Nanotechnology Applications in Produced Water Treatment

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Produced Water Management: Challenges & Opportunities

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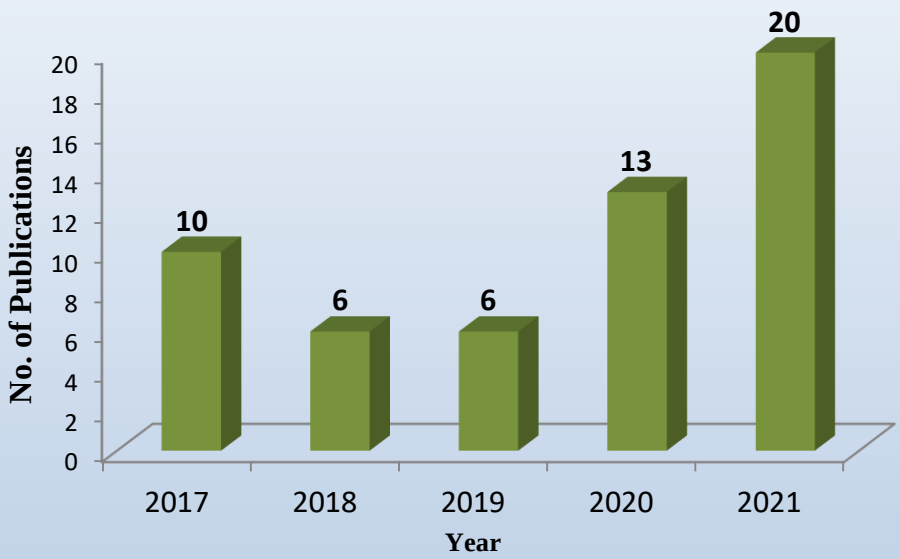
Nanotechnology Research Center



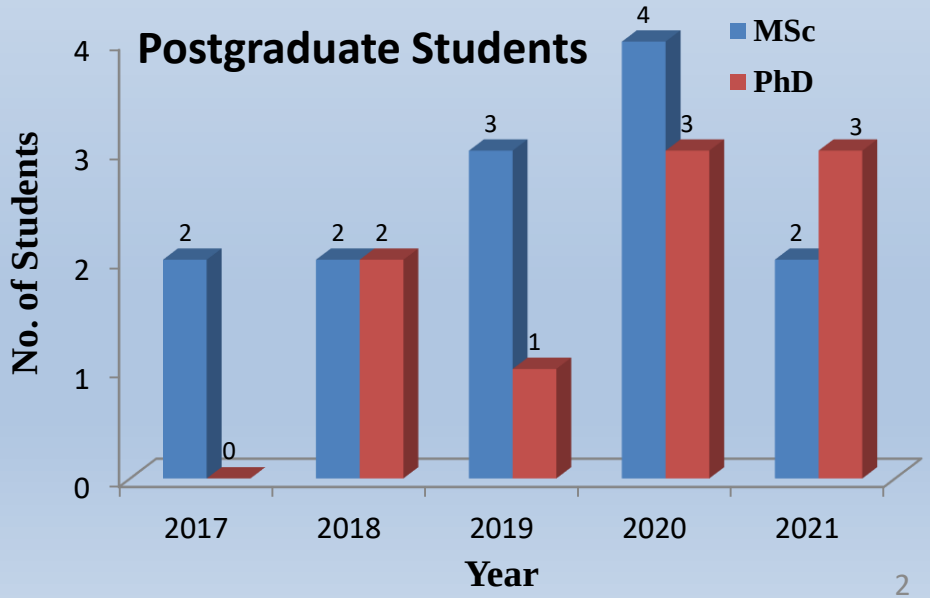
Founded in 2017

Water Treatment, Renewable energy, Oil & Gas Research

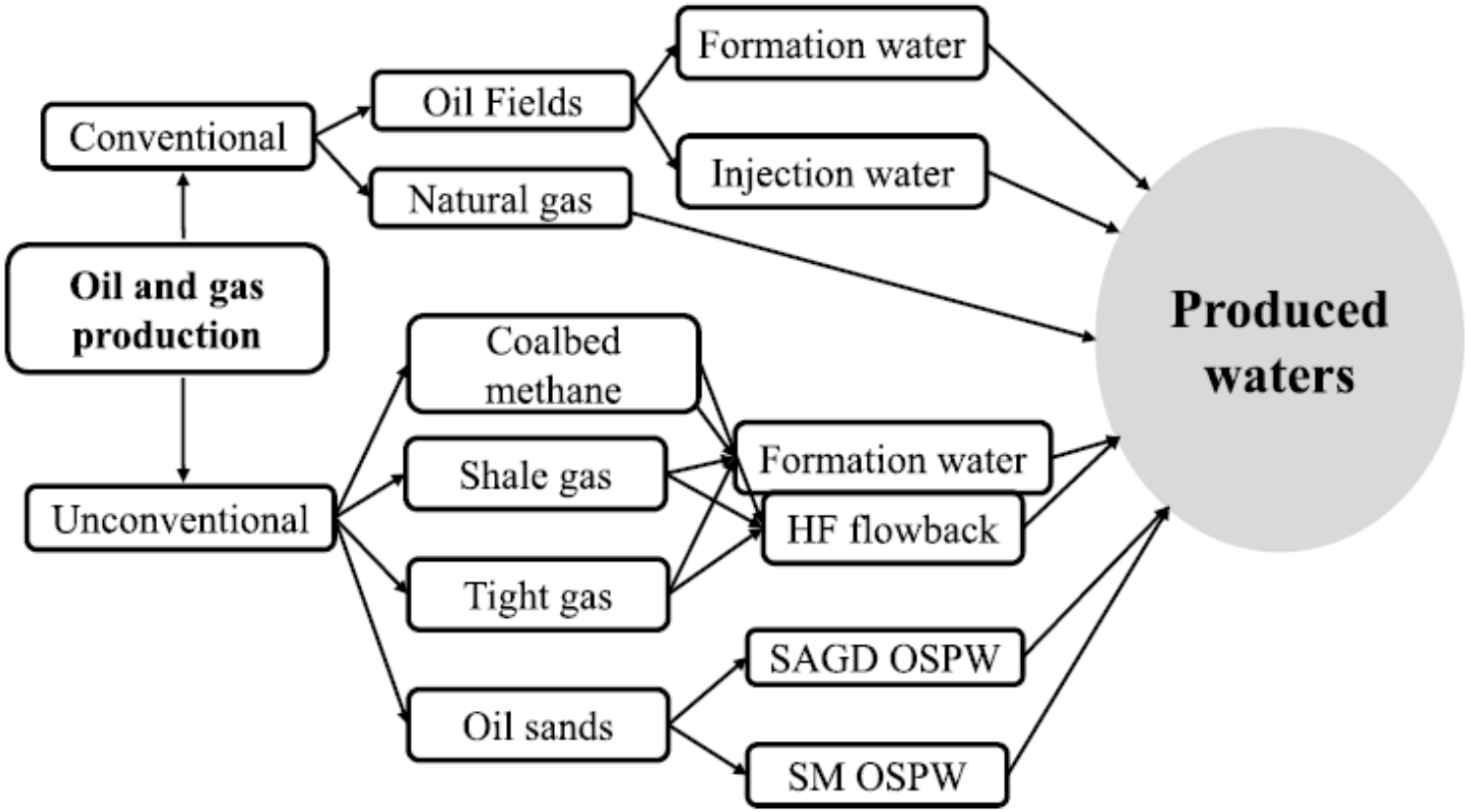
2 Patents granted + 2 Applied

> 55 conferences & workshops participation

> 70 UG students/ Research Assistants & Trainees



Produced water Sources



Scheme 1. Origin and classes of different effluents grouped as "produced water"

Ganiyu et al, Chemical Engineering Journal 429 (2022) 132492

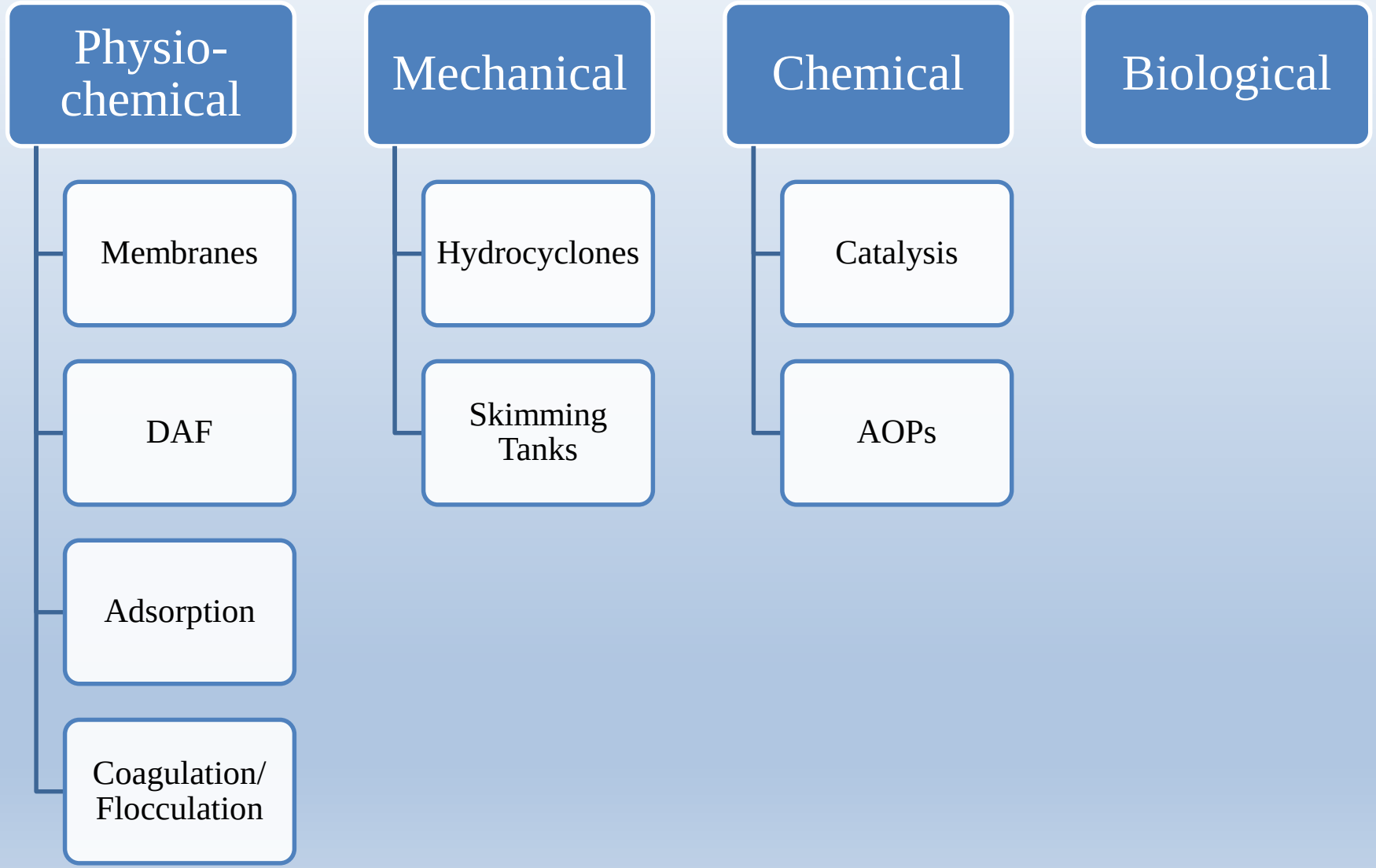
Produced water Characteristics

- Main constituents in PW:

- ❖ Dissolved salts
- ❖ Dissolved and dispersed oils
- ❖ Polymers
- ❖ Operational and extraction chemicals
- ❖ Heavy metals(Ba, Cd, Cr, Cu, Pb) and radioactive isotopes (NORMs)
- ❖ Dissolved gases such as CO_2, O_2 and H_2S
- ❖ Microorganisms
- ❖ Suspended solids

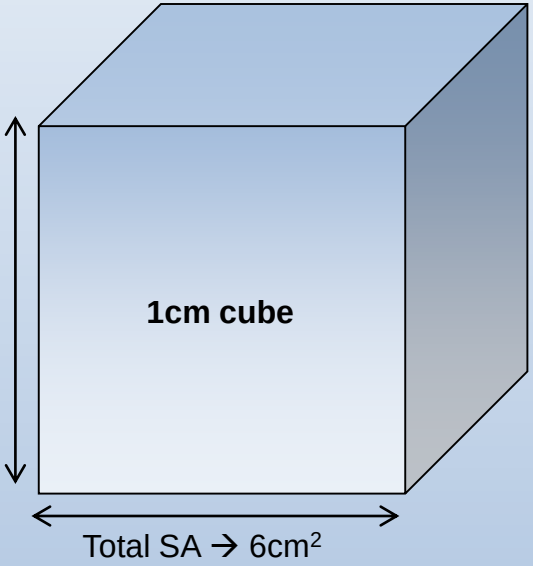
No single technology is suited for PW Treatment

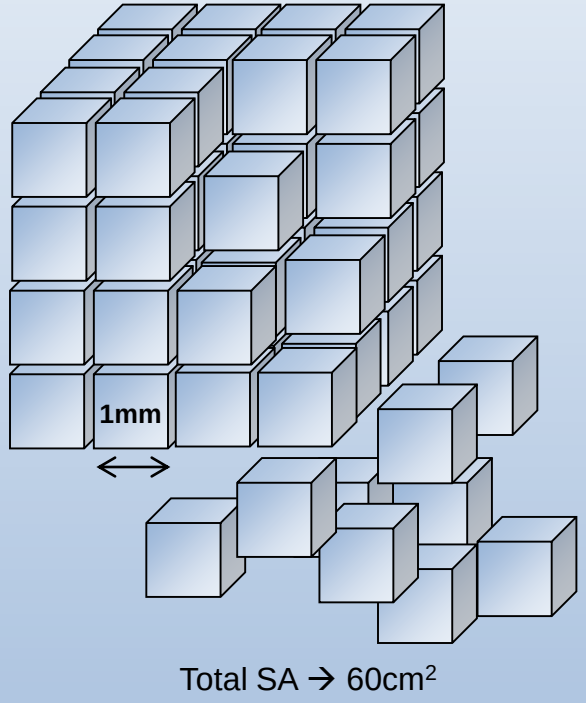
PW treatment technologies

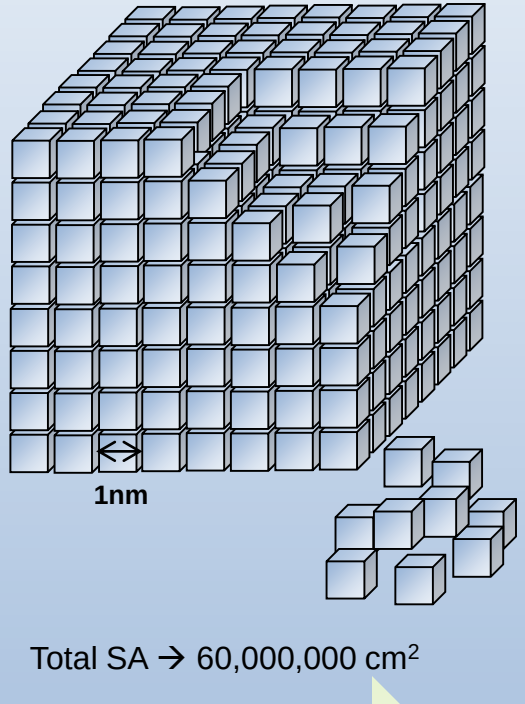


Bulk to Nanoscale

Surface area increment → Greater amount of the material comes into contact with surrounding materials and increases reactivity





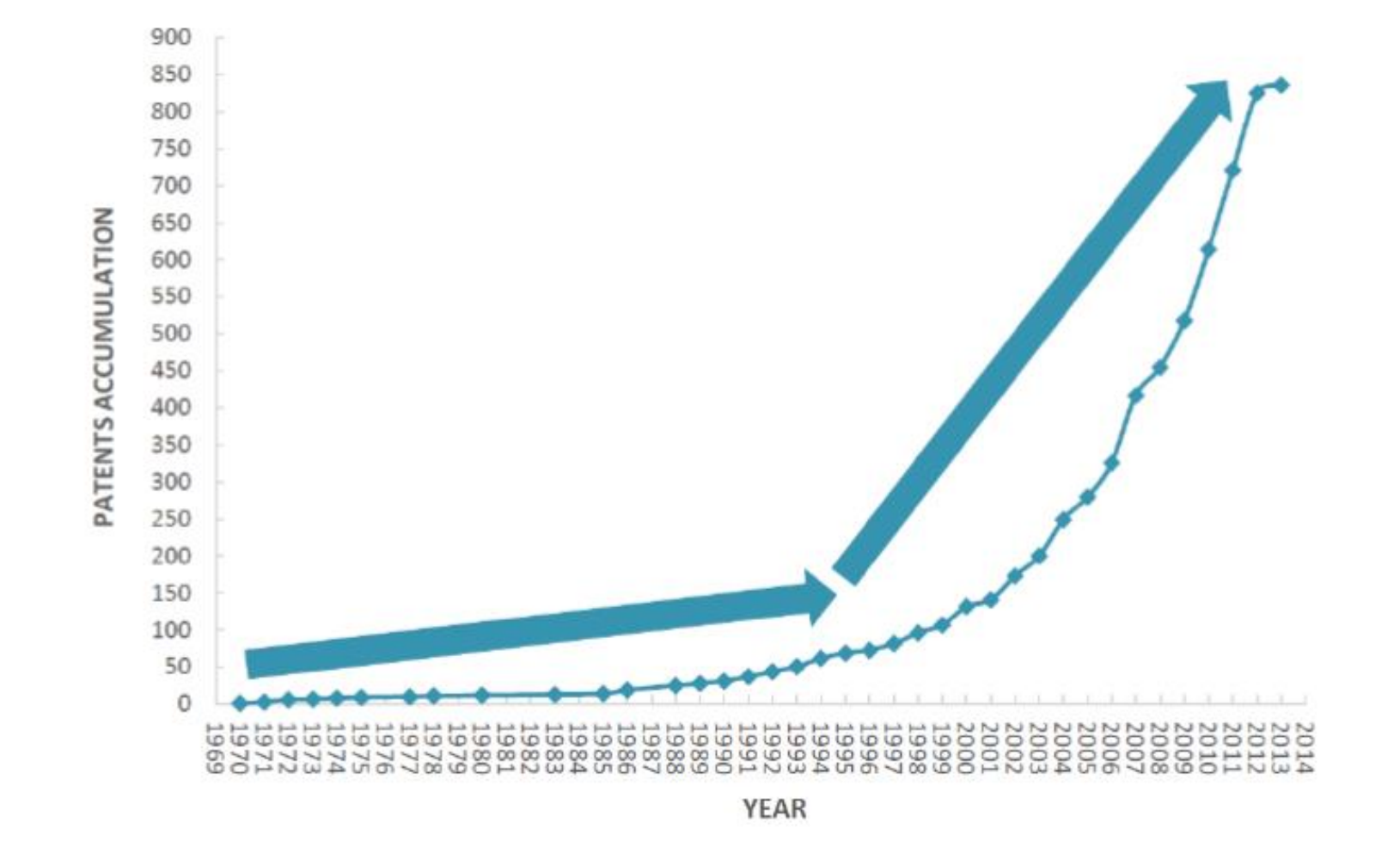


Dramatically increases surface area

At nanoscale, the material **properties (physical, chemical, optical and electronic) change**

Nanotechnology in Oil & Gas Industry

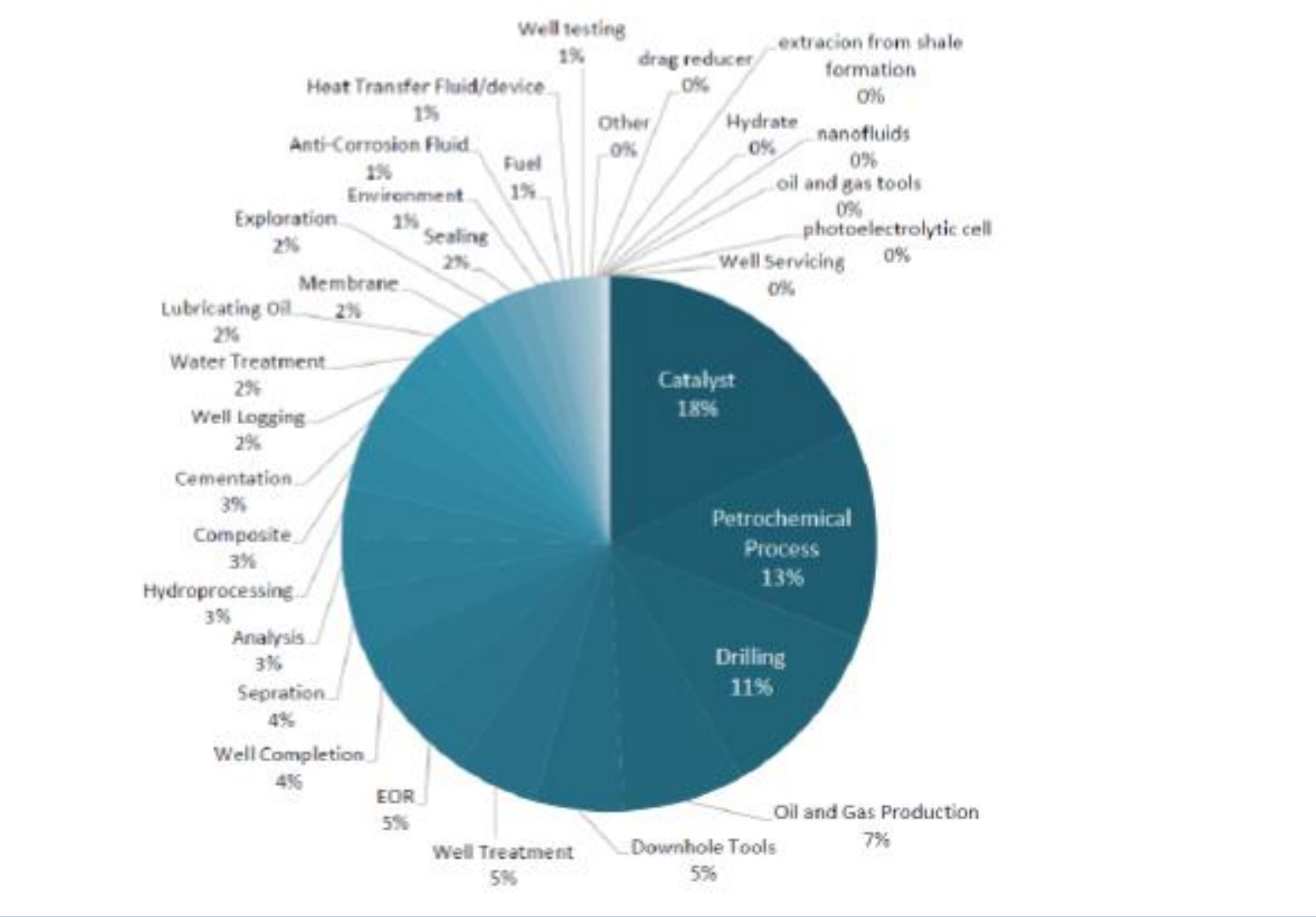
Accumulation of Patent Registrations related to Nanotechnology applications in Oil & Gas Industry



StatNano (2016)

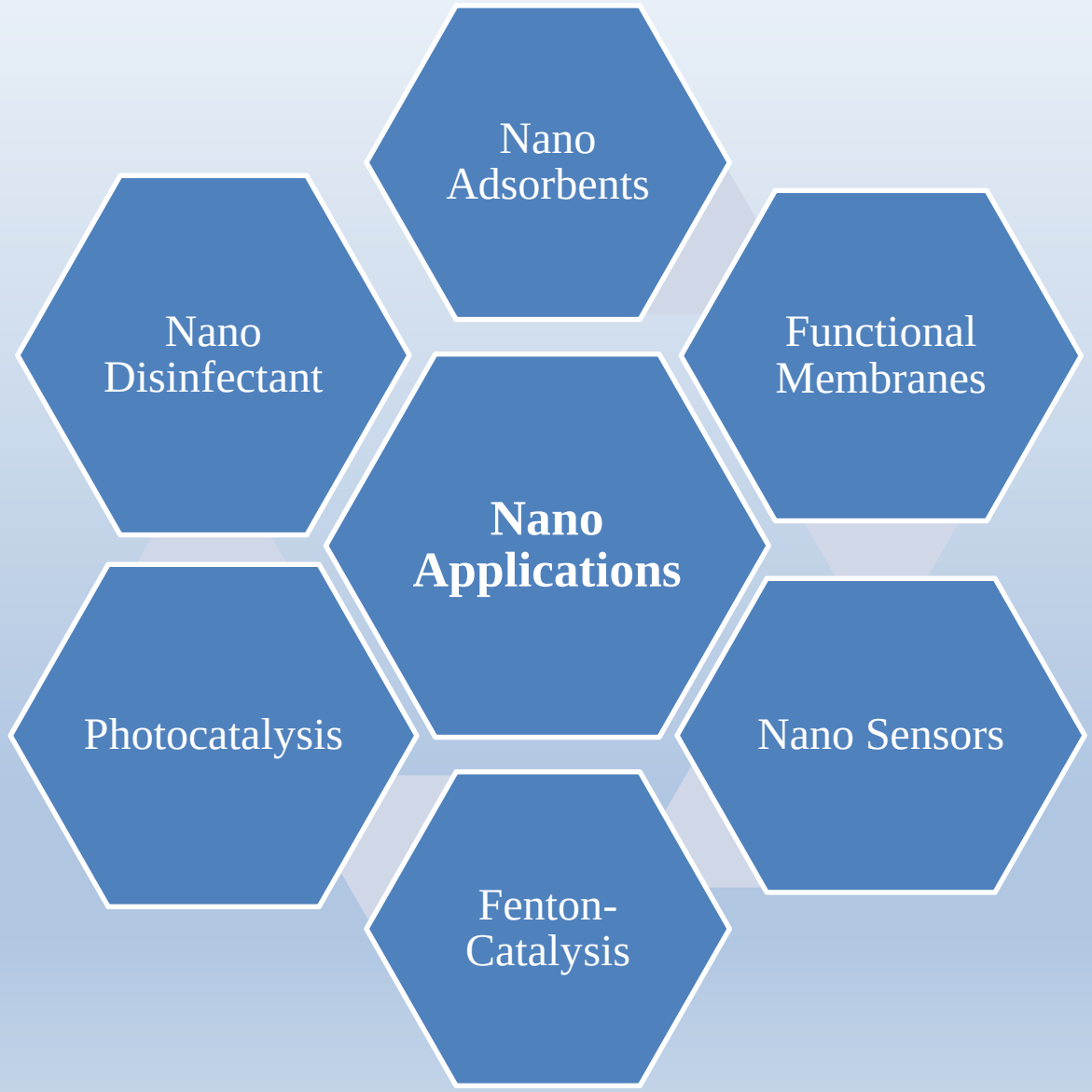
Nanotechnology in Oil & Gas Industry

Share of Patents related to Nanotechnology applications in Oil & Gas Industry according to technical subdivisions

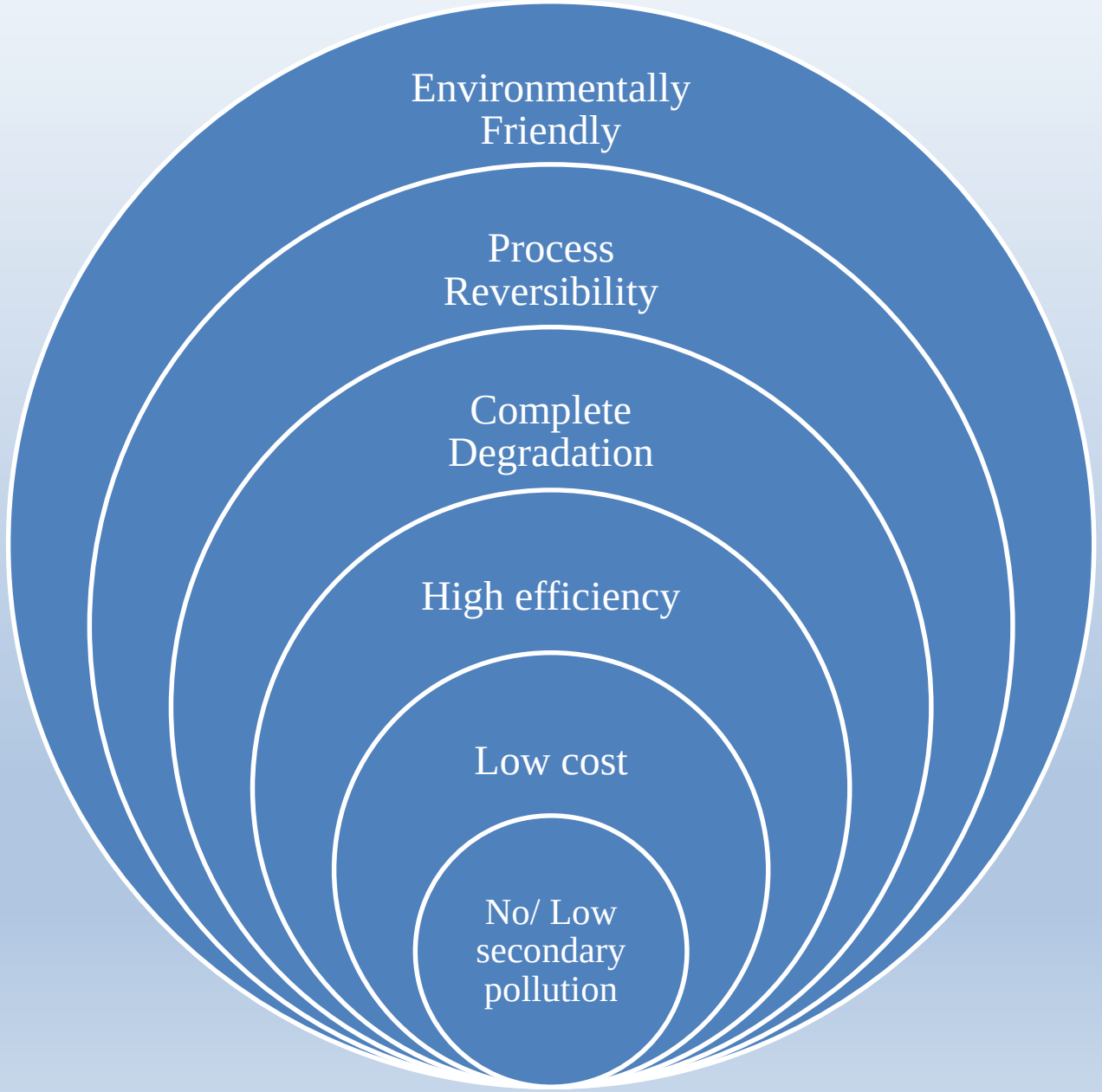


StatNano (2016)

Nanotechnology Processes



Nanotechnology Advantages



Technology readiness level

TRL1	Basic principles observed
TRL2	Technology concept formulated
TRL3	Experimental proof of concept
TRL4	Technology validated in lab
TRL5	Technology validated in relevant environment
TRL6	Technology demonstrated in relevant environment
TRL7	System prototype demonstration in operational environment
TRL8	System prototype demonstration in operational environment
TRL9	Actual system proven in operational environment

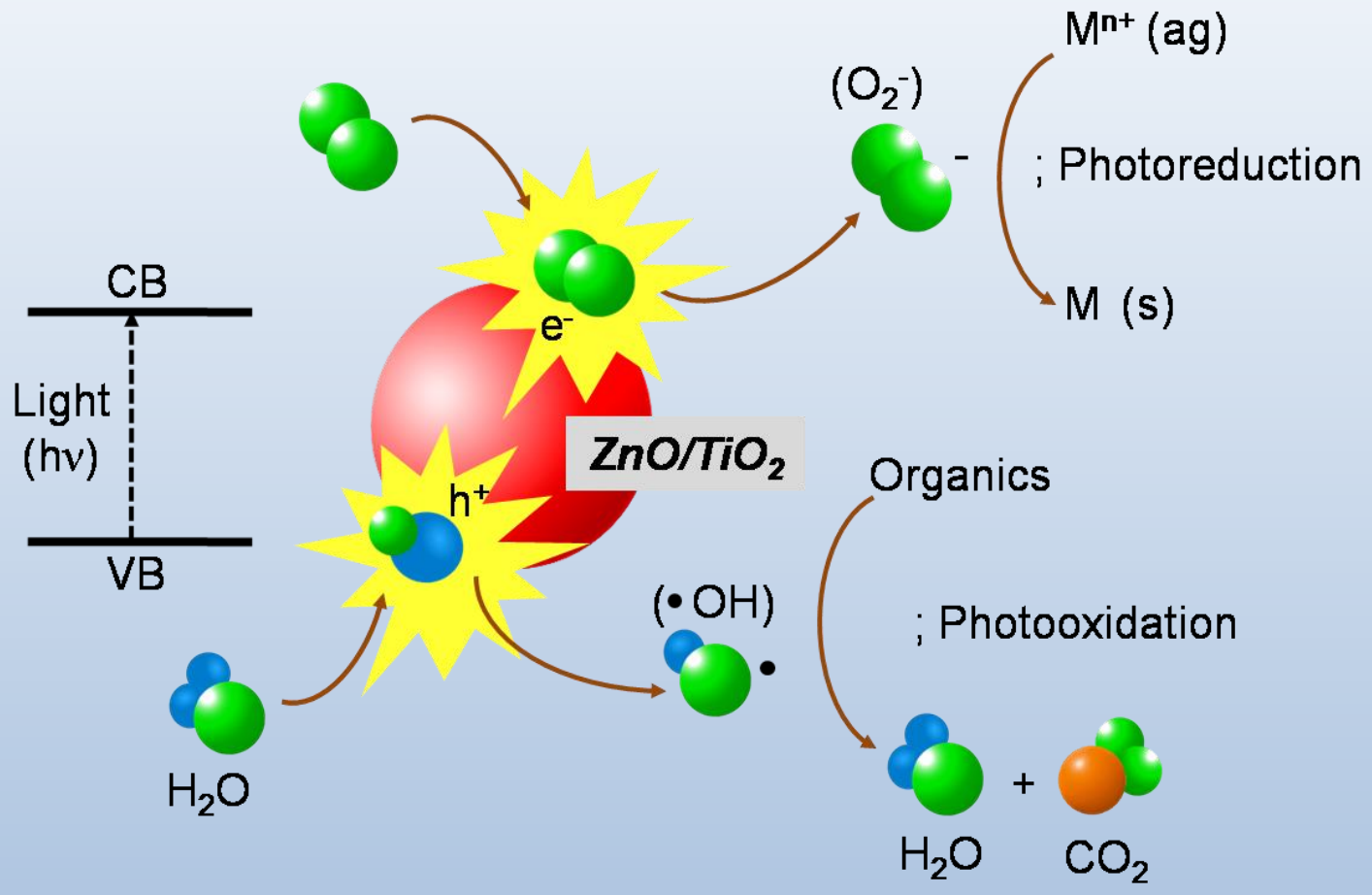
Nano Processes

Membranes
AOPs
Adsorption

Challenges

- Cost
- Scalability
- Process Development & Operation
- Competition with Conventional Technologies
- Environmental Considerations

Photocatalytic Decontamination of Water



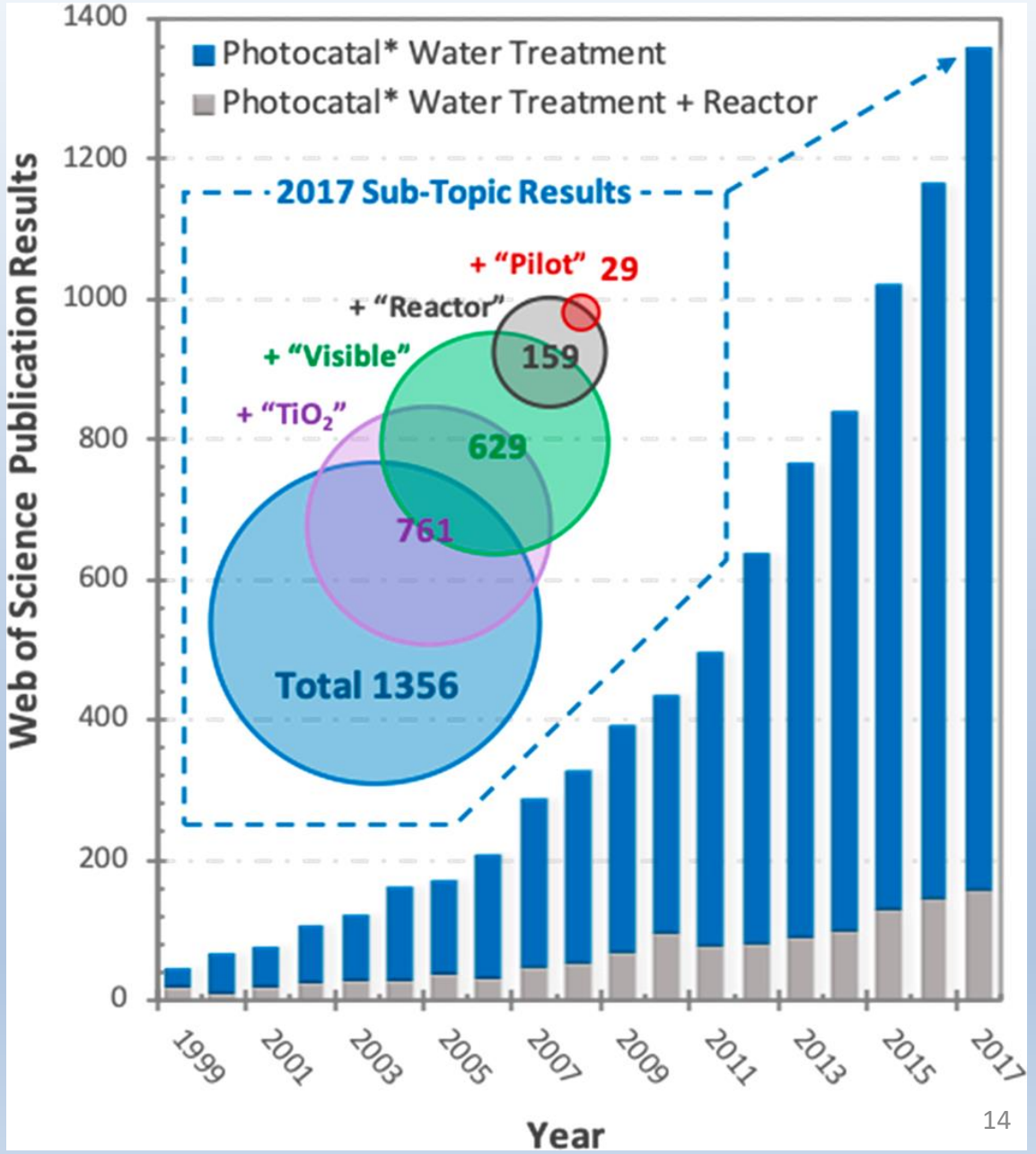
semiconductor (ZnO)

Organic pollutant+O_2 ⟶ CO_2+H_2O+mineral acids

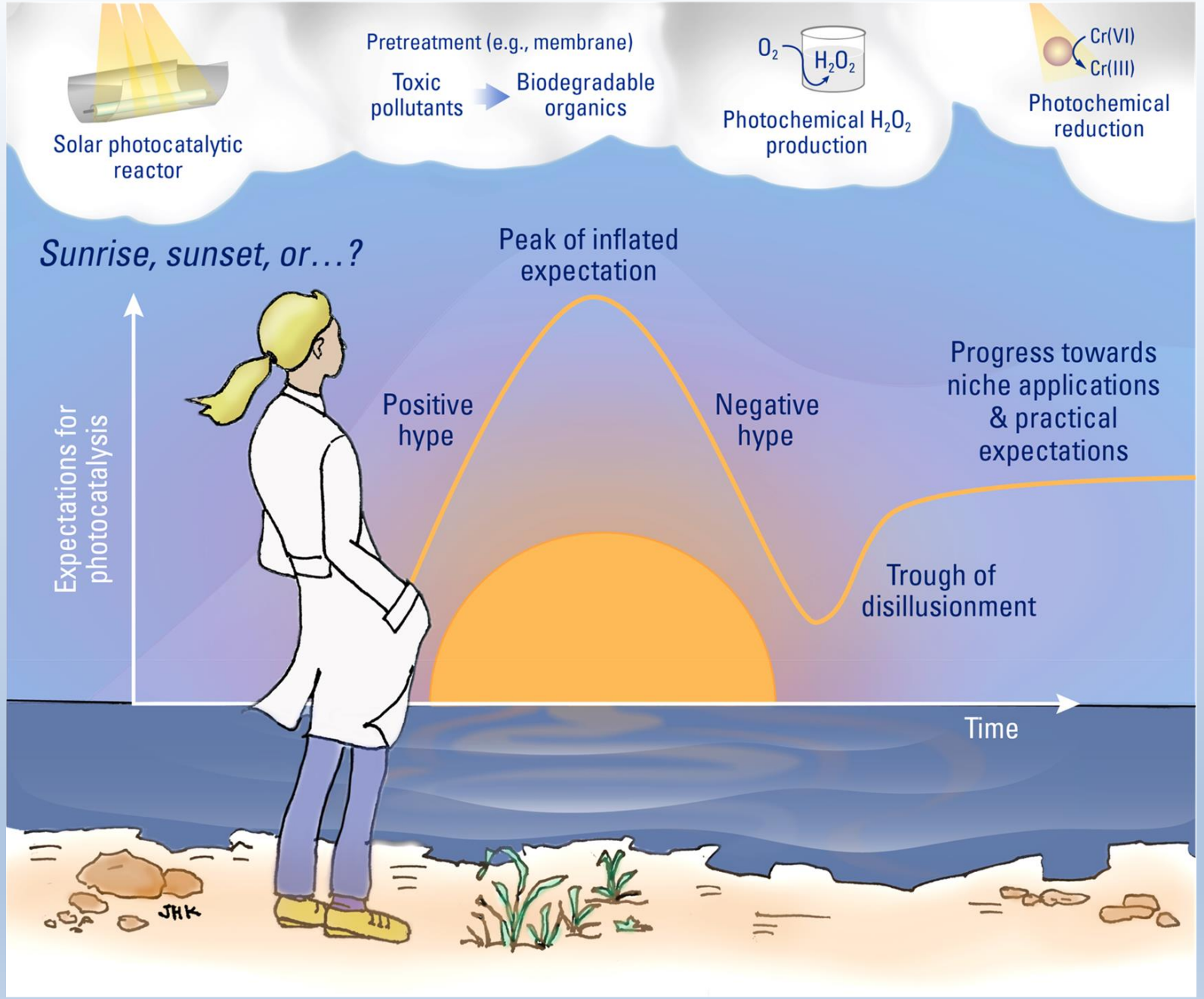
hv (UV or visible)

Photocatalysis in the Literature

- ✓ Fundamental Research
- ✓ Limited Applied Research
- ✓ Inadequate Industrial Application

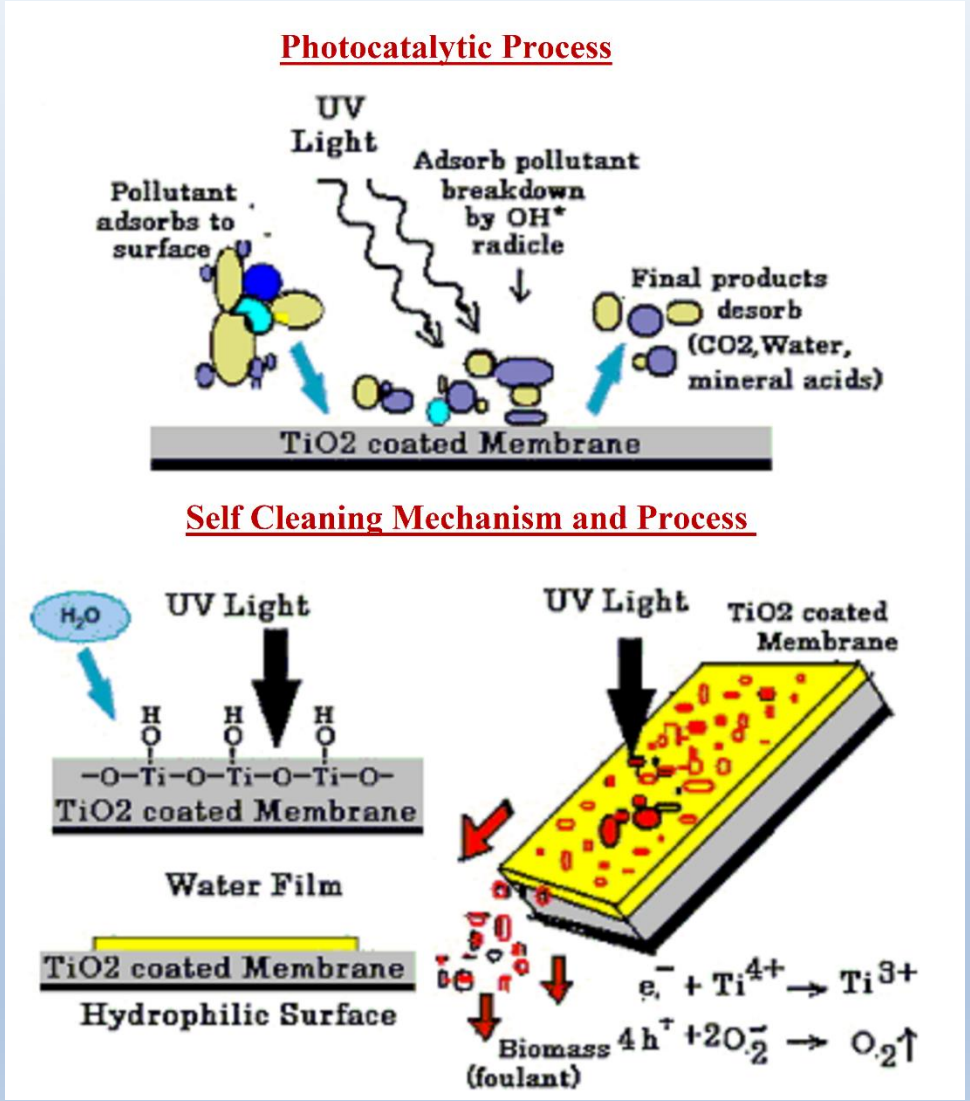


Loeb et al., Environ. Sci. Technol. (2019) 53

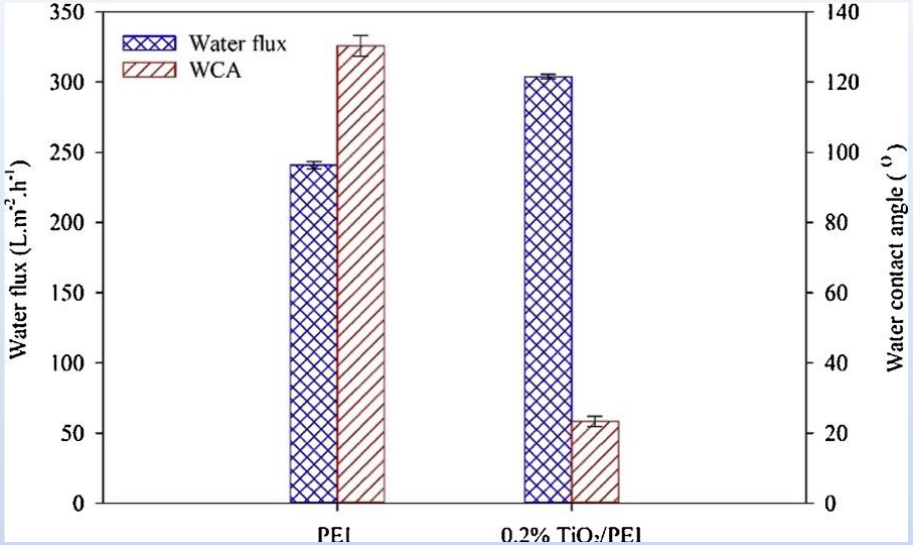


Loeb et al, Environ. Sci. Technol. (2019) 53

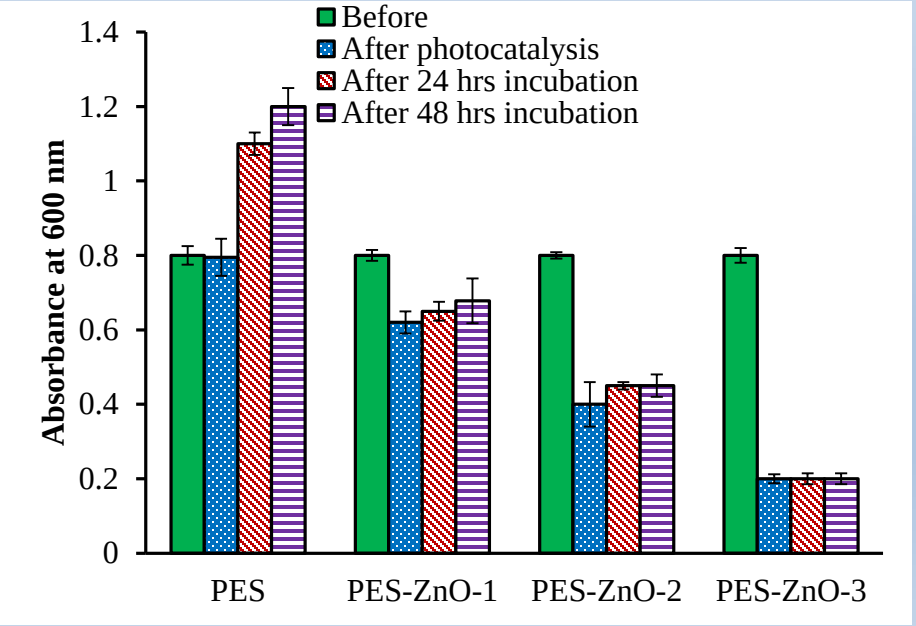
Hybrid Photocatalytic Membranes



Damodar et. al., Hazardous Materials, (2009) 172

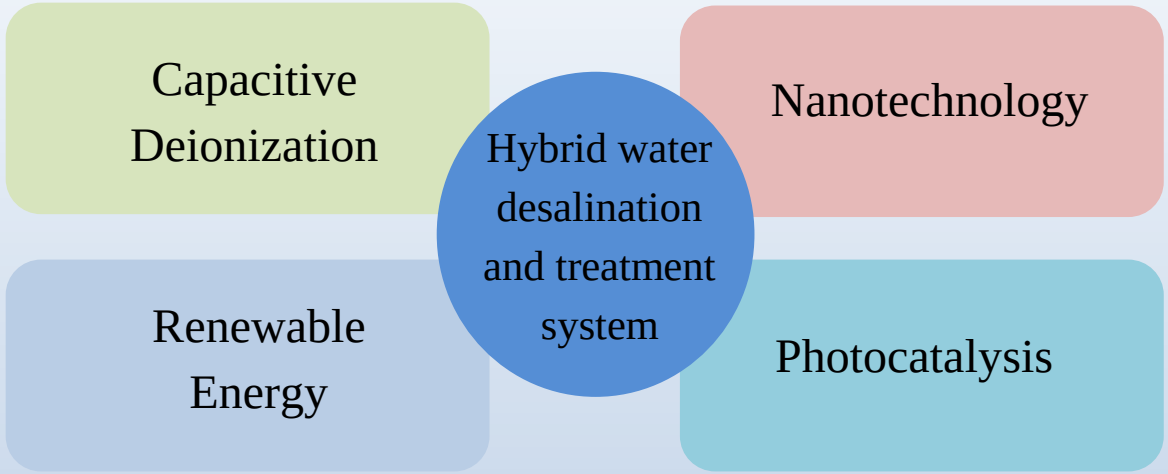


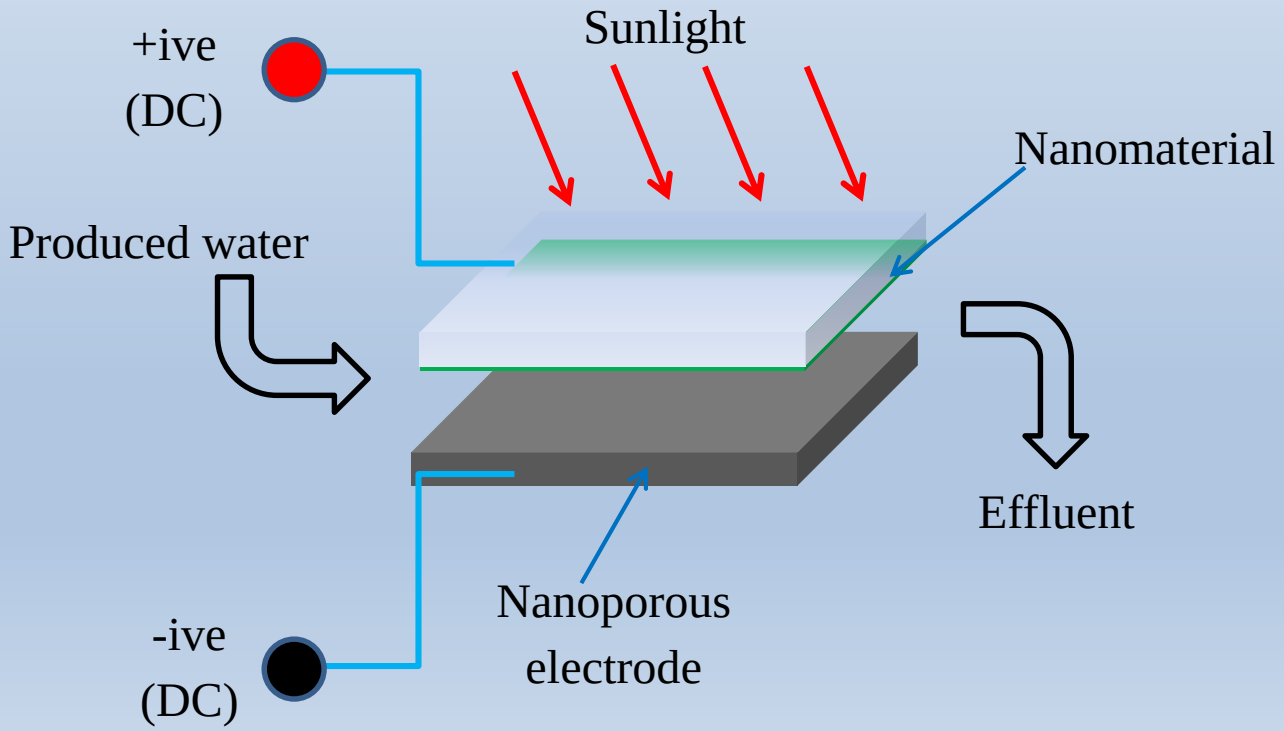
Al-Ghafri et. al., Water Process Engineering (2019) 32



Al-Hinai et. al., ACS Omega (2017) 2

Hybrid Photocatalytic CDI Desalination





Future Prospect

- Identify the Niche Market
- Technology Integration
- Large-Scale Research & Application
- Comprehensive Cost Analysis
- Long-Term Operation


Nanotechnology:
The Future
Thank you for your
kind attention