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Controlled Design of M@SCs Nano-Heterodimers by Laser Photodeposition: Growth Mechanism and Modeling (M= Metal Oxide and SC= Semiconductor)

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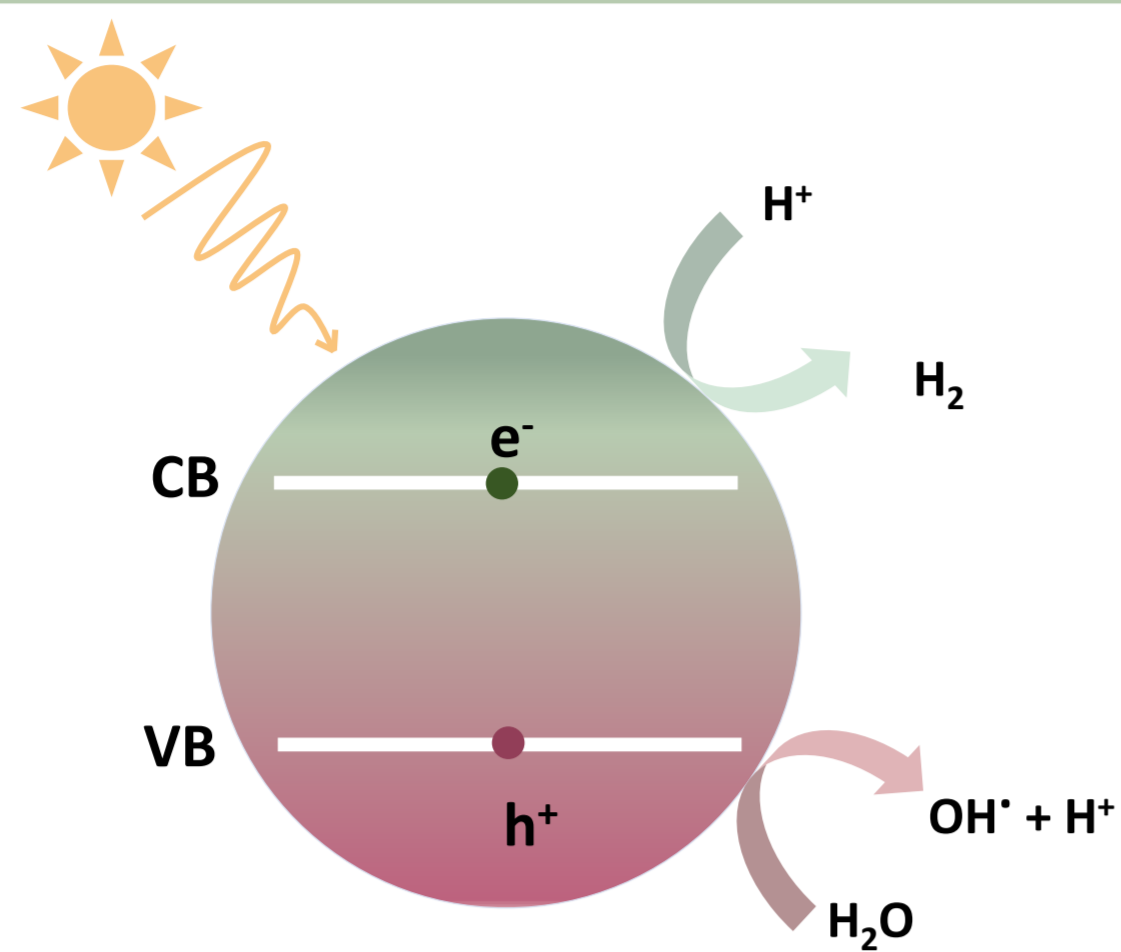
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INTRODUCTION

Objectives

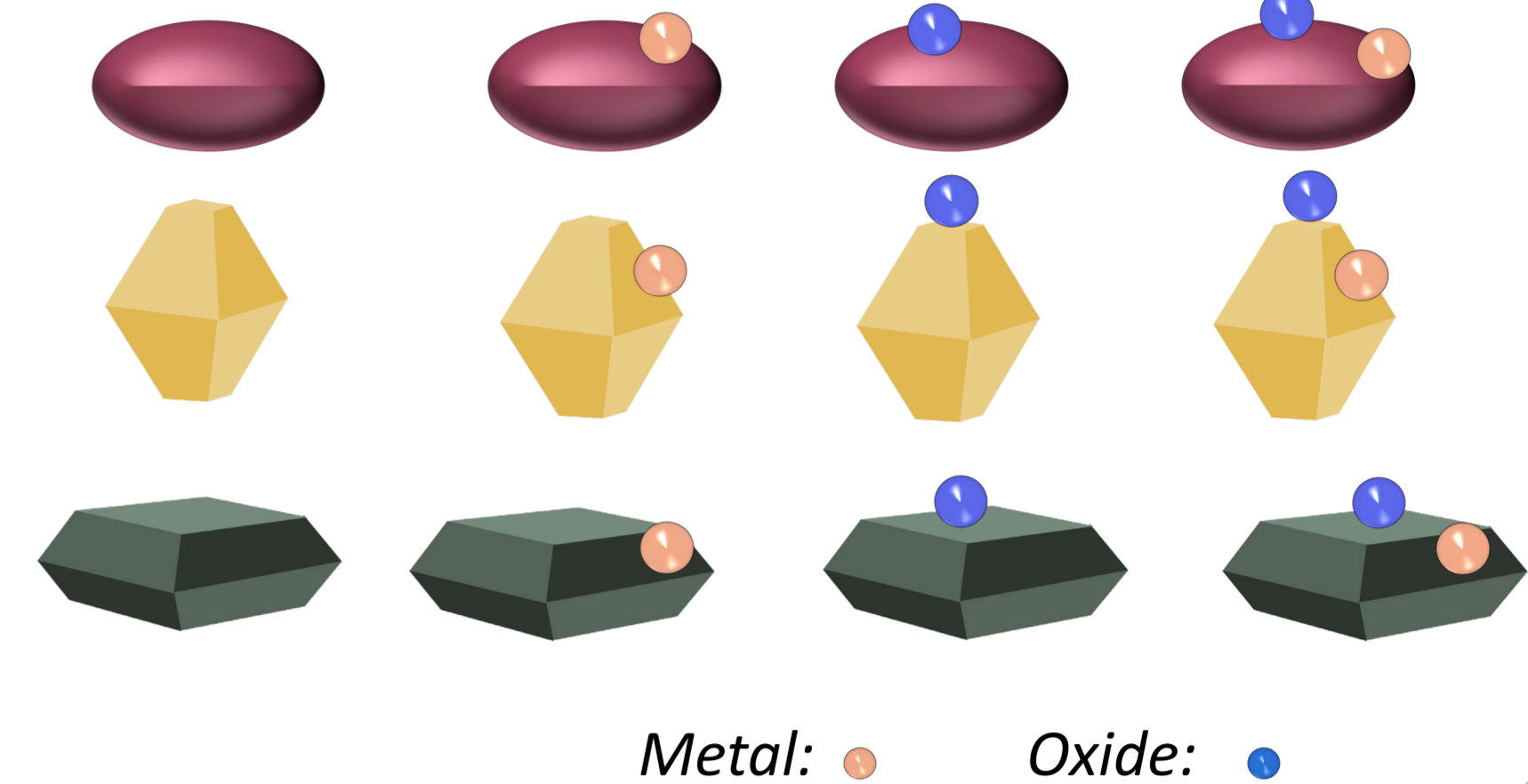
Develop a clean and renewable energy using **photocatalysis** based on solar energy



Strategy

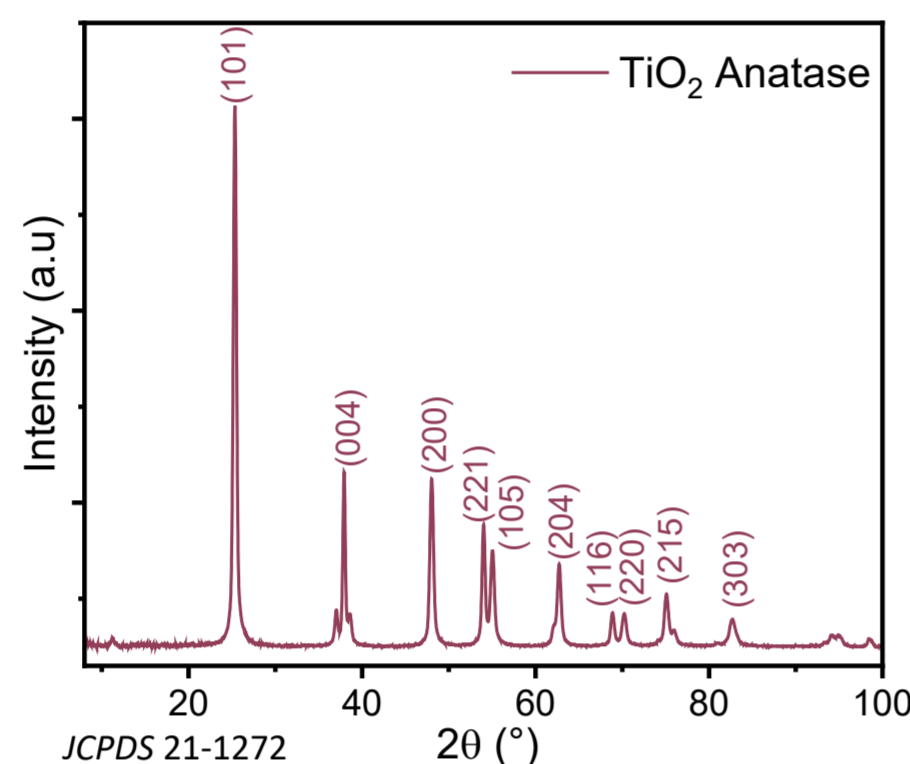
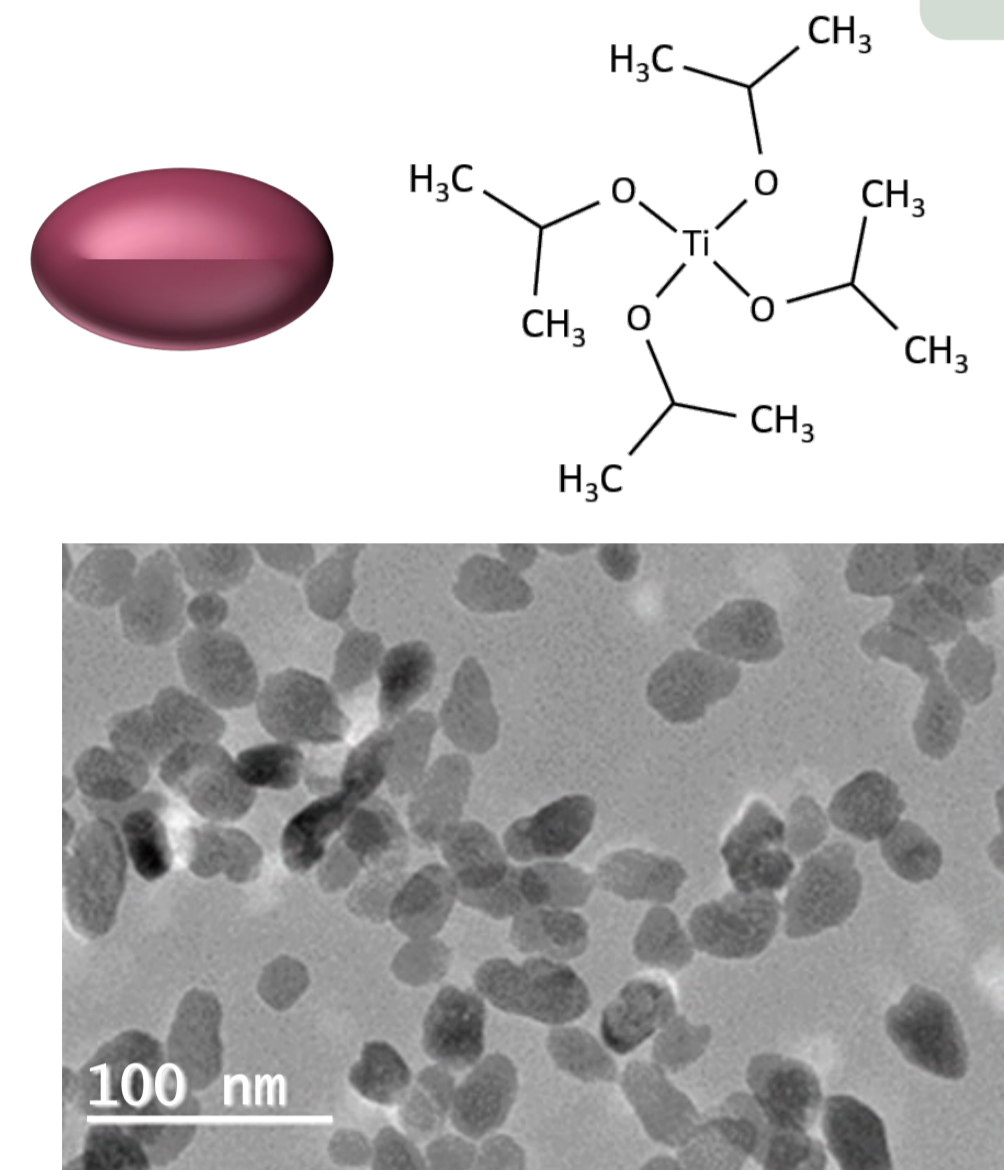
Coupling a co-catalyst to metal oxide semiconductor using **laser photodeposition**
↓
Nano-heterodimers (NHD)

Variety of semiconductor shapes to control the deposition of metals and/or oxides on specific facets ¹



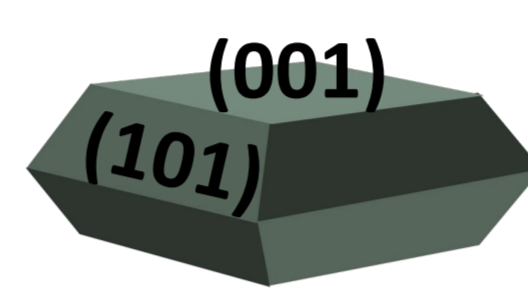
Metal: ● Oxide: ●

TiO₂ NPs SYNTHESIS



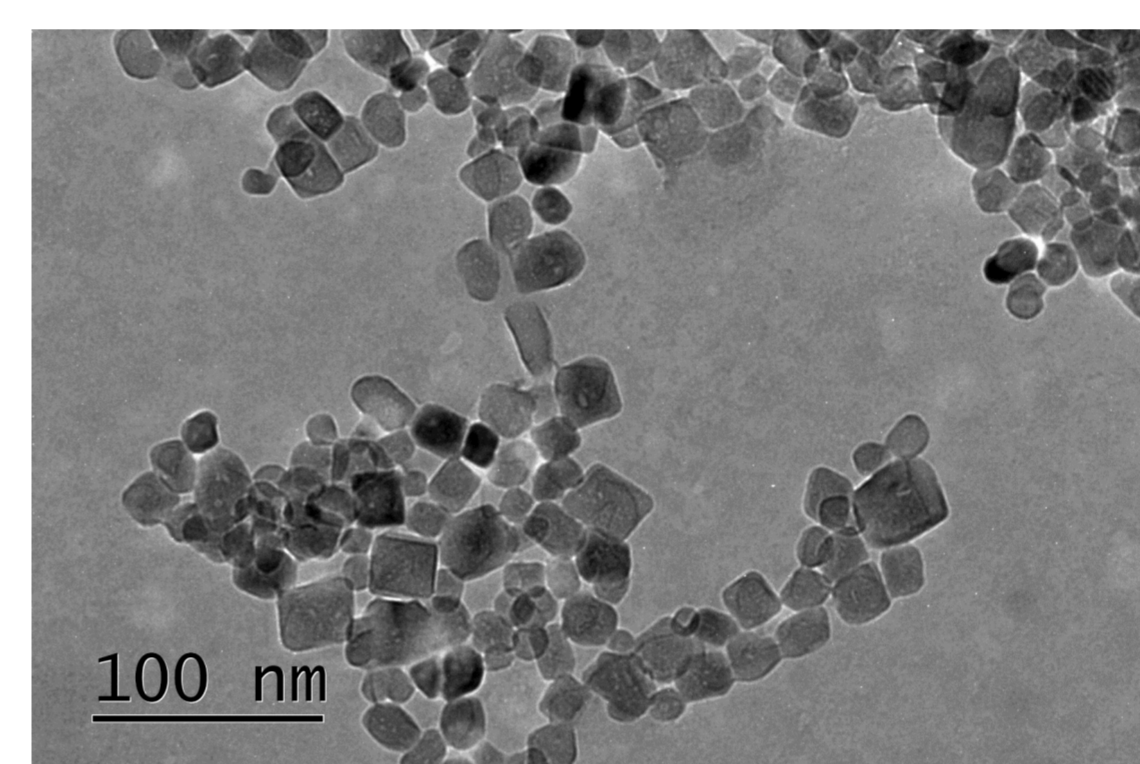
- Two-step hydrothermal synthesis ²
- Low temperature requirement
- Cheap and easily up-scalable

SHAPE CONTROL

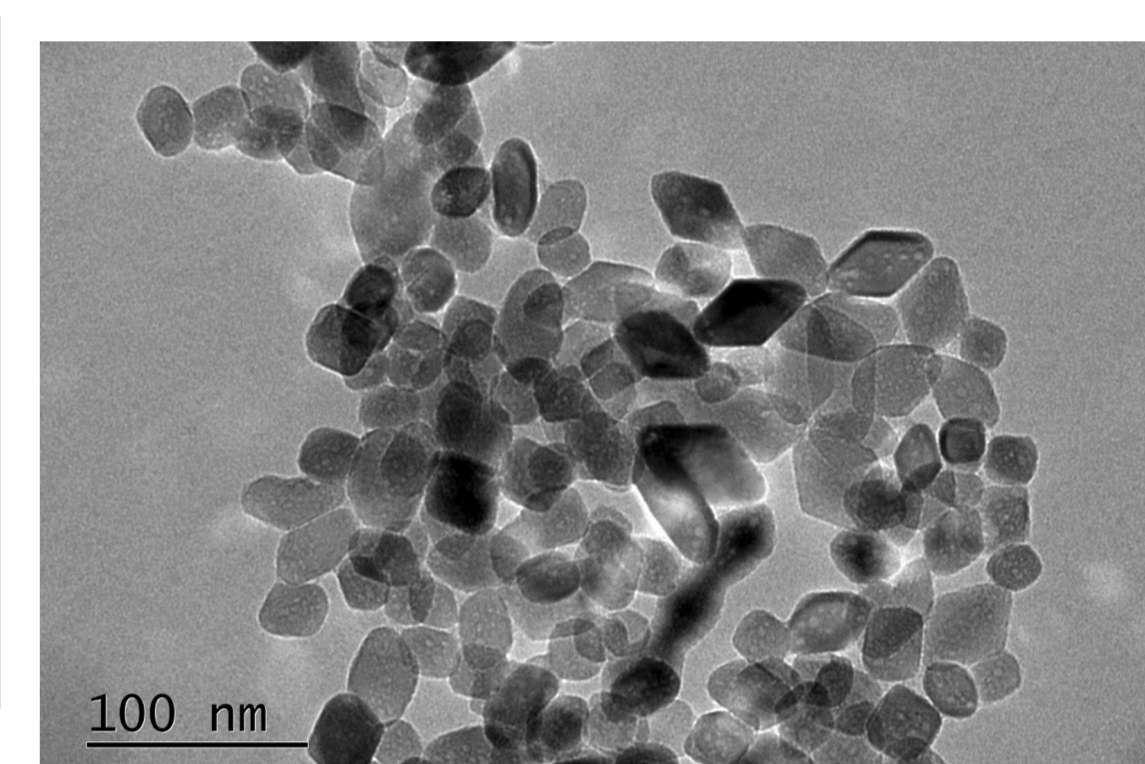


Addition of oleic acid as a capping agent ³

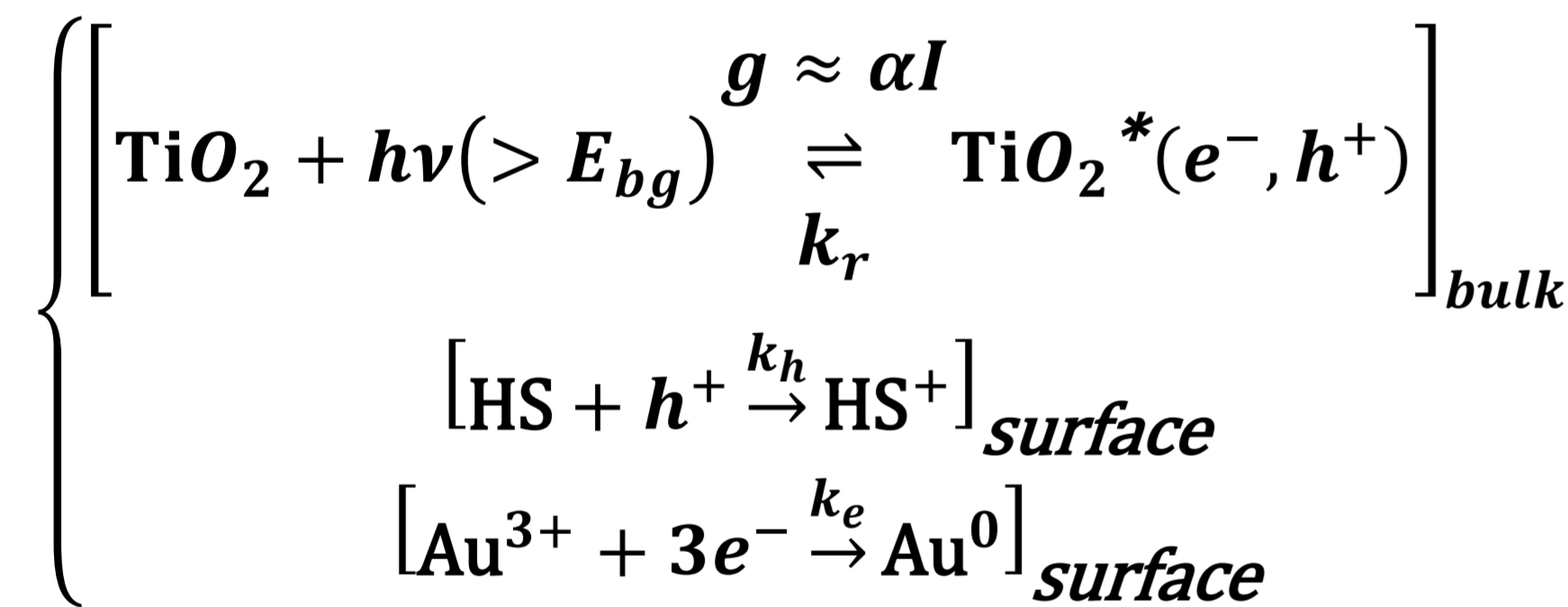
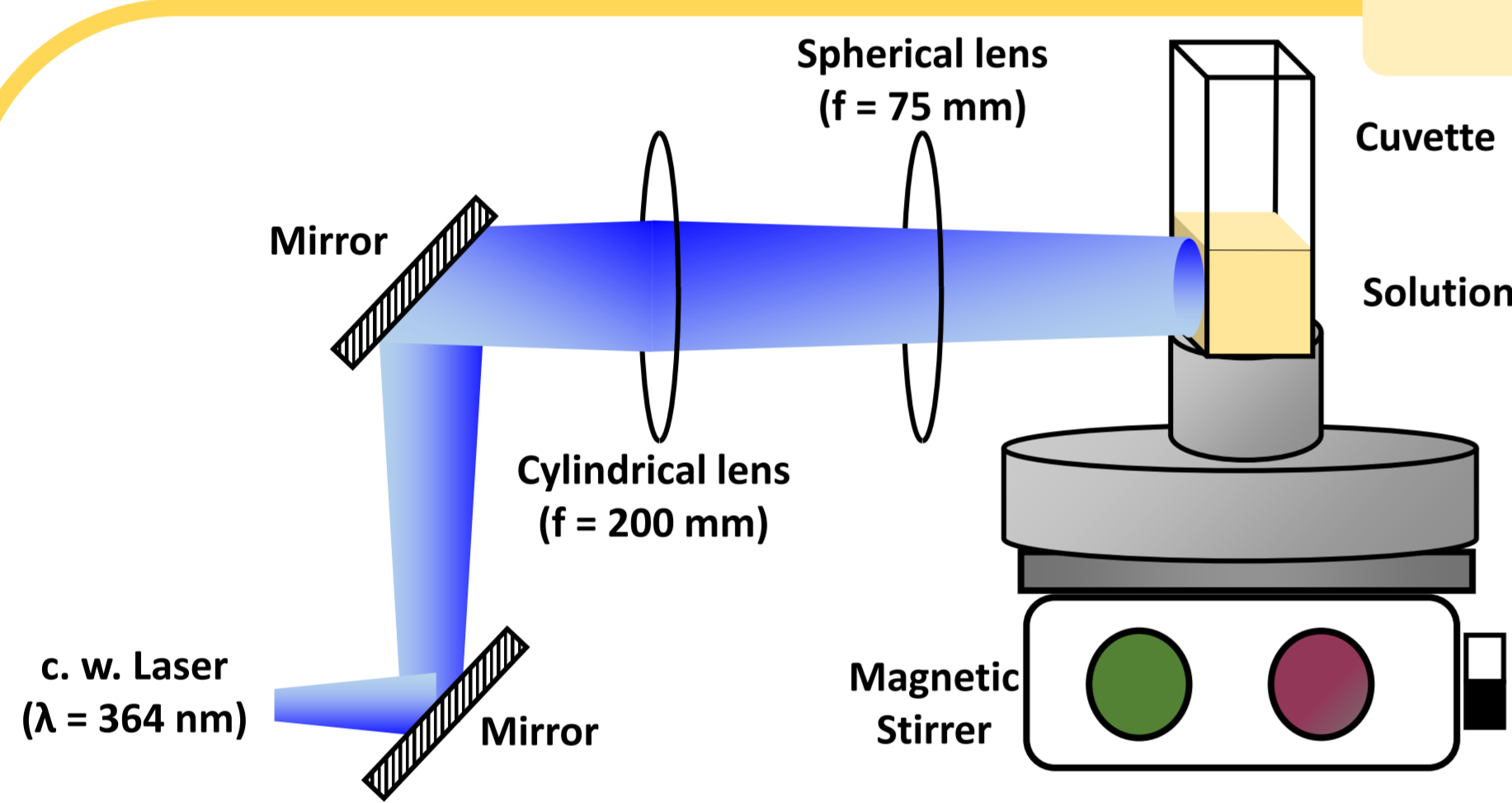
One-step hydrothermal reaction with reduced precursor concentration ⁴



Facets {001} and {101} present in different proportions

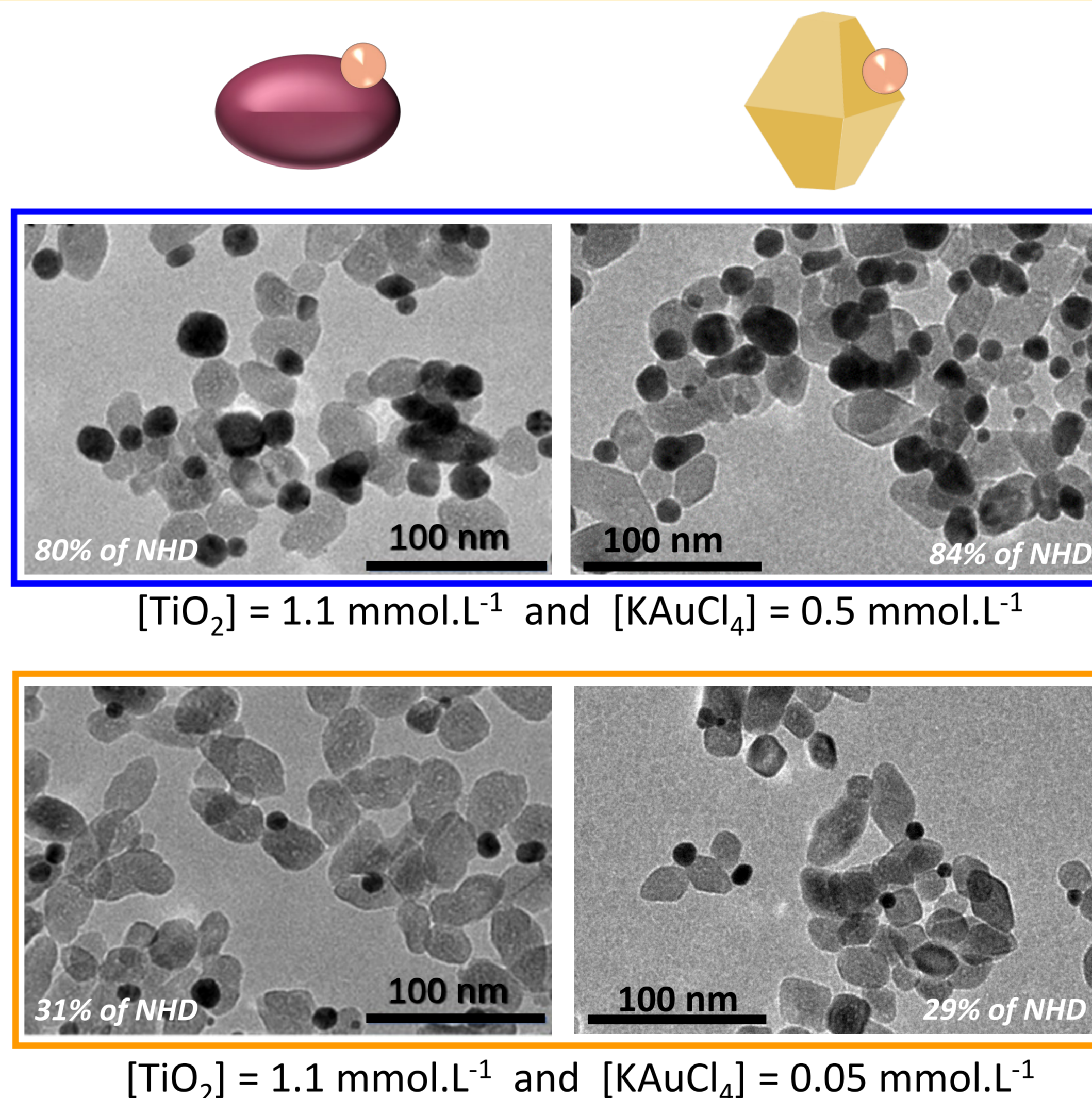


LASER PHOTODEPOSITION AND GROWTH MODEL

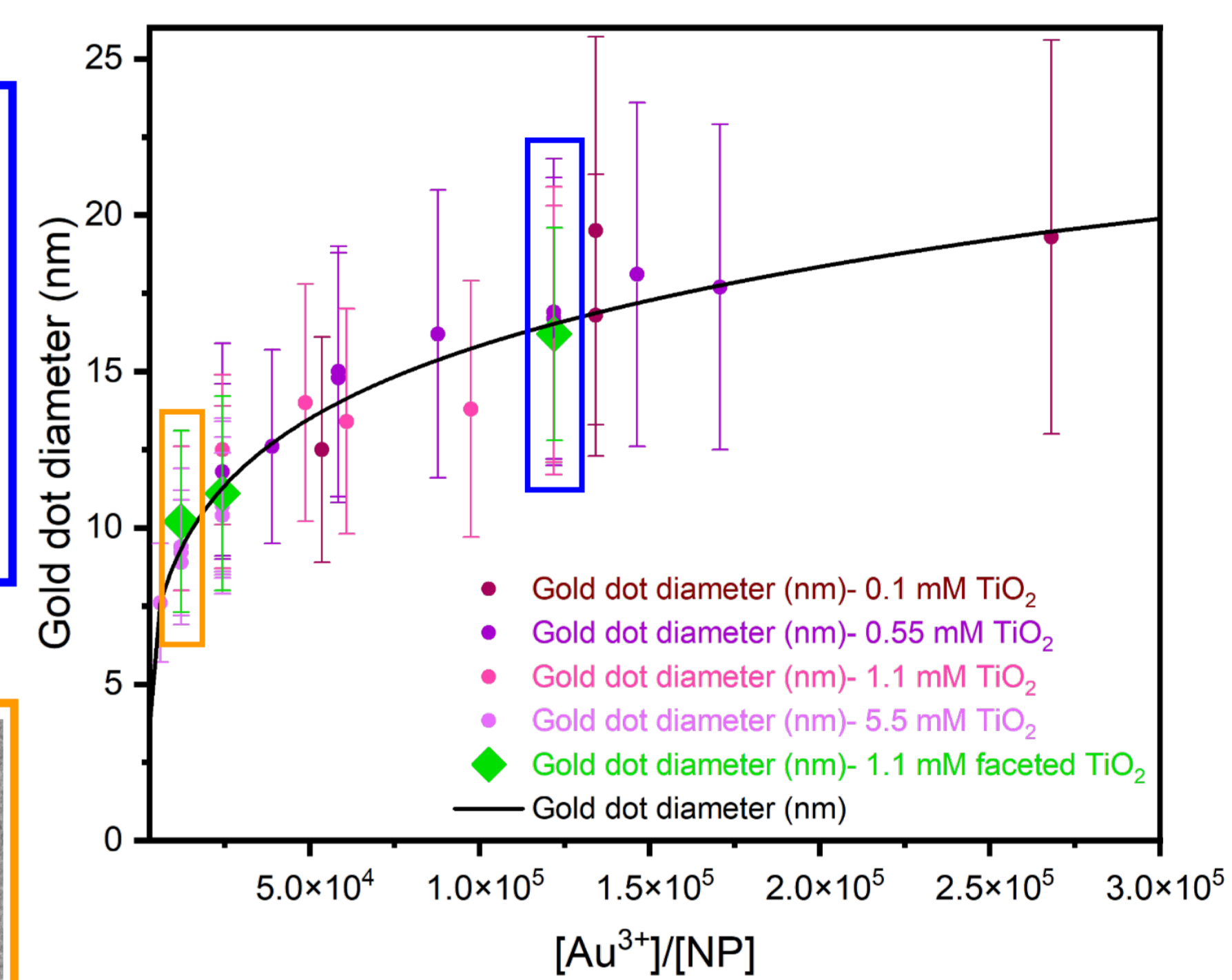


Fixed parameters ⁵

- Reaction under **Argon**
- Methanol (50%v) as a hole scavenger
- Power of the laser in the cuvette: **56 mW**
- **pH = 3** controlled with HNO₃
- Exposure time: **8 min**

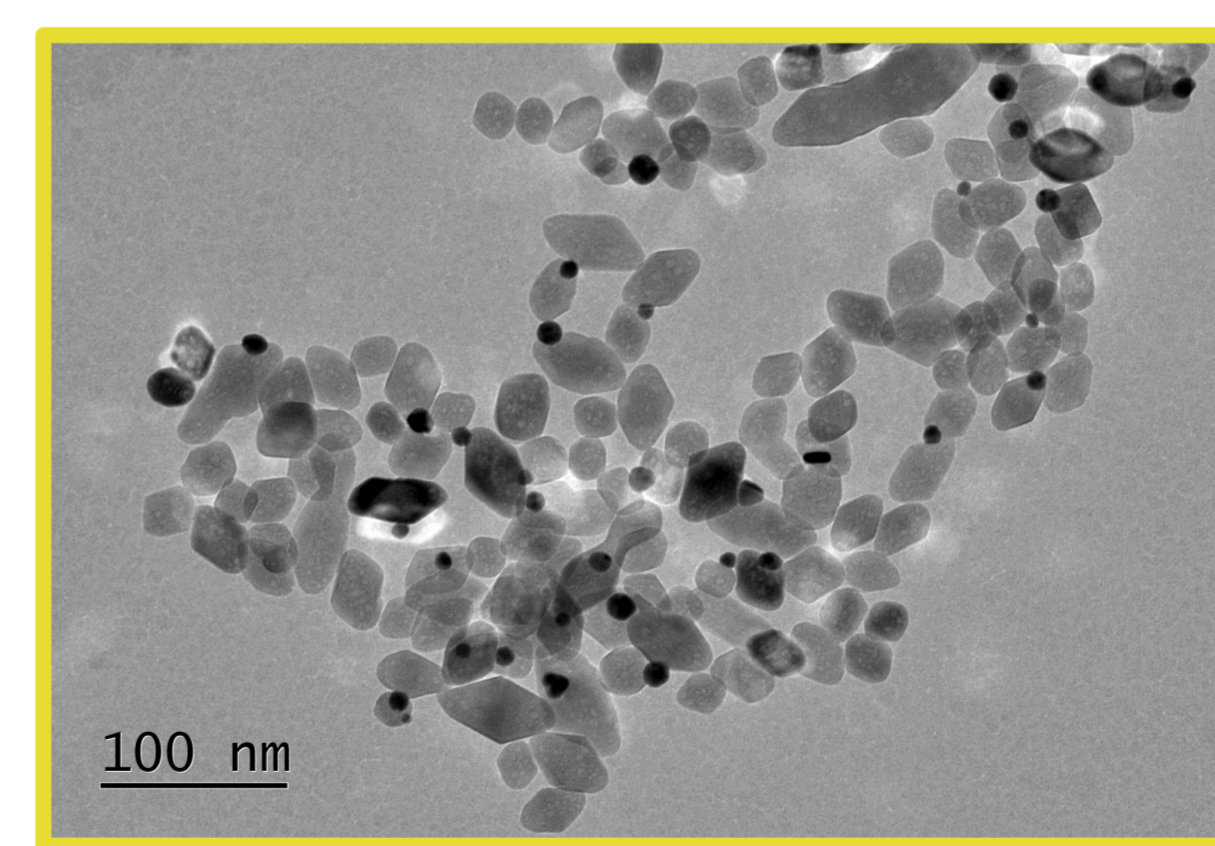
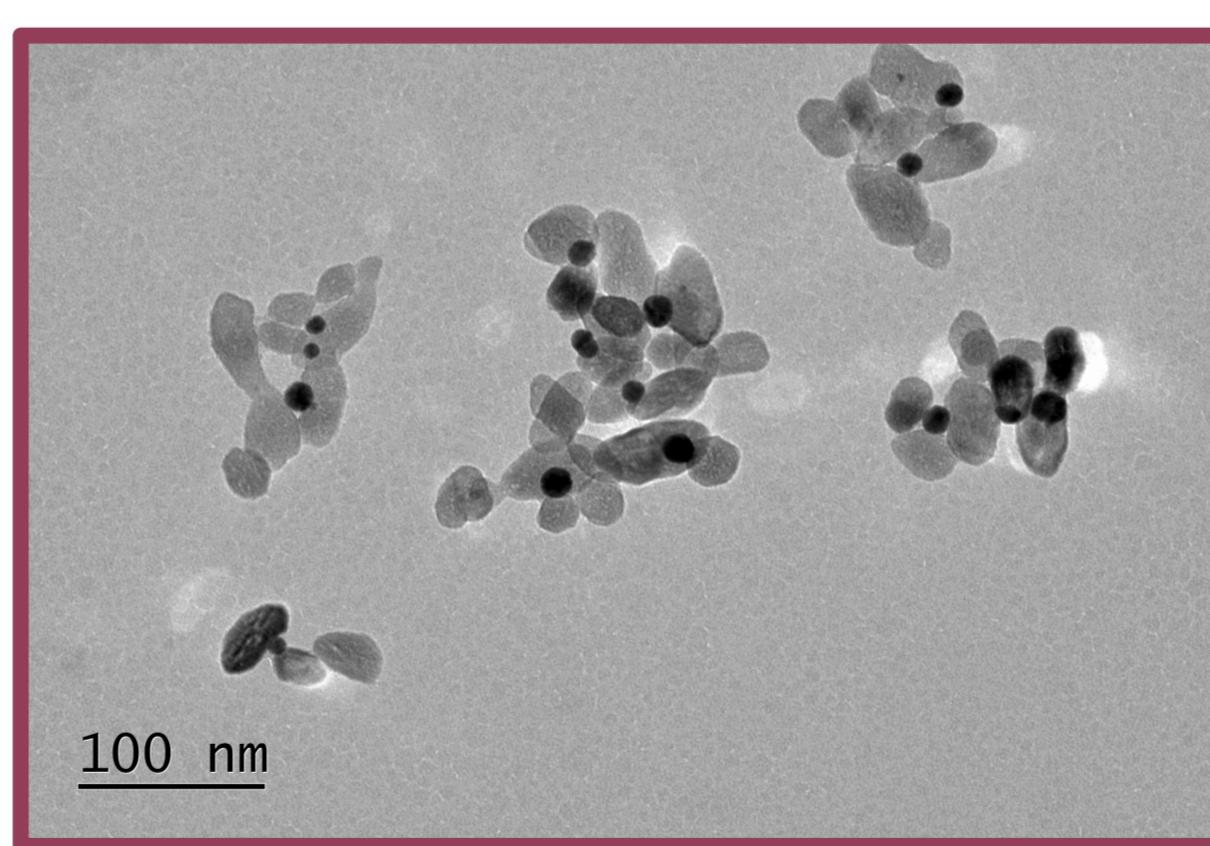
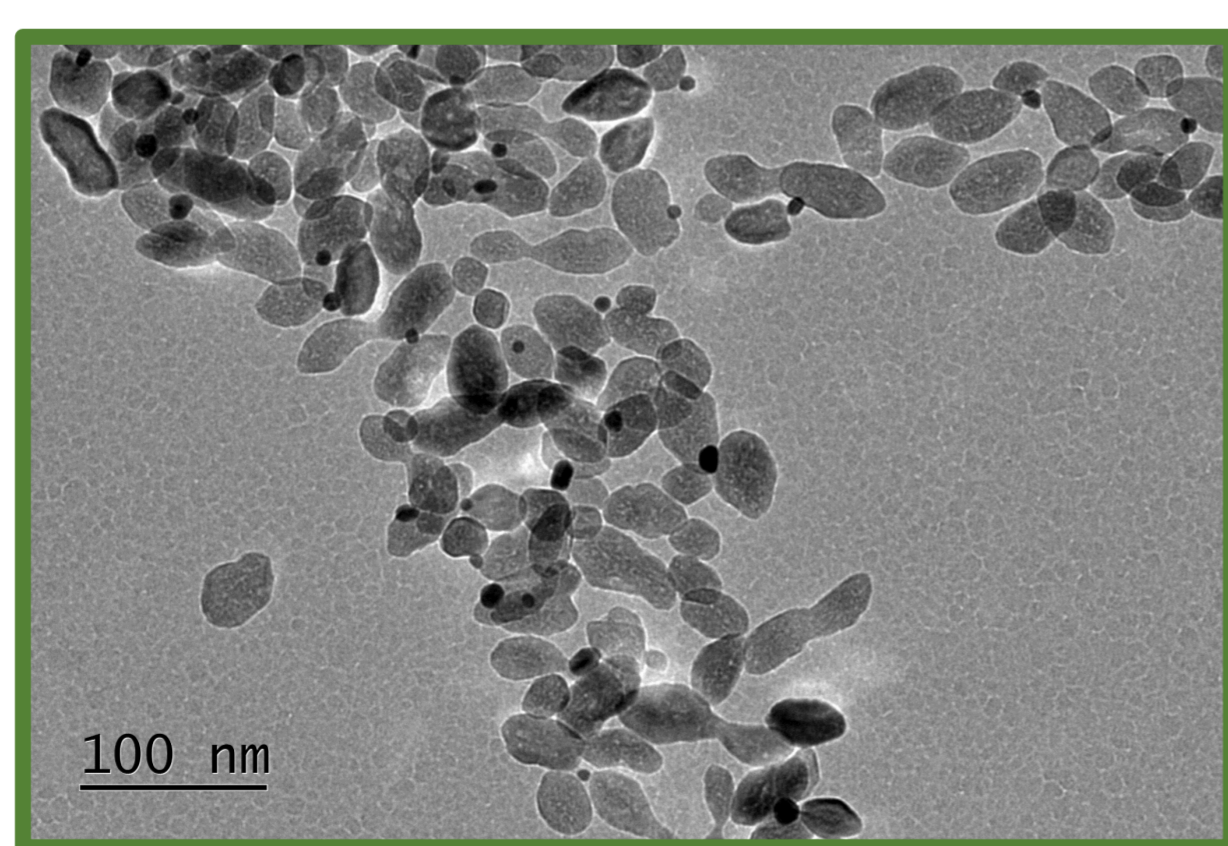
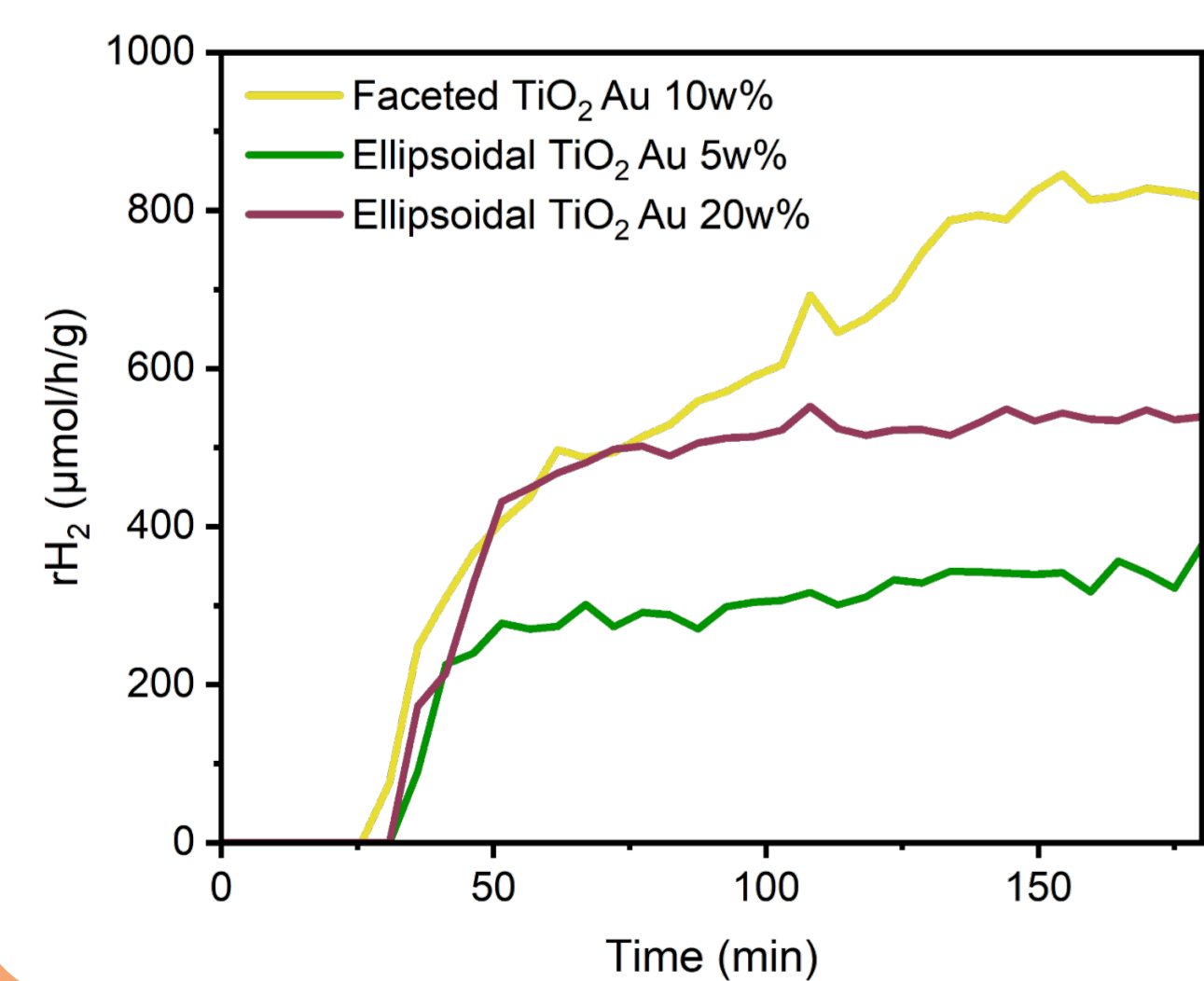


At completion:



$$D_{Au}^{t \rightarrow \infty} = \left(\frac{8}{\pi \kappa(\theta)} \frac{v_{Au}}{Y} \right)^{1/3} \cdot \left[\frac{[Au^{3+}]_0}{[NP]} \right]^{1/3} \quad 6$$

HYDROGEN PRODUCTION



Au deposition
↓
Hydrogen production
Next target: increase this production by synthesis modulations

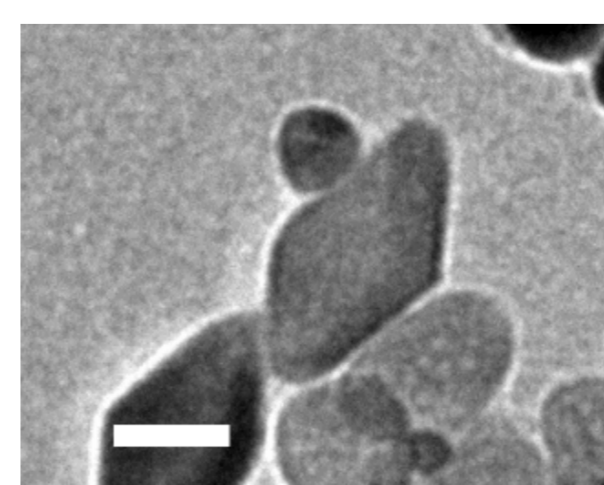
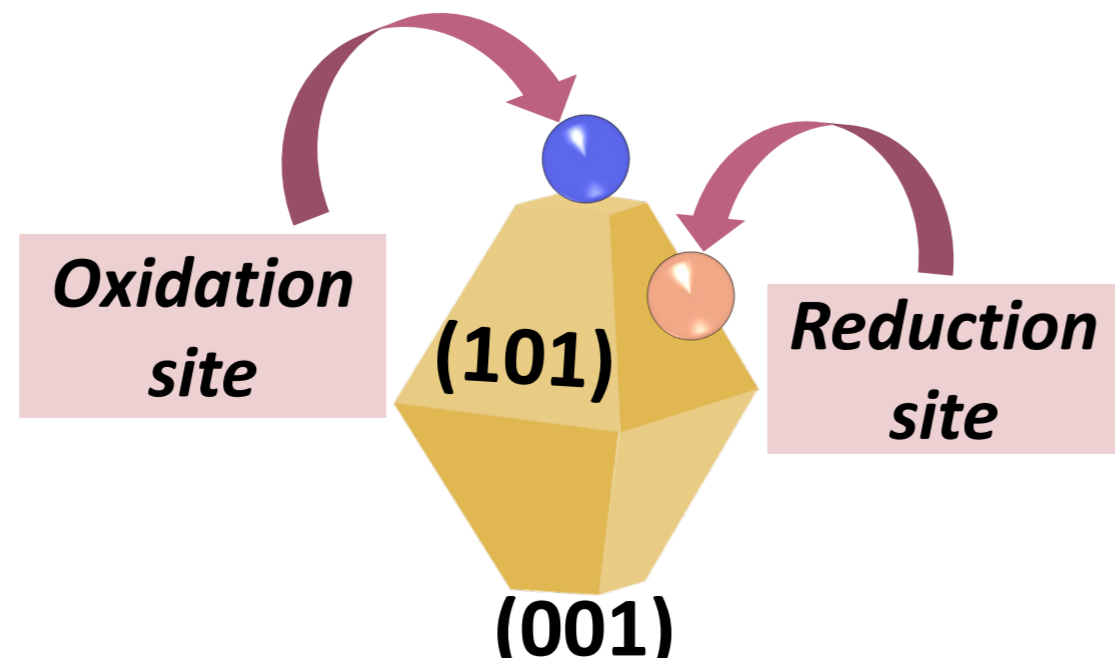
Collaboration: T. Cottineau University of Strasbourg/ ICEEPS

CONCLUSIONS

- Synthesis of the semiconductor ✓
- Shape control of TiO₂ ✓
- Laser photodeposition ✓
- Photoreduction reactions ✓

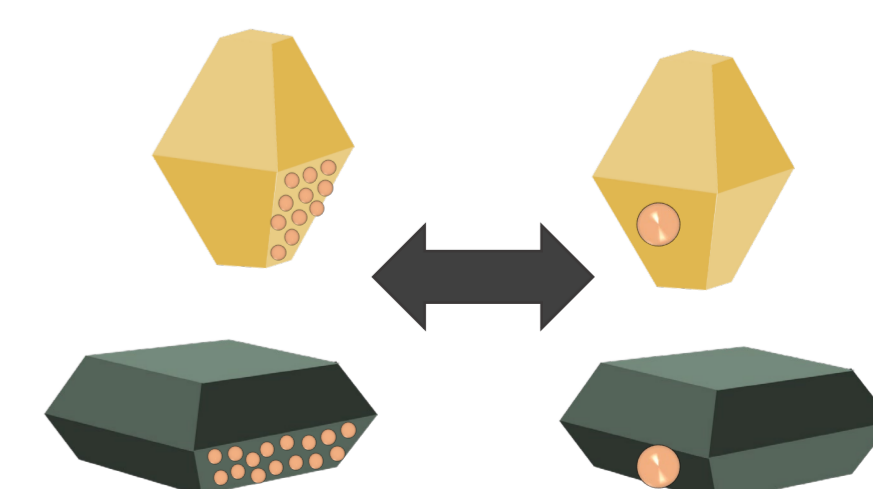
PERSPECTIVES

- Photooxidation reactions and **co-deposition**



Scale bar: 20 nm

- Transition from a **single dot** to **multidots**
- Improve the ratio of **hydrogen production**
- Extension to **other metals and metal oxides**



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