Kyushu University

Platform of Inter-/Transdisciplinary Energy Research

Established in October 2016

Professor
Akari Hayashi, Ph.D.

Introducing myself

Akari Hayashi

- B.A. in Chemistry
  at Sonoma State University, CA, USA
- Ph.D. in Chemistry
  at University of California, Davis, CA, USA
- A member of UCD Alumni Japan Chapter

At Kyushu University

- Q-PIT
- Department of hydrogen energy systems
  (Advanced hydrogen energy system lab)
- International research center for hydrogen energy
- Next-Generation Fuel Cell Research Center

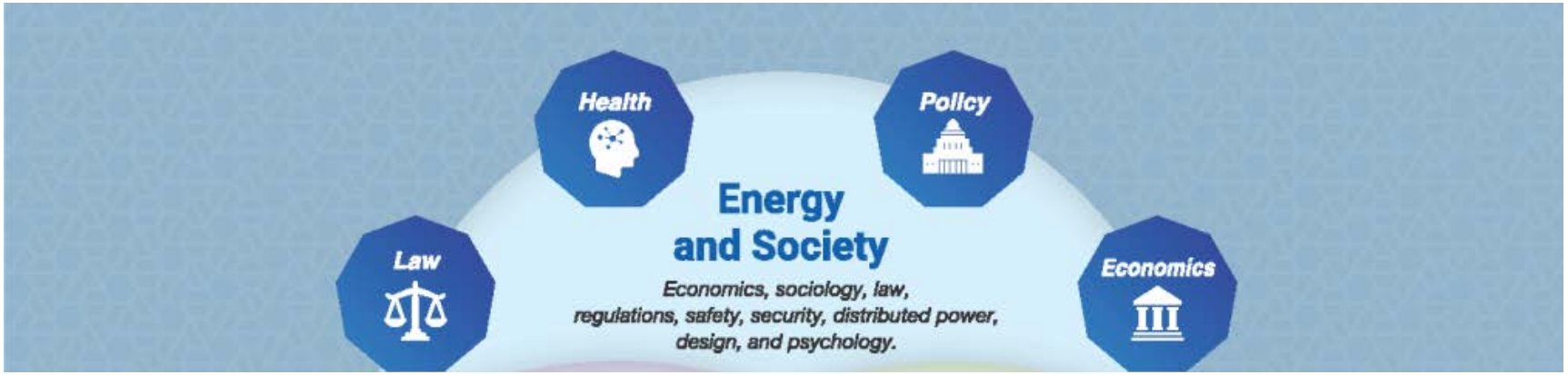
Q-PIT's Challenge and Vision

December 2015

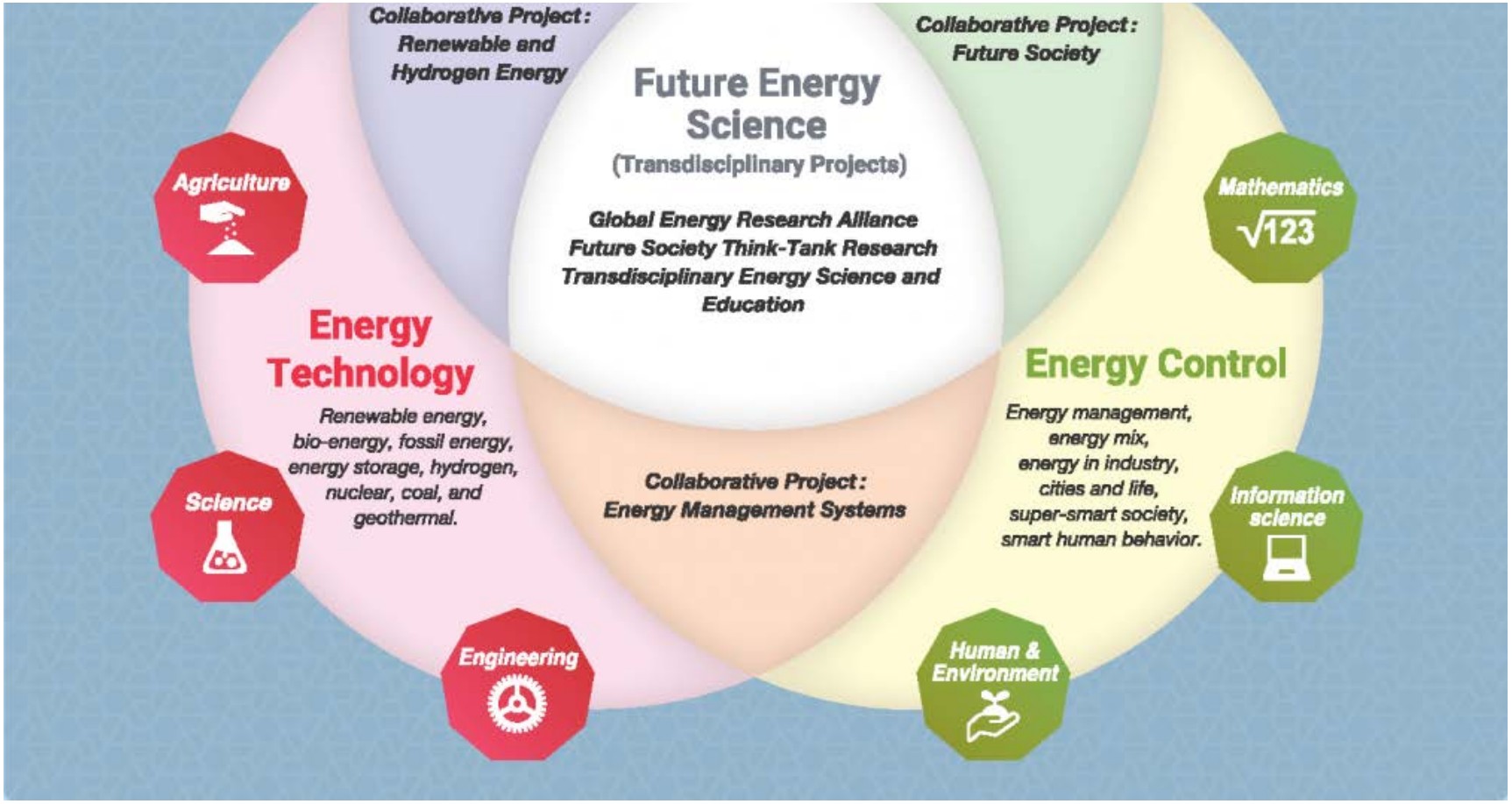
The Paris Agreement

"achieve a balance between emissions caused by humans and the removal of greenhouse gases in the second half of this century"

Ideal Energy for the Society of the Year 2100
"Carbon-free"



All-Kyushu University without Barriers among Dept.



Organization of Q-PIT's

Director = President

Future Energy Society Research Unit

Professor：Yoshida Kentaro*

Associate Professor：Aoki Keiko

Future Energy Management Research Unit

Professor：Tada Tomofumi*

Associate Professor：Hori Maiya

Renewable Energy Utilization Research Unit

Professor：Yamazaki Yoshihiro*

Professor：Hayashi Akari*

Associate Professor：Watanabe Kohichi

Future Society Think-Tank Research Unit

Professor：Yoshida Kentaro

Associate Professor：Lindner Robert

Global Energy Research Alliance Unit

Professor：Hayashi Akari

Associate Professor：Lyth M Stephen

Associate Professor：Wakeyama Tatsuya

Transdisciplinary Energy Science and Education Unit

Professor：Yamazaki Yoshihiro

Professor：Tada Tomofumi

Professor：Yoshida Kentaro*

Professor：Hayashi akari*

*；additional post

Global Energy Research Alliance unit

This research unit will advance cutting-edge research aimed at creating a low-carbon and carbon-free society, and will play a role leading Q-PIT by utilizing international research activities.

This unit is in charge of international collaboration including both research and education activity.

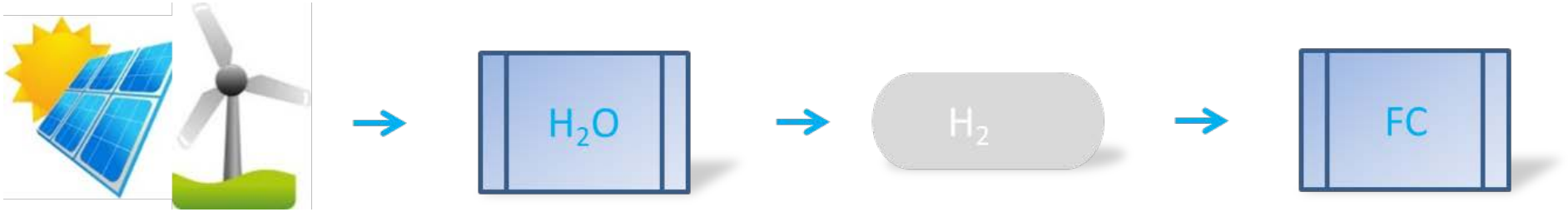
Collaboration with Hawaii State (Renewable Energy)

University of Hawaii
Hawaii state

Kyushu University

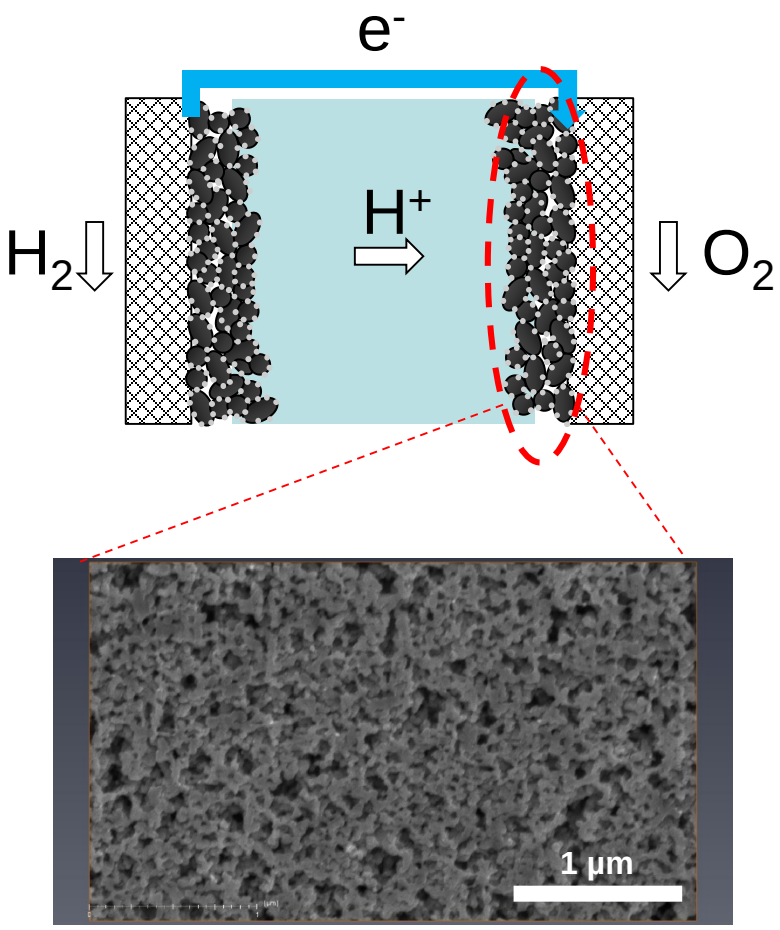
My research topic

Combination of Renewable energy and Hydrogen Energy

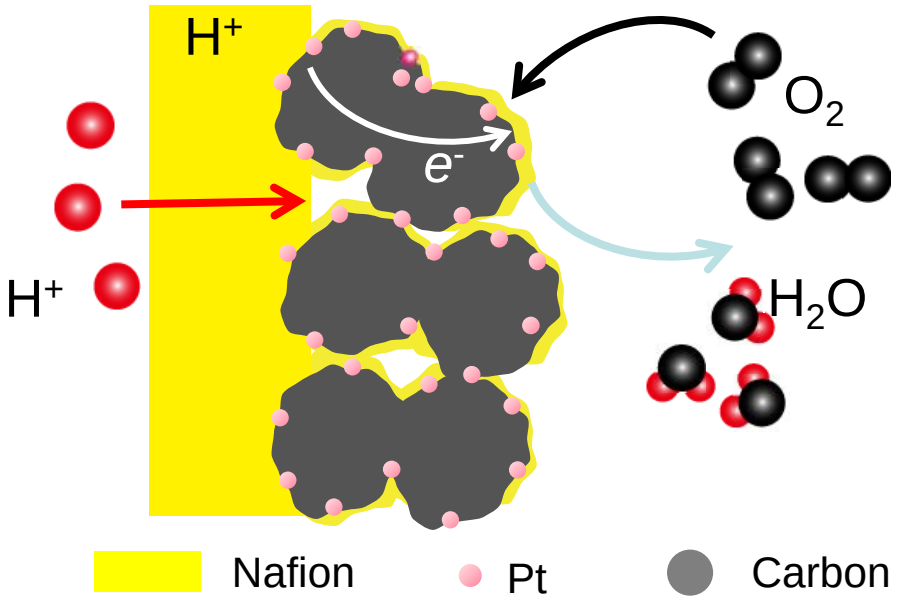


Renewable energy	Hydrogen production	Hydrogen storage	Hydrogen utilization
Wind power	PEM water electrolyzer	Metal hydride	PEM fuel cell (PEFC)

PEFC



Cross section of CL : porous

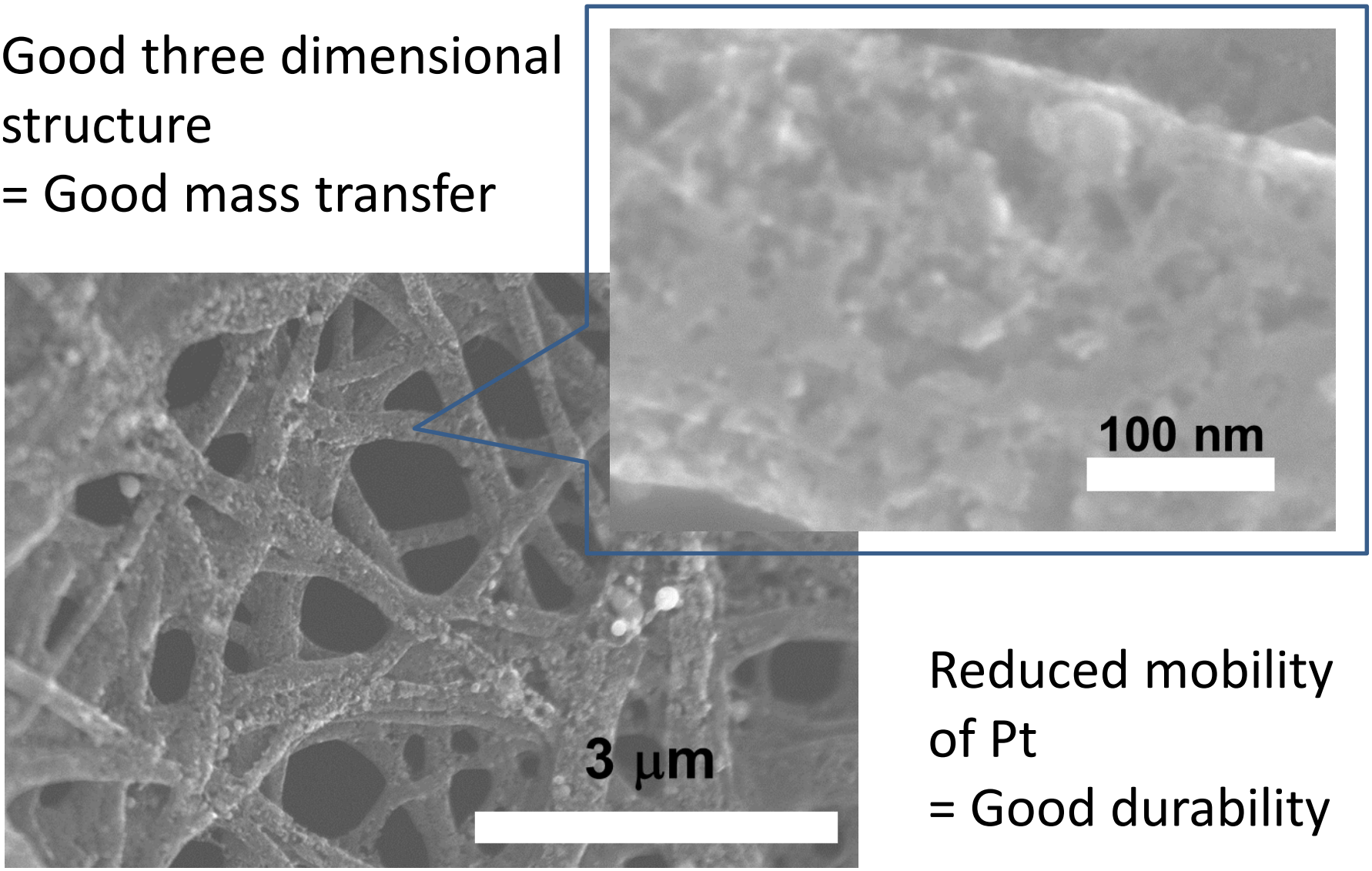


Nafion ionomer: Proton conductor
Pt: catalyst
Carbon: catalysts support

CL : a main component determining PEFC performance

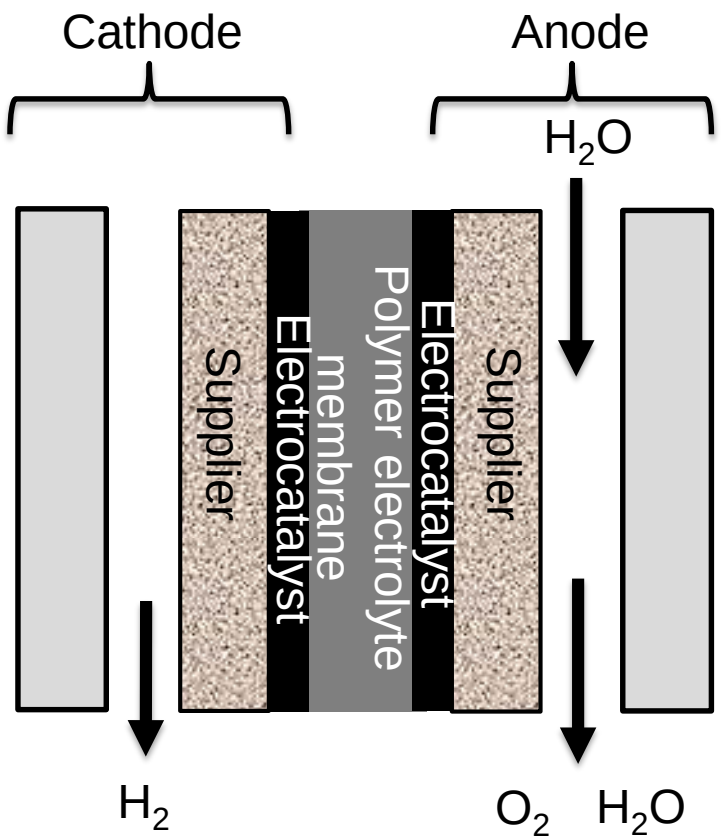
Mesoporous carbon fiber sheet cathode

Good three dimensional structure
= Good mass transfer



Reduced mobility of Pt
= Good durability

PEM WE



- Similarity to PEFC
- Reduced IR between electrodes
- Operation under high pressure

However

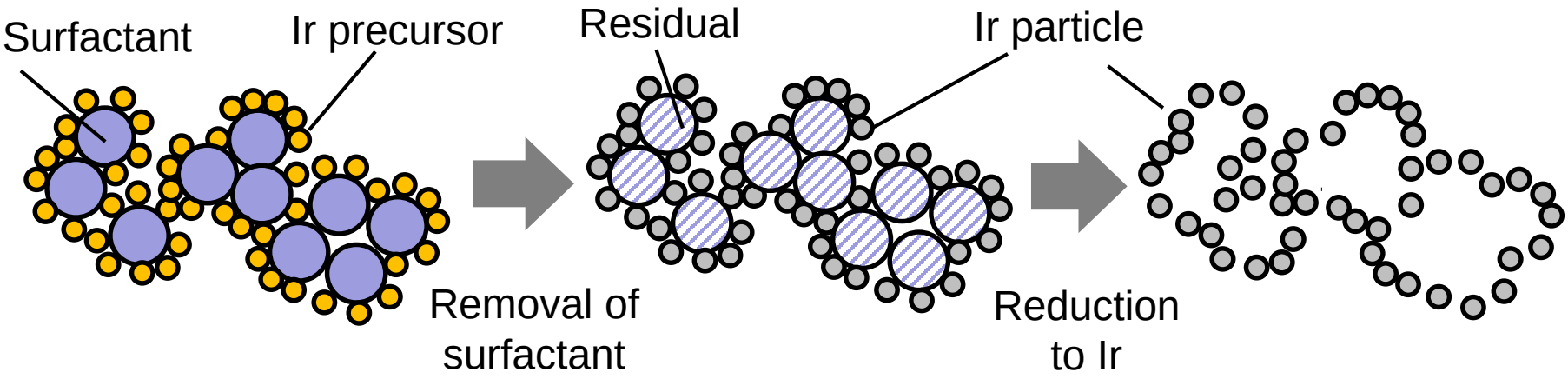
- Anode: No use of carbon support under high potential

- Difficulty in increasing active surface area of catalysts
  ⟶ High cost

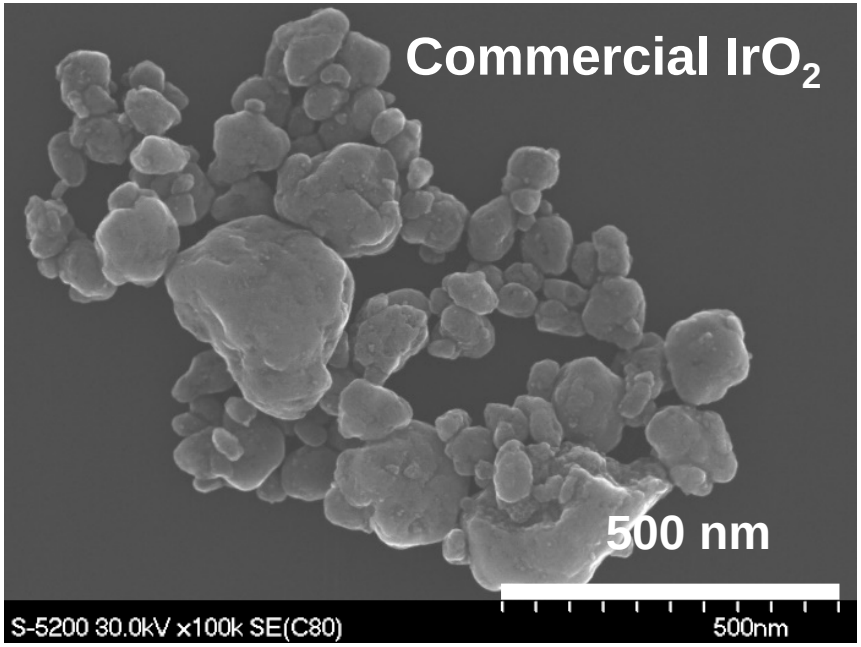
Development of new anode materials

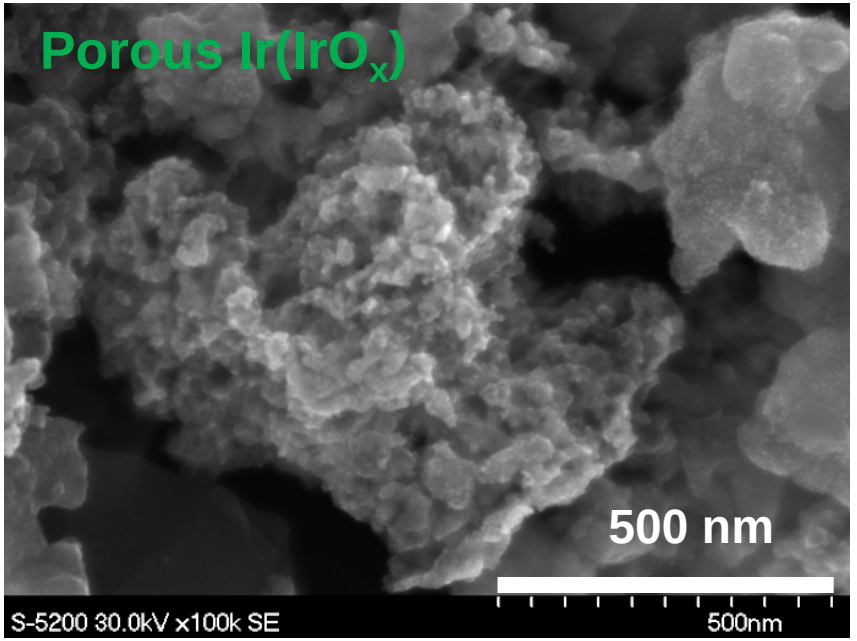
Applying mesoporous structure to water electrolyzer

Synthesis of bulk carbon-free mesoporous Ir catalyst



Comparison to commercial IrO_2

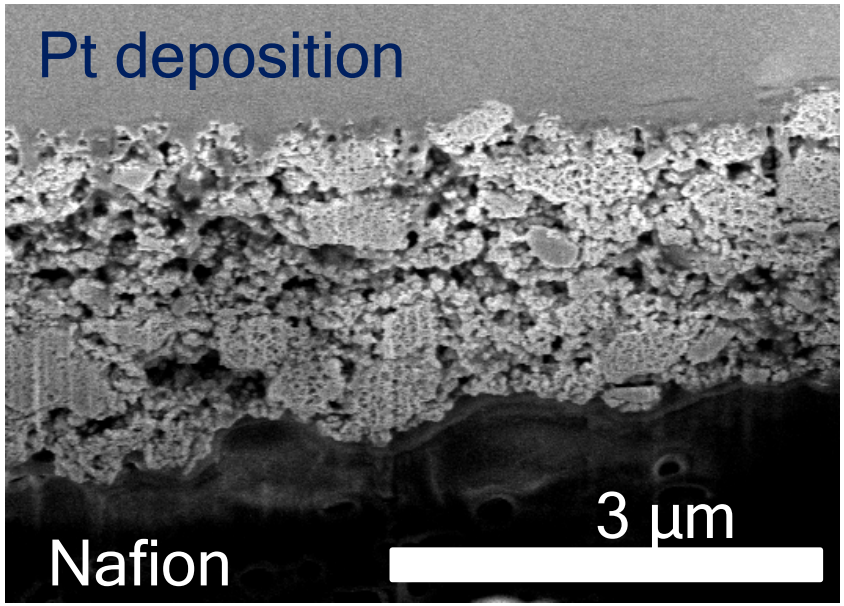




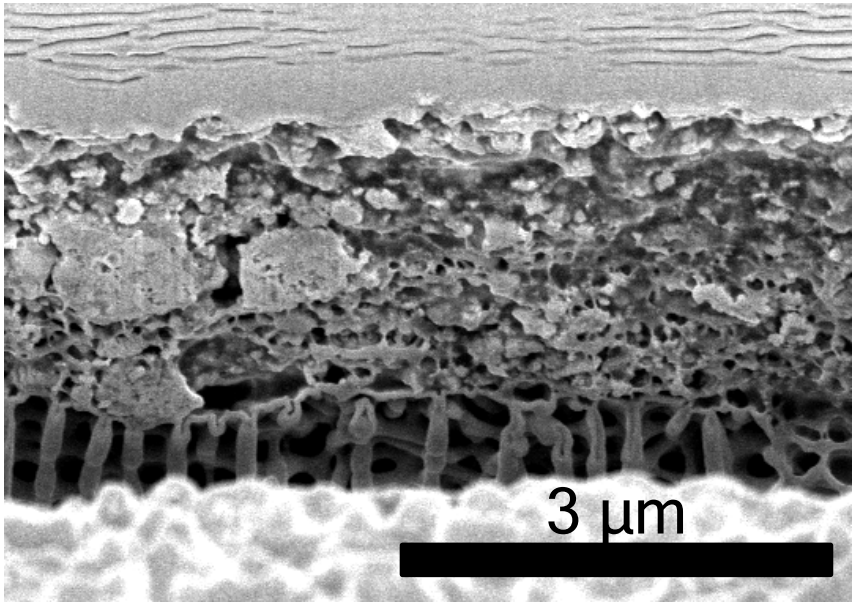
- Commercial IrO_2 : agglomeration of about 300 nm particles
- Porous $Ir(IrO_x)$: porous structure made by agglomeration of less than 50 nm particles

Observation of initial anode cross sections

Commercial IrO_2



Porous Ir



Commercial IrO_2	Porous Ir
2.15 μm	2.33 μm

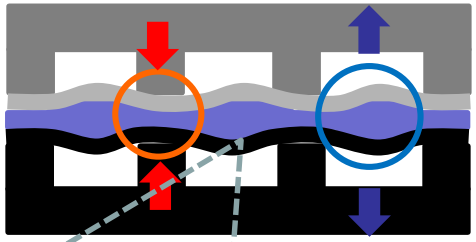
Observation of anode cross sections

Before assembling

Bipolar Plate
Ti mesh
MEA
Carbon paper
Bipolar plate

During IV measurement

Expansion of MEA

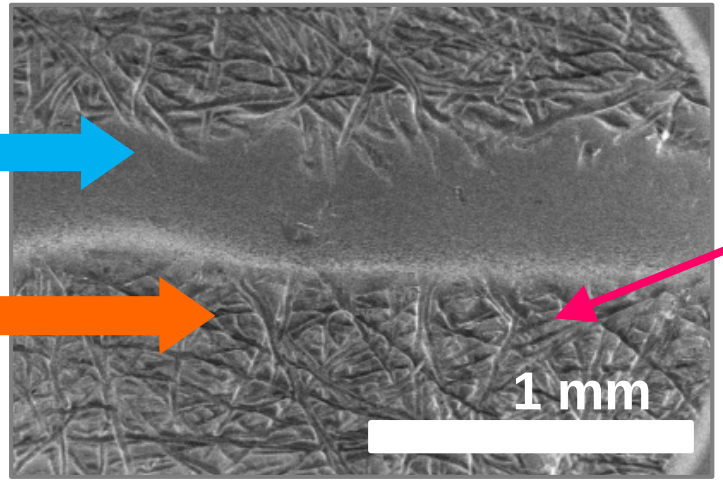


Compression of MEA

After IV measurement

Not attaching to Bipolar plate (channels)

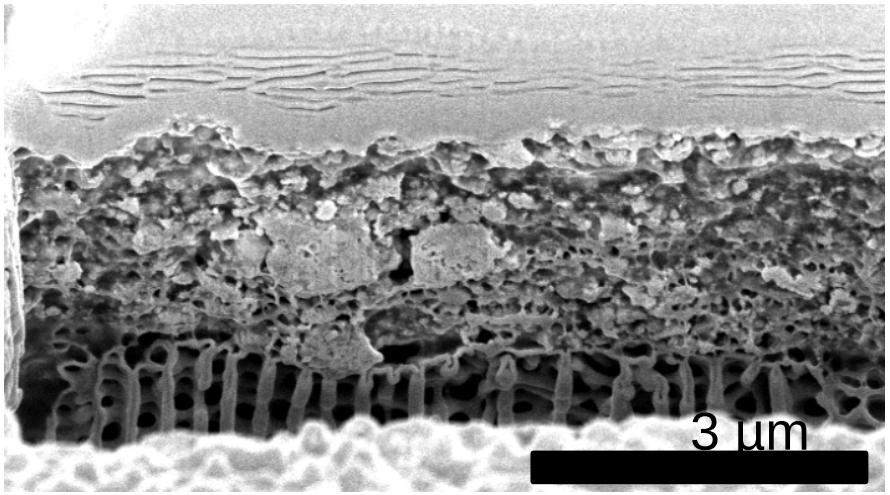
Attaching to Bipolar plate



Remained Ti mesh shape

Observation of anode cross sections

Commercial IrO_2



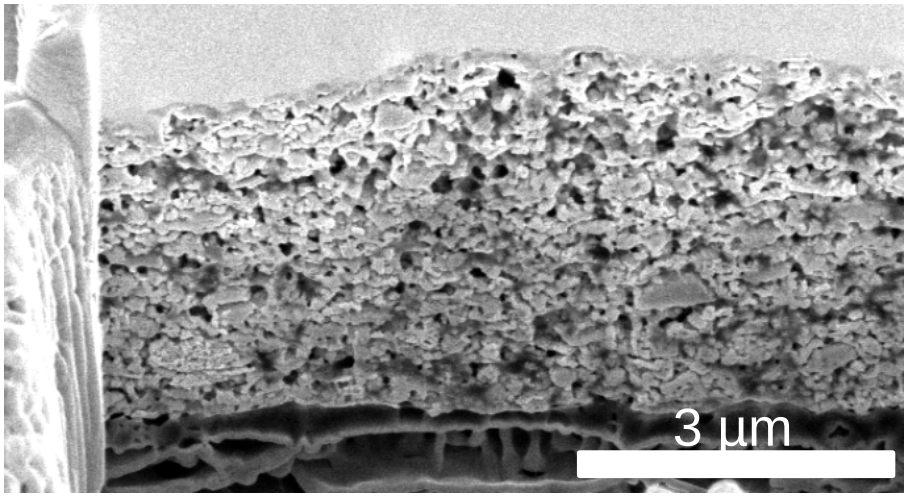
Fresh MEA : 2.15 μm

After IV

attaching : 1.47 μm

not attaching : 2.25 μm

Porous Ir(IrO_x)



Fresh MEA : 2.33μm

After IV

attaching : 2.27 μm

not attaching : 3.59 μm

Durable to compression/expansion because of porous structure

Metal Hydride (MH)

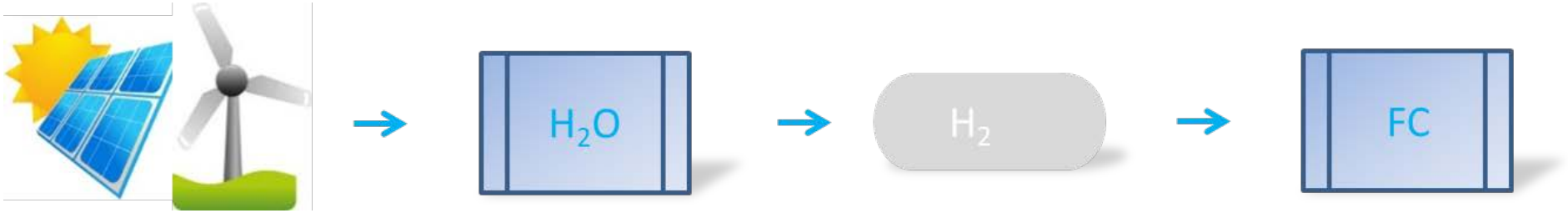
Hydrogen storage

- Compressed H_2 gas
- Liquefied H_2 gas
- Chemi-absorbed H_2 gas

AB5 + α : non flammable, usable in the living space

- Local government
- Regulation

Summary



Renewable energy	Hydrogen production	Hydrogen storage	Hydrogen utilization
Wind power	PEM water electrolyzer	Metal hydride	PEM fuel cell (PEFC)
Wind turbine	Porous Ir(IrO_x) anode	MH AB5	MC Fiber sheet cathode

Aiming future collaboration with UCSD !