

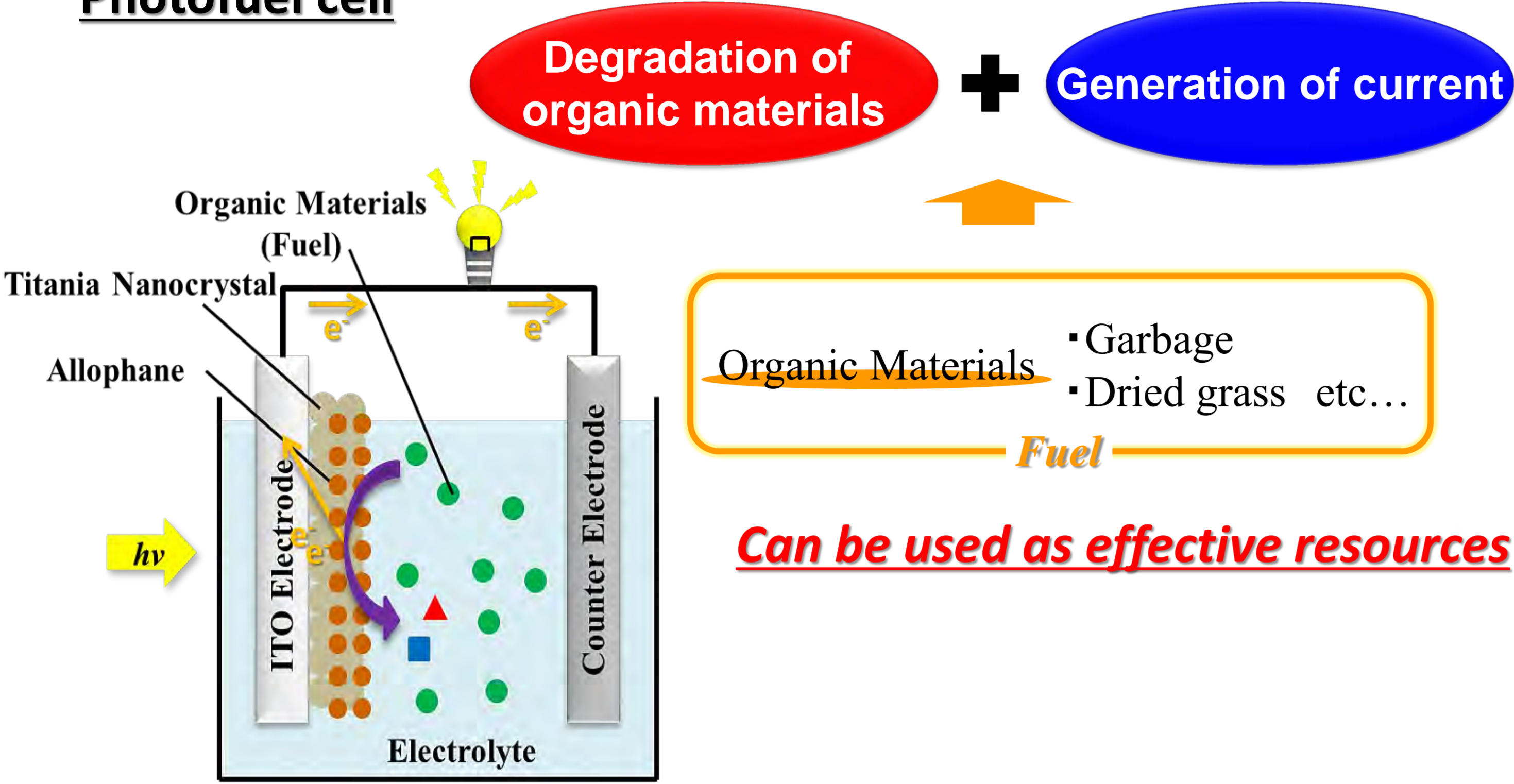
Reaction Rate in Photofuel Cells Using Allophane-Titania Composite Electrodes

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Introduction

Photofuel cell



Purpose of this study

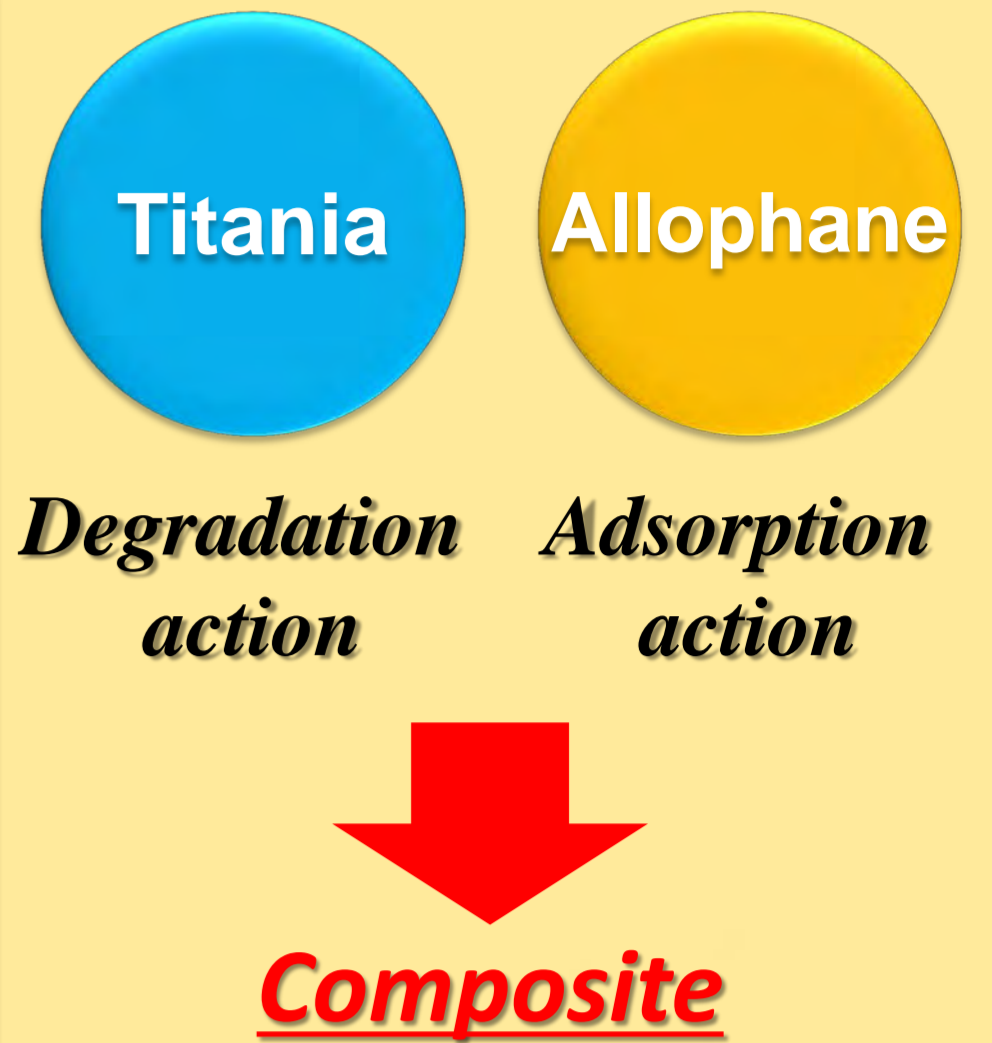
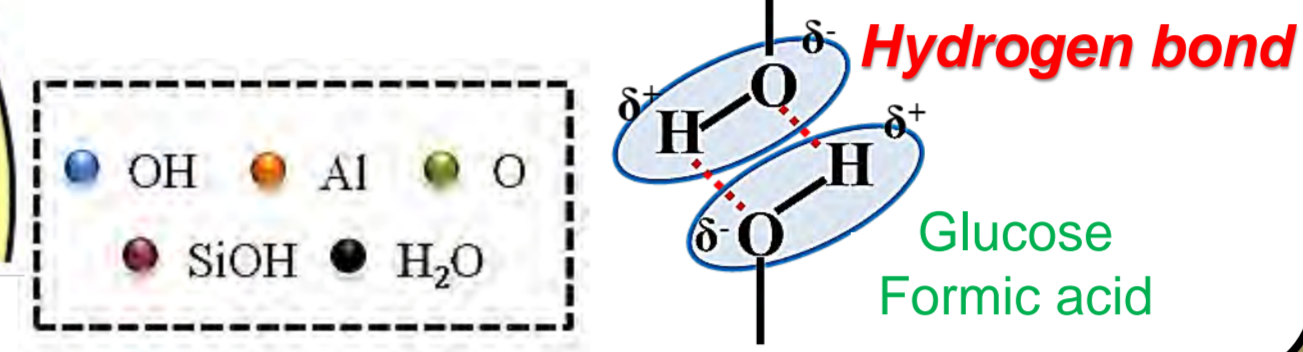
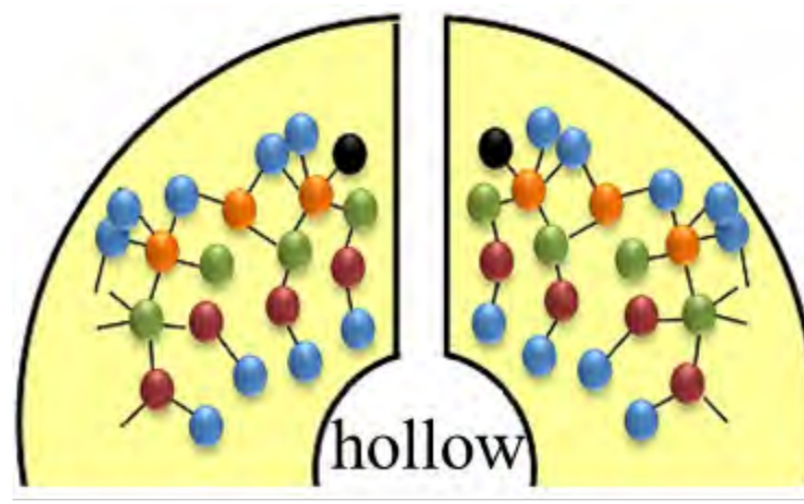
It is important that the reaction efficiency on the working electrode surface is improved

Allophane ($1.6\text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \cdot 5\sim 6\text{H}_2\text{O}$)

The smallest unit structure in the natural clay mineral



- ✓ small unit structure ⇒ **Easy dispersion into titania**
- ✓ high-specific surface area ⇒ **High adsorption capacity**

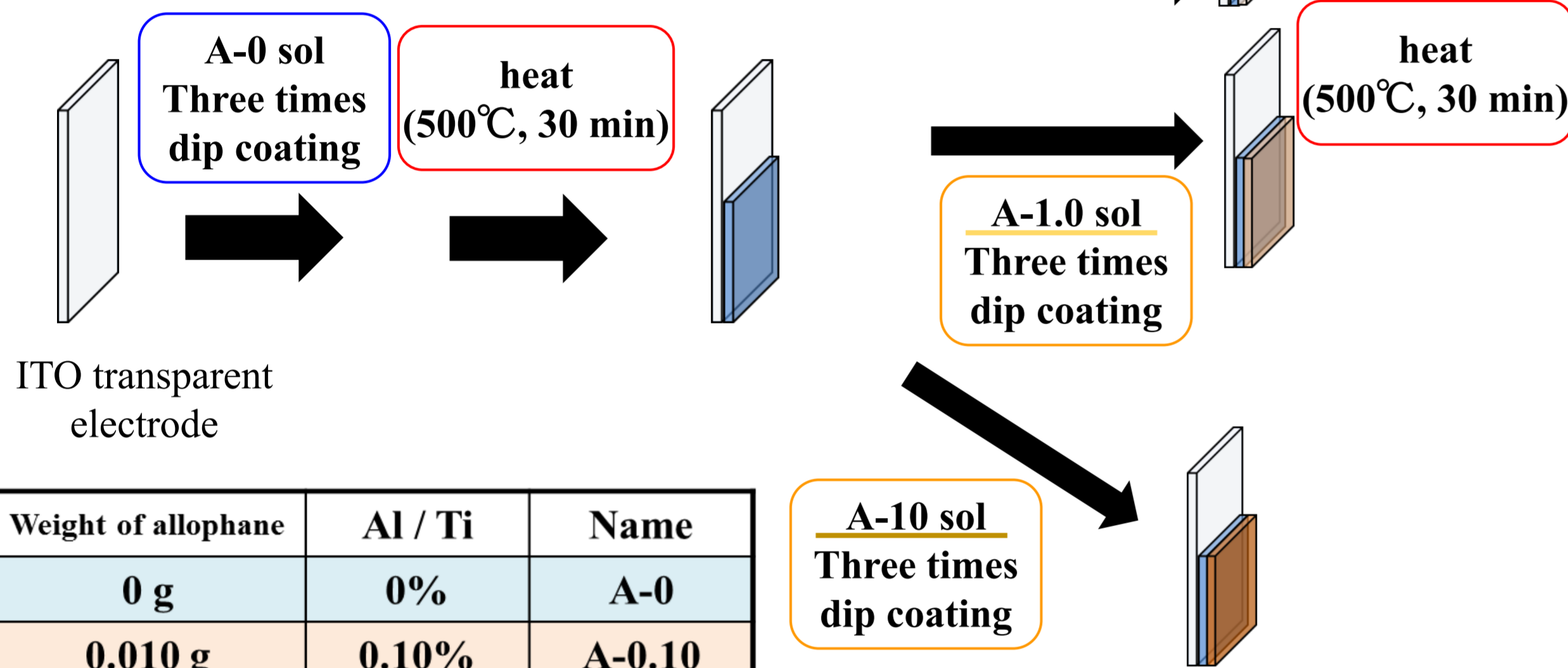


Experimental

Titania-sol (A-0 sol)

Ethanol	25 mL
TTIP*	5.0 mL
HNO ₃	0.21 mL
H ₂ O	0.21 mL

*TTIP: Titanium tetraisopropoxide



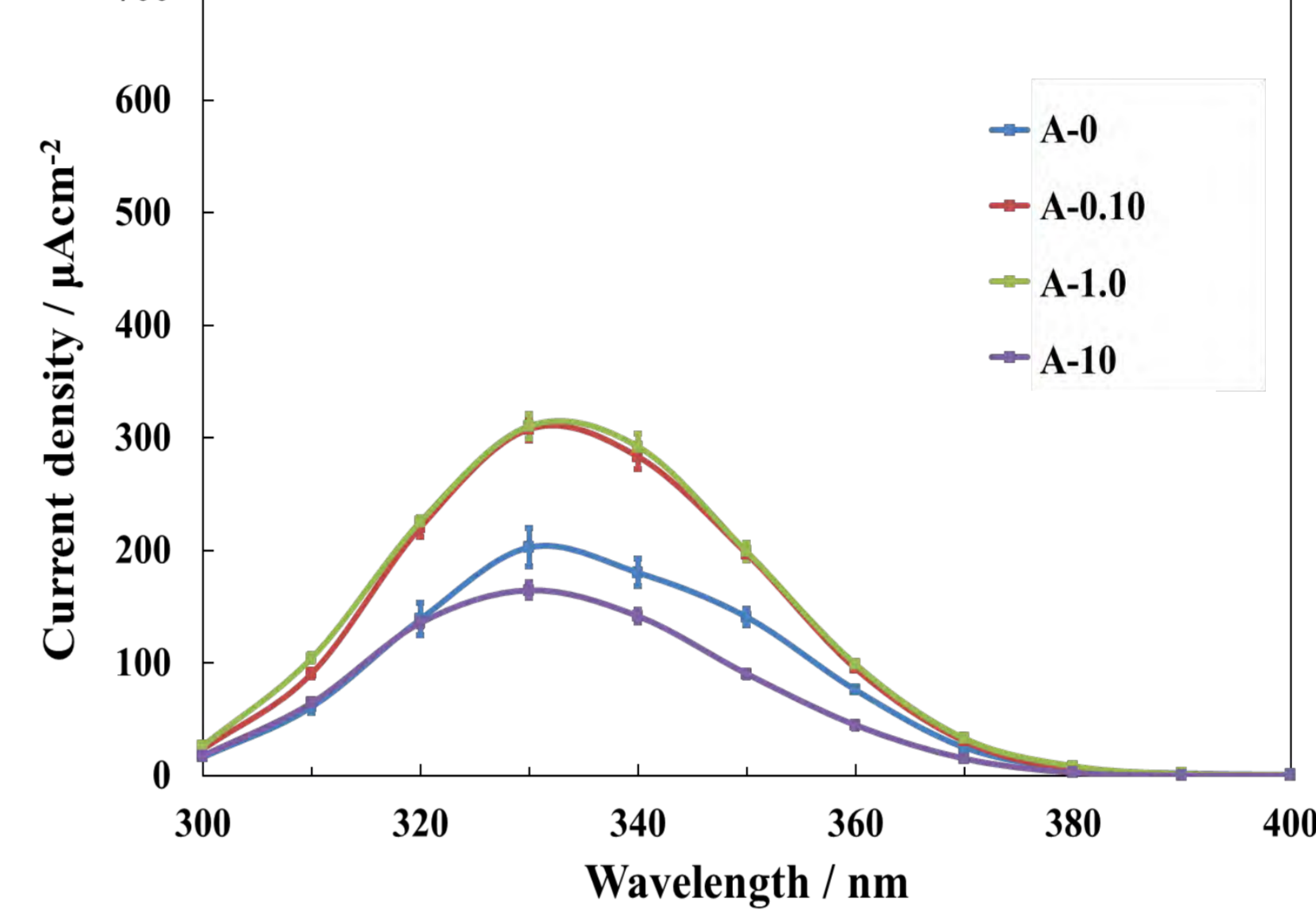
Weight of allophane	Al / Ti	Name
0 g	0%	A-0
0.010 g	0.10%	A-0.10
0.10 g	1.0%	A-1.0
1.0 g	10%	A-10

Results & Discussion

Cell performance

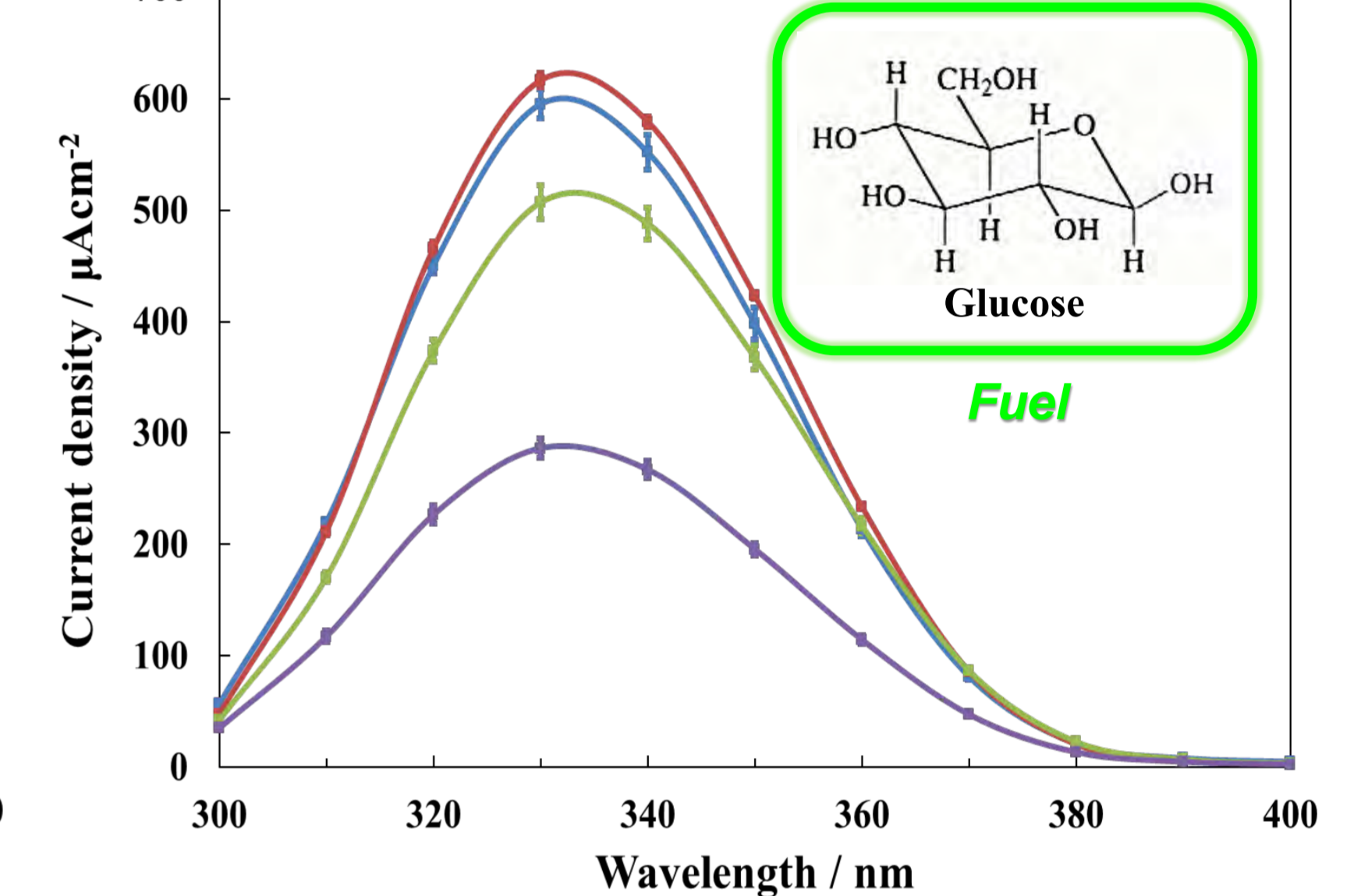
Photocurrent spectra

Electrolyte solutions without glucose (Irradiation intensity 13 mW)



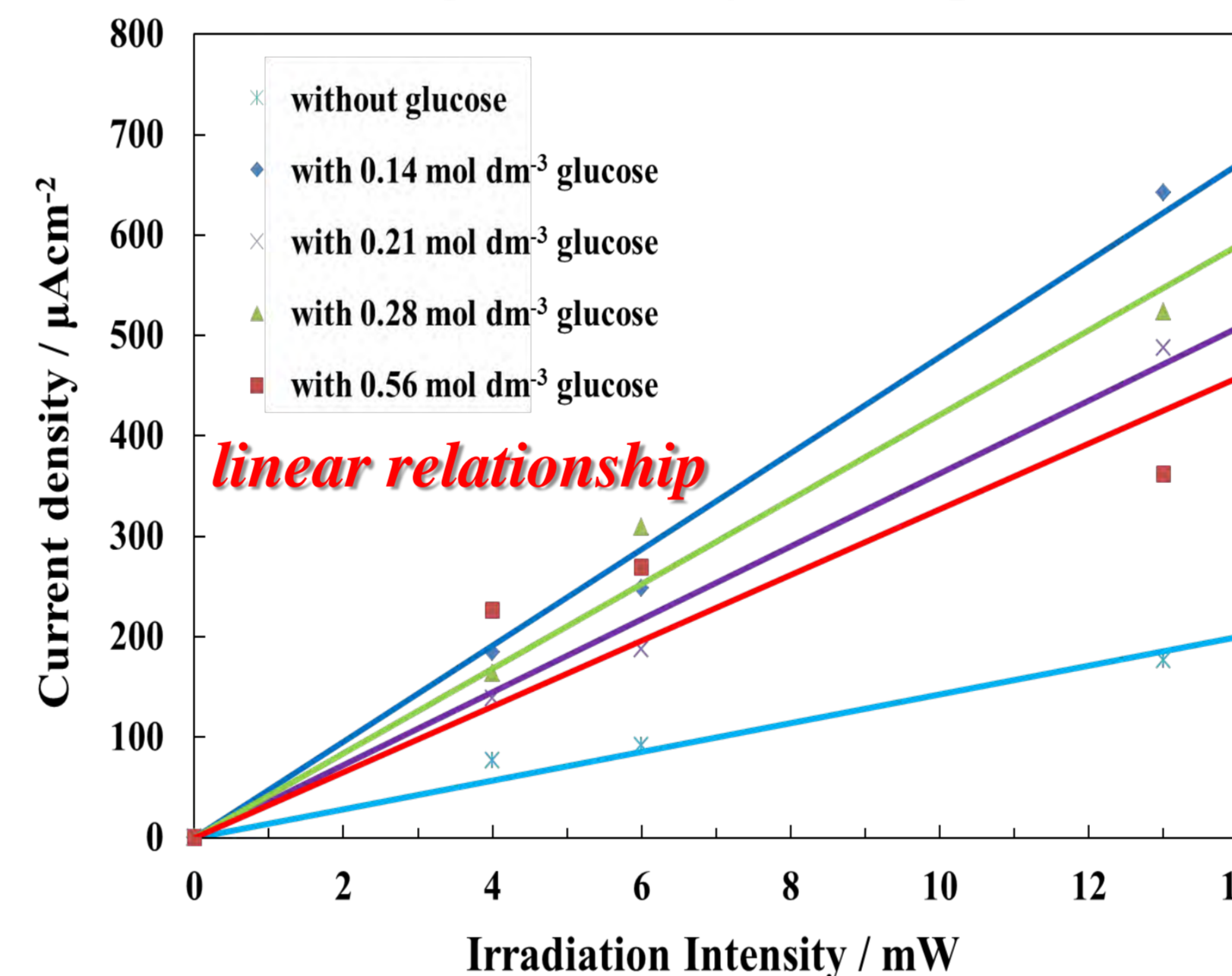
✓ Degradation of glucose contributed to the photocurrent generation

Electrolyte solutions with 0.28 mol dm⁻³ glucose (Irradiation intensity 13 mW)



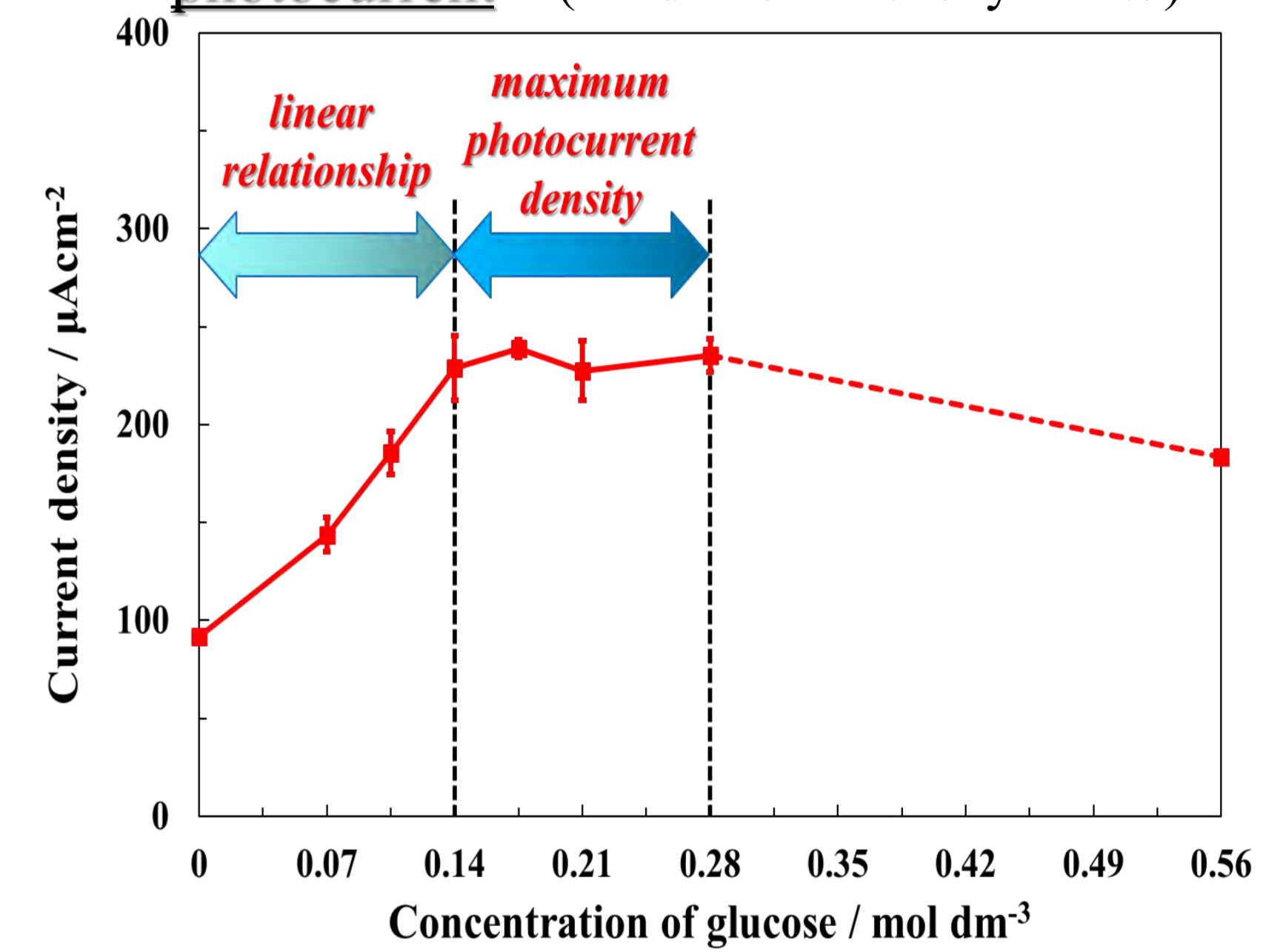
The addition of a small amount of allophane → enhancement of the adsorption and degradation efficiencies of glucose

Effect of the light intensity on the photocurrent



Linear relationship → Degradation is no diffusion-limited reaction in the electrolyte solution phase

Effect of the glucose concentration on the photocurrent (Irradiation intensity 6 mW)

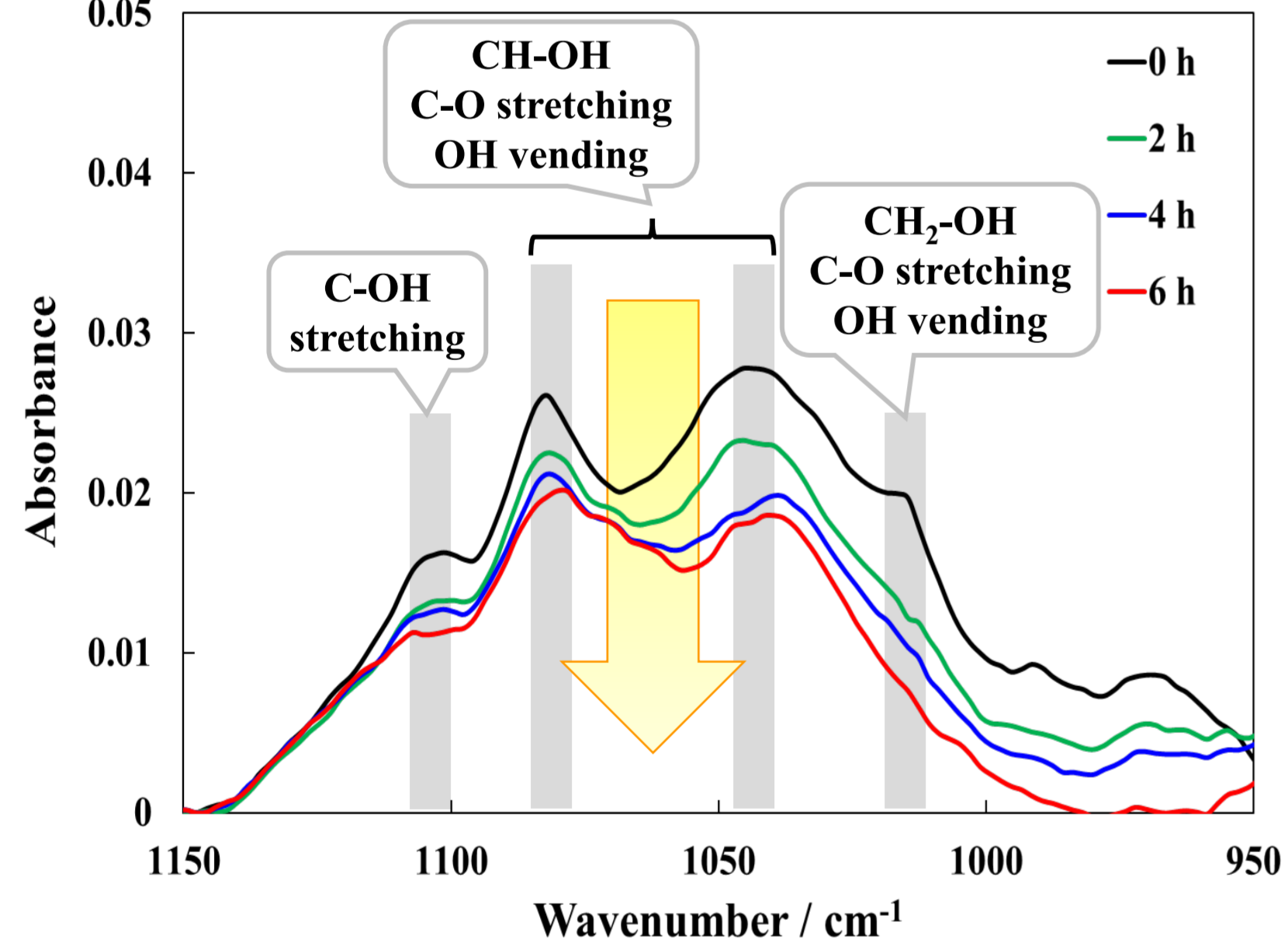


The adsorption saturation caused saturation of the surface diffusion rate

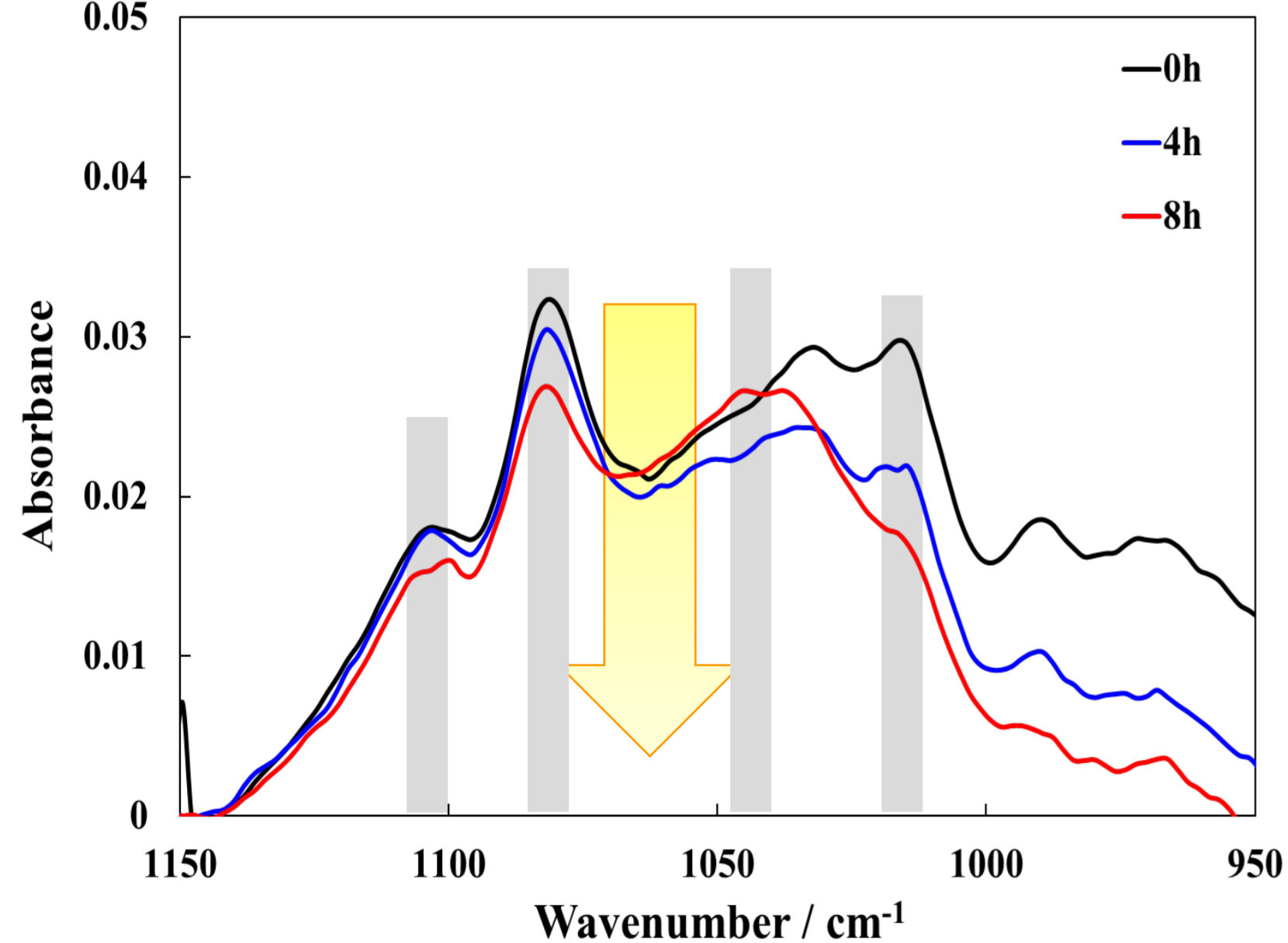
Degradation processes

FT-IR spectra

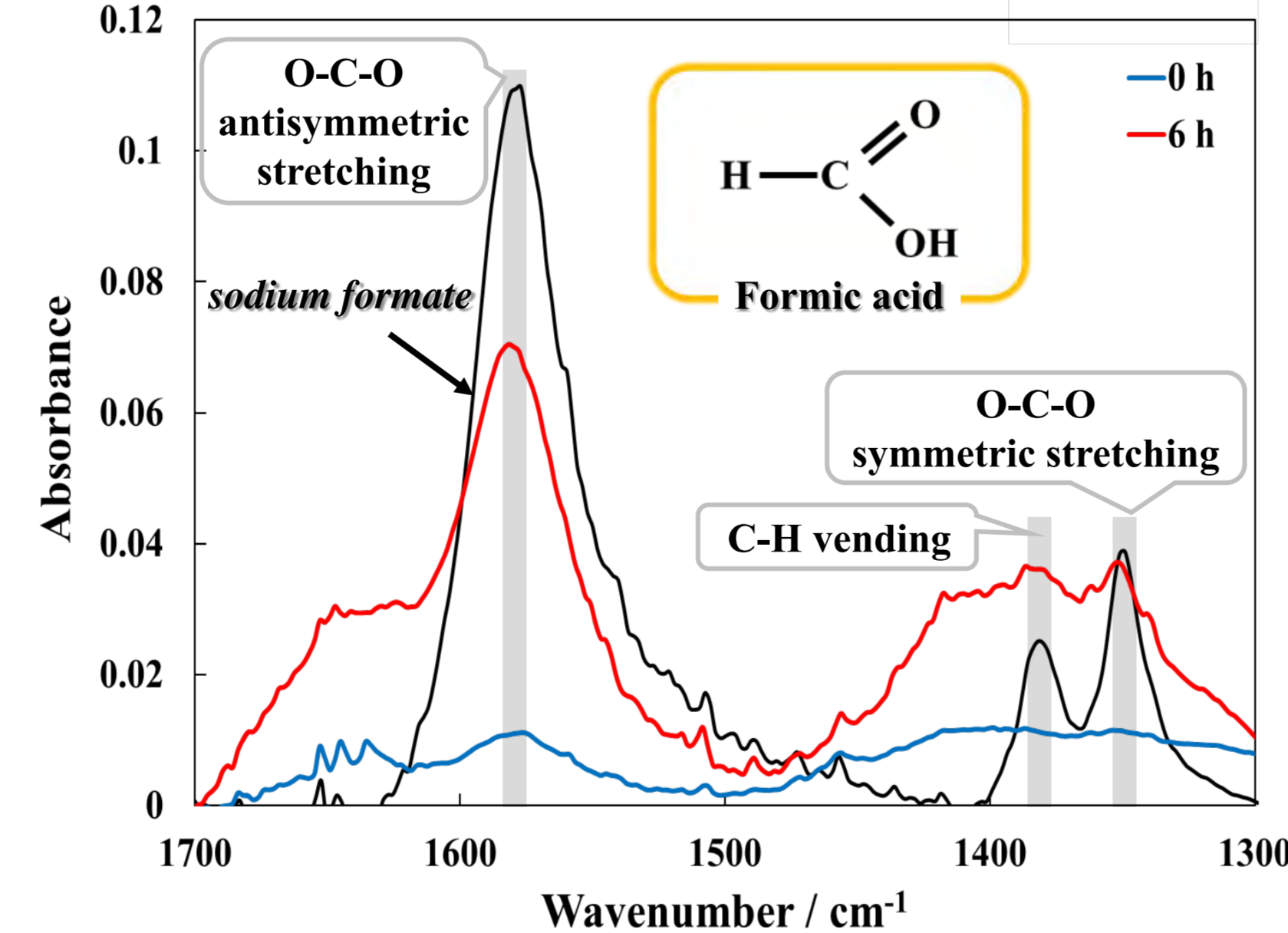
Powder (0.10% allophane-titania composite powders)



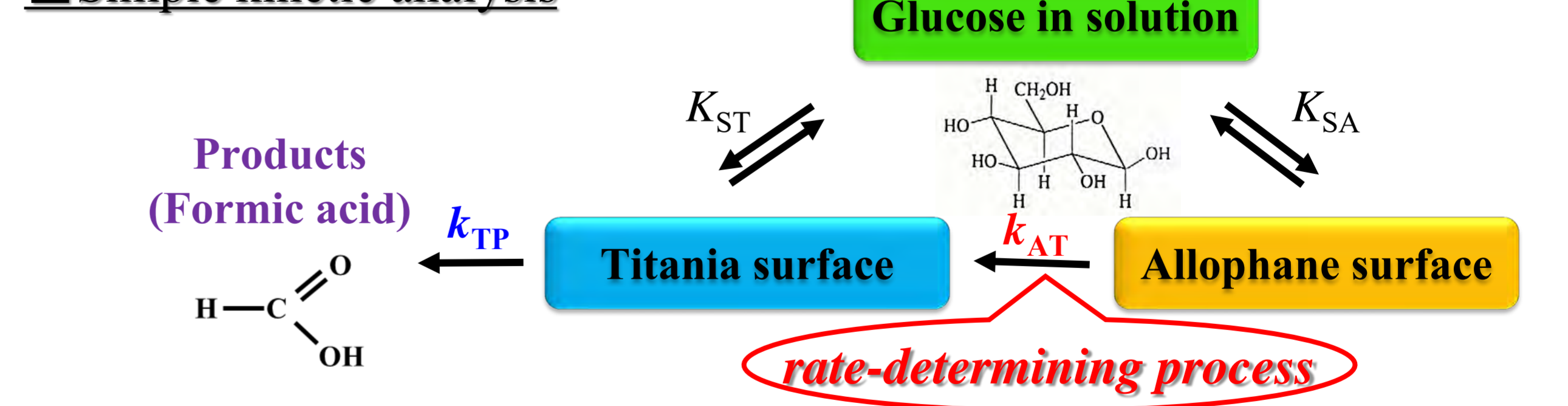
Thin film (0.10% allophane-titania composite powders)



Intermediate products



Simple kinetic analysis



Sample	K_{ST} / dm ³ mol ⁻¹	K_{SA} / dm ³ mol ⁻¹	k_{AT} / h ⁻¹	k_{TP} / h ⁻¹
A-0 (Titania)	0.13	-	-	0.27
A-0.10	0.13	0.0018	0.0037	0.36
A-1.0	0.13	0.0018	0.0014	0.25
A-10	0.13	0.0018	0.00046	0.45

Conclusions

- ▼ The allophane-titania composites enhanced the adsorption and degradation efficiencies of glucose on the working electrode surface
- ▼ The cell performance and photocatalytic activity was enhanced by adding a small amount of allophane
- ▼ It is suggested that the mass transfer from the allophane surface to the titania surface is the rate-determining process based on the simple kinetic analysis