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UNIVERSITY

Development of a novel photocatalytic nano-composite membrane to create new water resources from wastewater

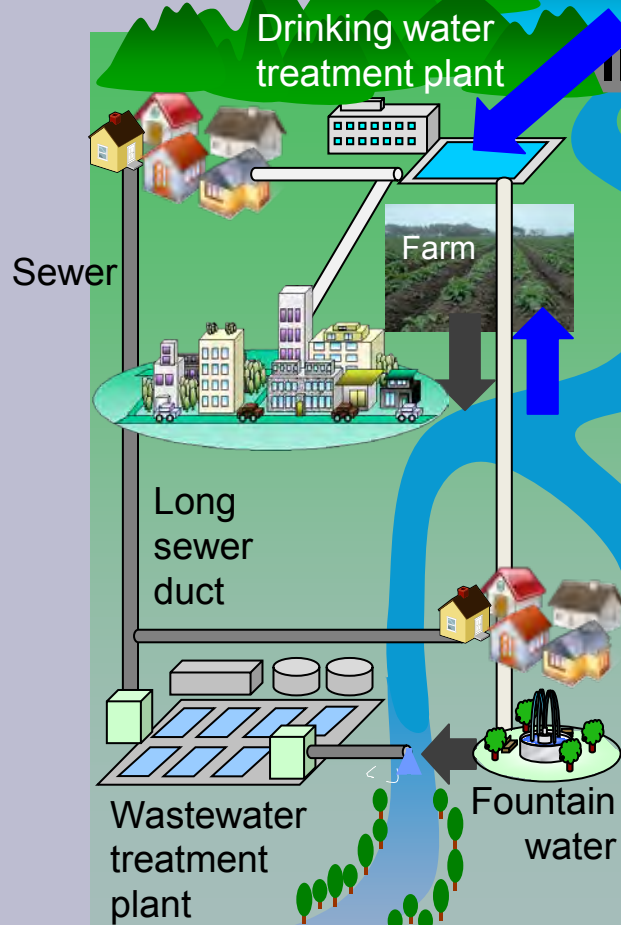
Daisuke Sano, Ph.D.

Associate Professor
Division of Environmental Engineering
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Hokkaido University

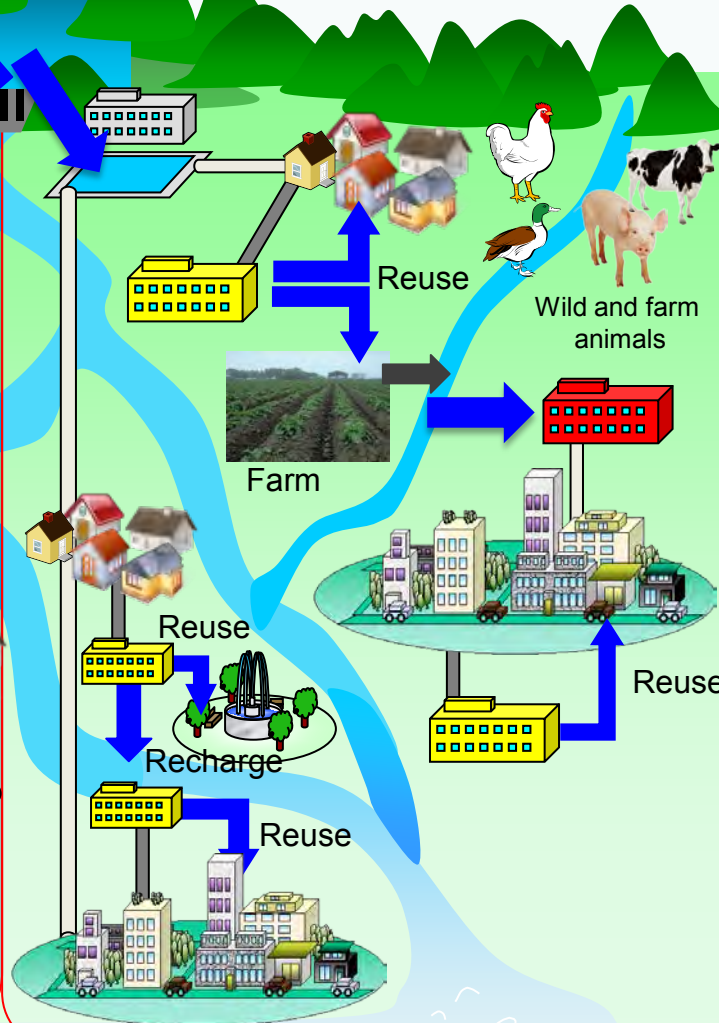


Mar. 5th, 2013

Conventional water utilization



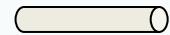
Autonomic and decentralized water metabolic system



Drinking water treatment plant with cutting-edge technologies



Small facility for membrane bioreactor



Drinking water pipe



Sewer duct



Intake

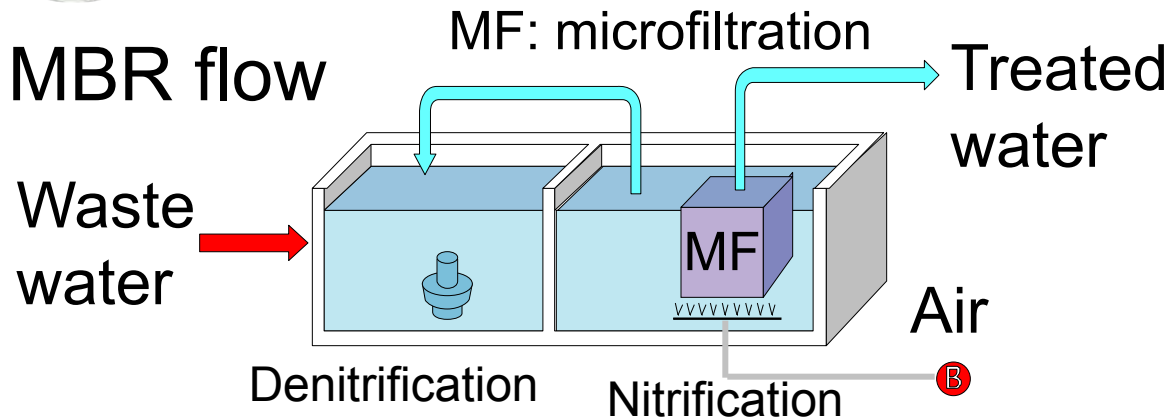


Wastewater effluent



Membrane Bioreactor (MBR)

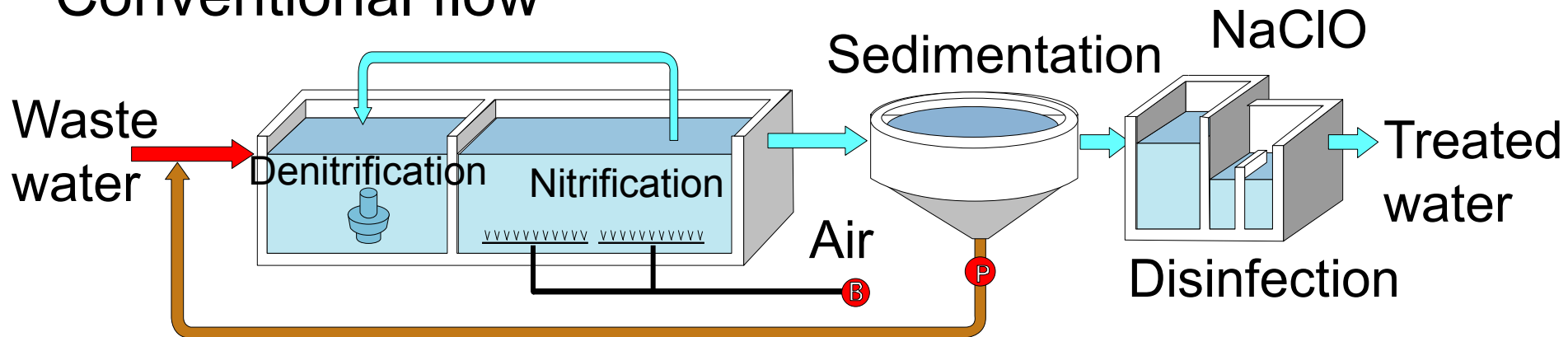
MBR flow



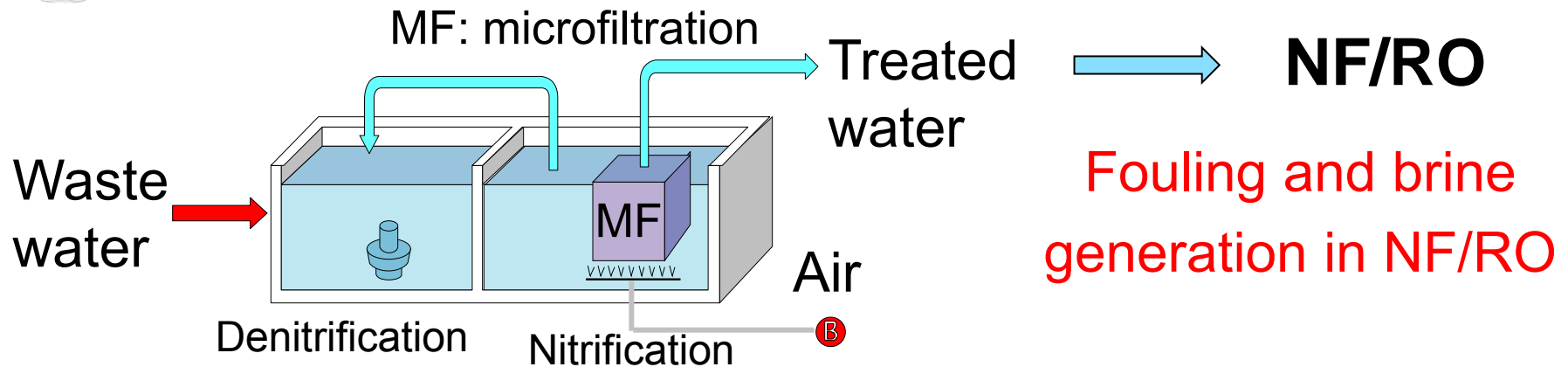
Advantages

- Small footprint
- Simple operation
- Simple maintenance

Conventional flow



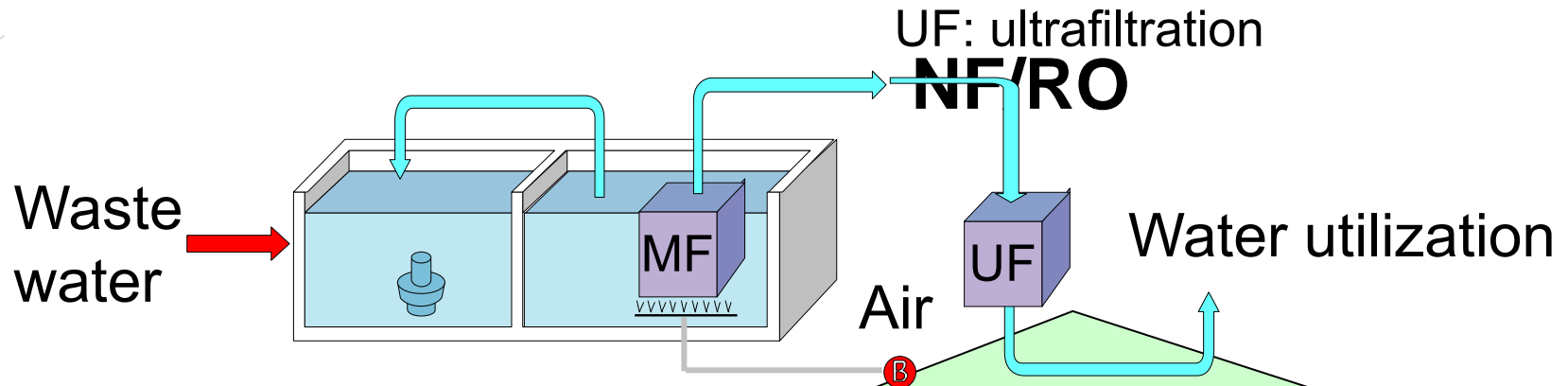
What we have to pay attentions to are...



- Organic matter in MBR effluent
- Viral pathogens and micropollutants



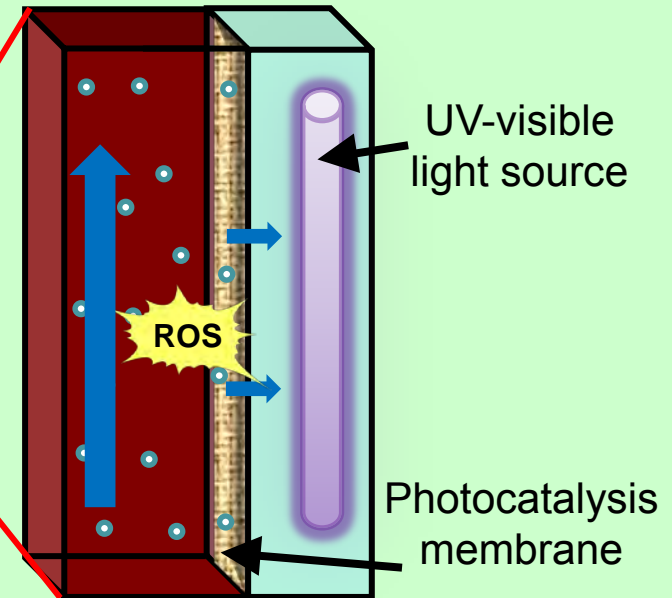
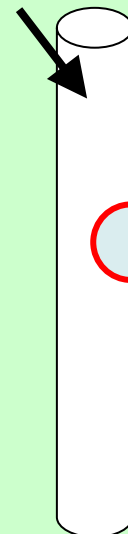
What we would like to achieve...



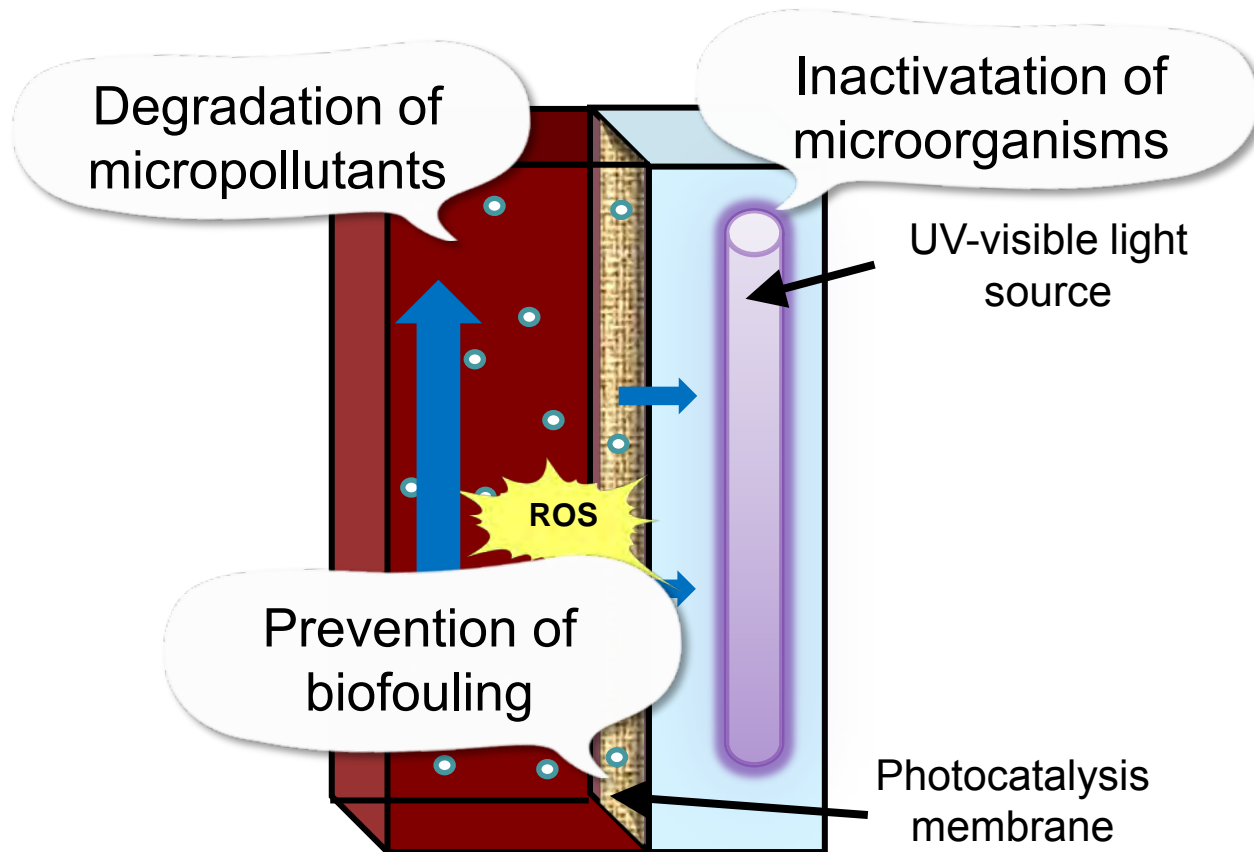
Hollow fiber
UF membrane



Photocatalysis
membrane



What we would like to achieve...



Main members

SPAIN

JAPAN



Dr. Katsuki KIMURA
Hokkaido University
Water Treatment Engineering
Membrane Technology



Dr. Daisuke SANO
Hokkaido University
Water Treatment Engineering
Public Health Microbiology



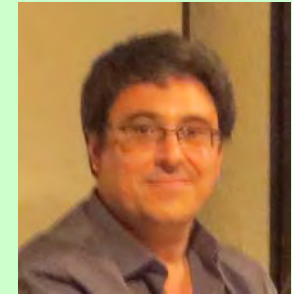
Team Leader
Prof. Satoshi OKABE
Hokkaido University
Water Treatment Engineering
Environmental Microbiology



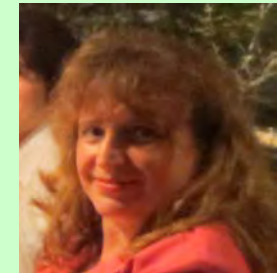
Dr. Hisashi SATOH
Hokkaido University
Water Treatment Engineering
Water Chemistry



Dr. Hiroshi YAMAMURA
Chuo University
Water Treatment Engineering
Membrane Technology



Team Leader
Prof. Marcos Fernandez-Garcia
ICP-CSIC



Dr. Maria Luisa Cerrada
(ICP-CSIC)



Dr. Marta Fernandez-Garcia
(ICP-CSIC)



HOKKAIDO UNIVERSITY

Mar. 5th, 2013
Daisuke Sano



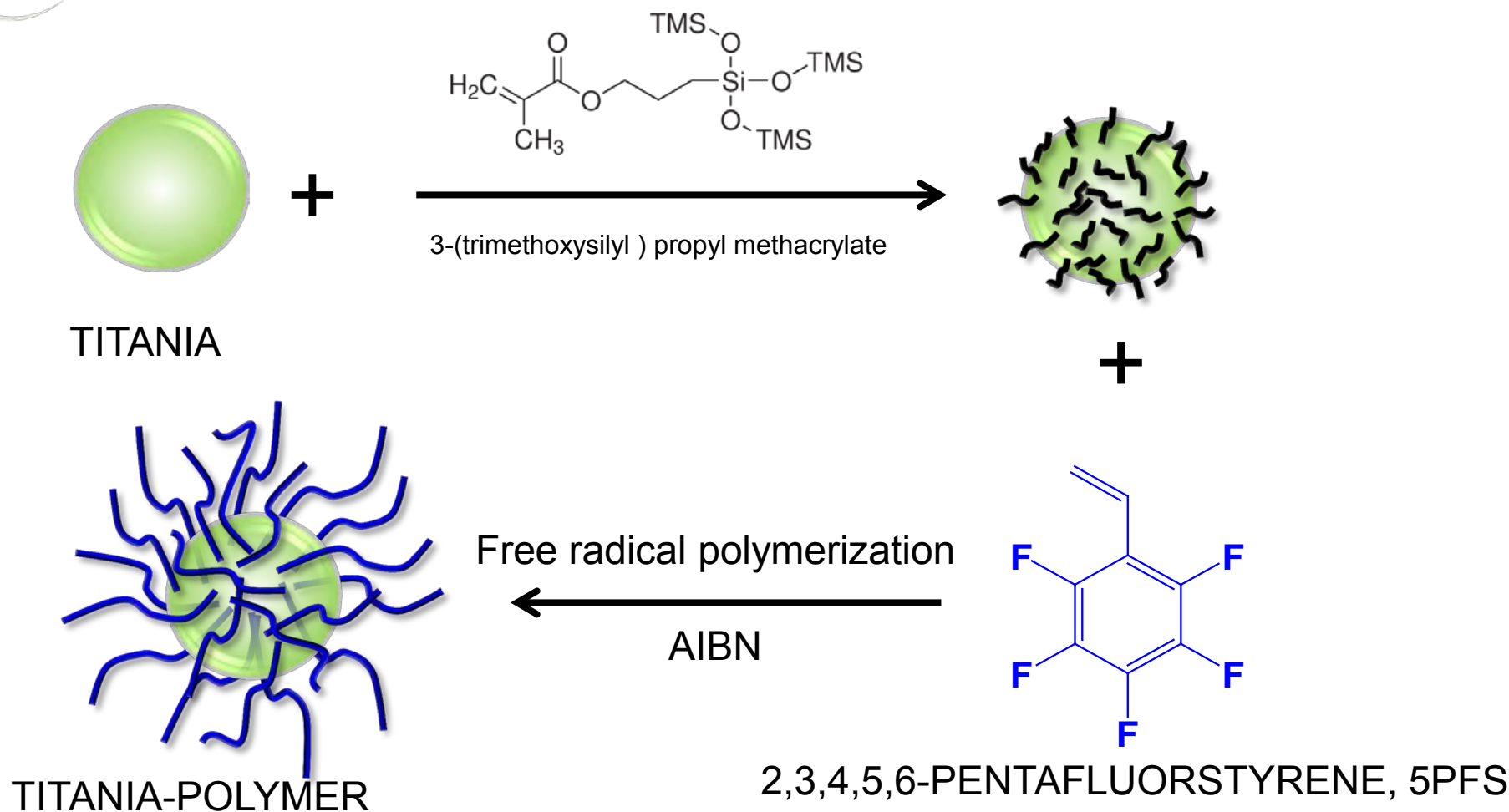
Research schedule

March 5th, 2013

Topics	2012	2013	2014
Equipment preparation and preliminary analyses	←→		
Evaluation of depollution and disinfection capabilities		←→	
Biofilm development analysis		←→	
Synthesis of photoactive materials	←→		
Synthesis of photocatalytic nanocomposite membranes		←→	
Characterization of photocatalytic nanocomposite membranes		←→	
Analysis of light-matter interaction in nanocomposite membranes			←→



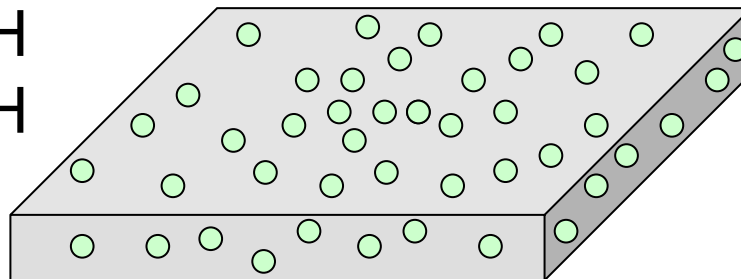
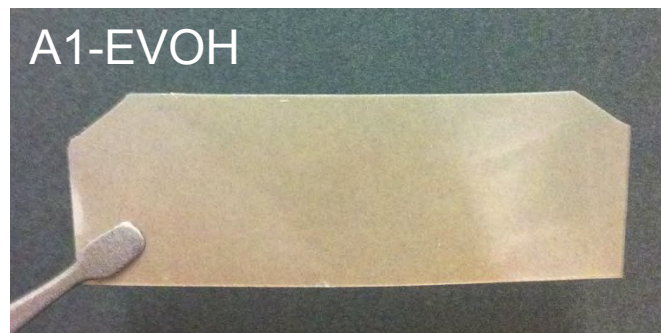
Modification of titania (Spanish team)



Synthesis of photoactive materials (Spanish team)

Ethylene vinylalcohol copolymer (EVOH) films

EVOH
A1-EVOH
A2-EVOH
B2-EVOH
S-EVOH
C1600-EVOH
C1700-EVOH

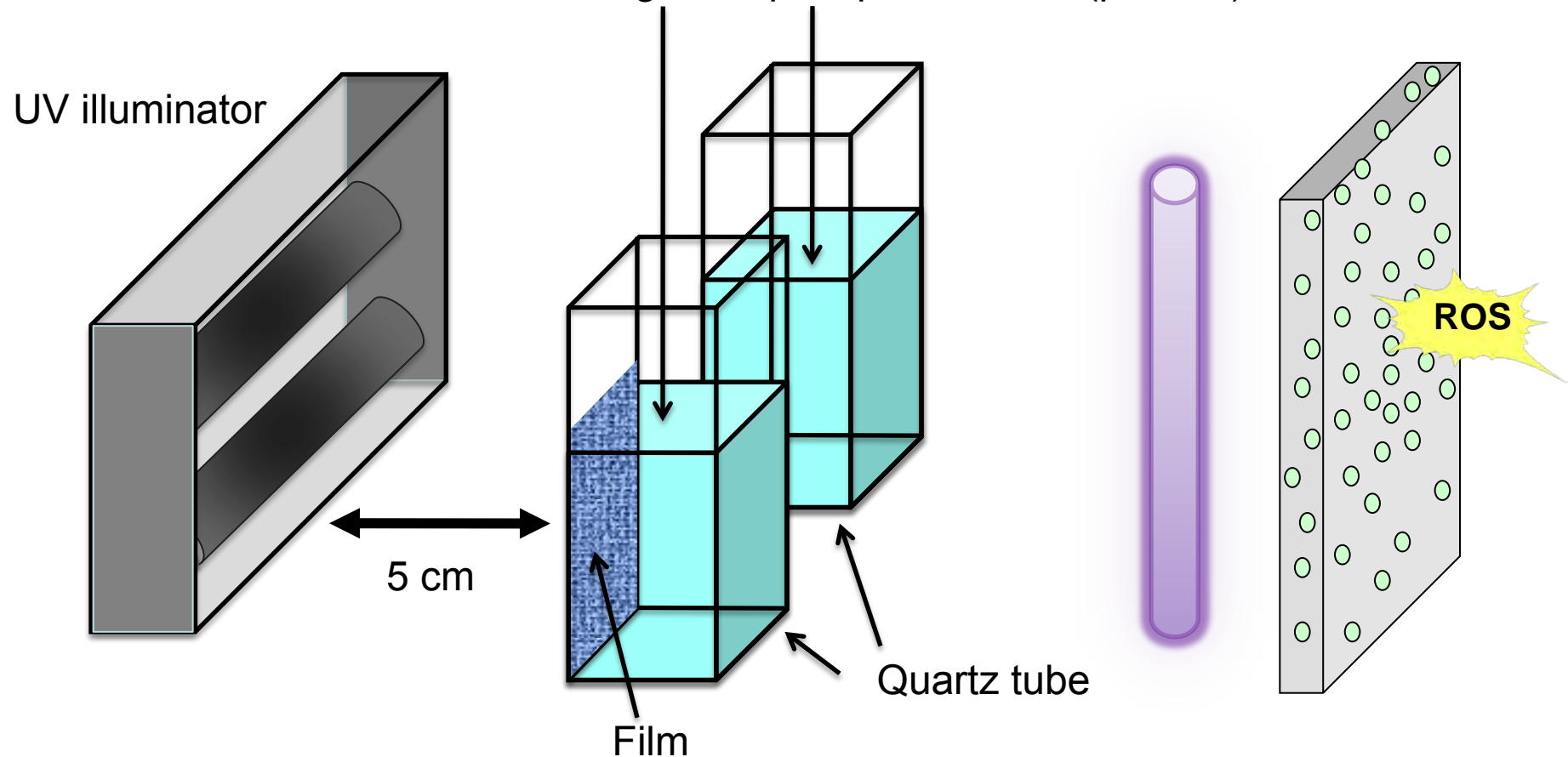


Polypropylene (PP) films

PP
S-PP
A1-PP
A2-PP
B1-PP
B2-PP
C1600-PP
C1700-PP

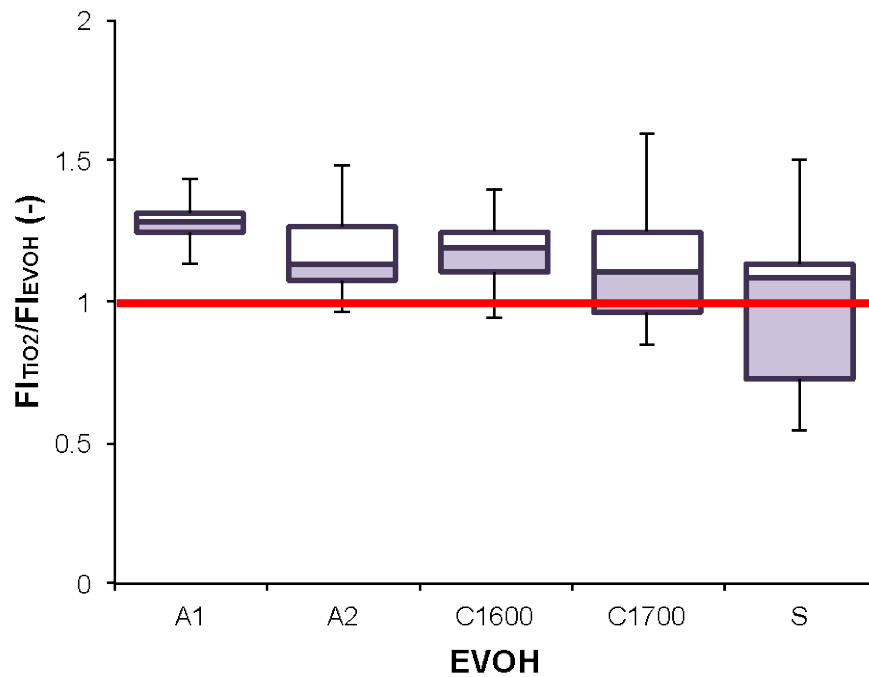
ROS production potential of films (Japanese team)

ROS detection reagent in phosphate buffer (pH: 7.2)

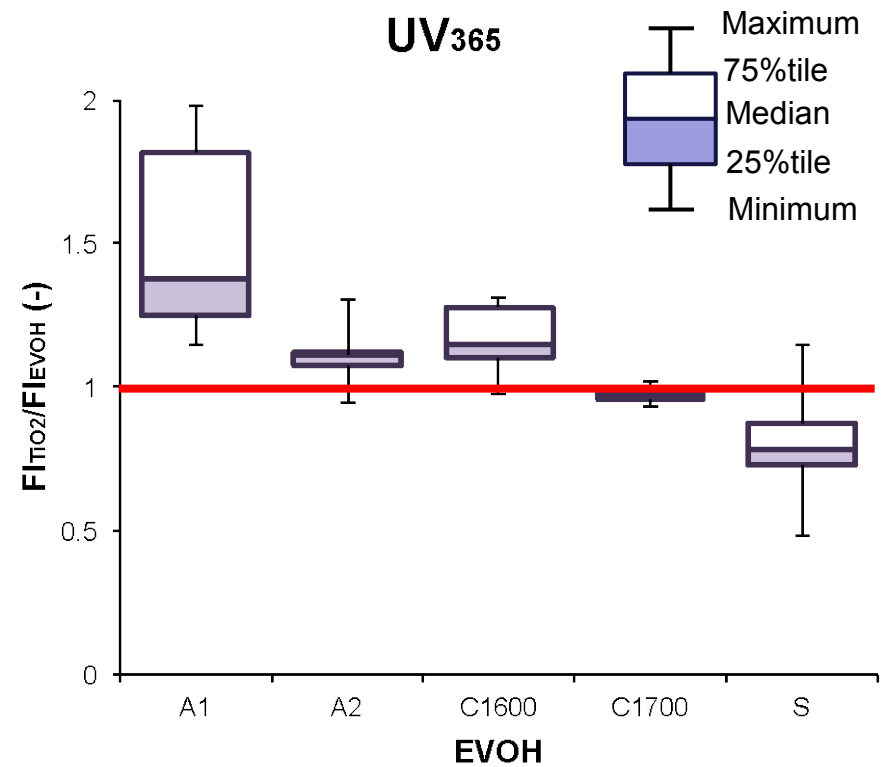


Total ROS production (Japanese team)

UV₂₅₄



UV₃₆₅

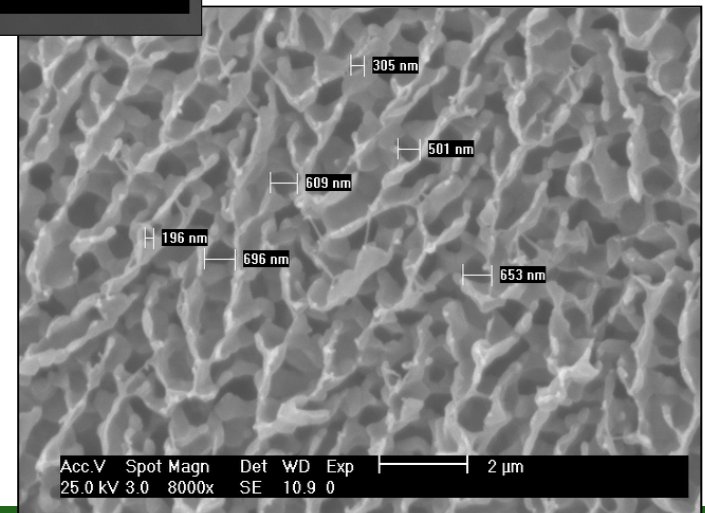
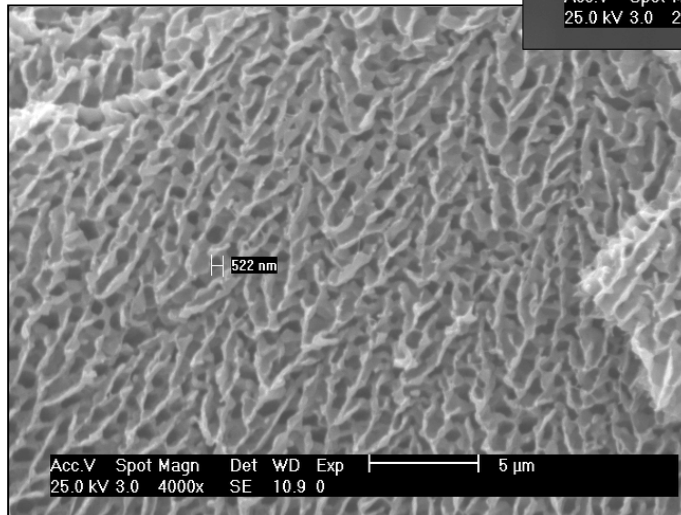
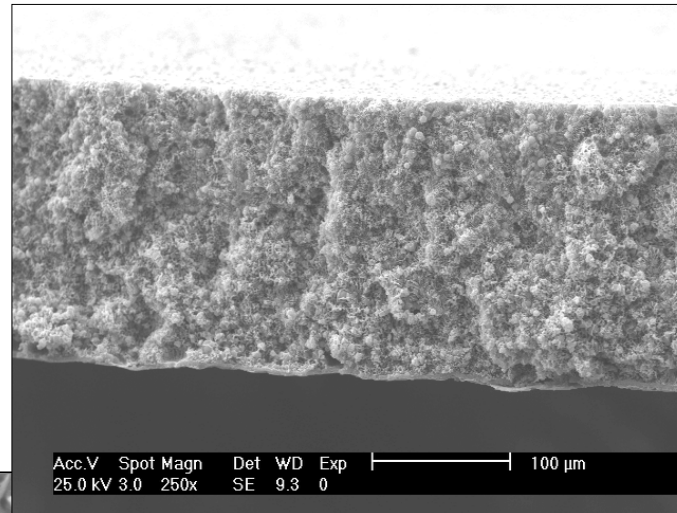


Preparation of membranes (Spanish team)

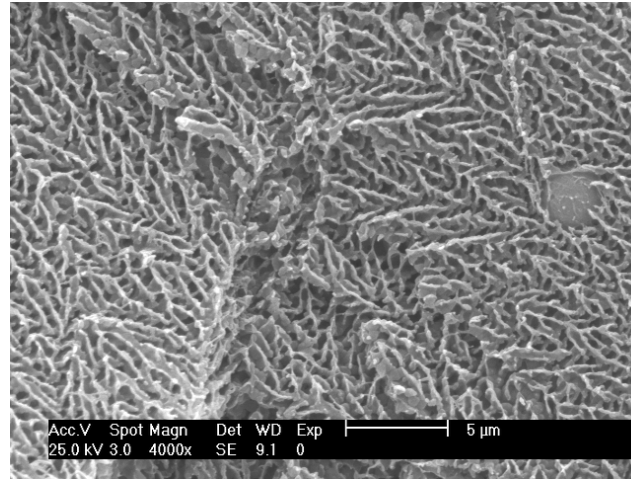
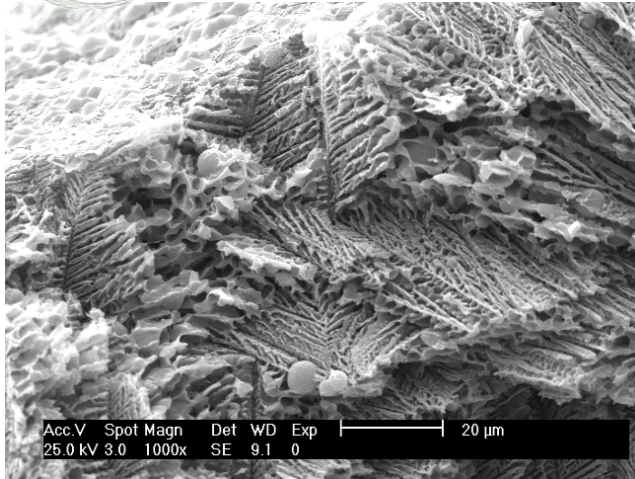
PVDF / Sulfolan

TIPS

$\phi = 150 - 200 \mu\text{m}$
Pore size = 200 – 700 nm

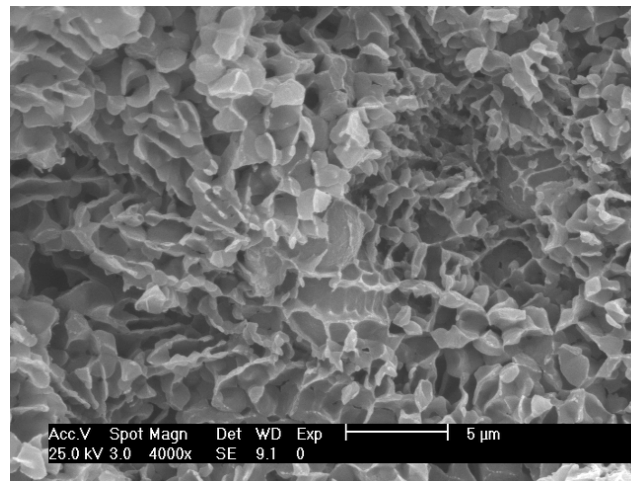
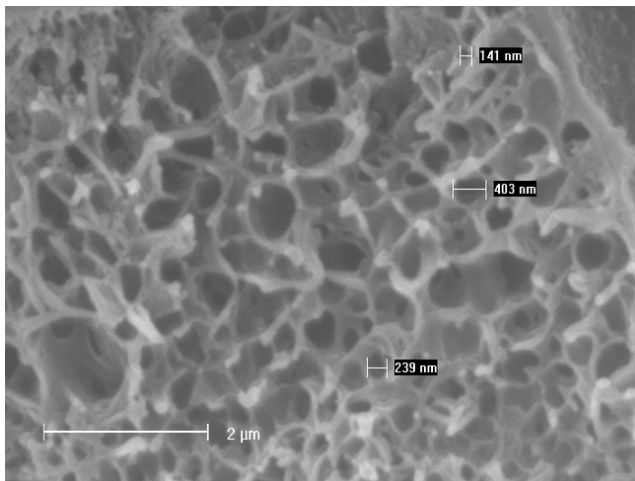


Preparation of membranes with titania (Spanish team)

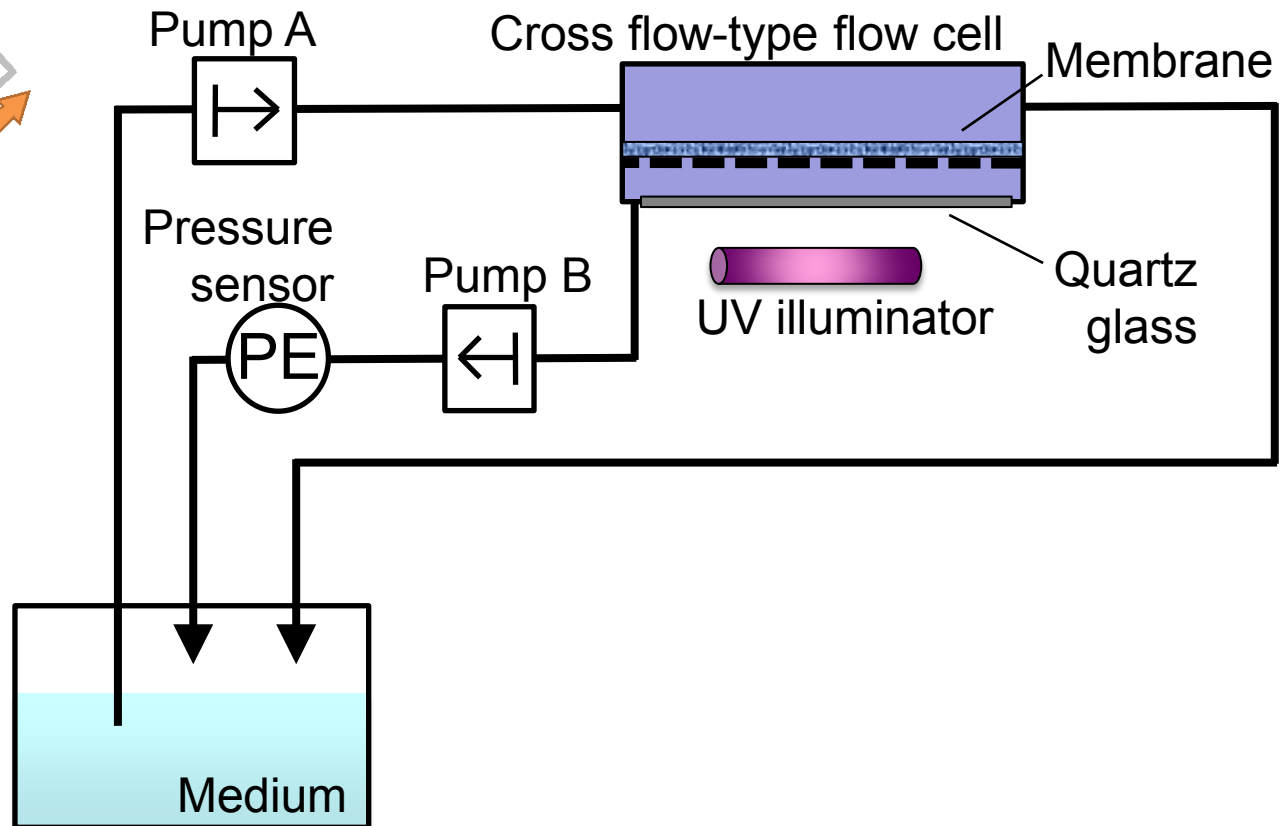
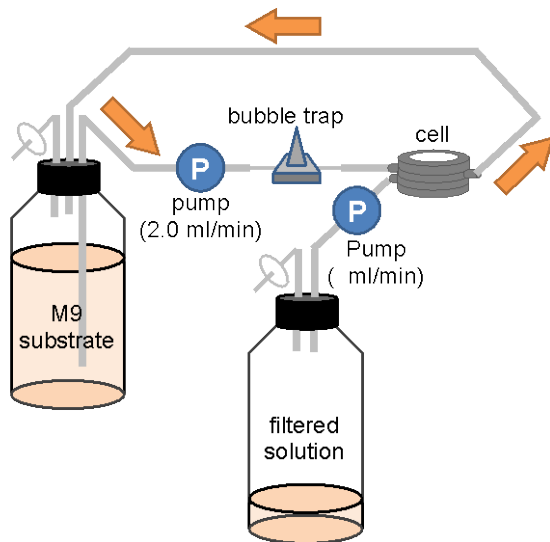


PVDF-TiO₂ /
Sulfolan

ϕ = 350 – 400 μ m
Pore size = 150 – 700 nm



A continuous-flow cell (Japanese team)



Main members

SPAIN

JAPAN

Membrane production
+ titania provision

Dr. Katsuki KIMURA
Hokkaido University
Water Treatment Engineering
Membrane Technology

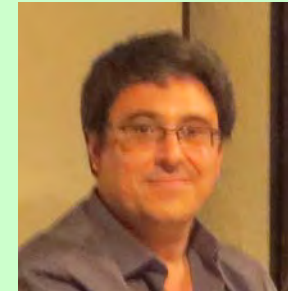


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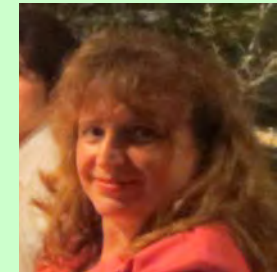
Depollution, disinfection
and biofilm prevention
capabilities

+

Membrane production



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Environmental Microbiology



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Mar. 5th, 2013
Daisuke Sano

Research schedule

Topics

March 5th, 2013

Sep. 2012:
Spain team
visited Sapporo

Oct. 2012:
Japan team
visited Madrid

2013

2014

Equipment preparation and
preliminary analyses

Evaluation of depollution and
disinfection capabilities

Biofilm development analysis

Synthesis of photocatalytic
nanocomposite membranes

Synthesis of photoactive
materials

Synthesis of photocatalytic
nanocomposite membranes

Characterization of photocatalytic
nanocomposite membranes

Analysis of light-matter interaction
in nanocomposite membranes





Summary and future perspectives

- Photocatalysis capability of prototype films was tested.
- Prototype membranes are being produced by both sides of Japan and Spain teams.
- Flow cell type reactor for analyzing biofilm prevention, chemical decomposition and virucidal capabilities of photocatalytic nano-composite membrane was constructed.
- Biofilm formation, chemical decomposition and virucidal capabilities of photocatalytic nano-composite membrane will be tested using real wastewater.

