

# Hydrogen Production by Water Electrolysis

DI water, tap water, sea water, and oil field produced water

## Zhifeng Ren

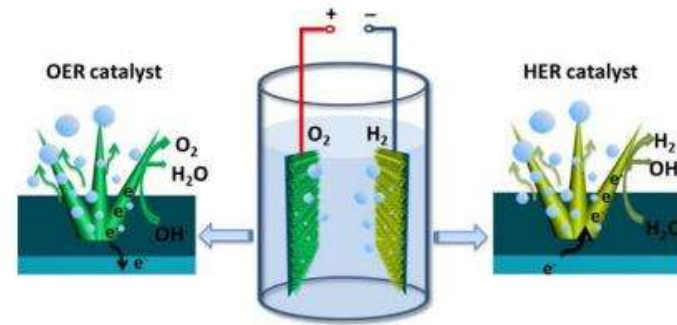
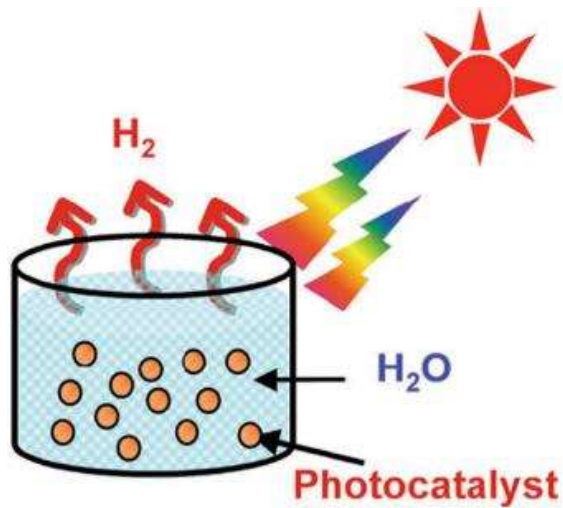
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# Two Ways for Hydrogen Production from Water



## Photocatalysis

1. Complicated photocathode: Light absorber
2. Low conversion efficiency
3. Ultraviolet catalyst, 2% in solar
4. Depending on the weather

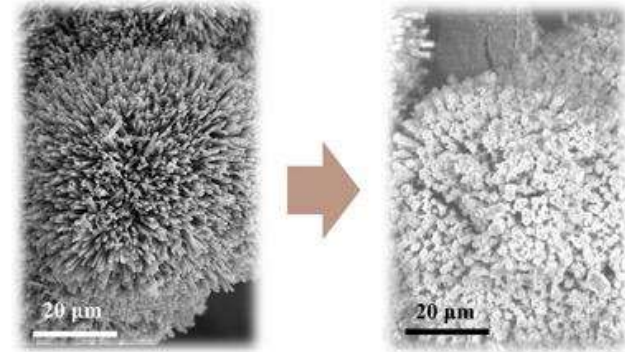
## Electrocatalysis

1. Simple process
2. High conversion efficiency
3. Simple setup
4. Electricity consuming

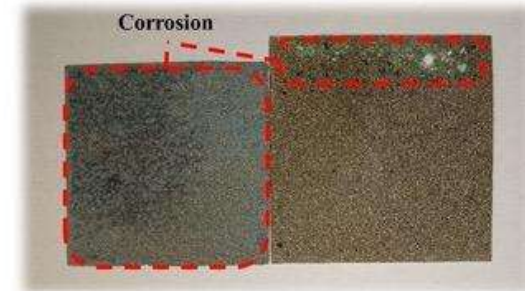
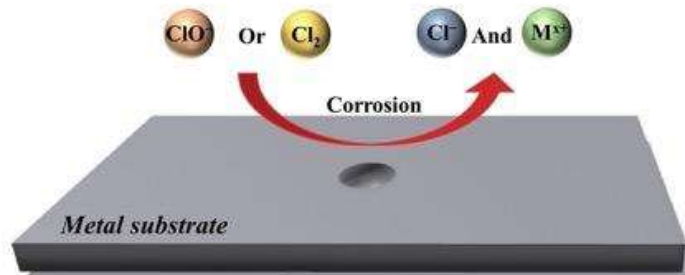
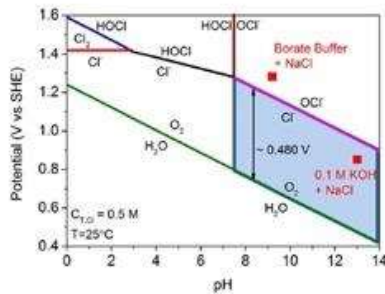


# Challenges of low-grade water electrolysis

## 1. Metal ions such as $Mg^{2+}$ and $Ca^{2+}$



## 2. Corrosion effect of CER



F. Dionigi & et al, *ChemSusChem* 2016, 9, 1–12



# Ions in Sea Water

1-6 M KOH solutions from seawater



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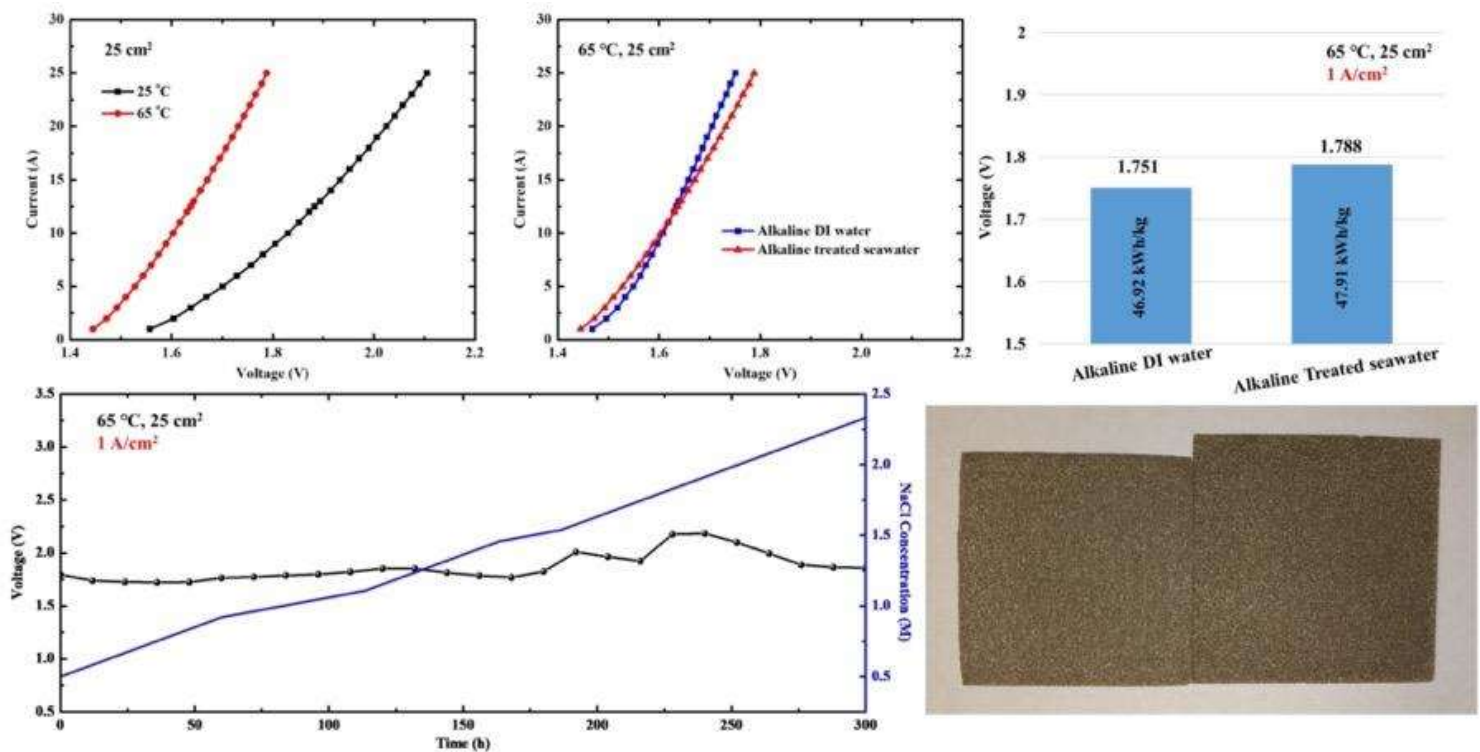
# Sea Water after Removing the Ions

1-6 M KOH solutions from treated seawater



# Seawater Electrolysis

Direct seawater electrolysis with commercial electrolyzer





# Hydrogen Transport and Storage

- H<sub>2</sub> gas vs. liquid
- Density of liquid H<sub>2</sub>
- Temperature of liquid H<sub>2</sub>
  - 20 K
- Gas, has to be under high pressure
- Liquid, pipe system
  - Meet the society needs in very large scale



# Grand Concept for Hydrogen Transport, Usage, and Storage Superconductor Levitated System for Transport/Storage of Energy and People

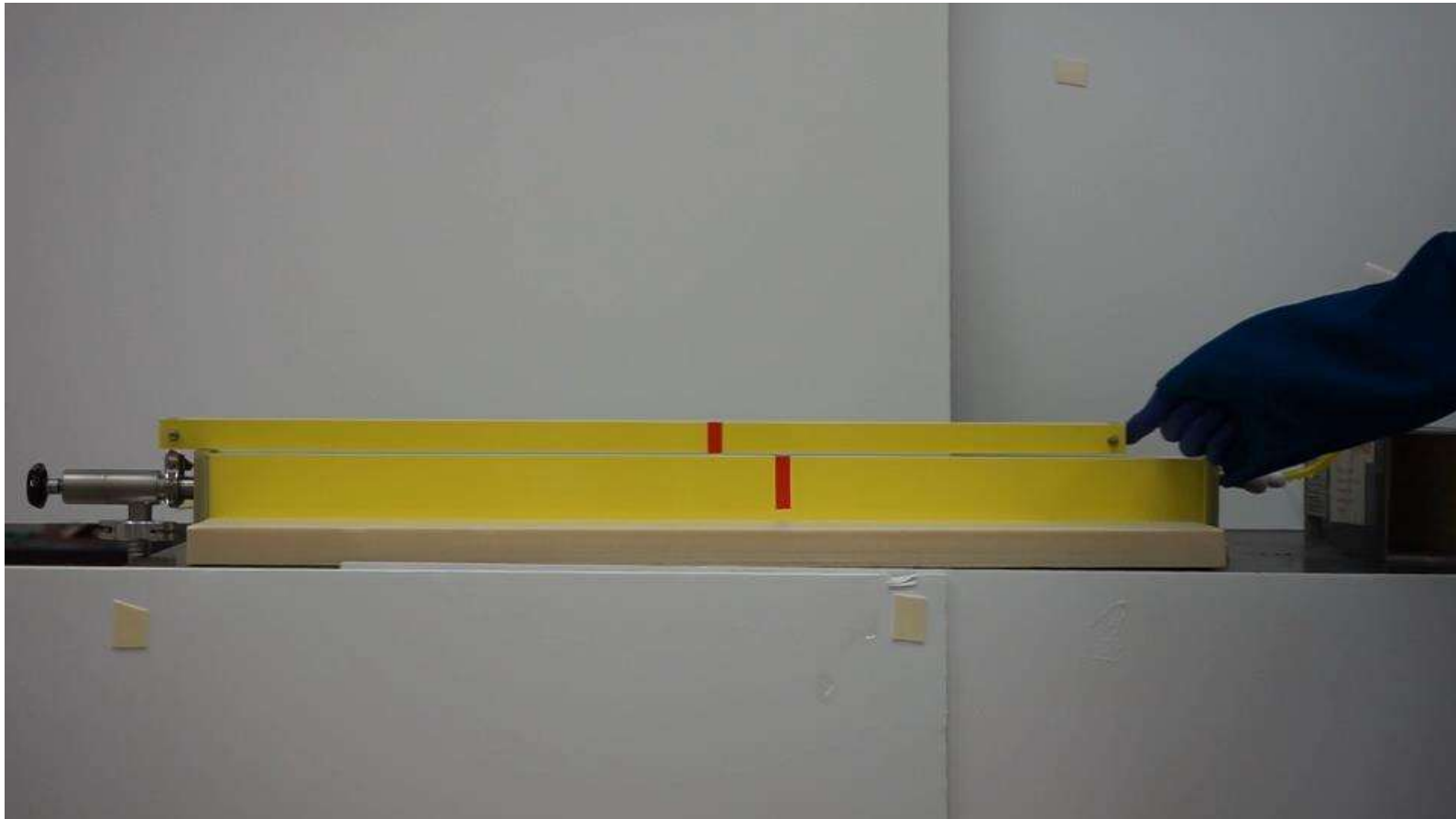


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## Superconductor Levitated Vehicle



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