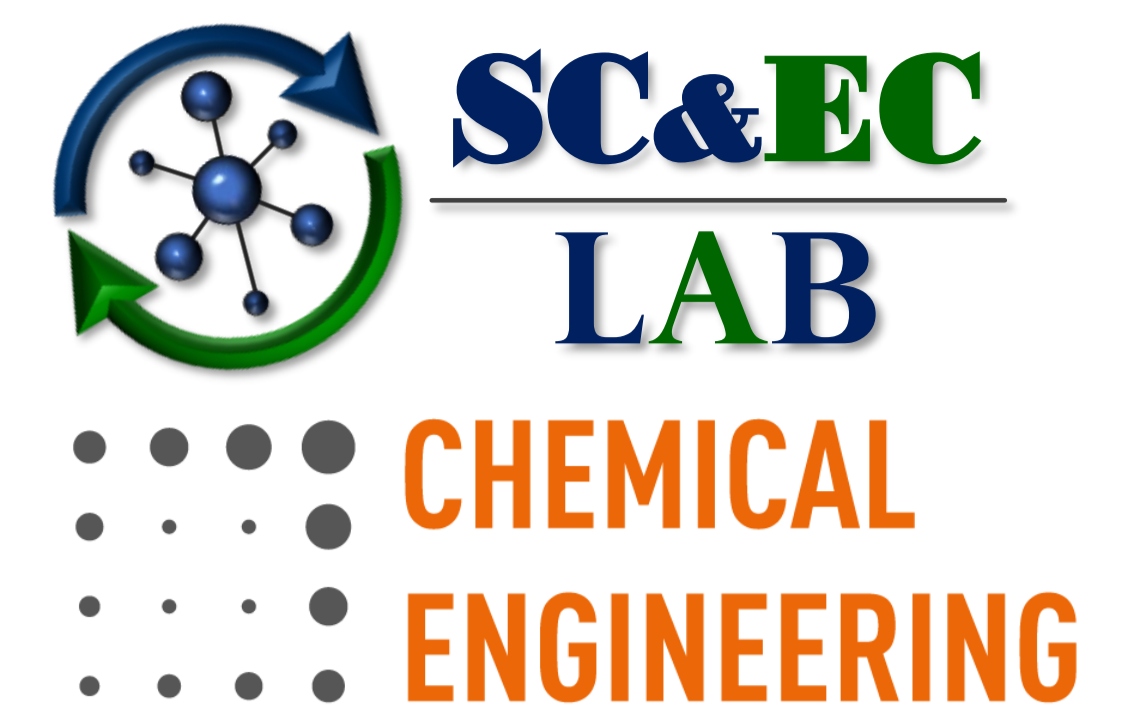


# Circular Carbon and Plastic Waste Valorization via Photoelectrochemical H<sub>2</sub> Production and CO<sub>2</sub> Conversion



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## Introduction

### Global Challenges [1]

- High CO<sub>2</sub> emissions (> 430 ppm).
- Accumulation of plastic waste.
- Dependence on fossil fuels.
- Need for clean H<sub>2</sub>.

### Research Gap

- Current technologies remain energy intensive.
- Plastic waste valorization is often disconnected from renewable H<sub>2</sub> production [2].
- Limited integration of photoelectrochemical (PEC) systems and carbon valorization strategies [3].
- Demand for multifunctional and low-carbon pathways.

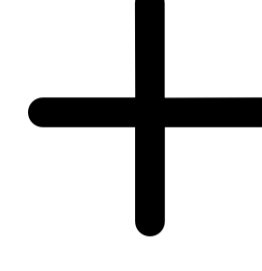
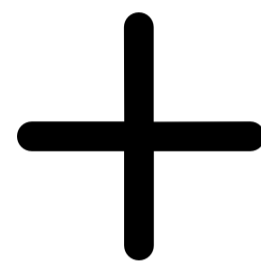
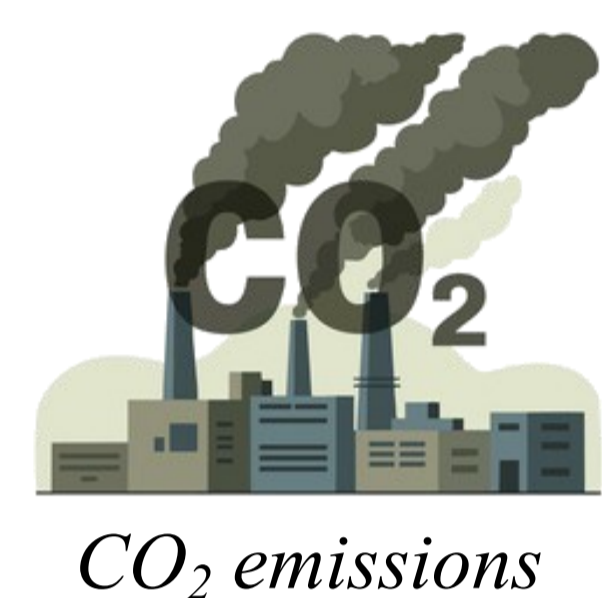
### Circular Carbon Concept



CO<sub>2</sub> MUST NOT be treated as **waste** but as a **resource** [4].

## Research Objective

This research proposes the **integration** of photoelectrochemical H<sub>2</sub> production with CO<sub>2</sub> conversion and plastic waste valorization to develop sustainable circular carbon pathways.



**Environmental Challenges**

### Aim

Need for integrated waste-to-value technologies.

## Overall Research Approach

### Integrated Circular Carbon Concept

Plastic waste monomers  
 + CO<sub>2</sub> + Solar energy  
 ↓  
 PEC system  
 (Conversion platform)  
 ↓  
 H<sub>2</sub> + Chemicals  
 + Carbon circular products

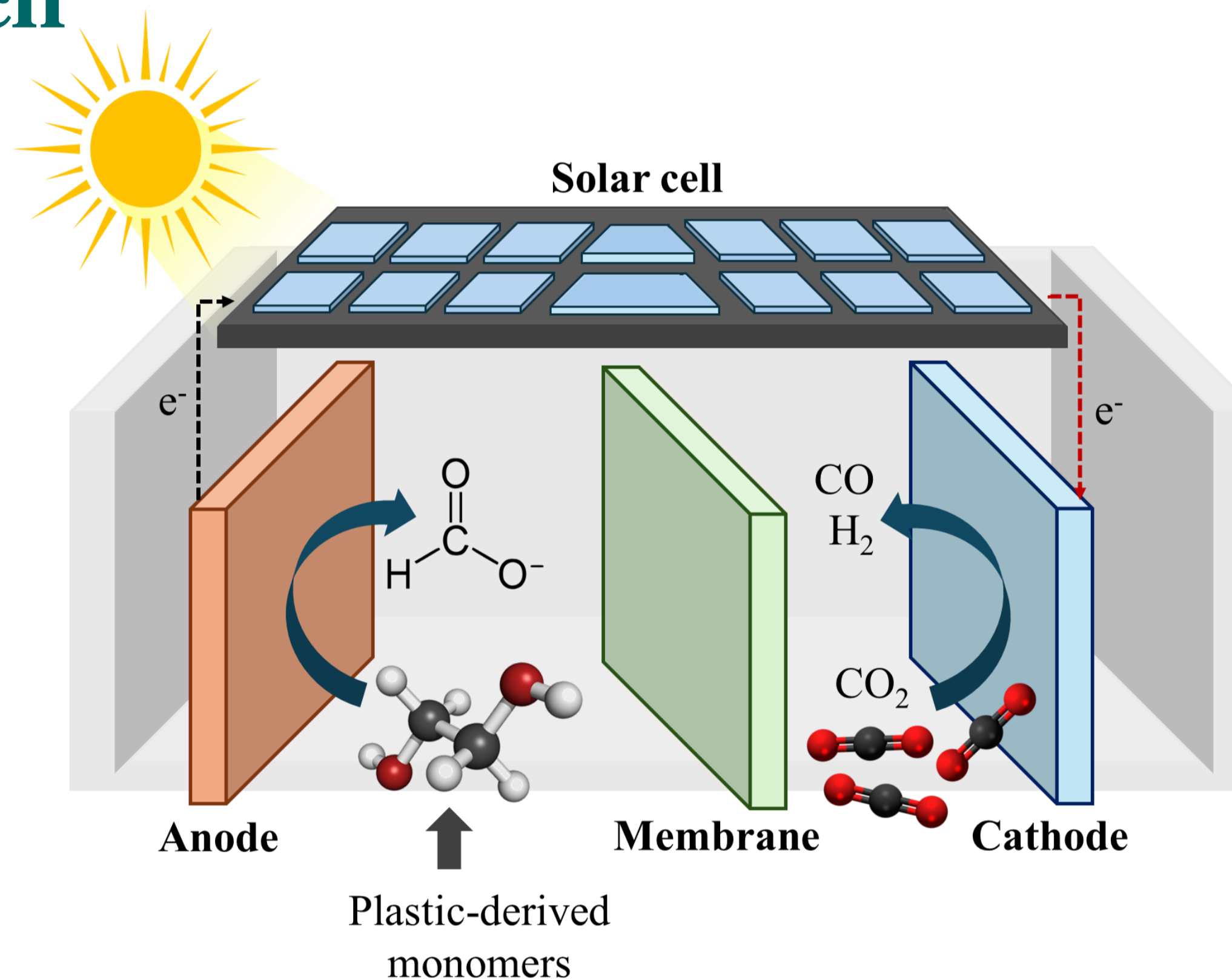
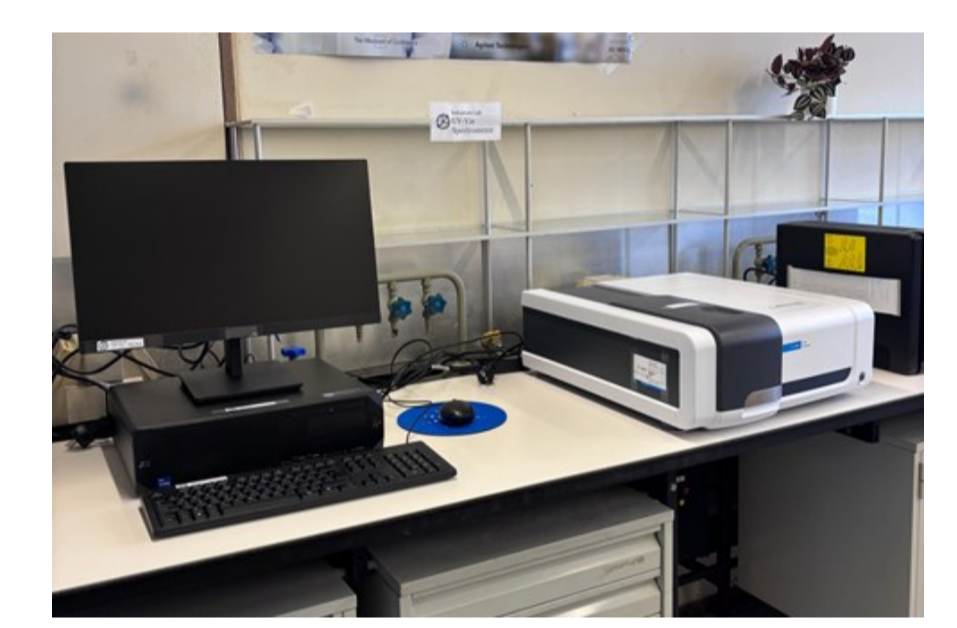


Figure 1. PEC conversion system.

## Materials



Gas chromatograph

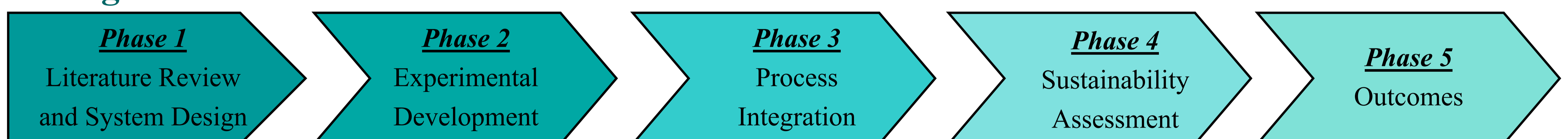


UV-Vis spectrophotometer



Potentiostat & Booster

## Working Plan



## Expected Outcomes

- Improved understanding of PEC-driven carbon conversion.
- Integrated waste-to-hydrogen strategies.
- Novel circular carbon pathways.
- Plastic waste upcycling.
- Sustainable H<sub>2</sub> production routes.
- CO<sub>2</sub> utilization opportunities.
- Reduced carbon emissions.
- Enhanced resource efficiency.
- Contribution to circular economy goals.

## Future Perspectives

- Industrial scalability.
- Renewable integration.
- Decentralized systems.
- Carbon-neutral chemical production.

## Projected Conclusions

PEC technologies are a **promising route** for **sustainable H<sub>2</sub> production** while enabling the **valorization of carbon-based waste streams**. By integrating CO<sub>2</sub> conversion and plastic waste utilization, waste can be converted into **valuable resources**, and **produce clean energy carriers and value-added products**.

## References

- [1] K. Richardson, et al. Earth beyond six of nine planetary boundaries. *Sci Adv* **9**, 37 (2023). <https://doi.org/10.1126/sciadv.adh2458>
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