

# Fabrication of Fe-S/FeOOH hetero junctions by electrochemical deposition

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# Background of iron sulfide

## FeS<sub>2</sub>(Pyrite)

- Band gap : 0.95 eV
- Absorption coefficient :  $5 \times 10^5 \text{ cm}^{-1}$
- Cheap and nontoxic materials



Promising as an **absorber material** for solar cell.

We succeeded in fabricating p-type iron sulfide thin film (Fe-S) using electrochemical deposition(ECD)<sup>[1]</sup>

[1]S. Kawai, R Yamazaki, S. Sobue, E. Okuno and M. Ichimura, APL Materials 2, 032110 (2014)

# Background

## Lepidocrocite ( $\gamma$ -FeOOH)

Used for adsorbents, precursors to produce iron oxides, etc.

Characteristic

- n-type with bandgap of 2.2-2.6eV
- Cheap and nontoxic materials



Potential n-type material to fabricate p-n heterojunction

# Background

★ Electrodeposition(ECD) and Characterization of  $\gamma$ -FeOOH Thin Films. J. J. M. Vequizo, APEX 6, 125501 (2013)

★ Fabrication of  $\text{Cu}_2\text{O}/\gamma$ -FeOOH heterojunction solar cells using electrodeposition(ECD). J. J. M. Vequizo, APEX 7, 045501 (2014)

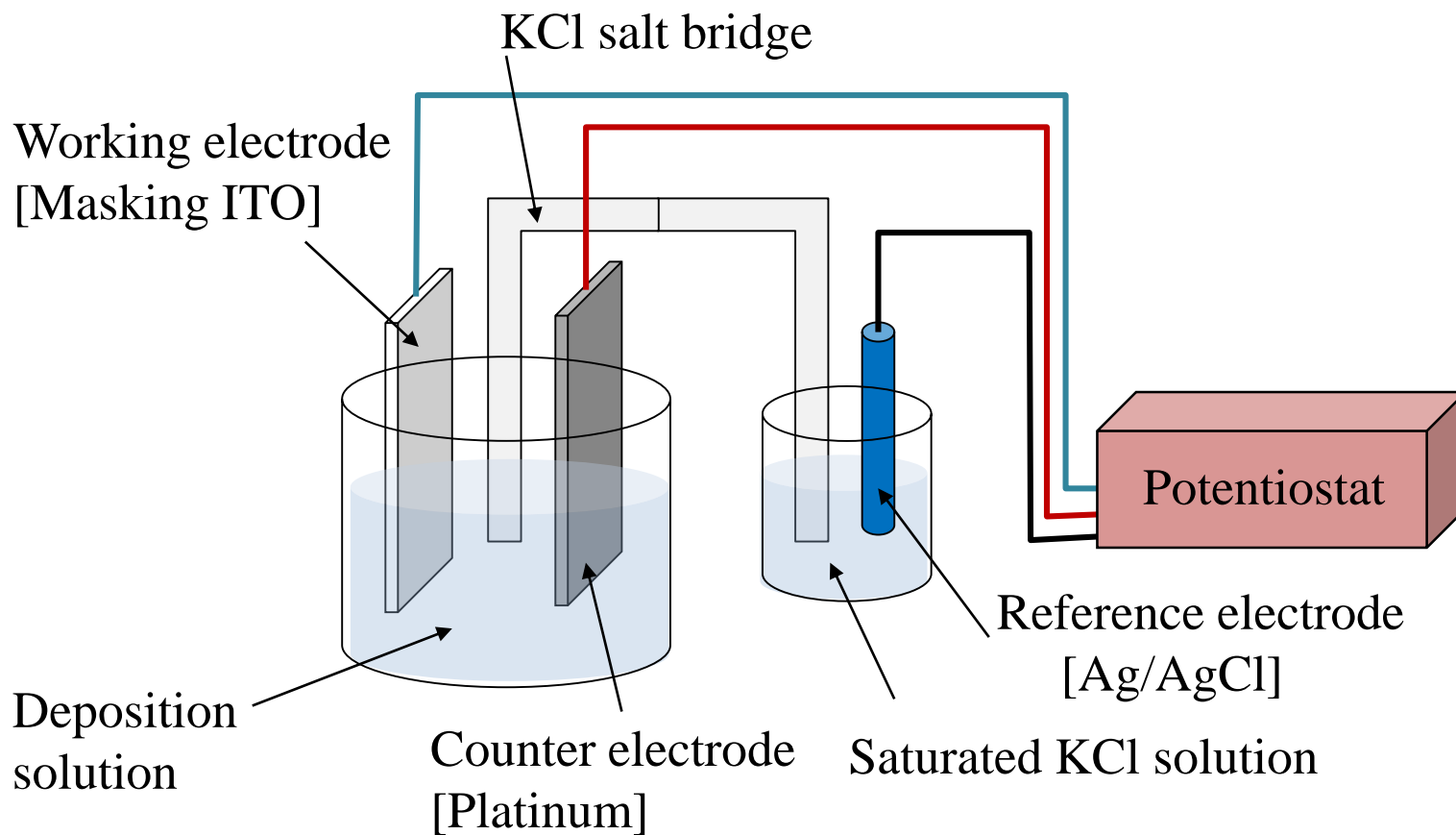


No report about fabrication of Fe-S/ $\gamma$ -FeOOH heterojunction solar cells using ECD has been published yet.



Attempt of fabrication of Electrodeposited Fe-S/ $\gamma$ -FeOOH heterojunction.

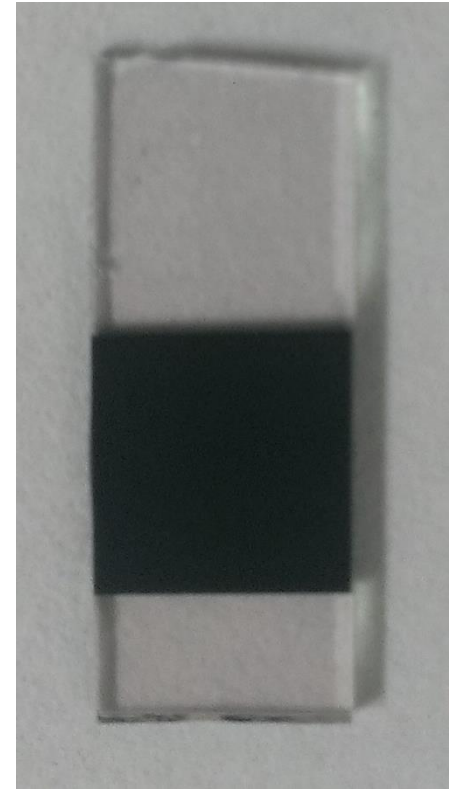
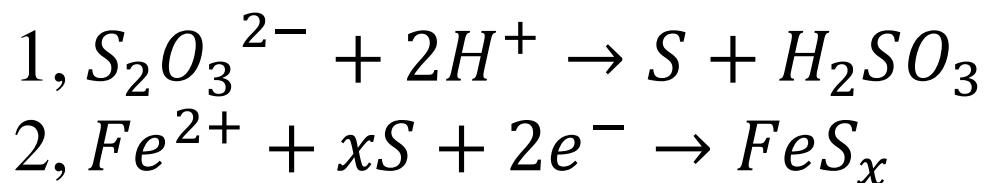
# ECD (Electro Chemical Deposition)



- Simple technique and economical
- Easy to fabricate large film

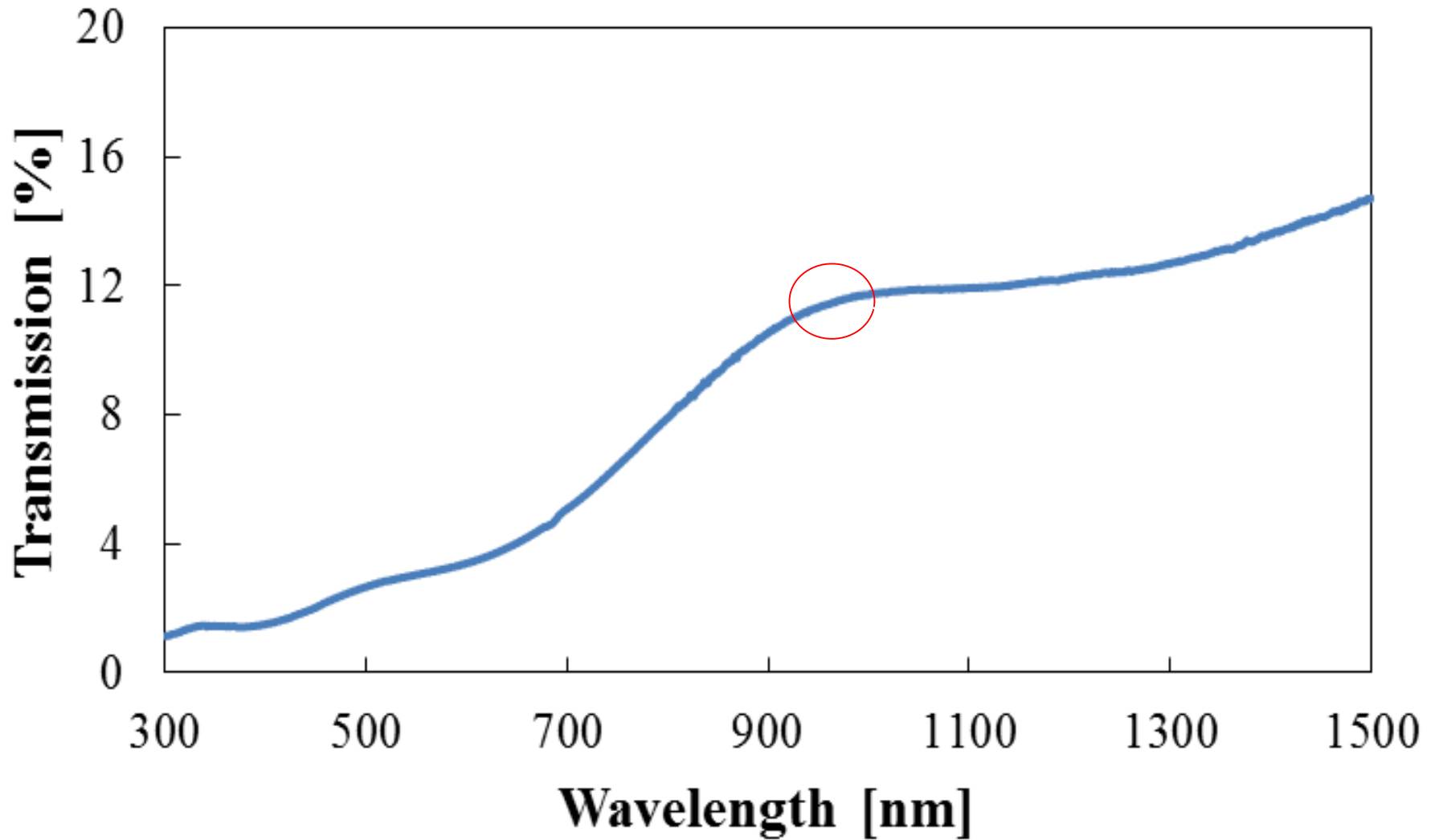
# Deposition condition of Fe-S

FeSO <sub>4</sub> [mM]	30
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> [mM]	100
Purified water [ml]	50
pH	Unadjusted (about 4.5)
Deposition time [s]	60
Temperature [°C]	15
Deposition current [mA/cm <sup>2</sup> ]	-1.5

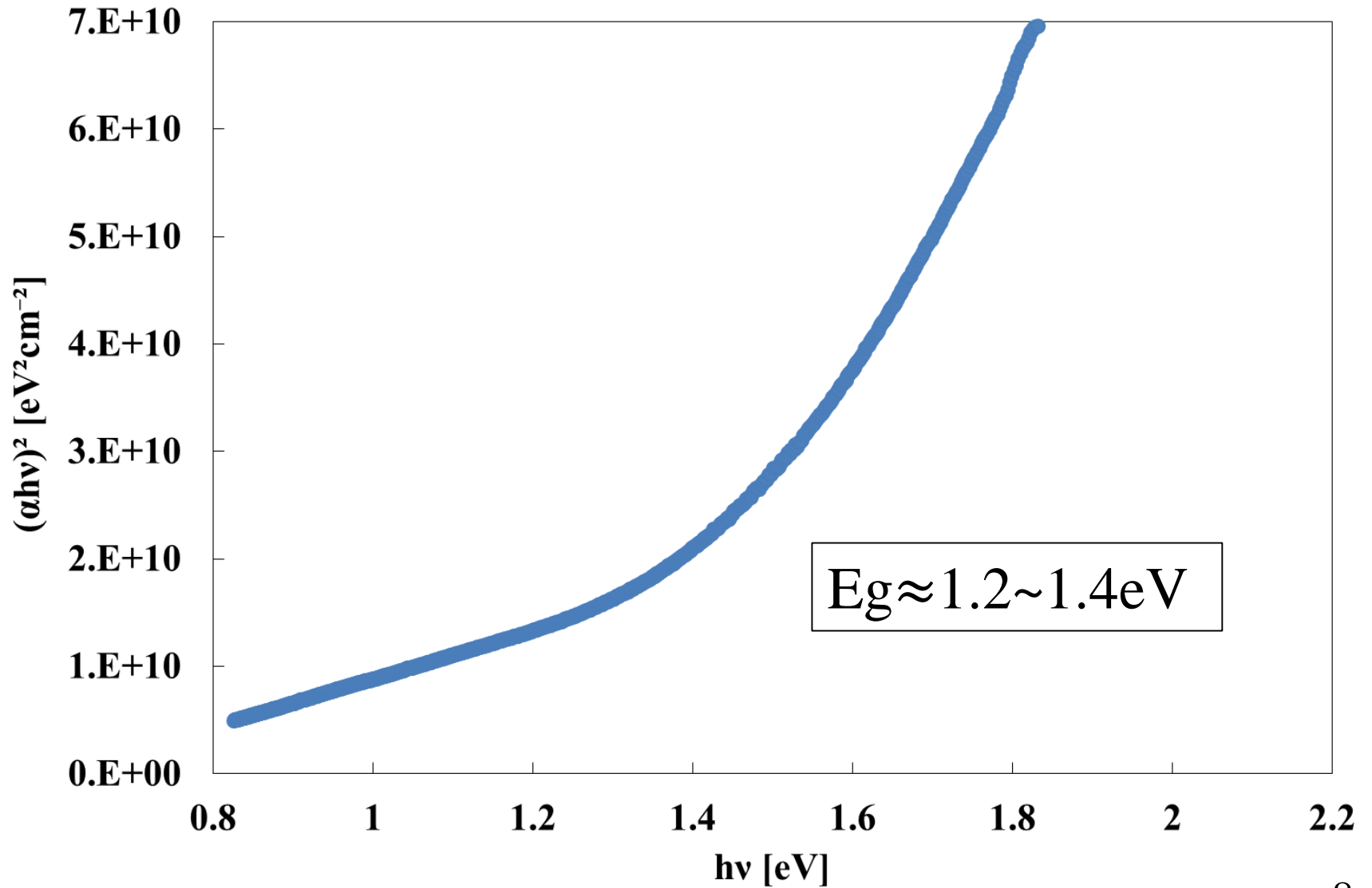


Appearance of film

# Transmission of Fe-S(thickness:0.2 $\mu\text{m}$ )

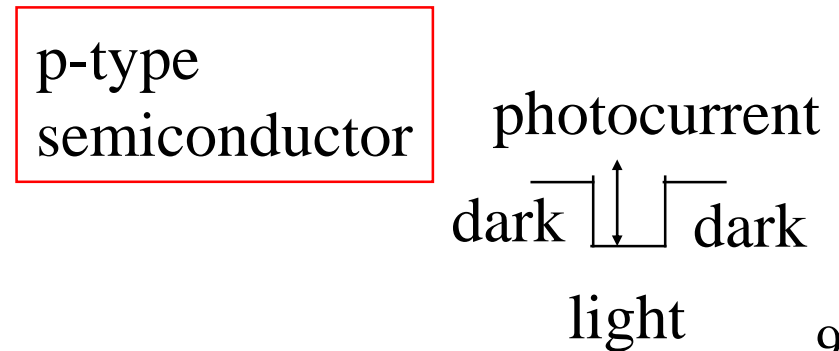
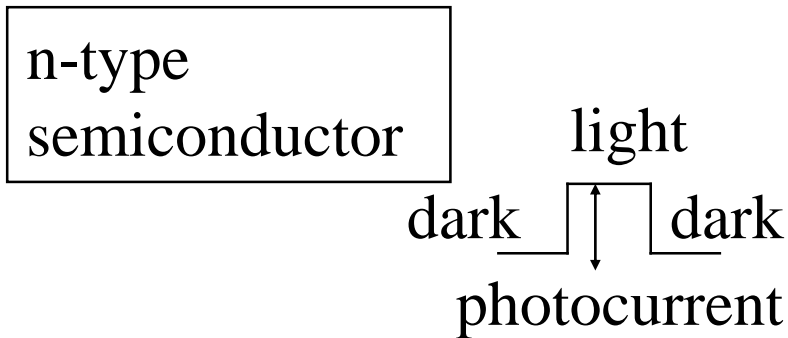
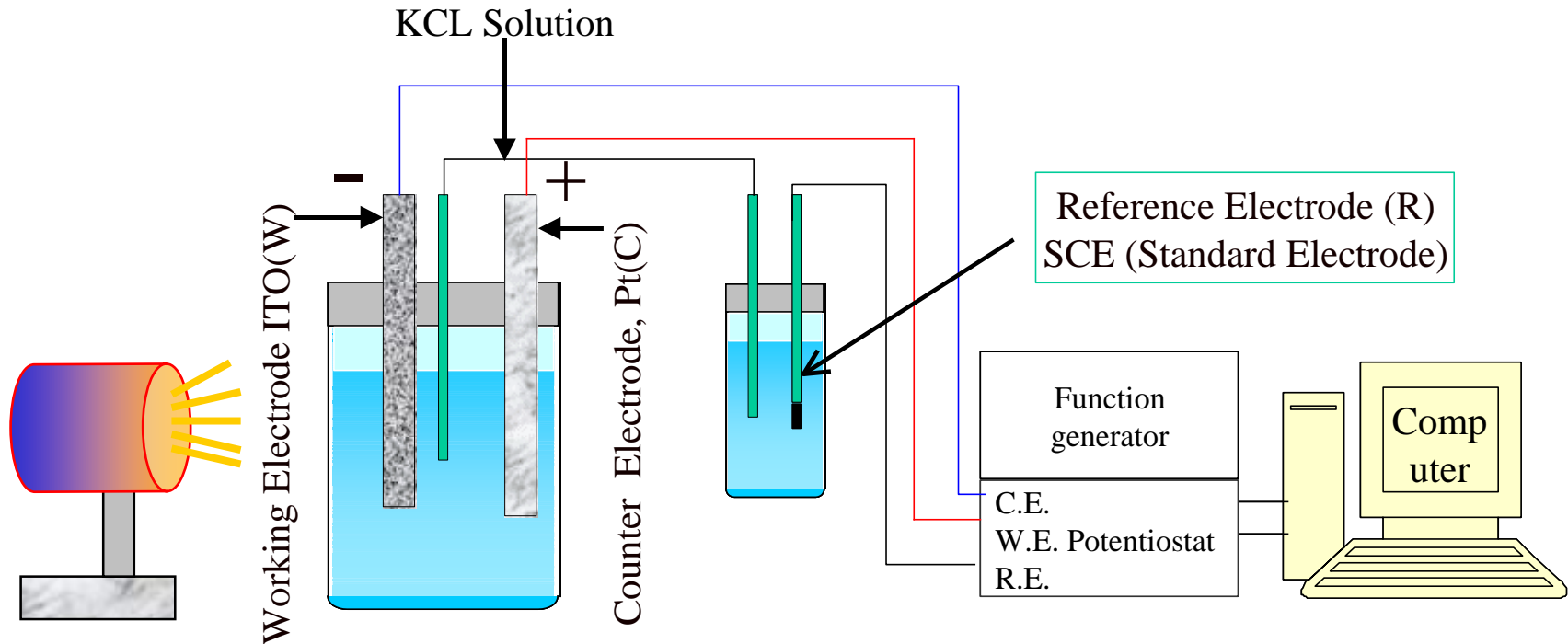


# Bandgap of Fe-S

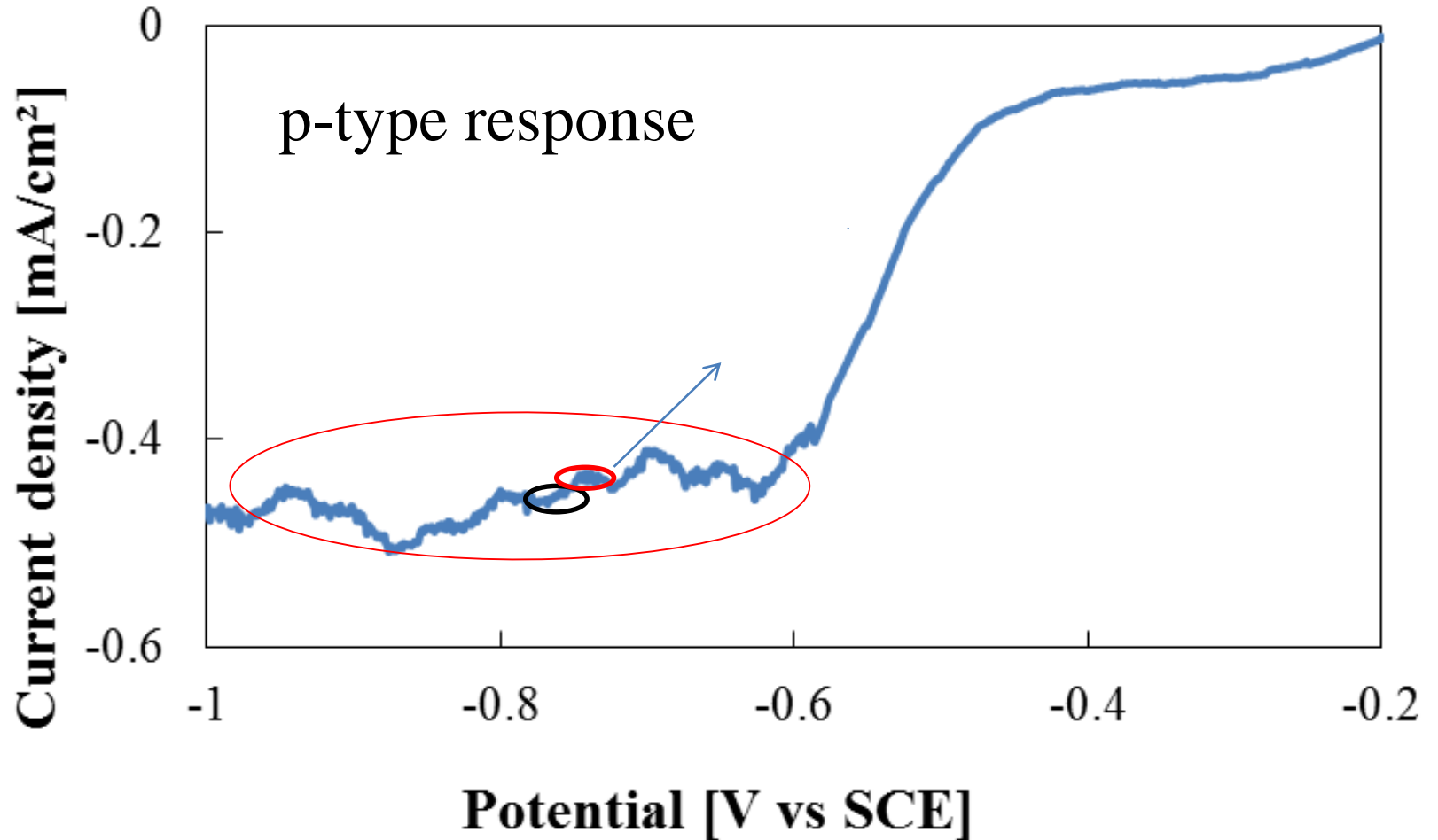




# Photo Electro Chemical (PEC) measurement

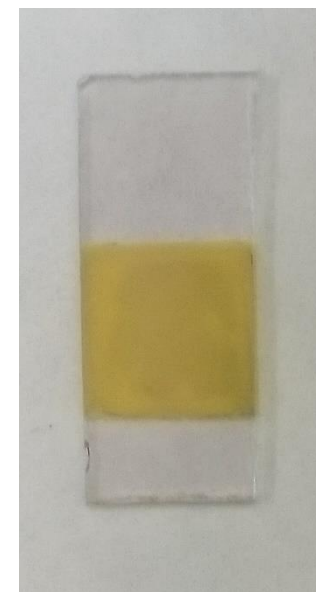


# PEC result of Fe-S



# Deposition condition for FeOOH

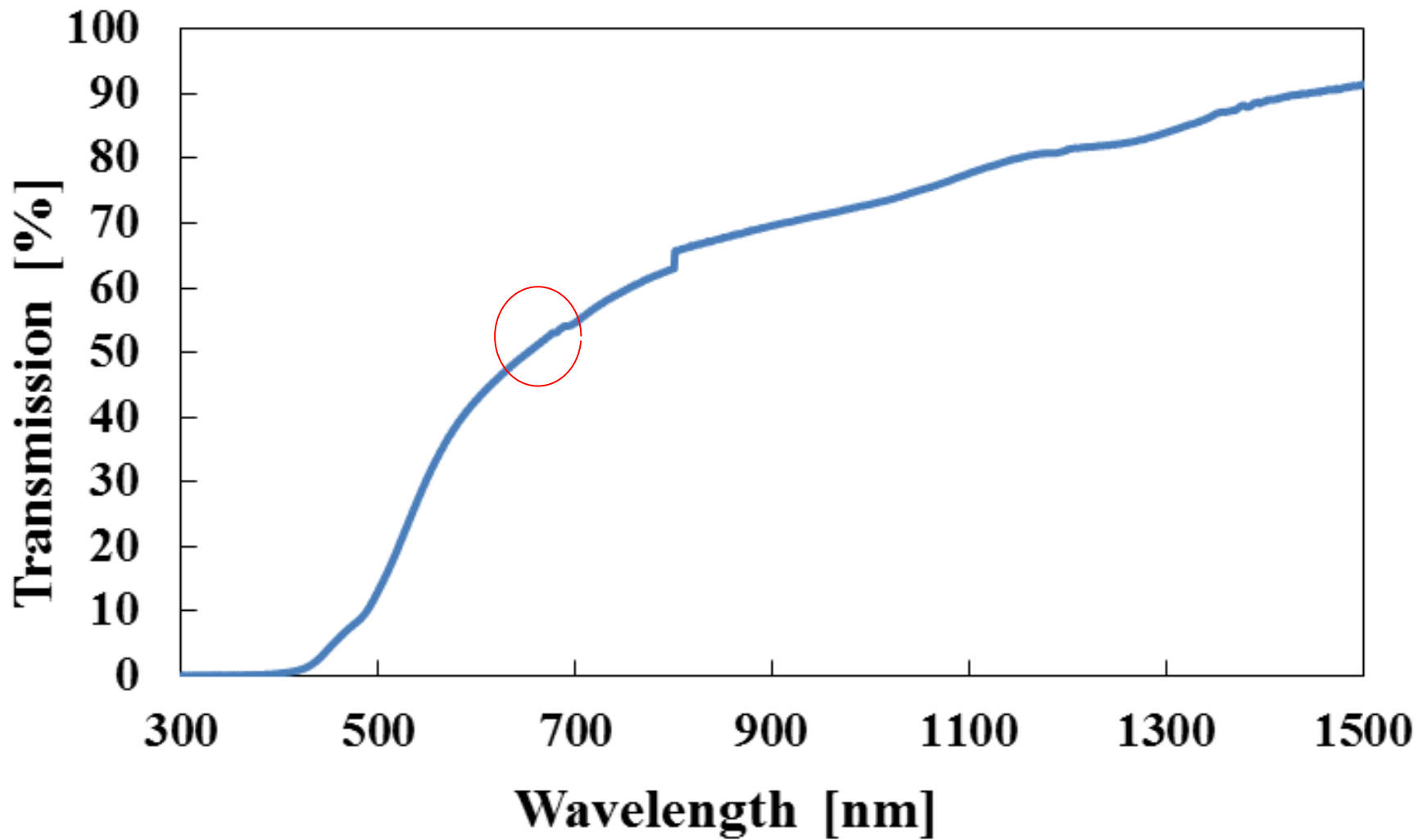
FeSO <sub>4</sub> ·7H <sub>2</sub> O [mM]	50
Na <sub>2</sub> SO <sub>4</sub> [mM]	100
Purified water [ml]	50
pH	Unadjusted(about 4.5)
Temperature [°C]	Room temperature(25)
O <sub>2</sub> bubbling [min]	10
Deposition Current [mA/cm <sup>2</sup> ]	-0.32
Deposition time [min]	10



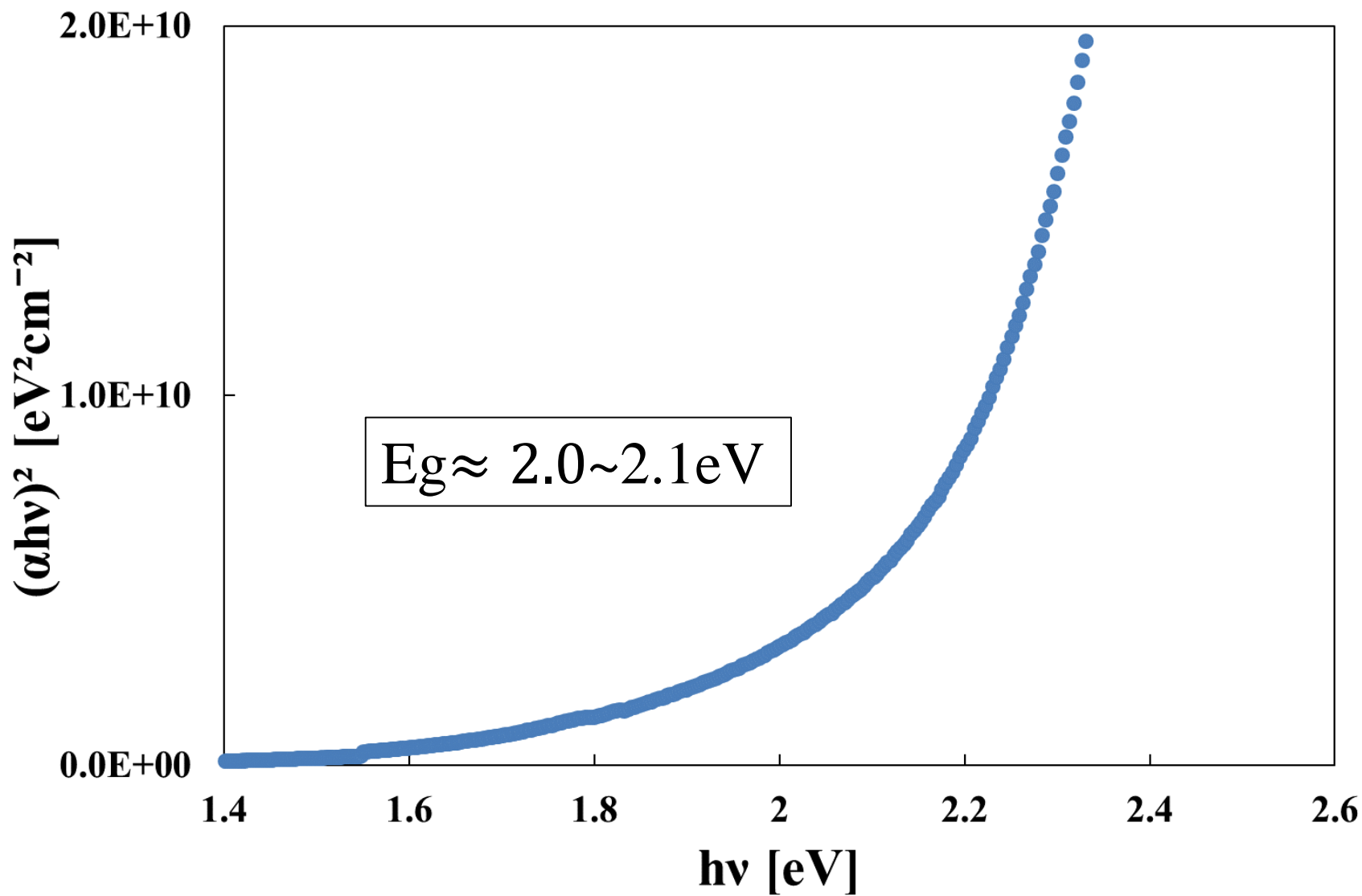
Appearance  
of film



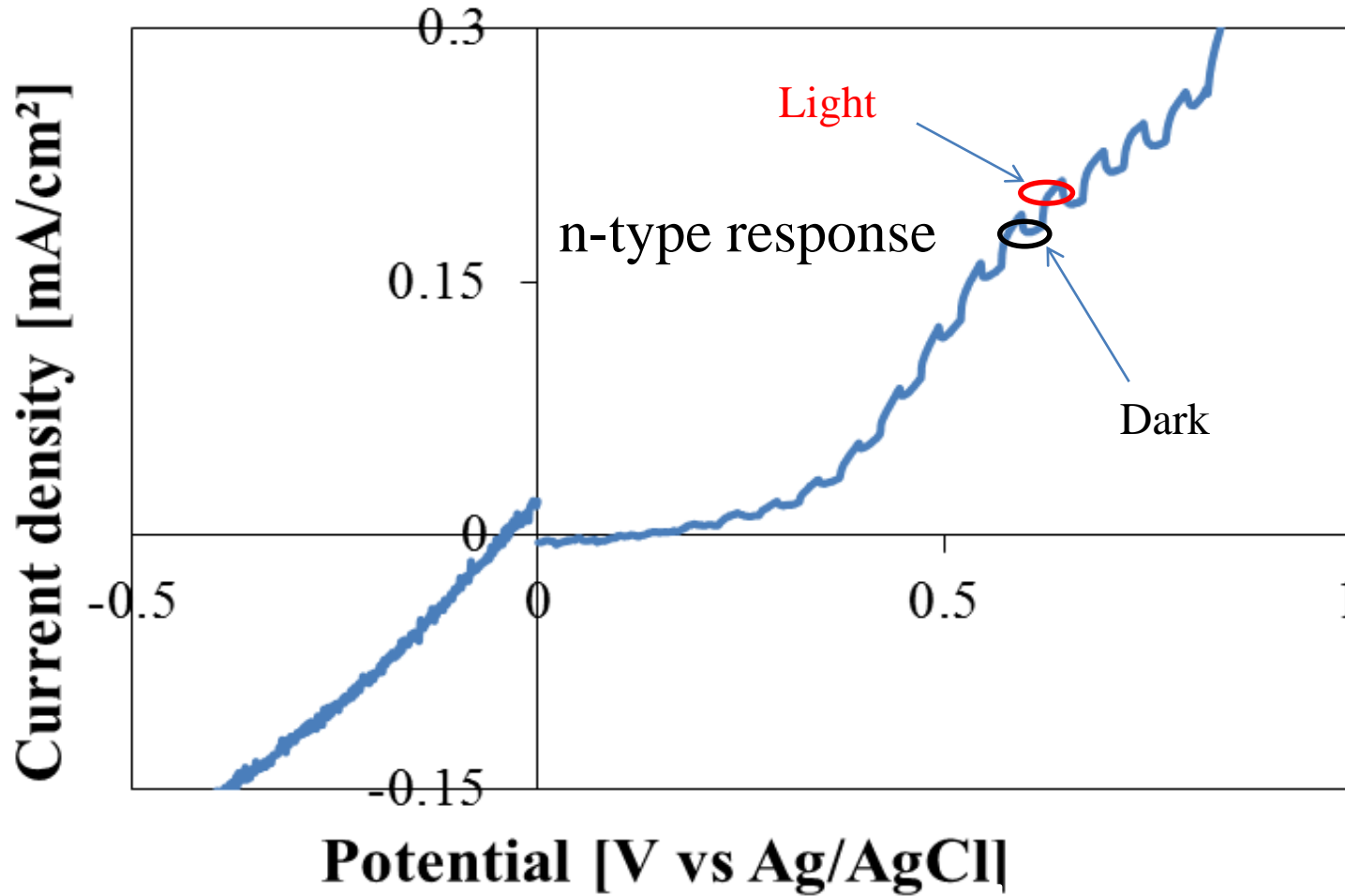
# Transmission of FeOOH(thickness:0.5 $\mu\text{m}$ )



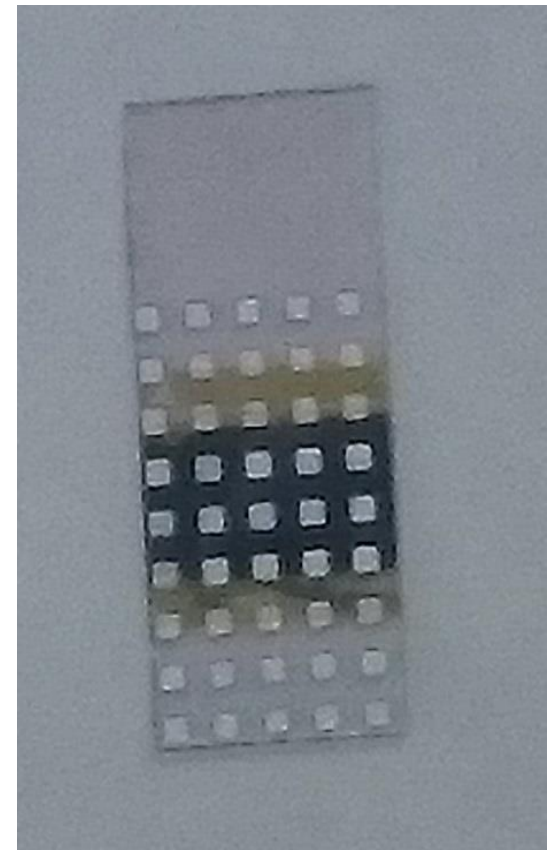
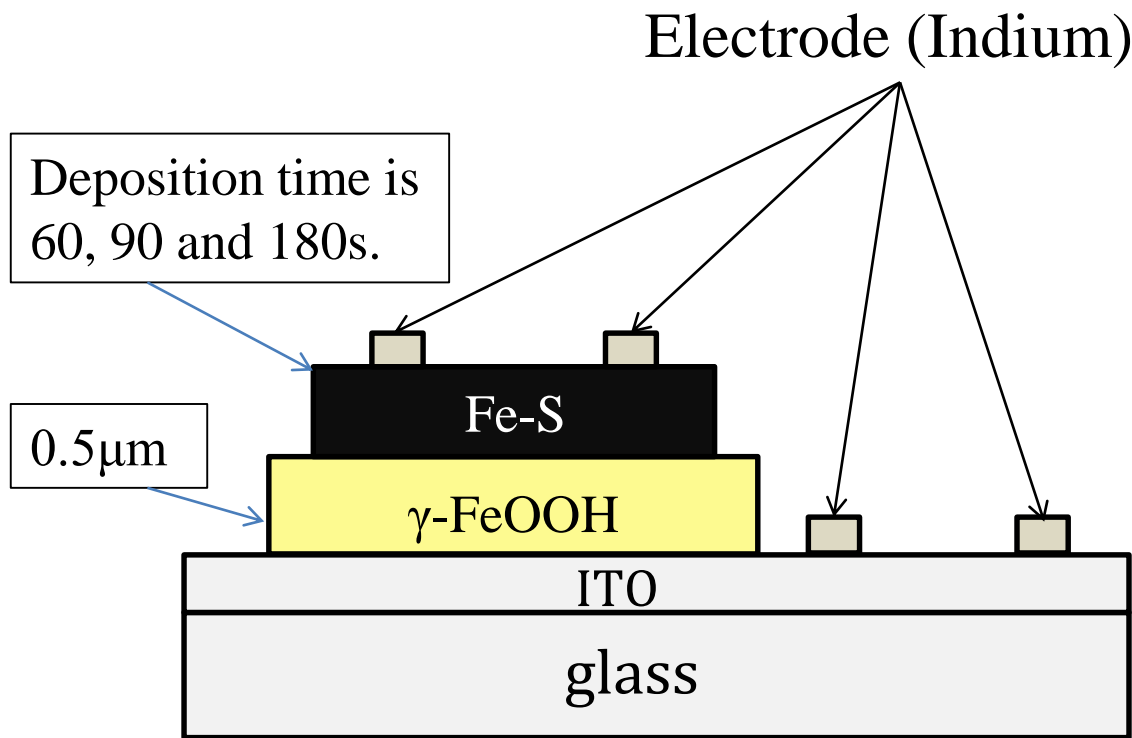
# Bandgap of FeOOH



# PEC result of FeOOH



# Fabrication of heterojunction cells of Fe-S/FeOOH

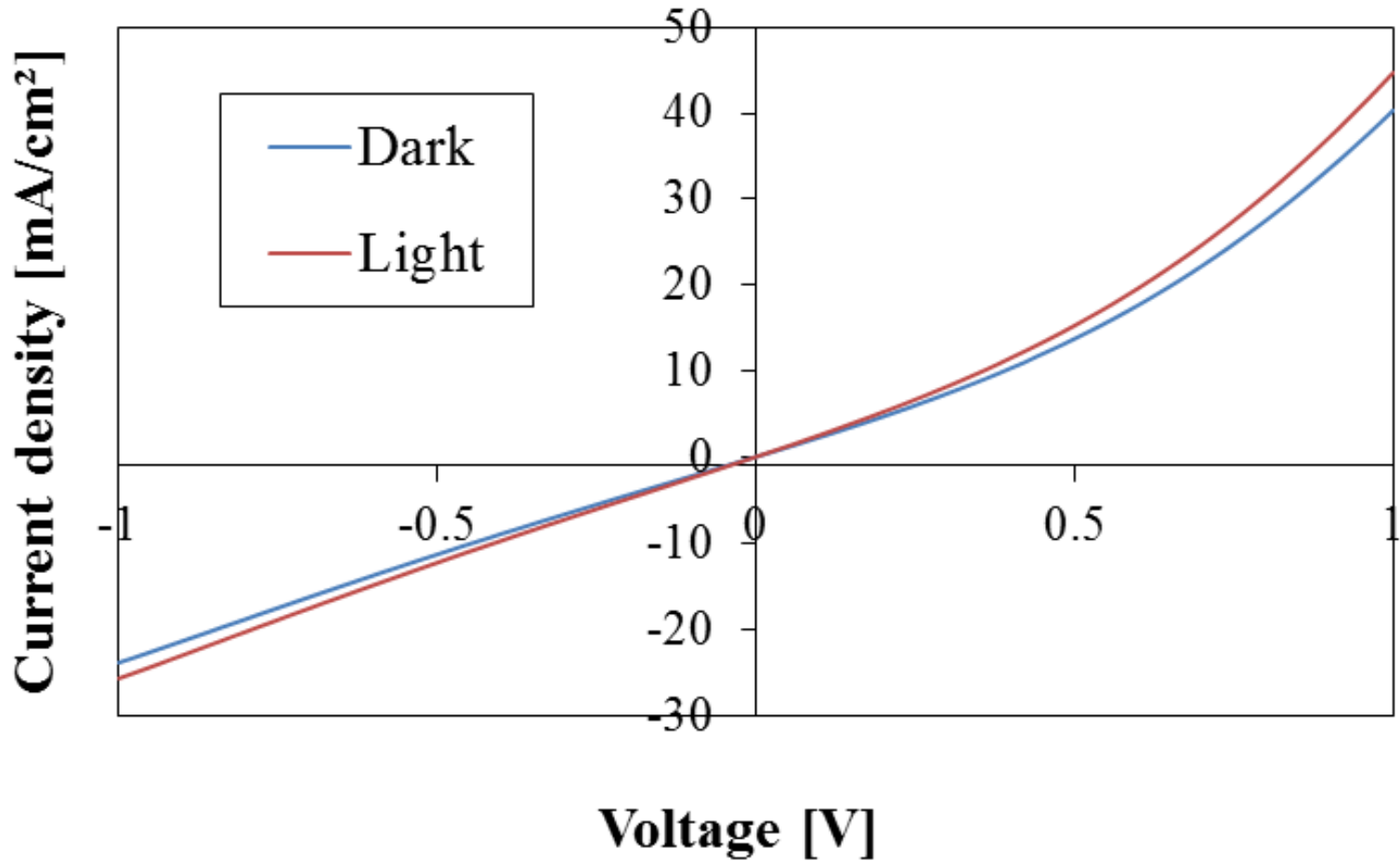


Appearance of heterojunction



Light (generated by solar simulator,  $100\text{mW}/\text{cm}^2$ )

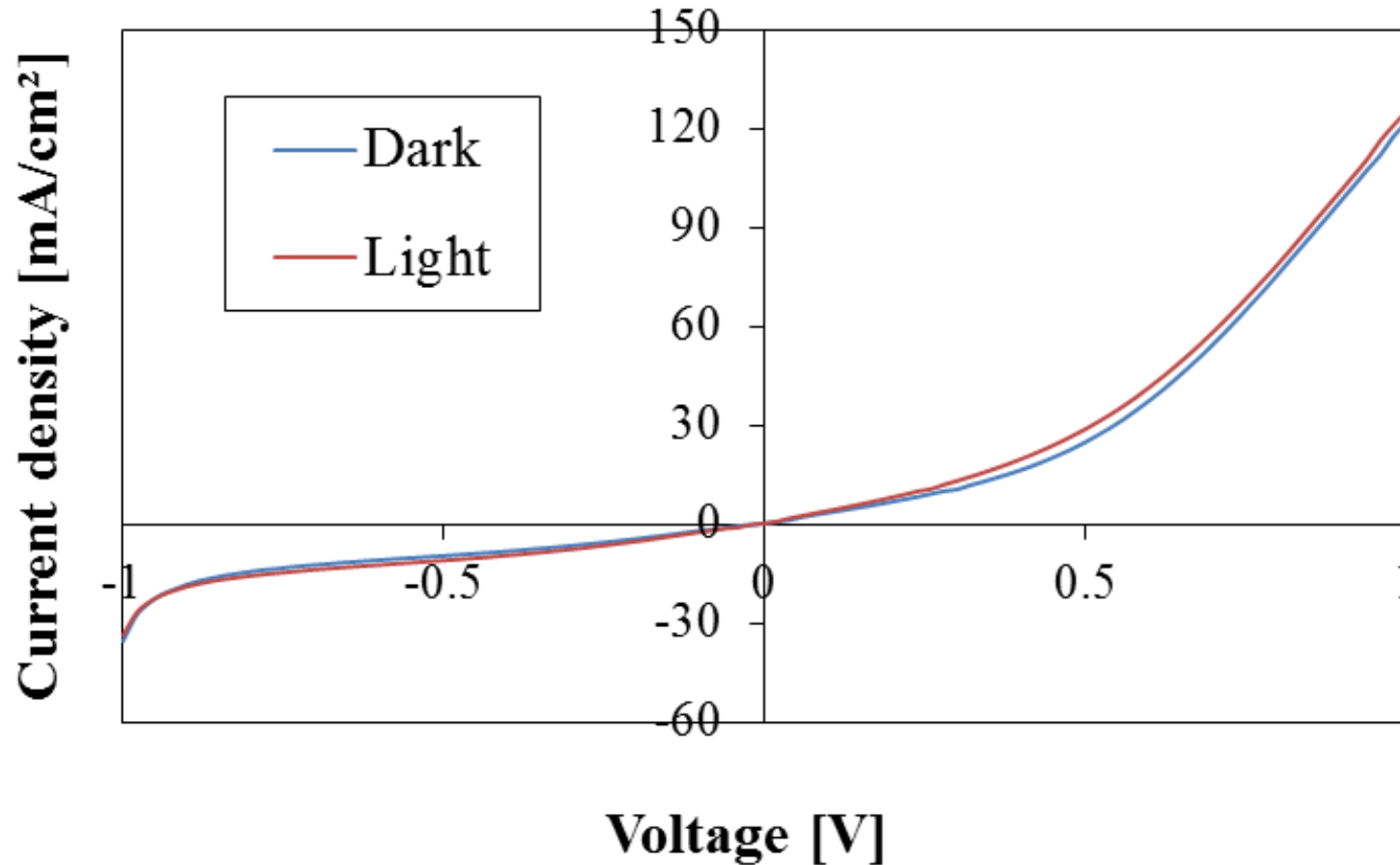
# I-V result



60s deposited Fe-S(0.2 $\mu$ m)/FeOOH

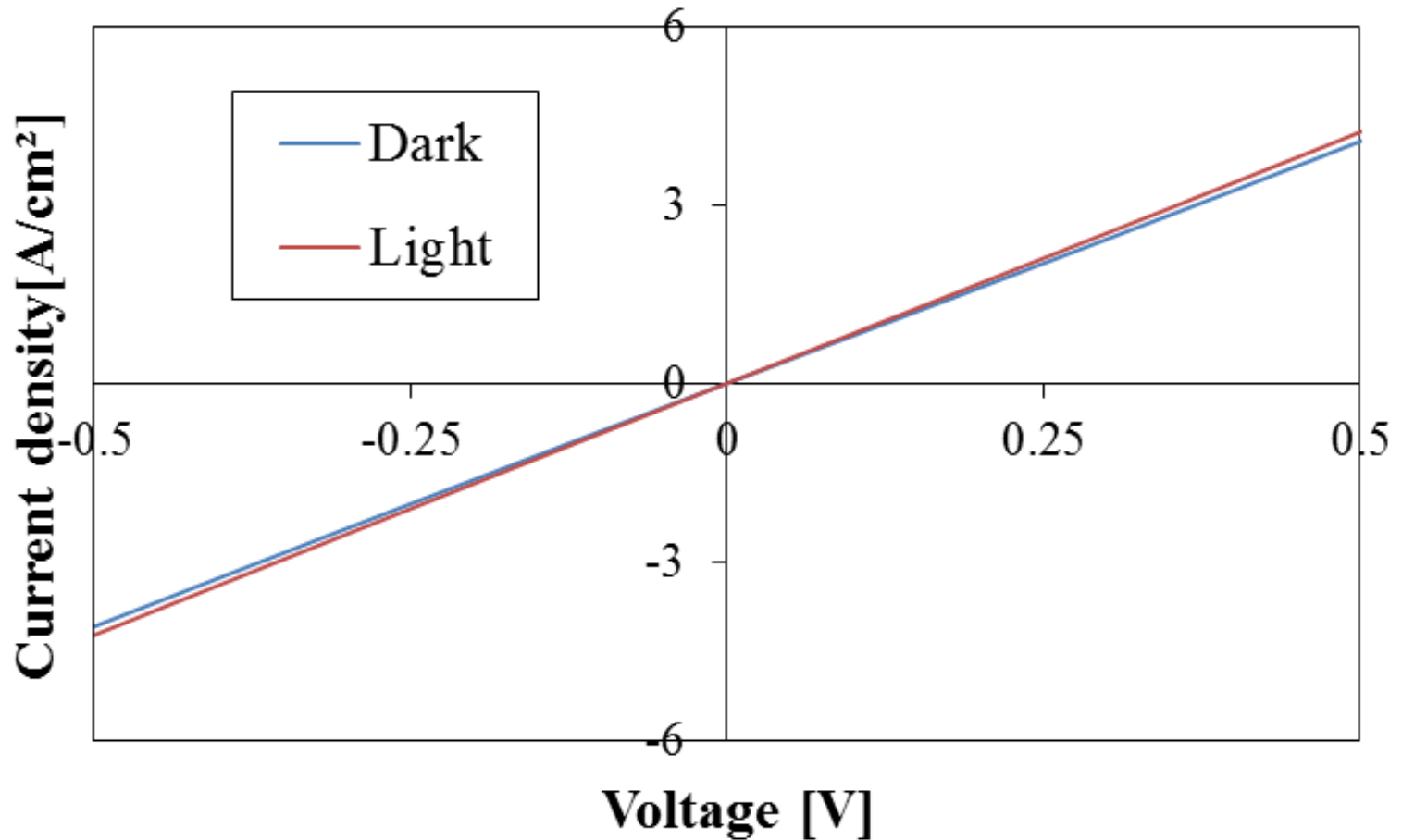


# I-V result



90s deposited Fe-S(0.3μm)/FeOOH

# I-V result



180s deposited Fe-S(0.5 $\mu$ m)/FeOOH

# Summary

- We deposited p-type Fe-S and n-type FeOOH films by ECD.
- We fabricated Fe-S/FeOOH heterojunctions for the first time.
- The samples with short Fe-S deposition time (60, 90 s) showed weak rectification properties, but the sample with 180s deposition did not.