Motivation & Introduction

Researches on water electrolysis:
- Electrocatalytic materials
- Temperature and pressure
- Optimization of electrolyzer design

Debye-length & Potential Distribution

$$\lambda = \frac{4\pi \varepsilon \varepsilon_0 n kT}{e^2}$$

Water electrolysis

Electrode gap distance smaller than the Debye-length, large electric field can be uniformly distributed in the entire gap. The gap distance is tuned by adjusting the nitride thickness.

Device Fabrication

Low DC-bias Etching
- DC-bias down to 19-21 V.
- Enhance the yield of device fabrication.

Experiment Results

- The electrolysis current became larger when the gap shrank.
- Current is limited by electron-transfer rate when the gap is small enough.
- Bubble generation around 2V.
- For the first time, we proposed the relationship between fundamental electrochemistry performance vs. gap distance.
- The electrolysis current density from pure water is much larger than that from NaOH solution.

Summary

Field-assisted efficient splitting of pure water at room temperature has been successfully achieved based on our deep-sub Debye-length nanogap electrochemical cells.

- The nanogap between cathode and anode has been down to 37 nm.
- Proposed virtual breakdown mechanism.
- Even pure water can be electrolyzed!