

## Introduction

Plastic pollution is a critical global challenge. Their environmental persistence adversely affects both living and non-living components of the environment, contributing to 30% of marine life deaths. There is an urgent need for a sustainable plastic upcycling strategy, particularly with the challenges of chemically inert plastics.

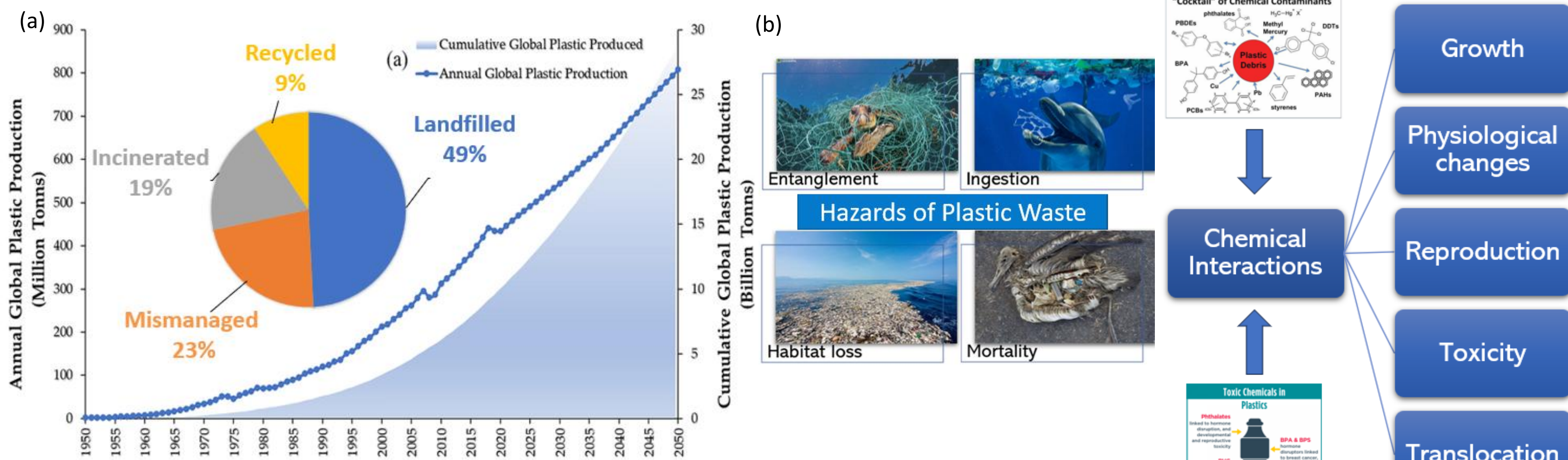
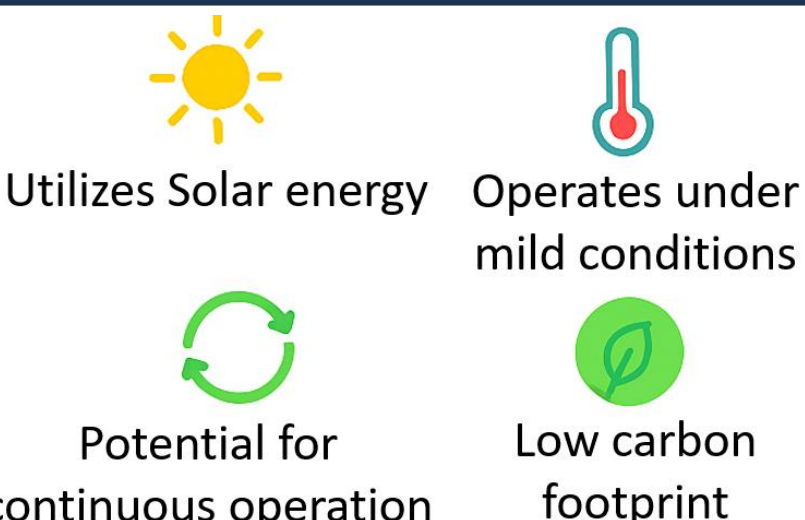


Figure 1 (a) Global Annual Plastic Production, (b) Physical and Chemical Hazards of Plastic Waste

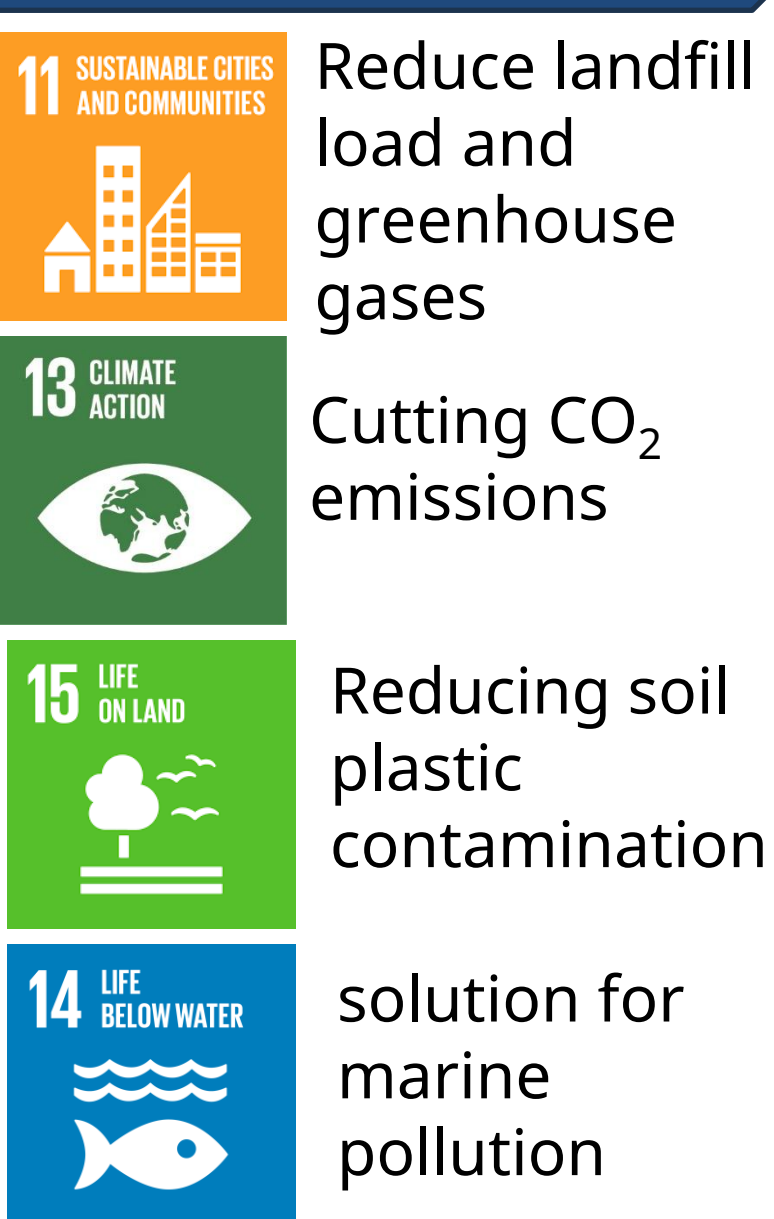
## Major Challenges



## Why Photocatalysis?



## Relevance to SDGs



## Research Objectives

- Develop a Z-scheme heterojunction (S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>) with optimized band alignment
- Enhance solar energy utilization by tuning optical properties
- Improve selectivity toward desired products while minimizing unwanted by-products.
- Evaluate performance under simulated real-world conditions using real plastic

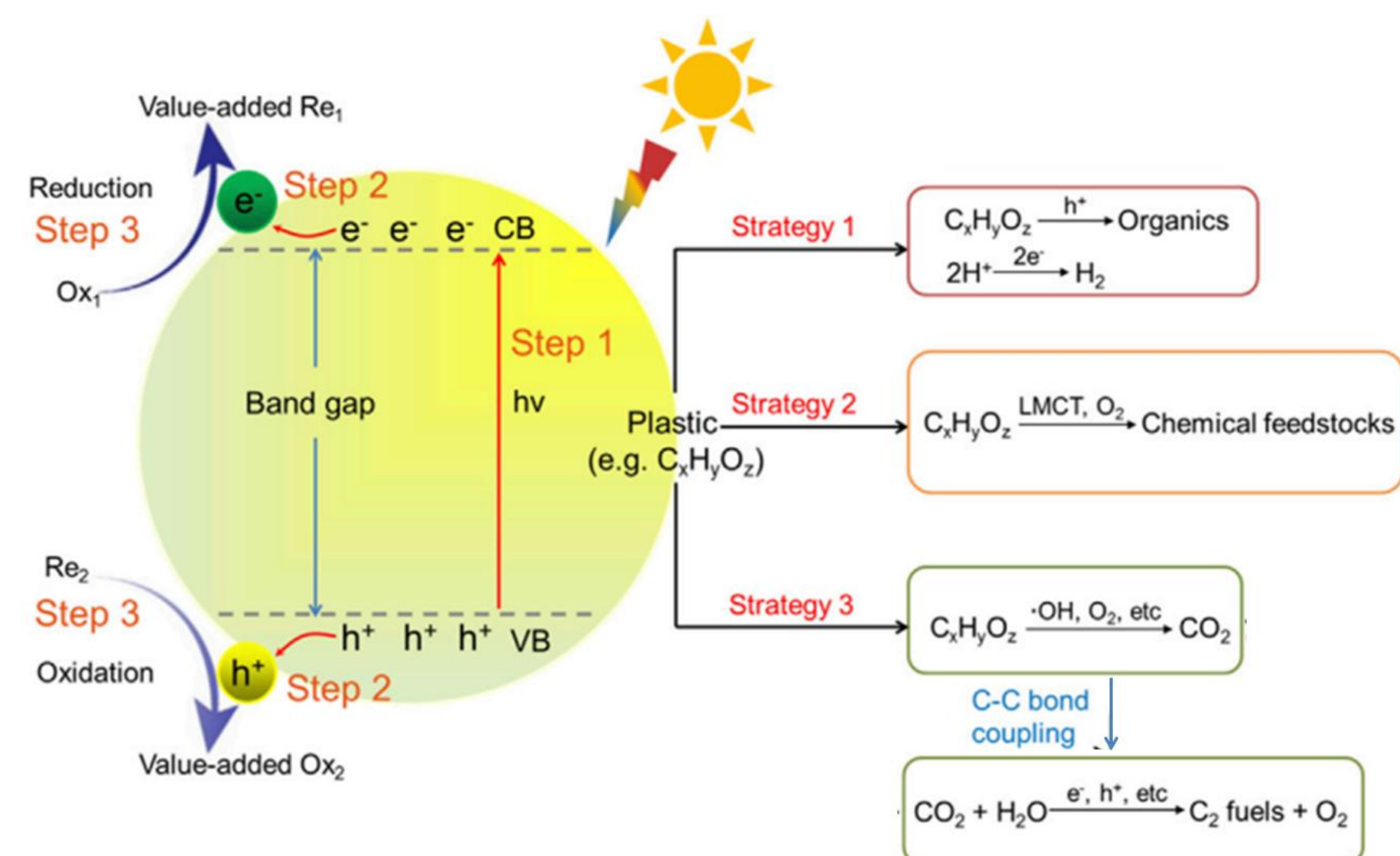


Figure 2 Common Pathways of Plastic Waste Valorization Via Photocatalysis

## Catalyst Preparation and Characterization

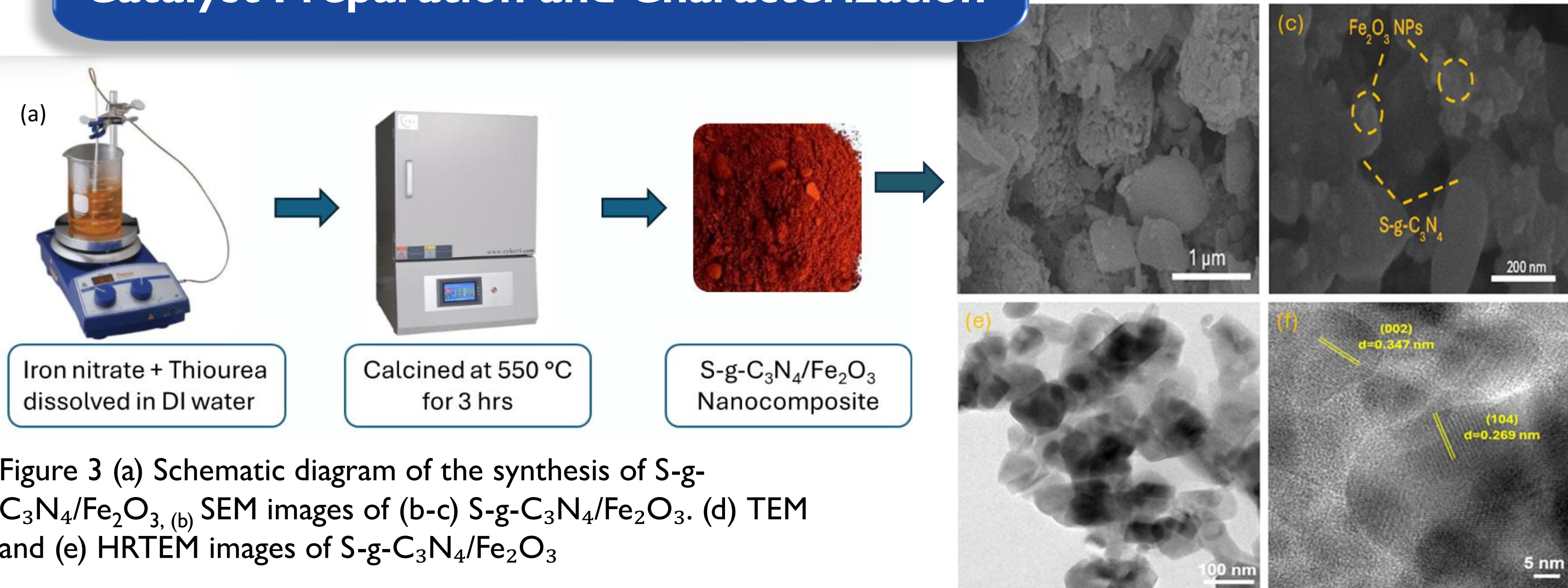


Figure 3 (a) Schematic diagram of the synthesis of S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>, (b) SEM images of (b-c) S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>. (d) TEM and (e) HRTEM images of S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>

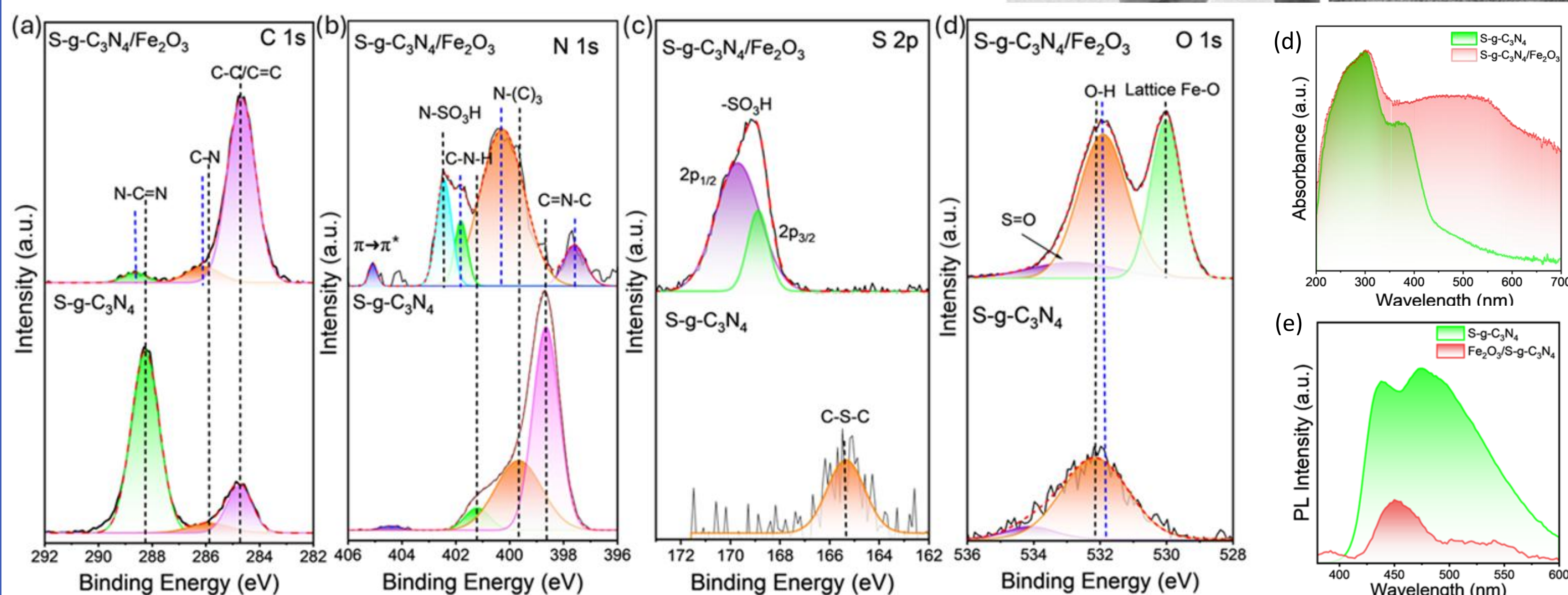
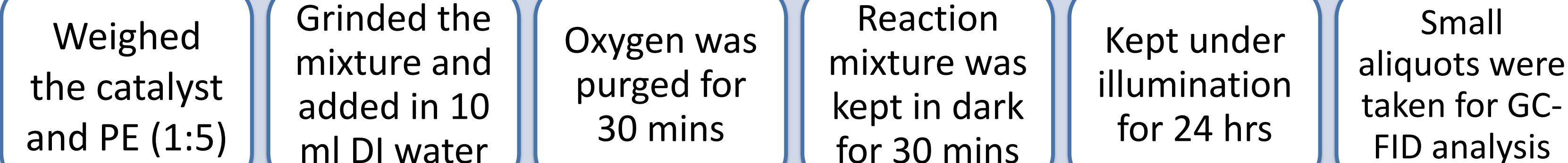


Figure 4 High resolution XPS scans of (a) C 1s, (b) N 1s, (c) S 2p, and (d) O 1s for S-g-C<sub>3</sub>N<sub>4</sub> and S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>, (e) Absorbance and PL intensity of S-g-C<sub>3</sub>N<sub>4</sub> and S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>

## Photocatalytic Reaction



## References

- Xing, C., et al. (2022). Solar energy-driven upcycling of plastic waste on Z-scheme heterostructure of V-substituted phosphomolybdic acid/g-C<sub>3</sub>N<sub>4</sub> nanosheets. *Applied Catalysis B: Environmental*, 281, 120000.
- Jiao, X., Zheng, K., Chen, Q., Li, X., Li, Y., Shao, W., ... & Xie, Y. (2020). Photocatalytic conversion of waste plastics into C<sub>2</sub> fuels under simulated natural environment conditions. *Angewandte Chemie International Edition*, 59(36), 15497-15501.

## Key Results

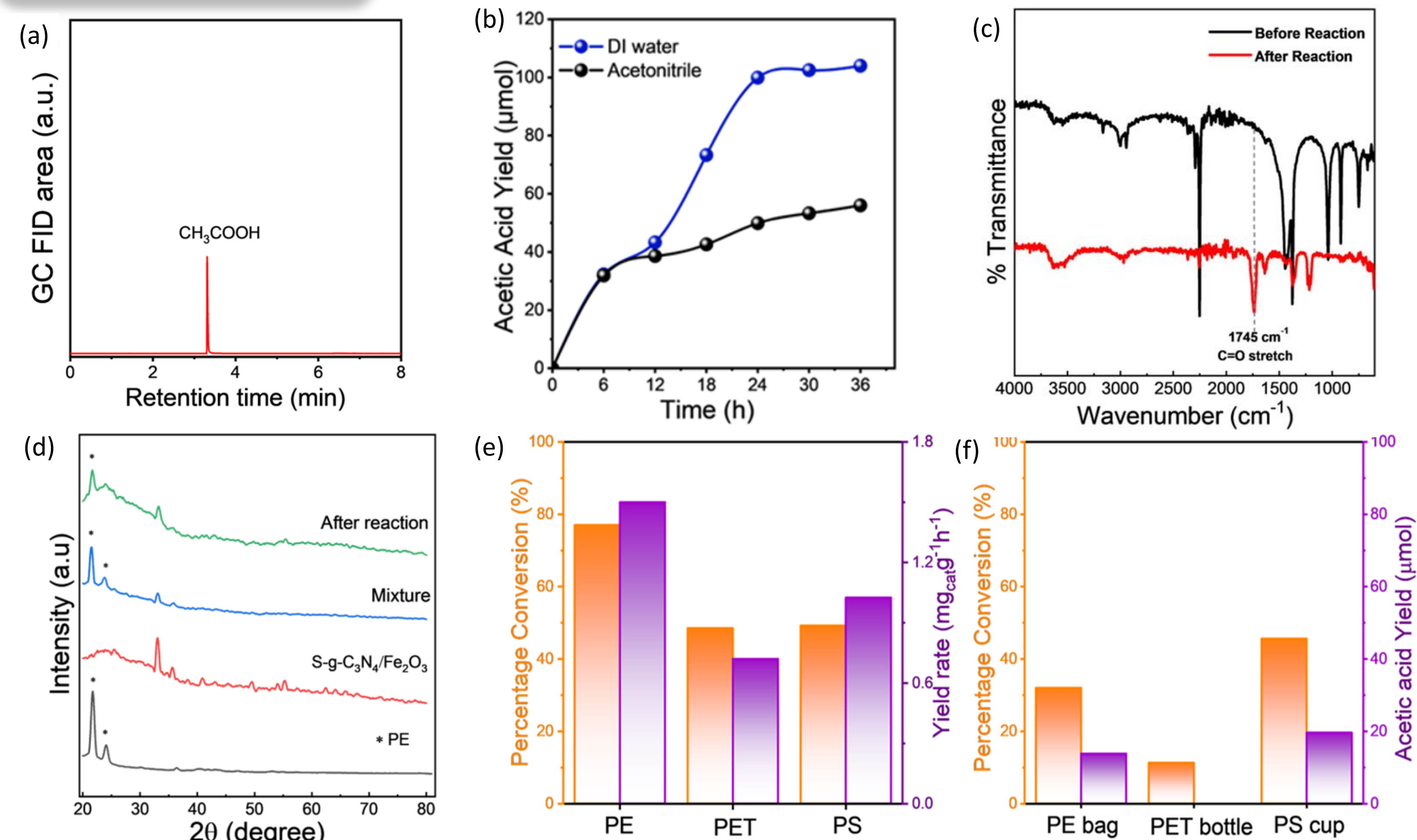
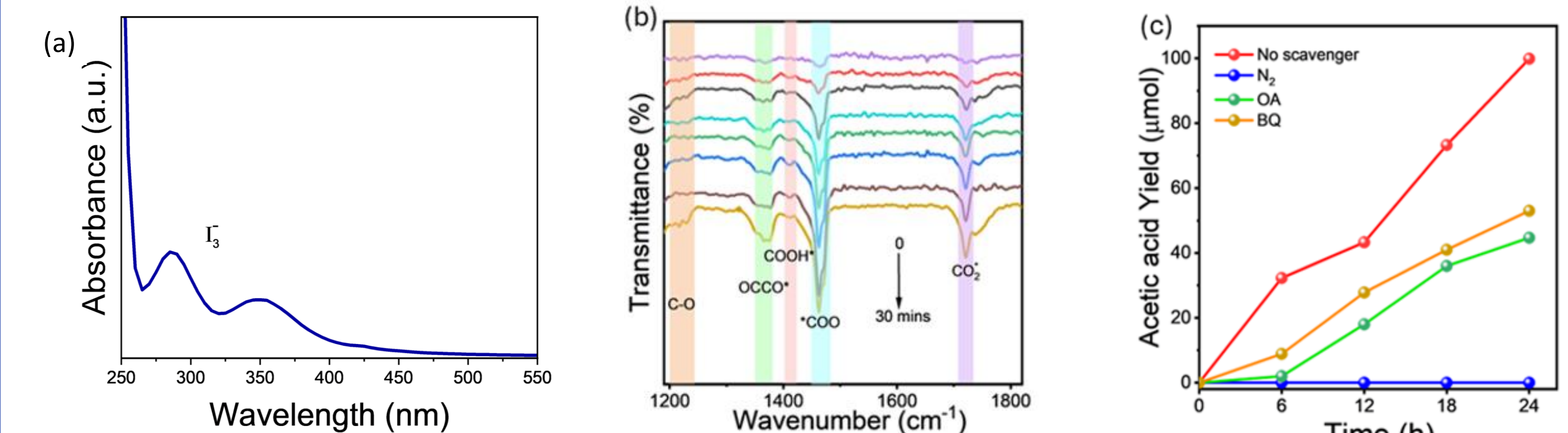


Figure 5 (a) GC-FID chromatogram of reaction mixture (b) Effect of solvent on the acetic acid yield, (c) IR spectra (in acetonitrile) before and after the reaction (d) XRD pattern of the mixture of PE and Fe<sub>2</sub>O<sub>3</sub>/S-g-C<sub>3</sub>N<sub>4</sub> (1:5) before and after the reaction, Photocatalytic upcycling of (e) different plastic types and (f) corresponding real-world plastics, using S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub>.



UV-VIS spectrum for H<sub>2</sub>O<sub>2</sub> detection (a) FTIR spectra as a function of time (b) of the reaction mixture (c) radical scavenging assay

## Conclusion

We have developed an efficient photocatalyst for the reforming of PE, PS, and PET. The S-g-C<sub>3</sub>N<sub>4</sub>/Fe<sub>2</sub>O<sub>3</sub> photocatalyst successfully oxidizes PE into acetic acid at room temperature and pressure without any pretreatment or oxidizing agent, achieving high selectivity. This research provides an environmentally friendly approach for PE photoreforming, offering potential applications in sustainable waste management and resource recovery.

