

Photocatalytic Performance of PLAL-Synthesized Chromium Nanoparticles Toward Methylene Blue Degradation

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INTRODUCTION

Problem:

- Methylene blue (MB) is a toxic and poorly biodegradable pollutant.
- Cause serious environmental and human health.

Solution:

- **Photocatalysis is a sustainable treatment approach:**

- Light-driven process
- Generates reactive oxygen species (ROS).
- Degrades pollutants into CO₂ and H₂O.

- **Chromium(III) oxide nanoparticles (Cr₂O₃ NPs)** are promising photocatalysts due to their visible-light activity.

Research Gap:

- Conventional synthesis often requires toxic chemicals.
- **Pulse laser ablation in liquid (PLAL) offers a green synthesis:**

- Surfactant-free and chemical-free
- High-purity NPs products
- Tunable properties

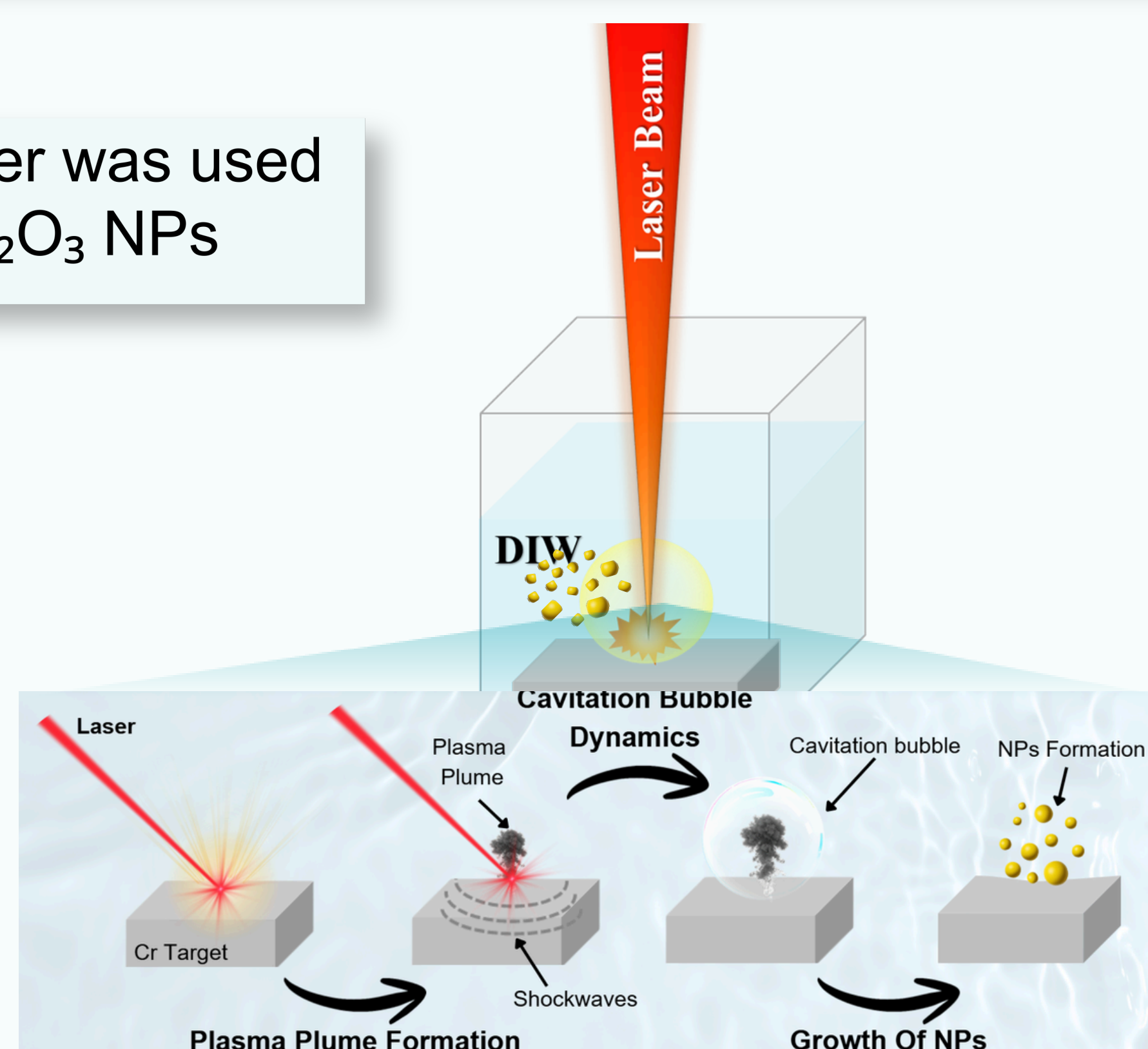
OBJECTIVES

- Synthesize Cr₂O₃ NPs via PLAL
- Characterize their optical & chemical properties.
- Evaluate MB degradation under blue-light irradiation.

EXPERIMENTAL WORKFLOW

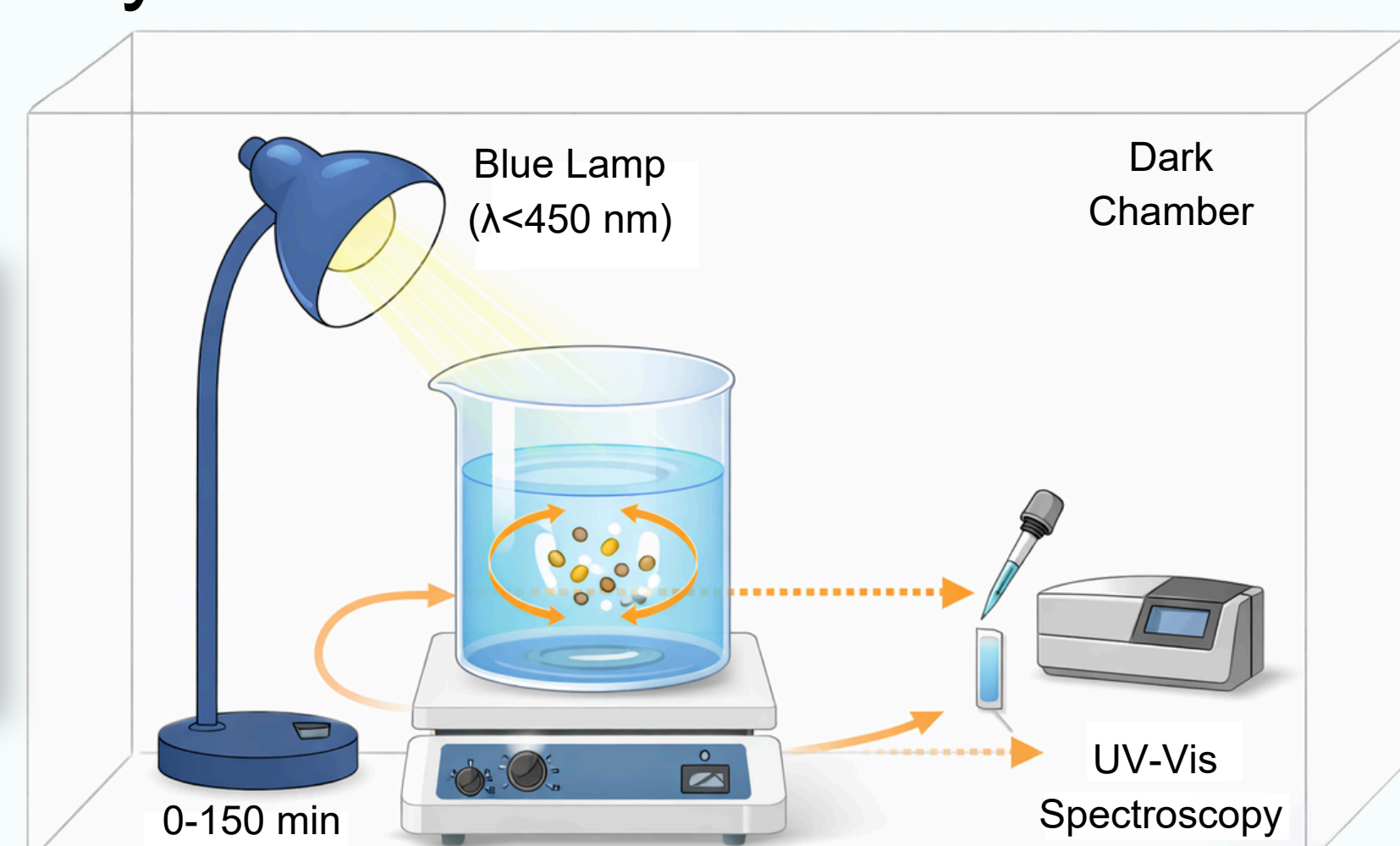
Synthesis:

A Q-switched laser was used to prepare Cr₂O₃ NPs



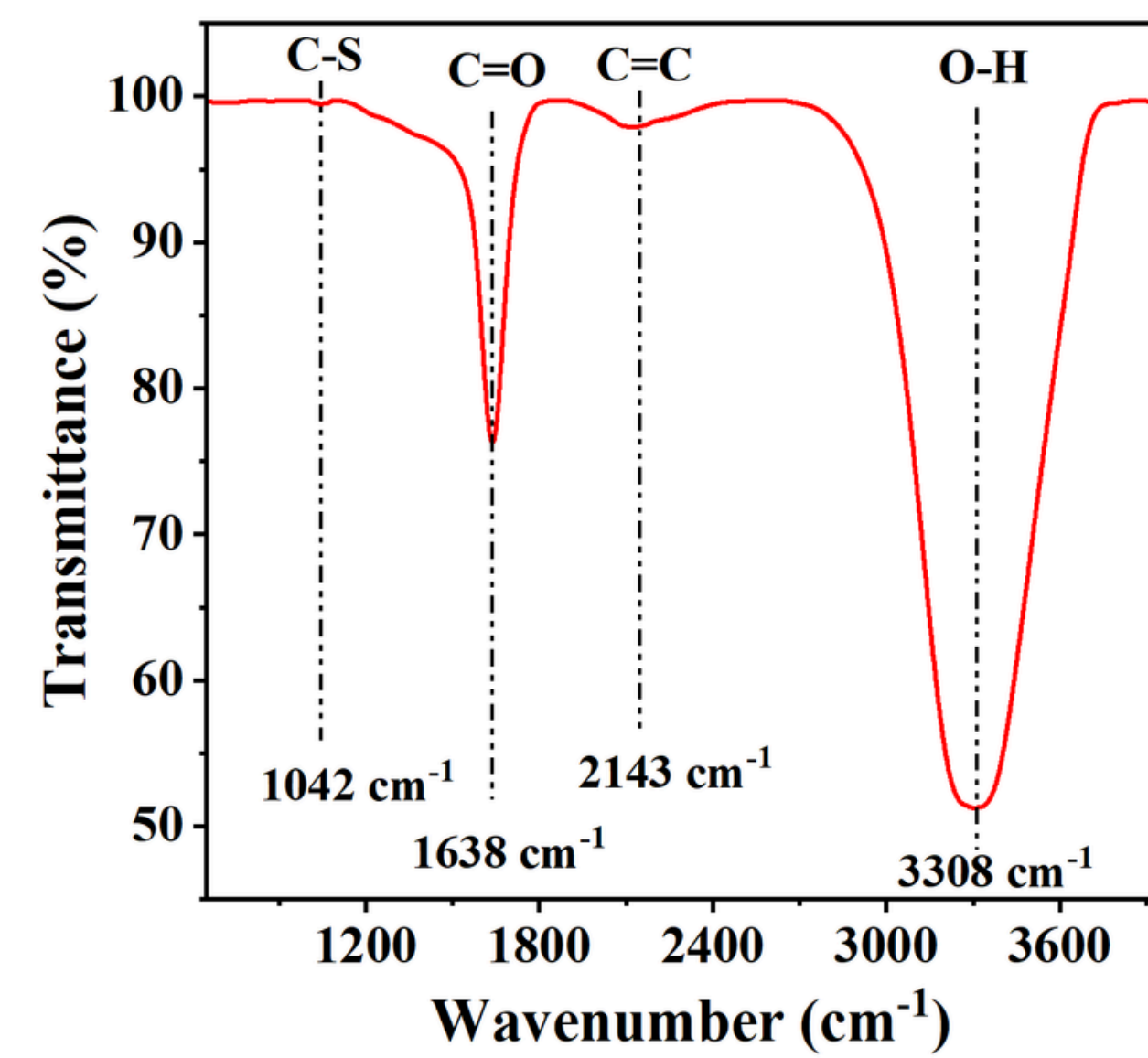
Characterisation: UV-Vis, fluorescence, and FTIR analyses.

Photocatalytic degradation of MB under blue-light irradiation.

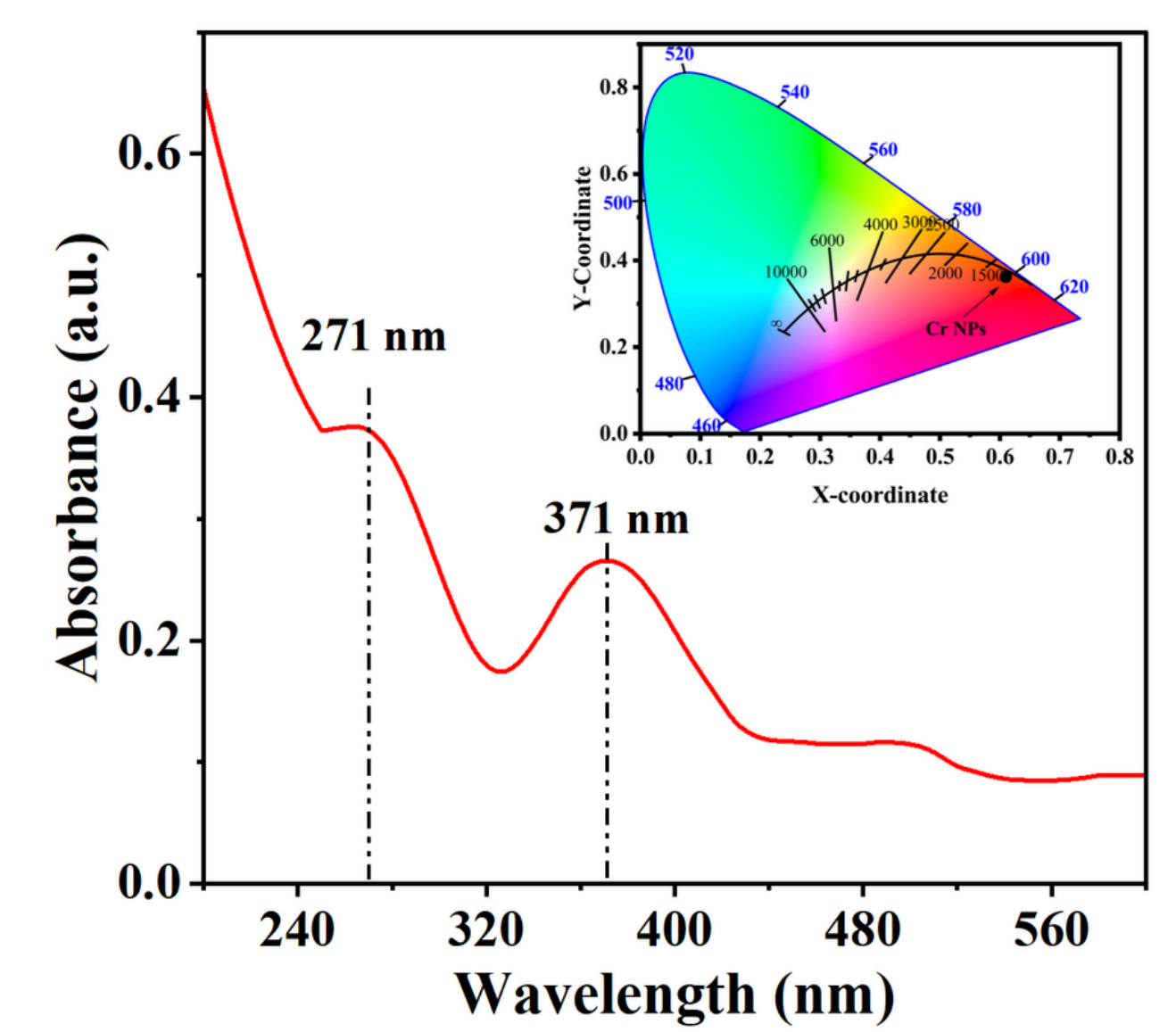


RESULTS & DISCUSSION

- Oxygen-containing groups (-OH, C=O) → enhances dye adsorption and photocatalytic activity.
- Broad absorption (~550 nm) → boost visible light performance.
- Chromaticity coordinates (0.61, 0.36) appear in visible → reddish region.

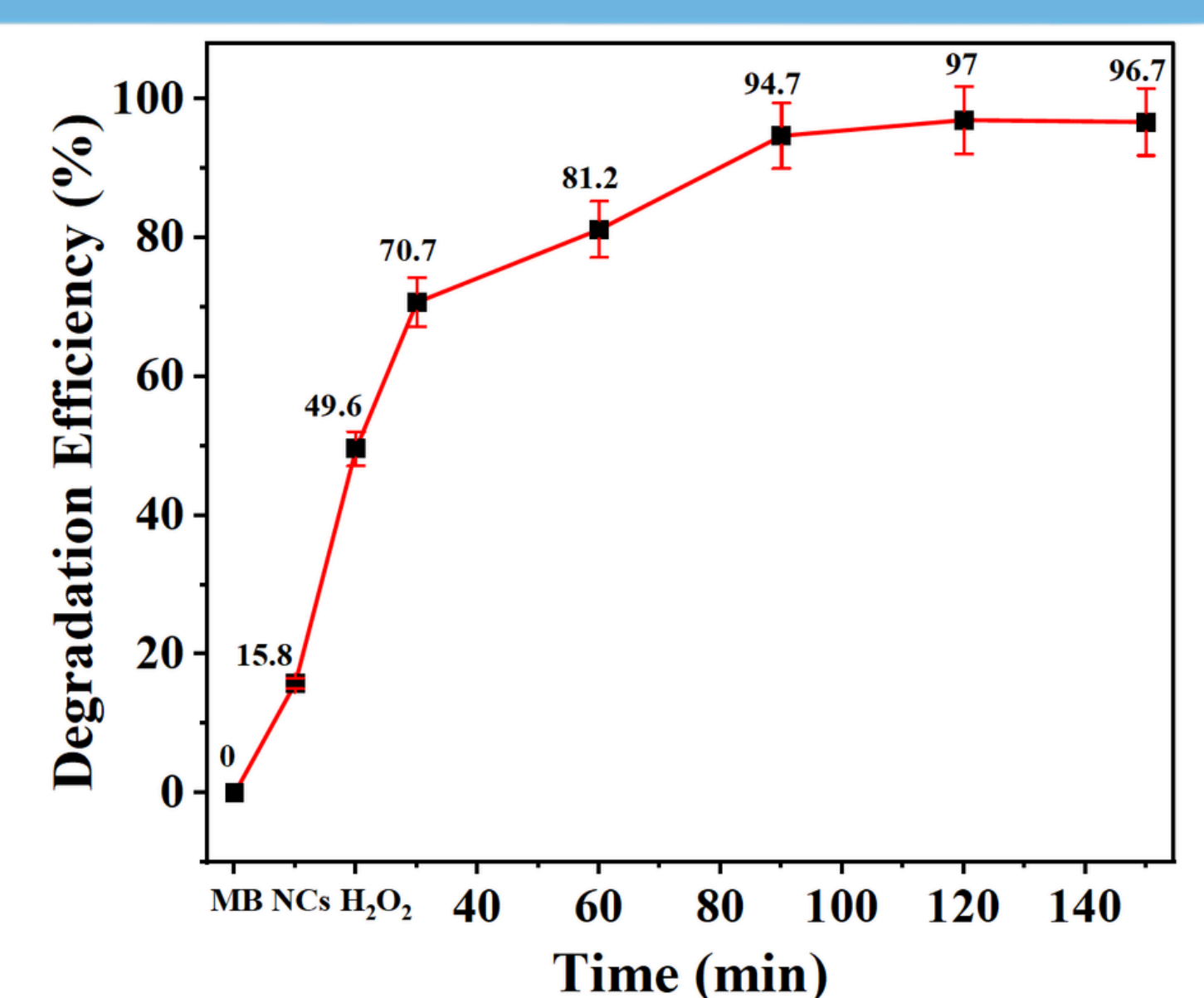
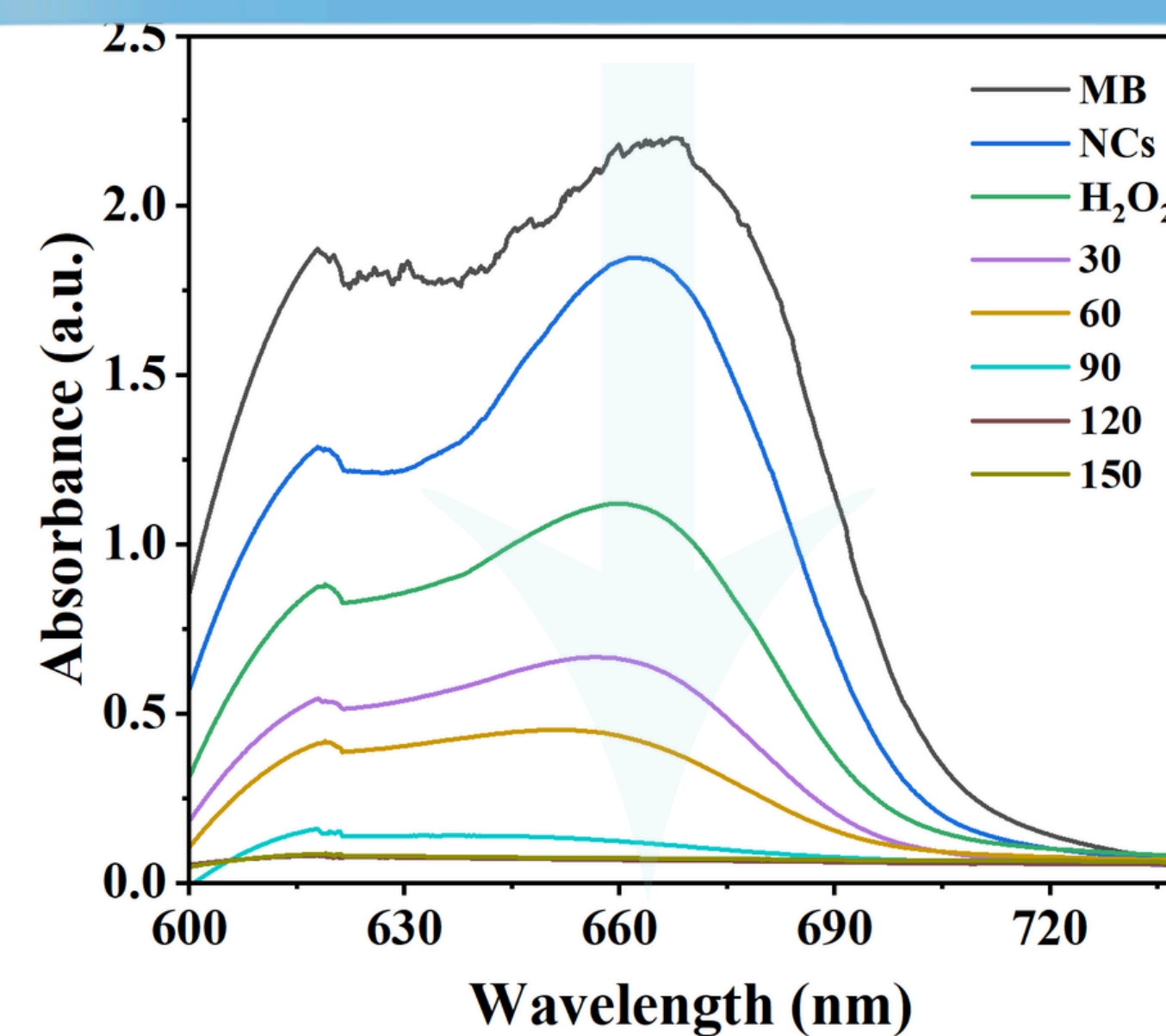


FTIR Spectrum



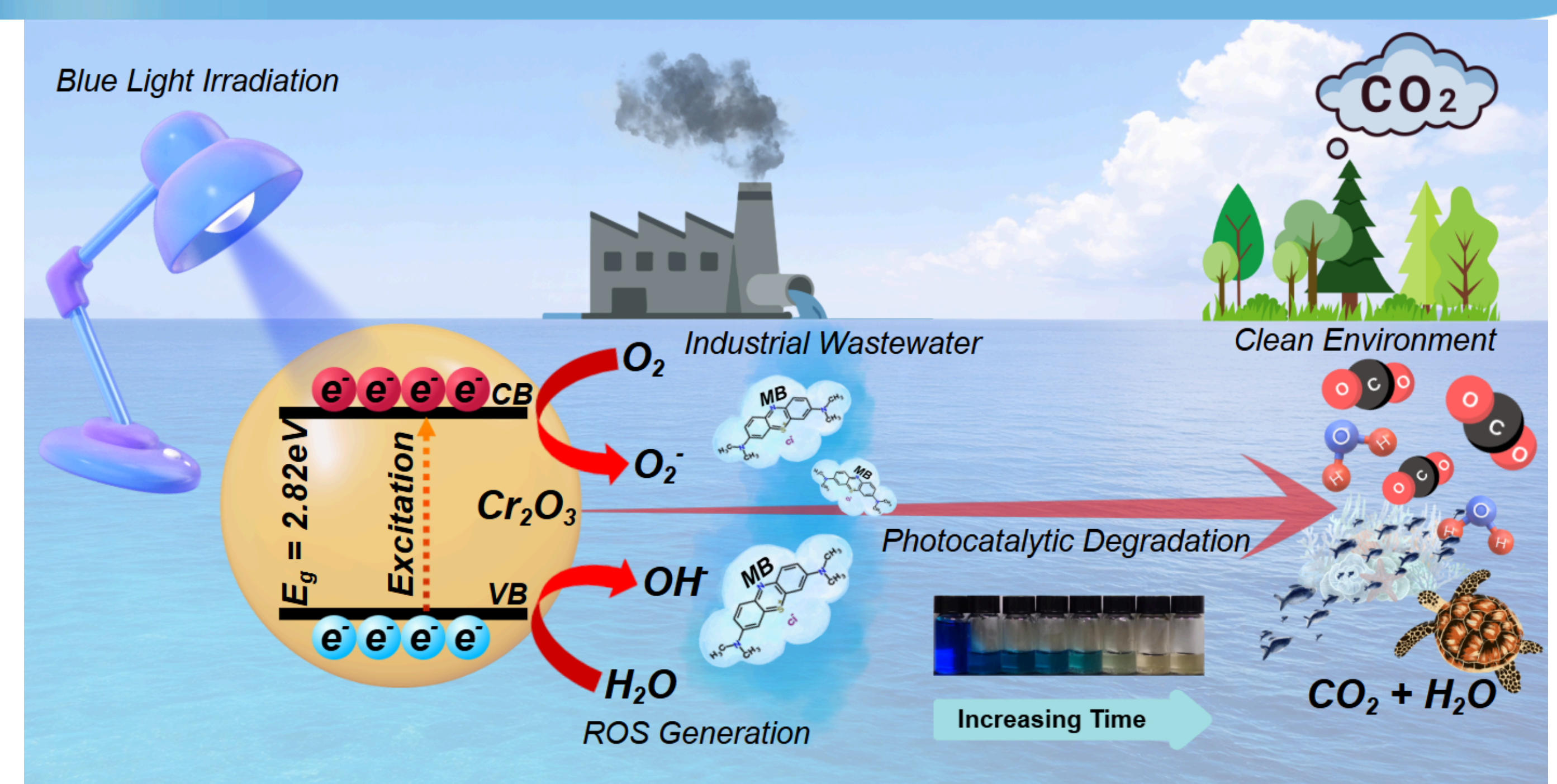
UV-Vis Spectrum

Photocatalytic Performance



- Photoinduced •OH and O₂^{•-} radicals drove dye degradation.
- These radicals attack MB molecules → mineralisation into smaller compounds (CO₂, H₂O).

Photocatalytic Mechanism



96.7 % MB Removal

Green Synthesis

Visible Light Active

CONCLUSION

- Cr₂O₃ NPs were synthesised by the chemical-free PLAL method.
- Spectroscopic results confirmed favorable optical and surface features.
- The material showed strong visible-light photocatalytic activity.
- Maximum MB removal reached 96.7% under blue-light irradiation.
- PLAL-derived Cr₂O₃ nanoparticles are promising green photocatalysts for wastewater treatment.