



# **Facet control and Three-dimensional $\text{Cu}_2\text{O}$ Films by electrodeposition and Its Photoelectrochemical Properties**

Sanghwa Yoon<sup>1)</sup>, Jaehong Lim<sup>2)</sup>, Bongyoung Yoo<sup>1)</sup>

<sup>1)</sup>Department of Materials Engineering, Hanyang University, Korea

<sup>2)</sup>Electrochemistry Research Group, Materials Processing Division, Korea Institute of Materials Science, Korea

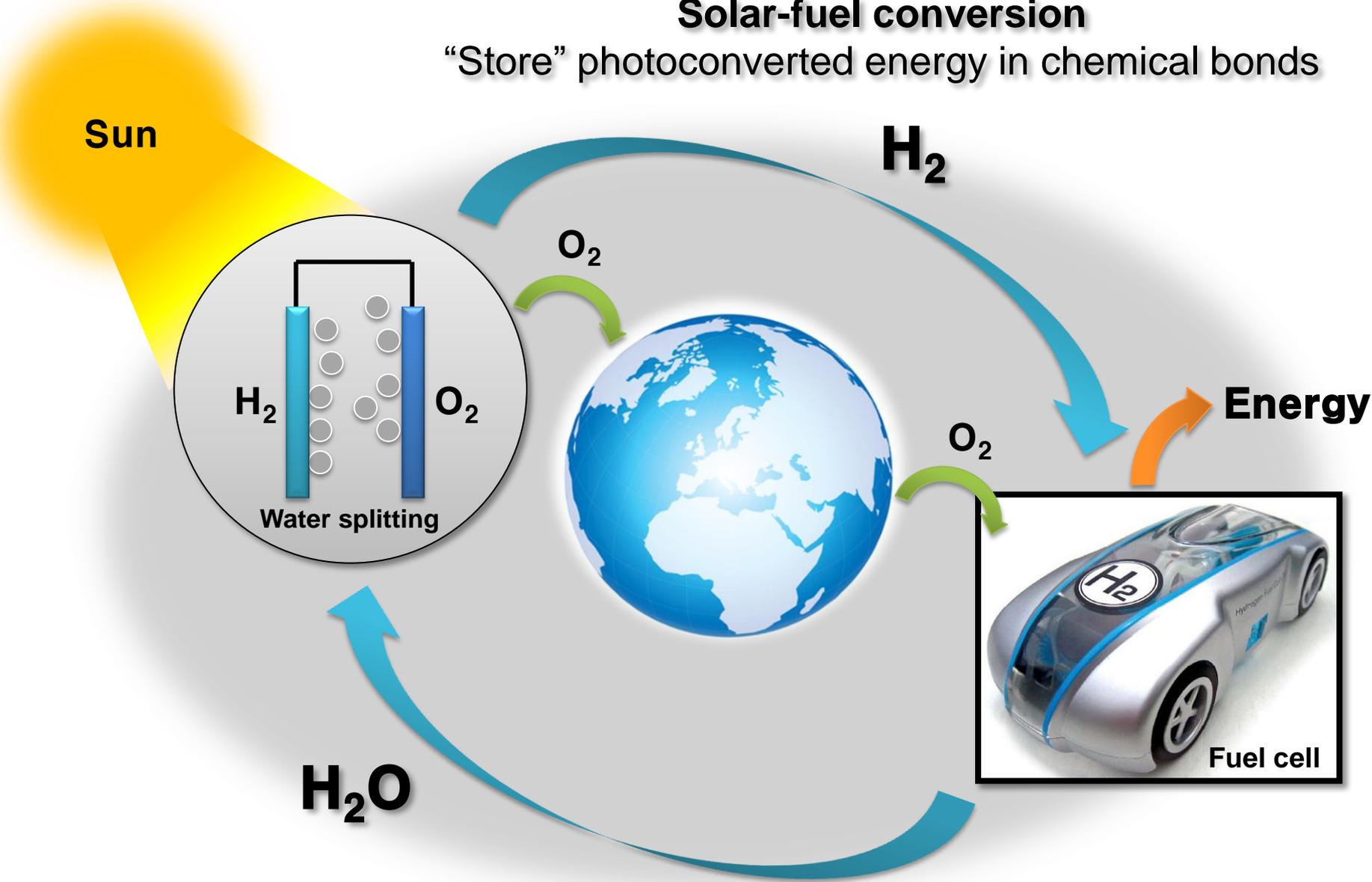
Hanyang University

2014. 09. 30

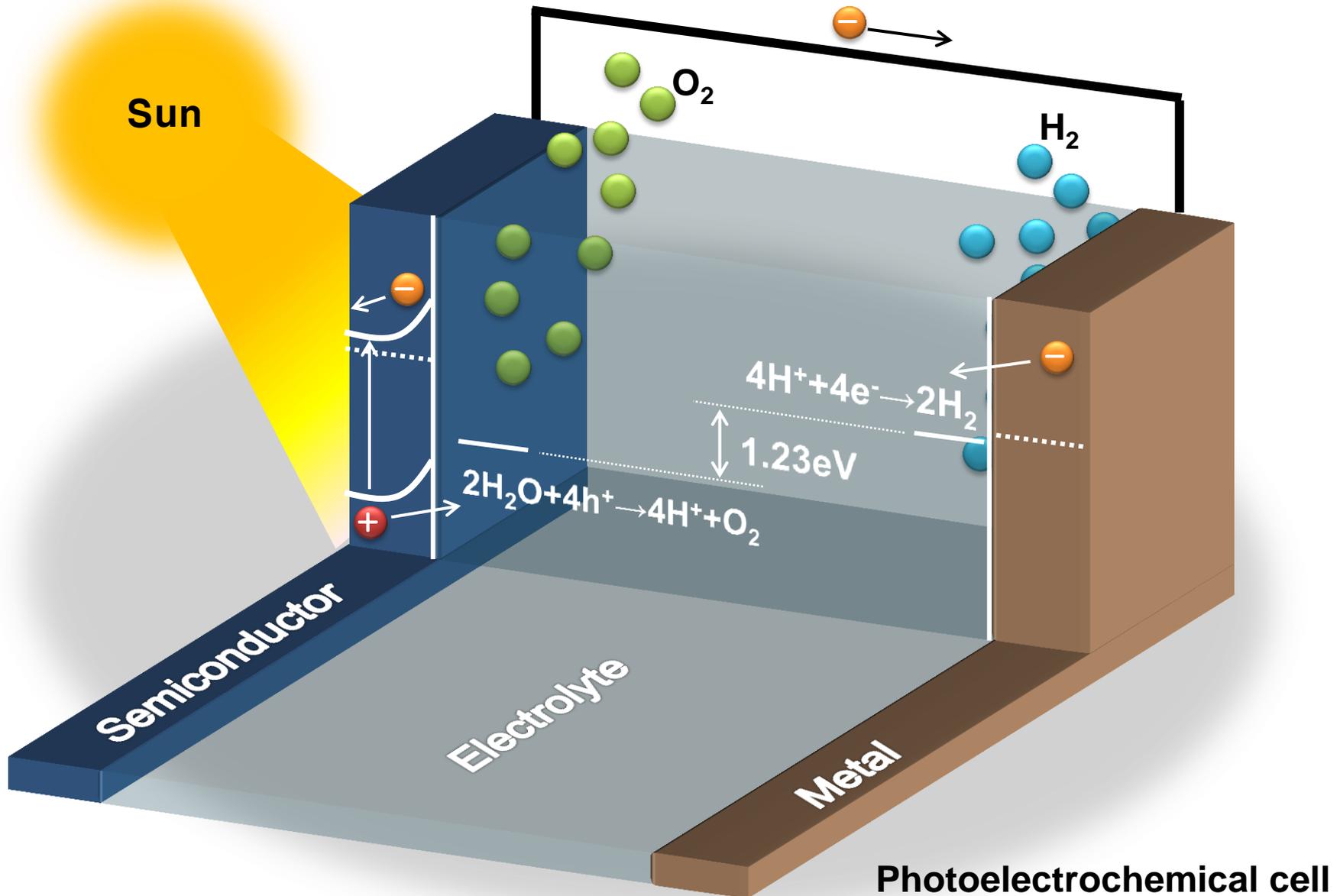
# Renewable Hydrogen Energy

## Solar-fuel conversion

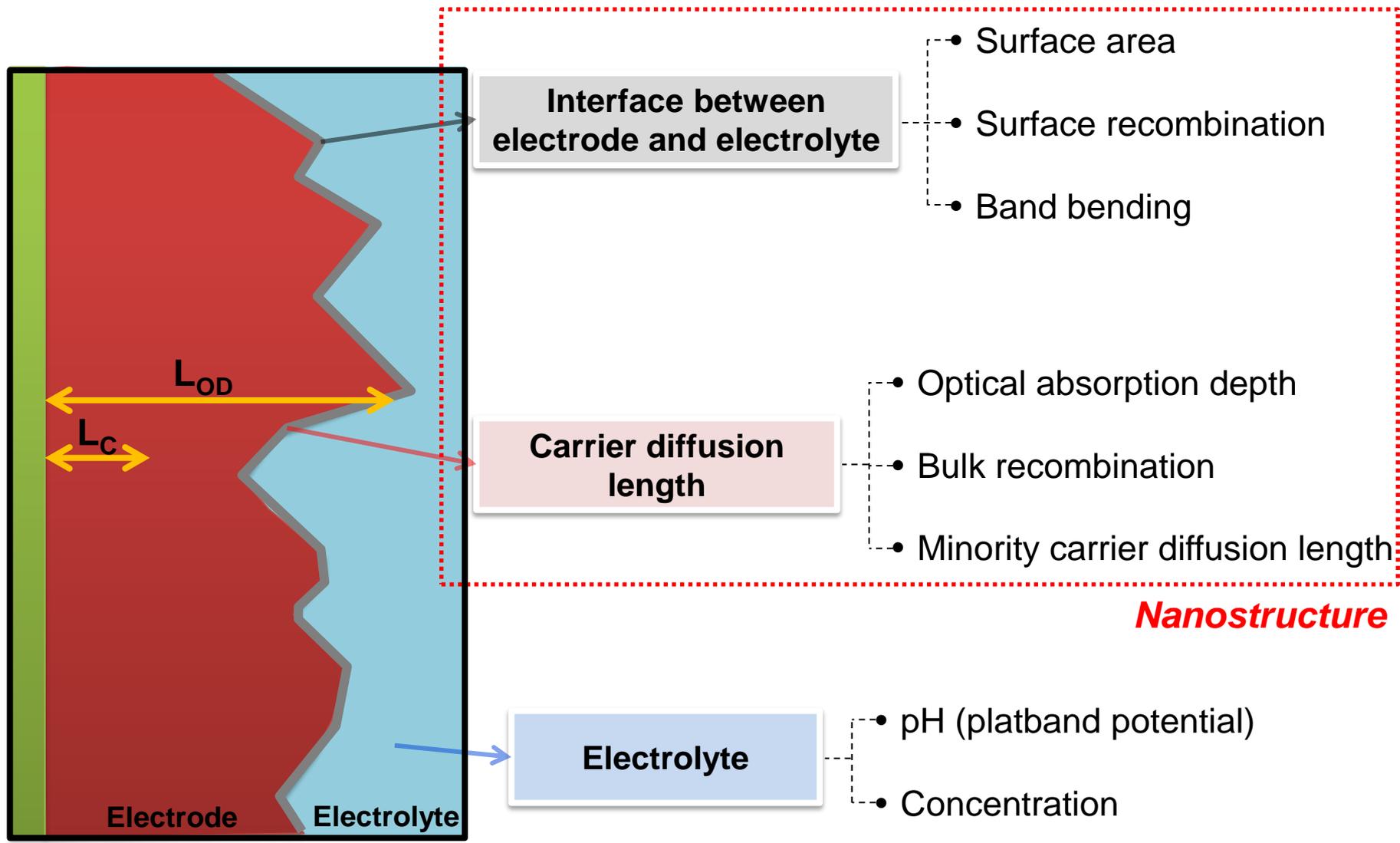
“Store” photoconverted energy in chemical bonds



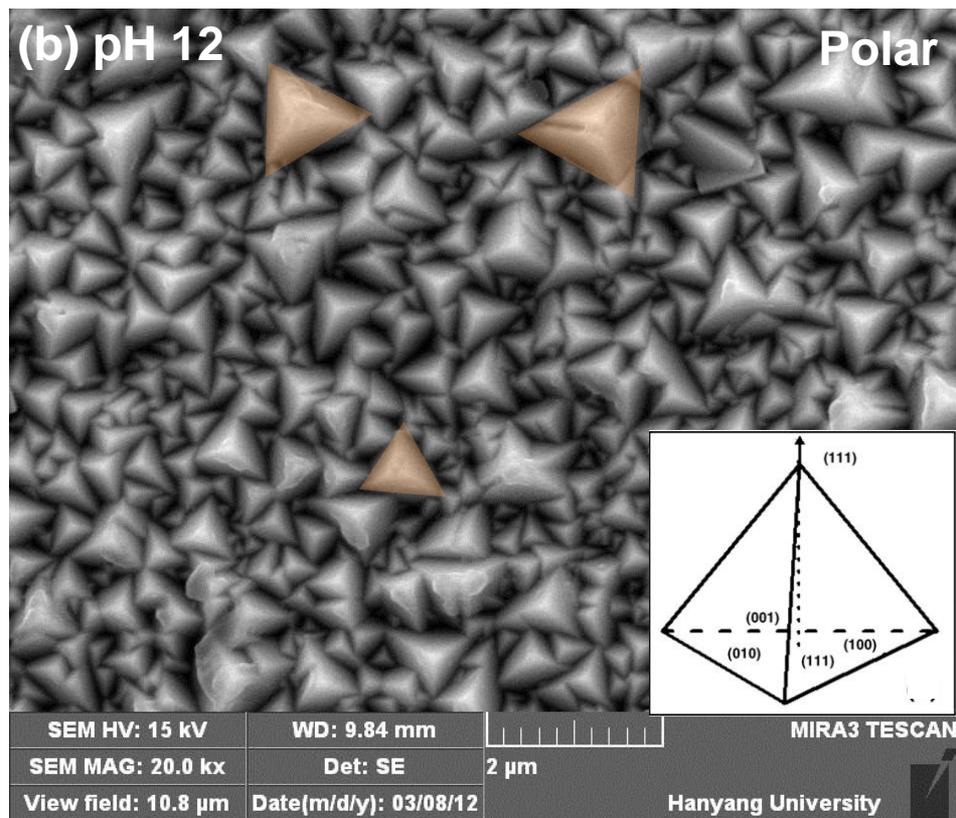
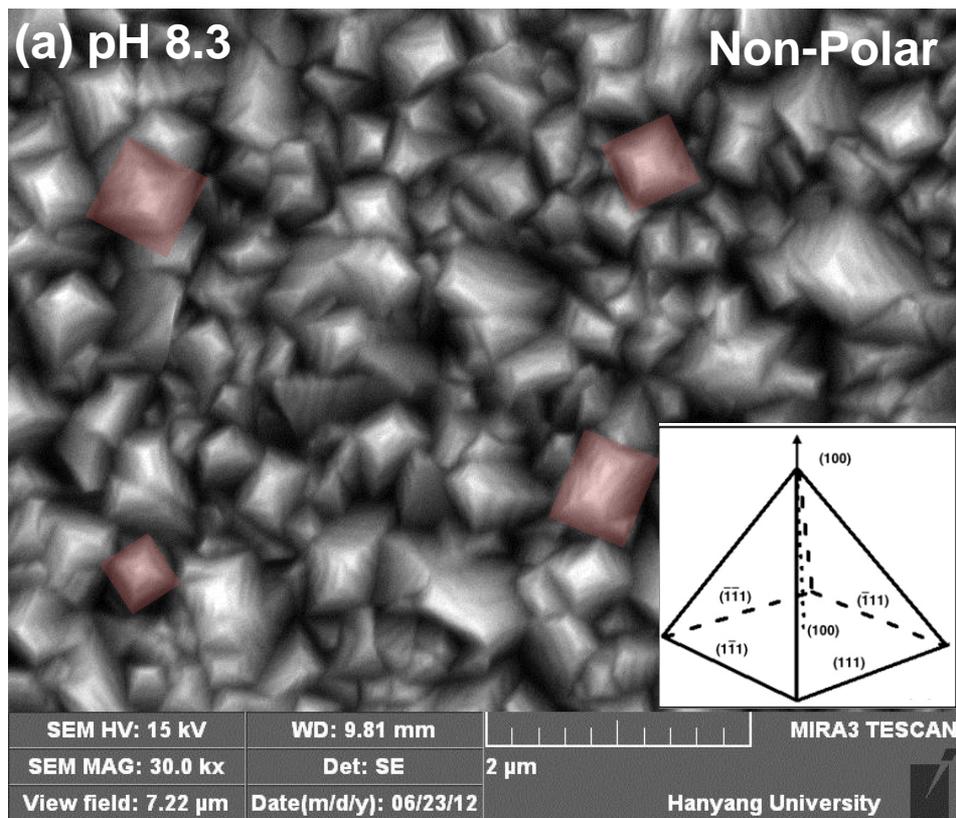
# What is water splitting?



# Why is design of electrode important at water splitting?

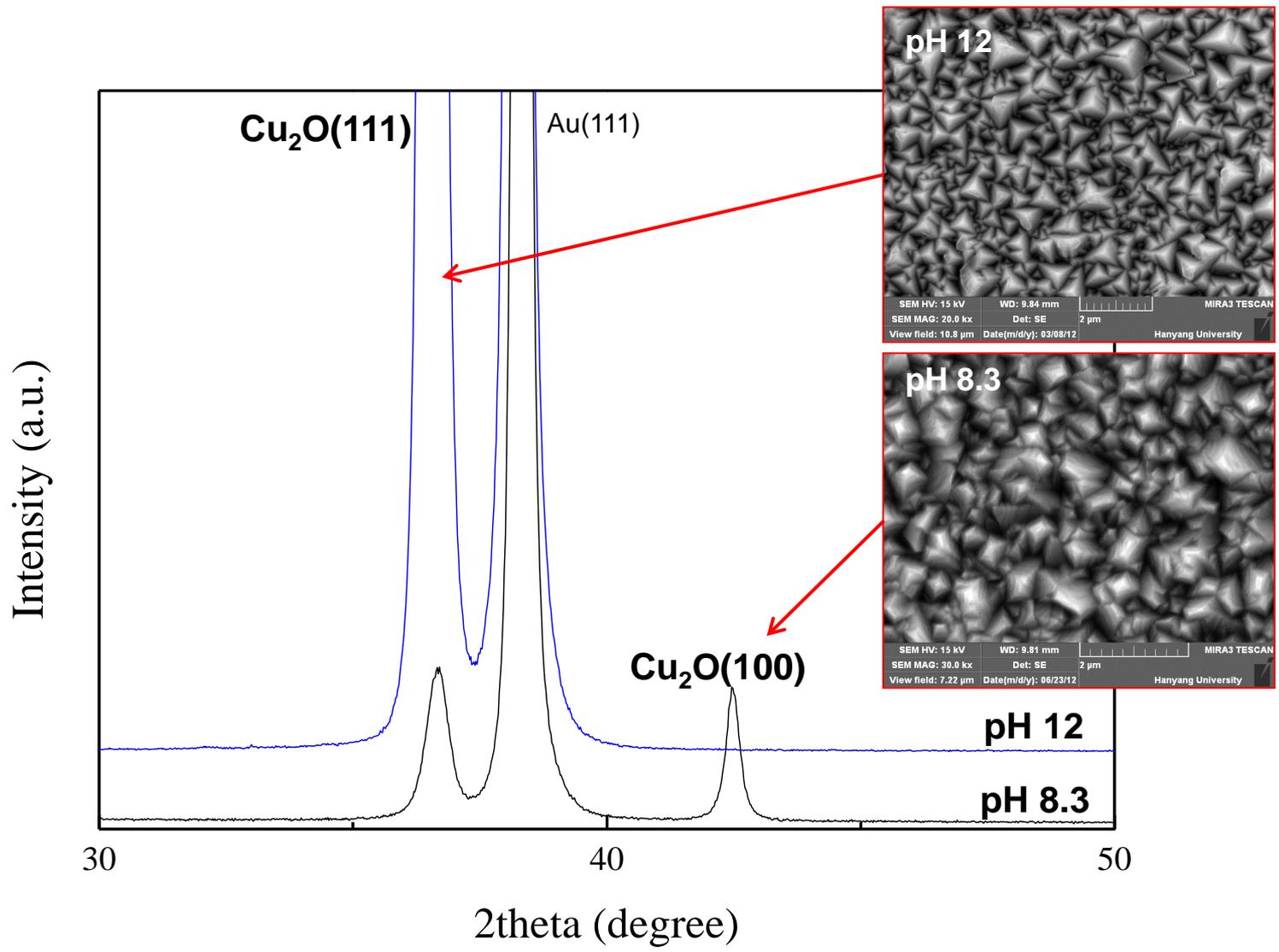


# ▪ Different facets with bath pHs



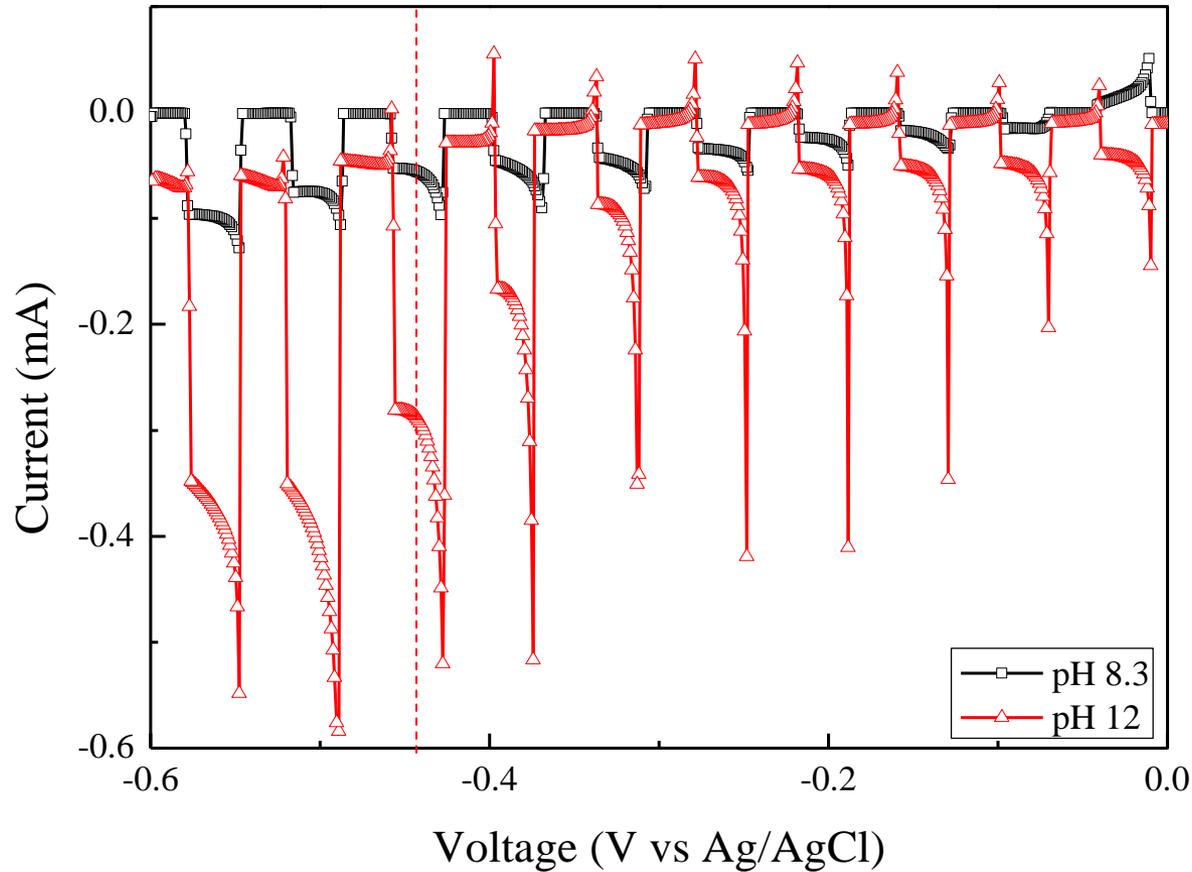
- SEM images of  $\text{Cu}_2\text{O}$  film on Au/Ti coated Si substrate-

# Different facets with bath pHs



- XRD patterns of the planar Cu<sub>2</sub>O films (pH 8.3, 12) -

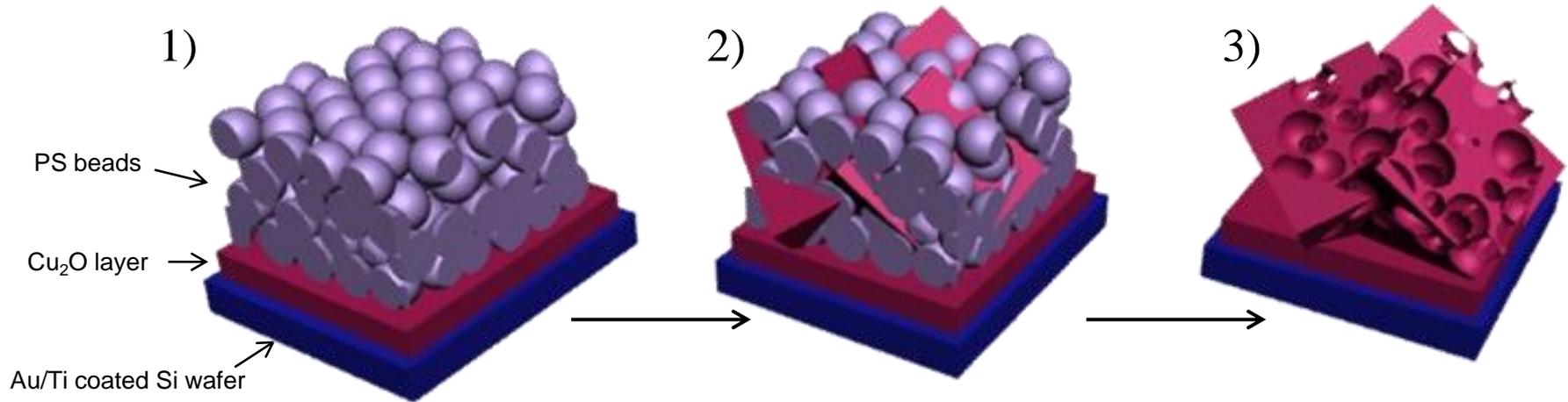
# Enhanced Photocurrent of Cu<sub>2</sub>O films by different facets with bath pHs



- LSV curves of the planar Cu<sub>2</sub>O films (pH 8.3 and 12) -

➤ **0.053mA ⇒ 0.28mA: 5.3 times increase (-0.45V vs. Ag/AgCl)**

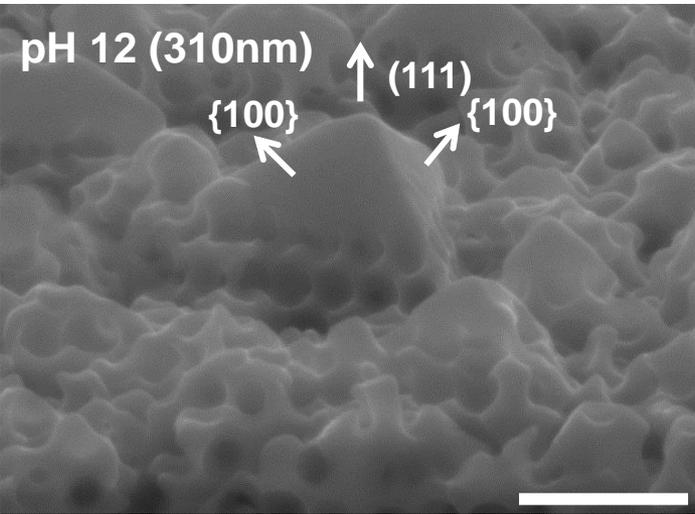
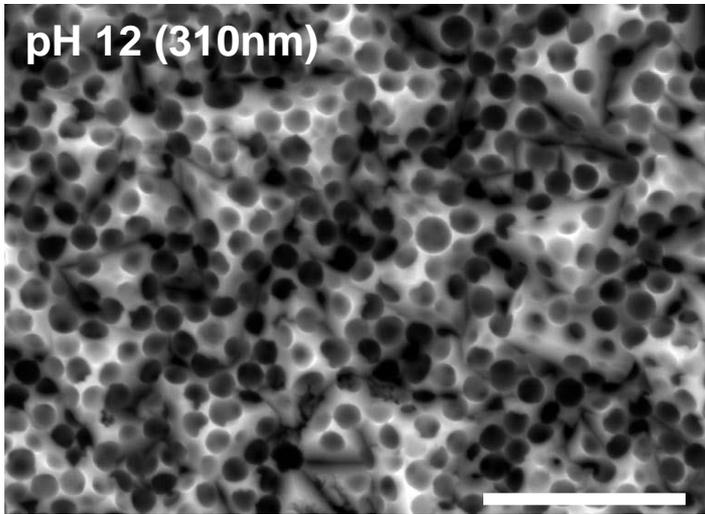
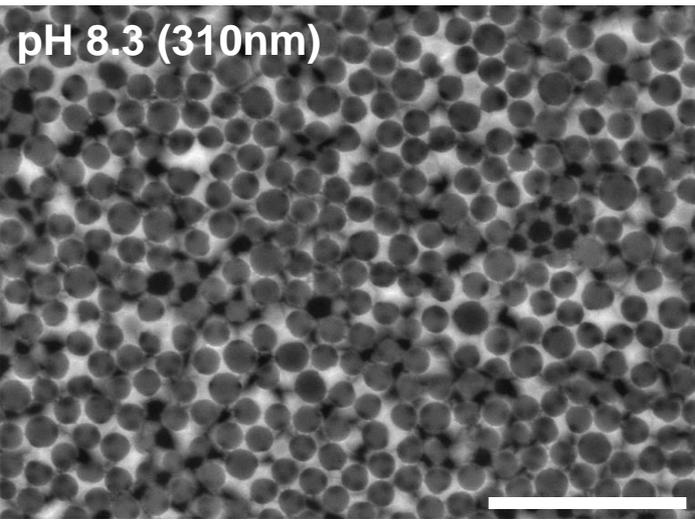
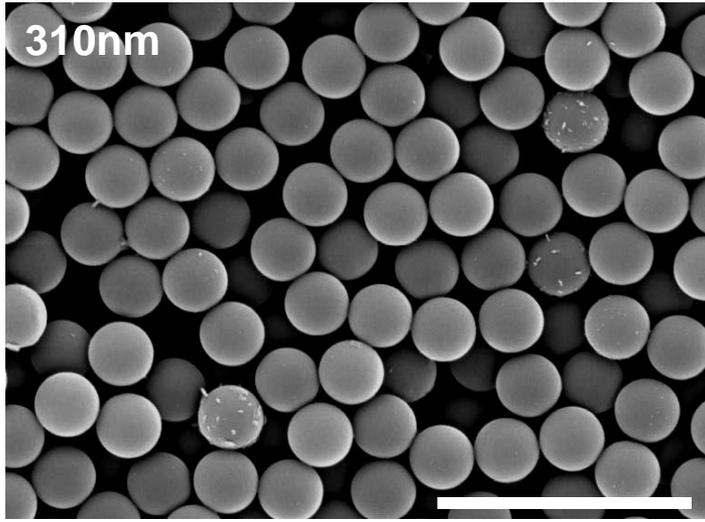
# ▪ Fabrication of Three-dimensional $\text{Cu}_2\text{O}$ film



## ➤ Schematic of 3D $\text{Cu}_2\text{O}$ fabrication process

- 1) Fabrication of Multilayer polystyrene(PS) beads template
- 2) Electrodeposition of  $\text{Cu}_2\text{O}$
- 3) Dip  $\text{Cu}_2\text{O}$  films in chloroform solution for removing of PS beads template

▪ SEM images of Three-dimensional  $\text{Cu}_2\text{O}$  film

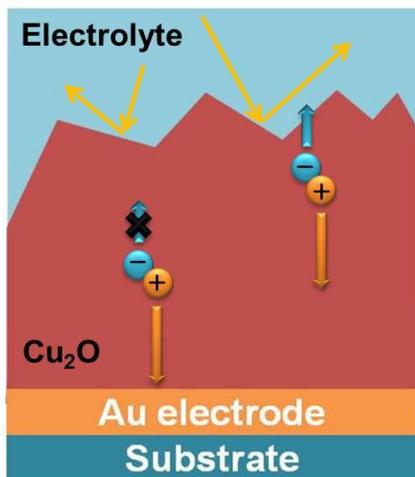


- SEM images of the PS beads template and the disordered 3D  $\text{Cu}_2\text{O}$  films (310, 1000nm PS beads) -

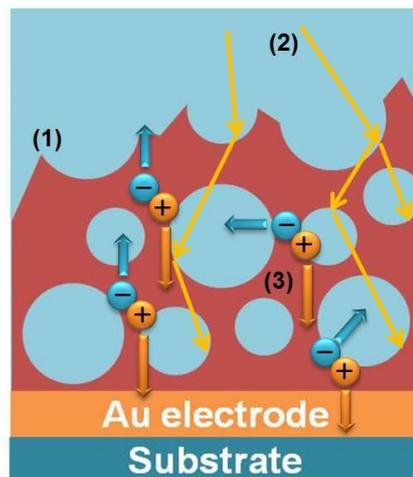
# Combination of two surface modification methods at an angstrom to micro level

## ☞ (111) Orientation + 3D structure

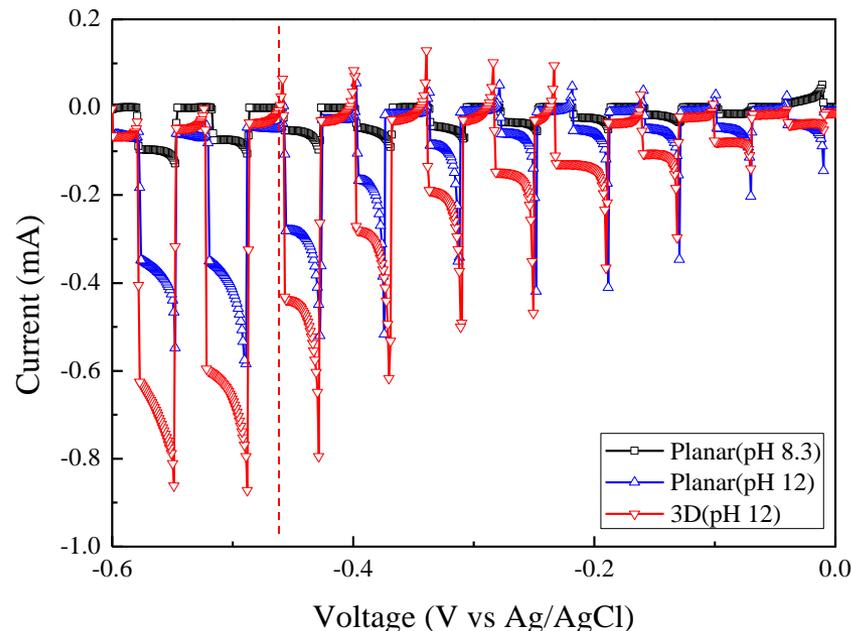
Planar films



3D Cu<sub>2</sub>O films



- (1) Large interface area between Cu<sub>2</sub>O and electrolyte
- (2) Improve light absorption by light scattering and trapping
- (3) Reduce minority carrier diffusion length (electrons, 50nm~100nm)



- LSV curves of the planar and disordered 3D Cu<sub>2</sub>O films (pH 8.3 and 12) -

➤ **0.053mA (pH 8.3) ⇒ 0.28mA (pH 12): 5.3times**  
 ⇒ **0.45mA (PS bead template): 1.6times (-0.45V vs. Ag/AgCl)**

# ▪ Acknowledgement

- This research was supported by the Pioneer Research Center Program through the National Research Foundation of Korea funded by the Ministry of Science, ICT & Future Planning(NRF-2012-0001262)
- This work was supported by the Human Resources Development program(*No.*20124030200130) of the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government Ministry of Trade, Industry and Energy.

**Thank you**