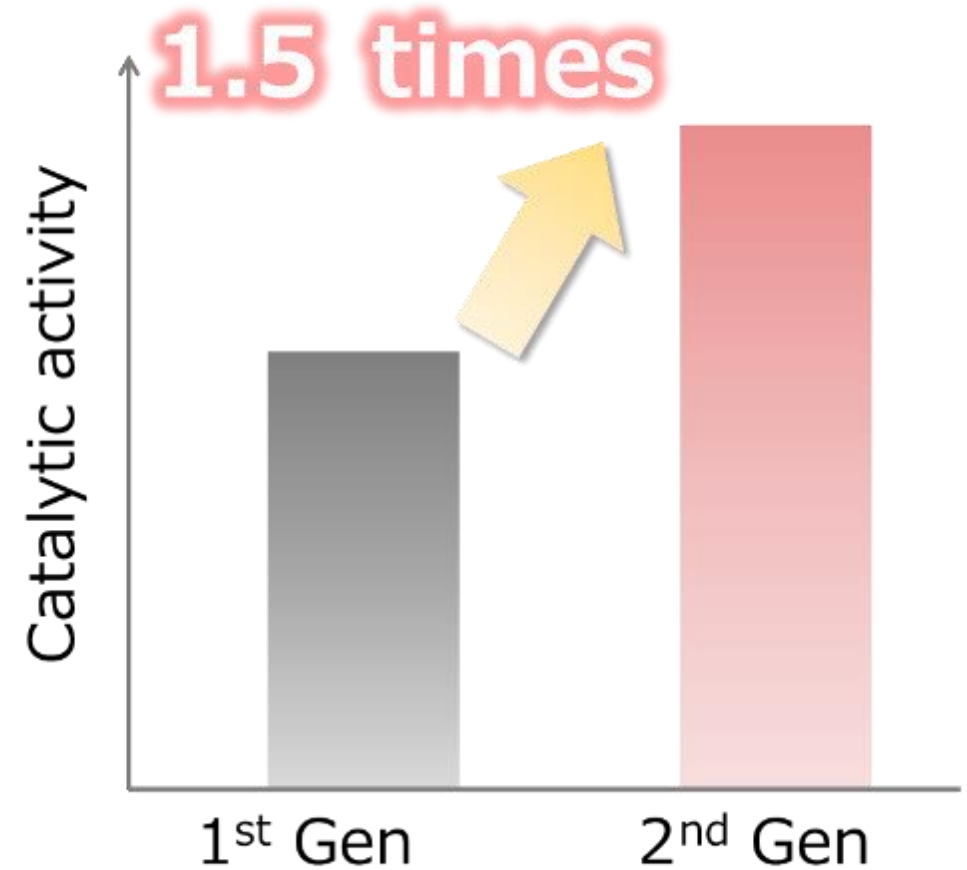
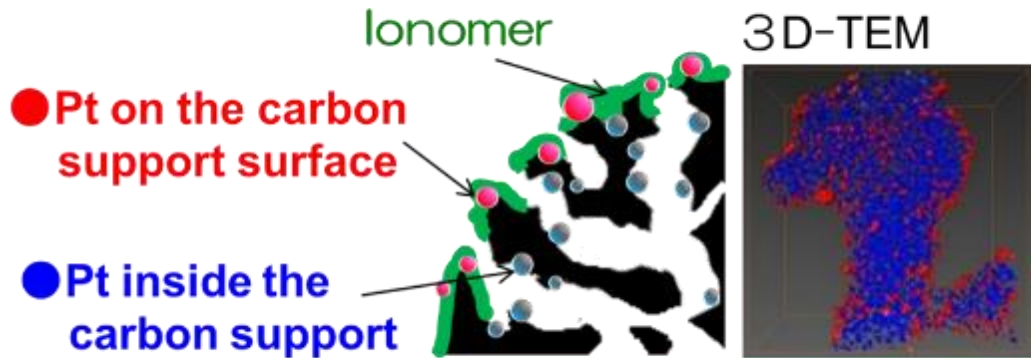
Power density on the electrode unit area was enhanced by 15% by adopting new electrode materials

3. Progress of technologies in 2nd Gen. Mirai

【1st generation : Low surface area carbon catalyst support】

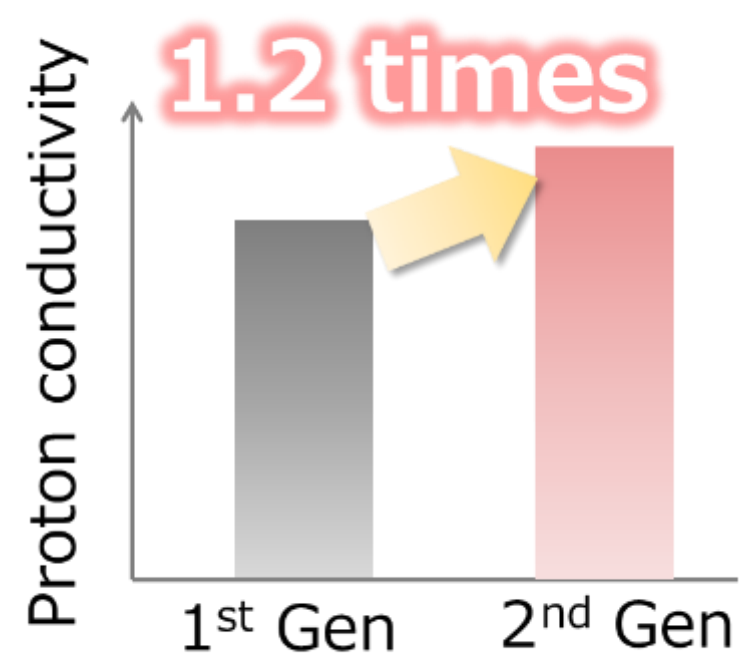
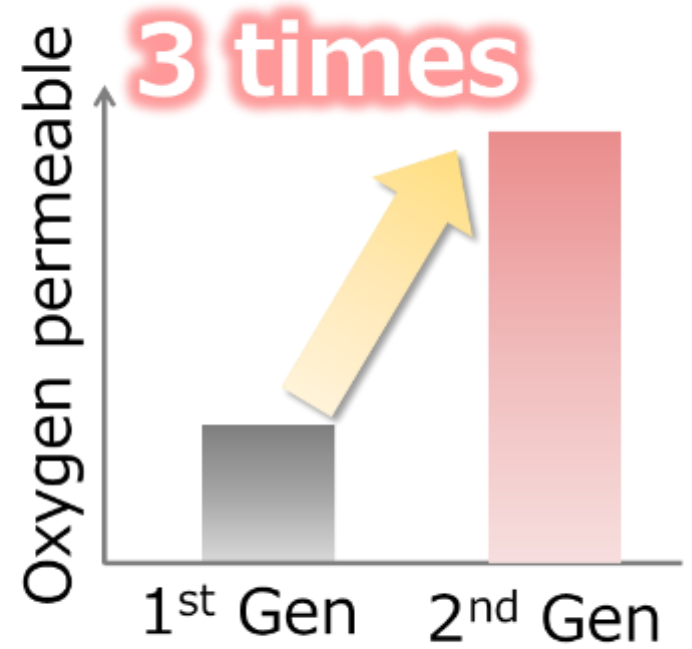
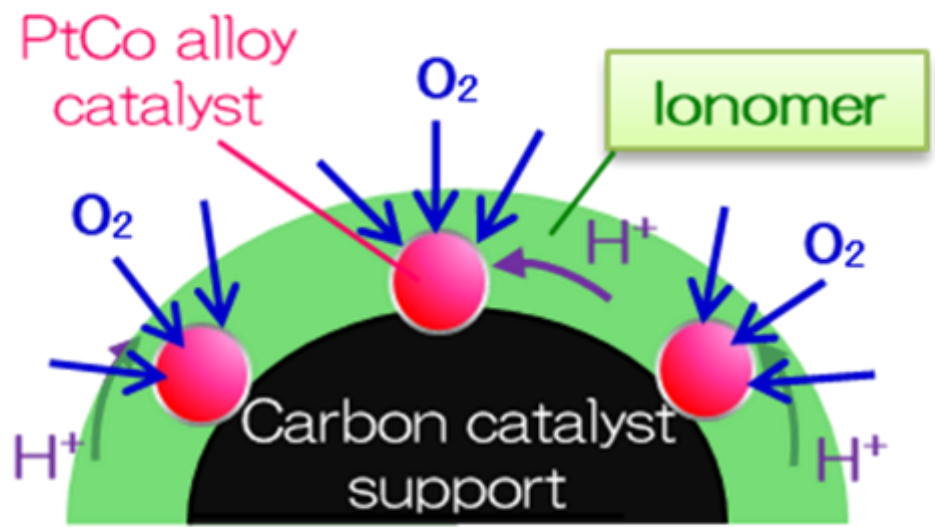


【2nd generation : Mesoporous carbon catalyst support】



About 80% of Pt is supported inside the mesoporous carbon.
Catalytic activity was improved by 1.5 times.

3. Progress of technologies in 2nd Gen. Mirai



The proton conductivity was increased by 1.2 times by adopting highly oxygen-permeable ionomer

4. Next action towards sustainable progress

Progress of Technologies

- Reliability/Durability
- Production Speed
- High Functionality
- Low Cost



① Progress of Fuel cell technologies

3rd Gen.

② Expanding application



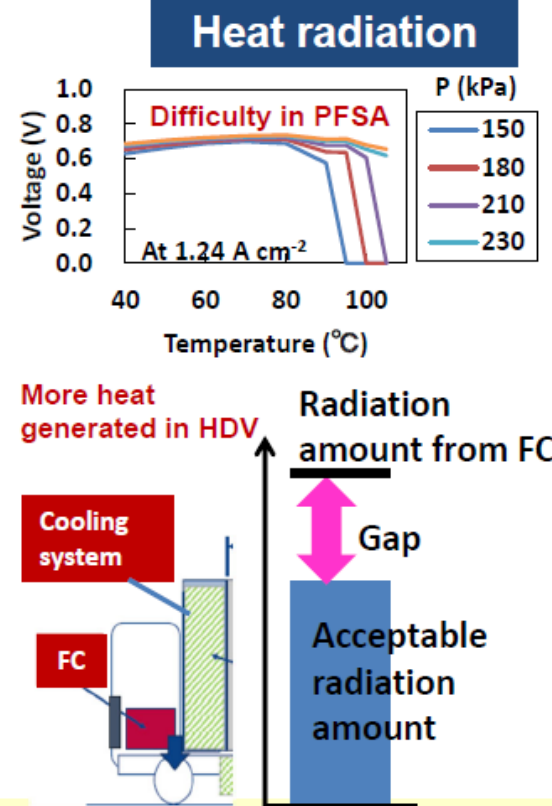
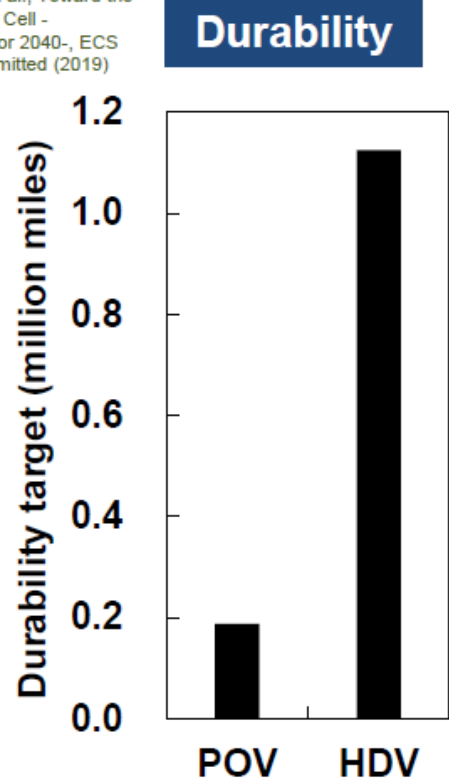
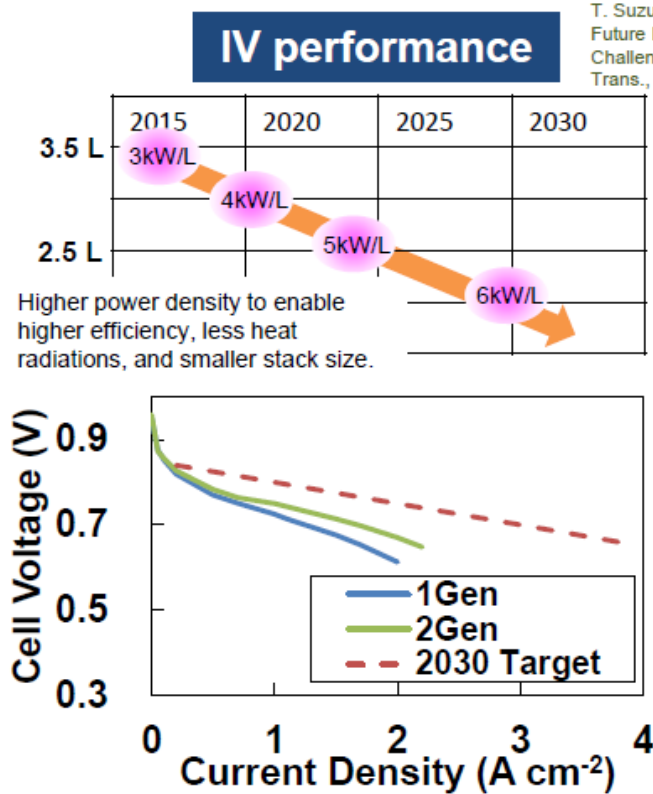
- Various variations
- Packaging
- After market

③ Building Associations



Increase of opportunity to use

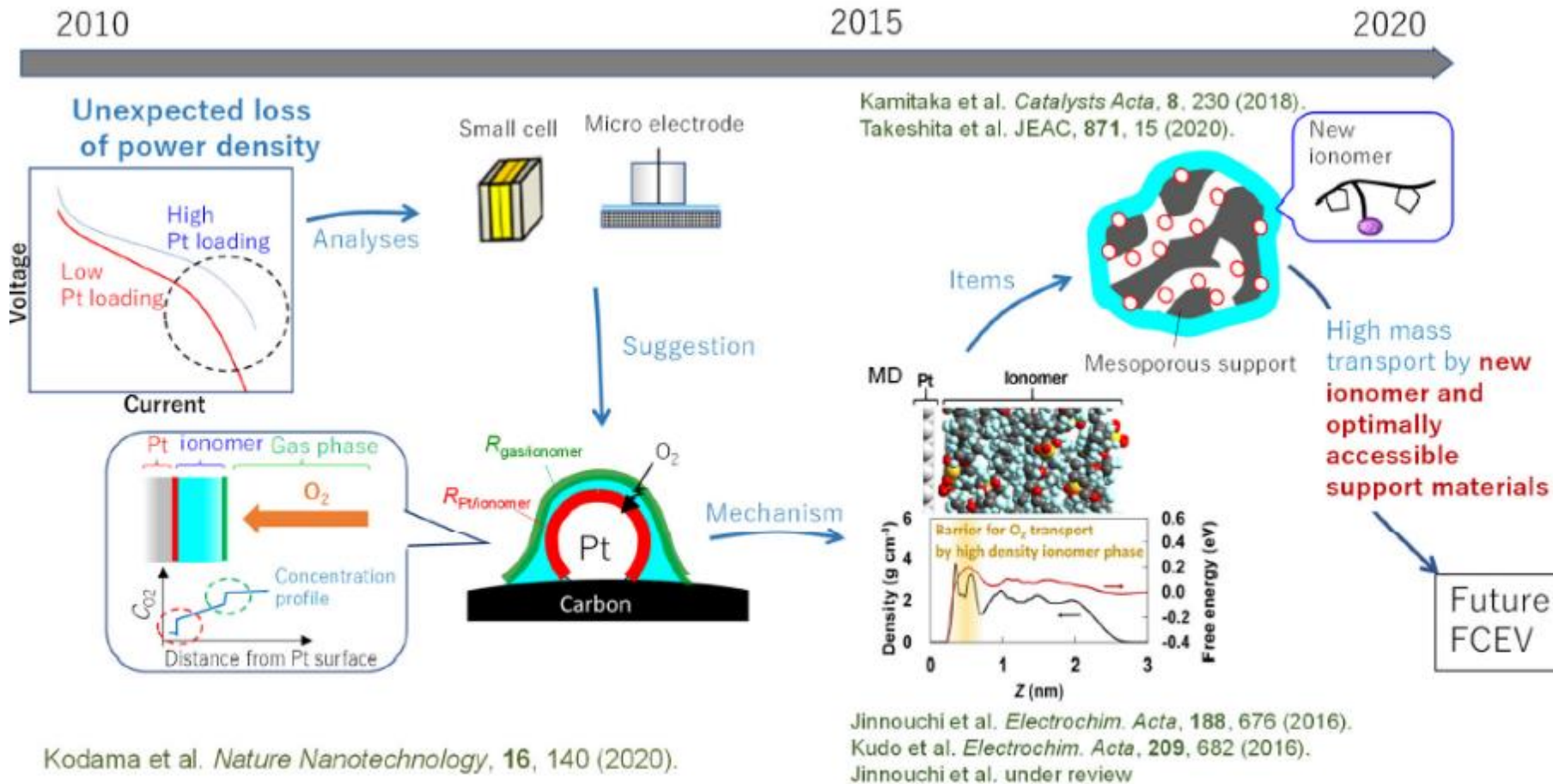
5. Importance of FURTHER-FC



- Higher IV performance.
- Higher durability.
- Compact heat radiation realized by efficient FC or high-temperature operation.

Toyota FC global workshop 2021 (TCRDL)

5. Importance of FURTHER-FC



- Enhancing local O₂ transport by new ionomer and meso-porous supports.
- Optimizing porous structure and ionomer distribution in catalyst layer.

Toyota FC global workshop 2021 (TCRDL)



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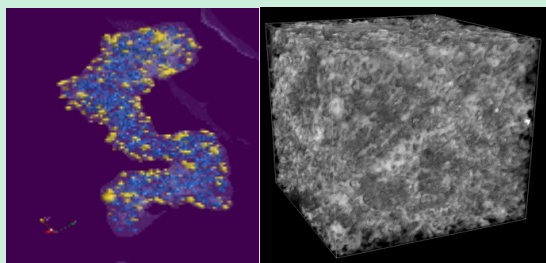


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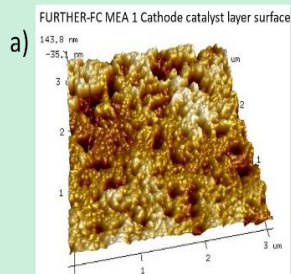
This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No **875025**. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

Thank you for your attention.
Your questions are welcome

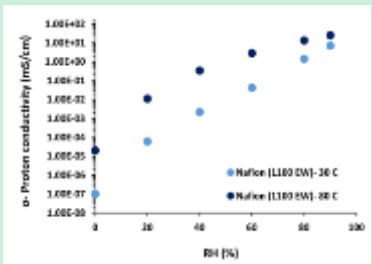
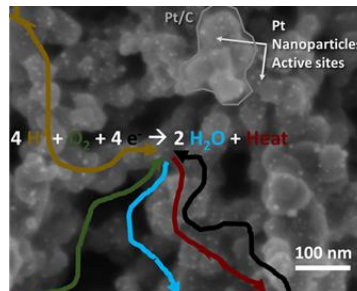
Multiscale characterization



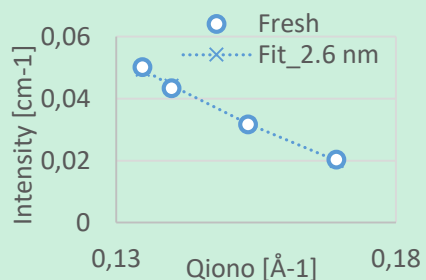
3D TEM and FIB/SEM



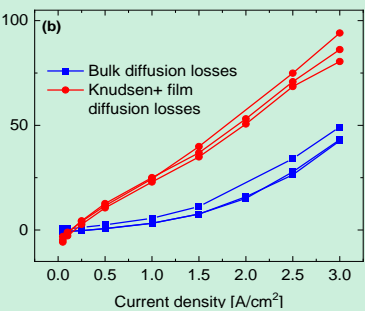
AFM



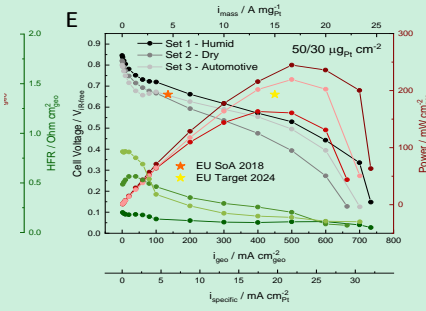
Ionomer transport properties



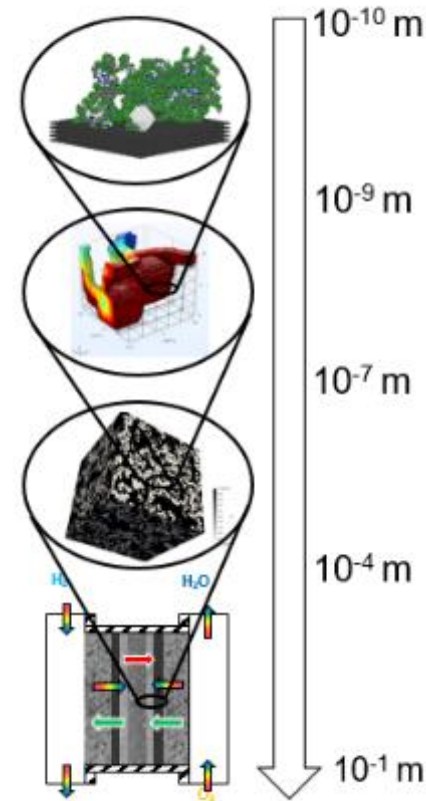
Ionomer swelling



Mass transport losses

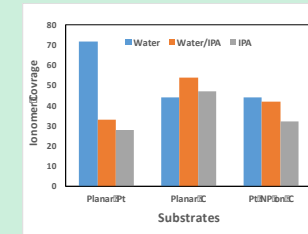
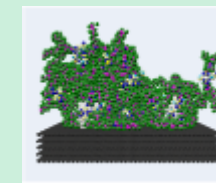
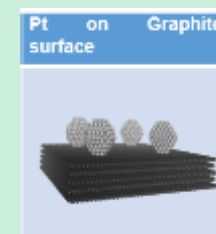


Ultra-thin electrode



Multiscale modeling

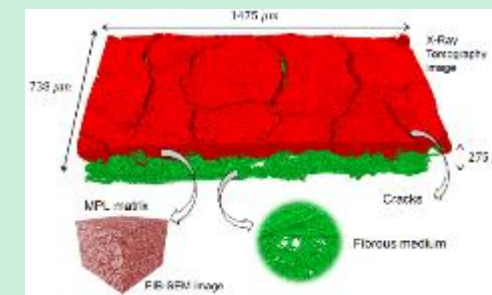
Ionomer film scale



Sub μm scale



CCL scale



Cell scale

