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Kinetic Analysis of the Photocatalytic Degradation of Ethylene over TiO₂ Thin Films in a Batch Reactor

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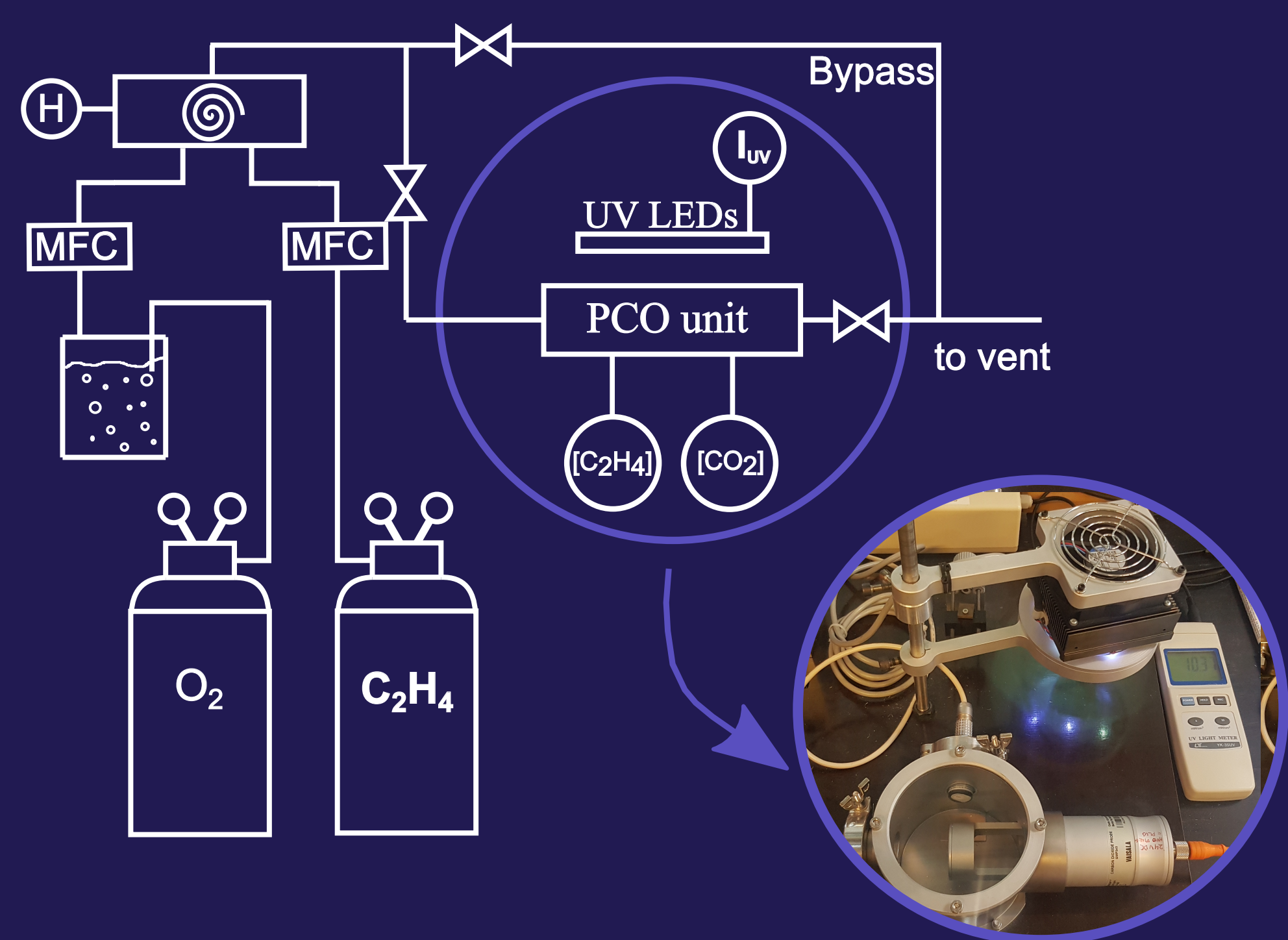


Introduction

- In the context of scarce resources, food waste needs to be addressed
- Ethylene (C₂H₄) - one of the main contributors to fresh produce spoilage in the postharvest industry
- Its removal has the potential of prolonging the shelf life of fresh produce
- Removal by photocatalytic oxidation over immobilized TiO₂ thin films
- Reaction is kinetically studied in a batch reactor, for subsequent modeling purposes
- Employed reaction models: first-order and Langmuir-Hinshelwood (LH) kinetics.

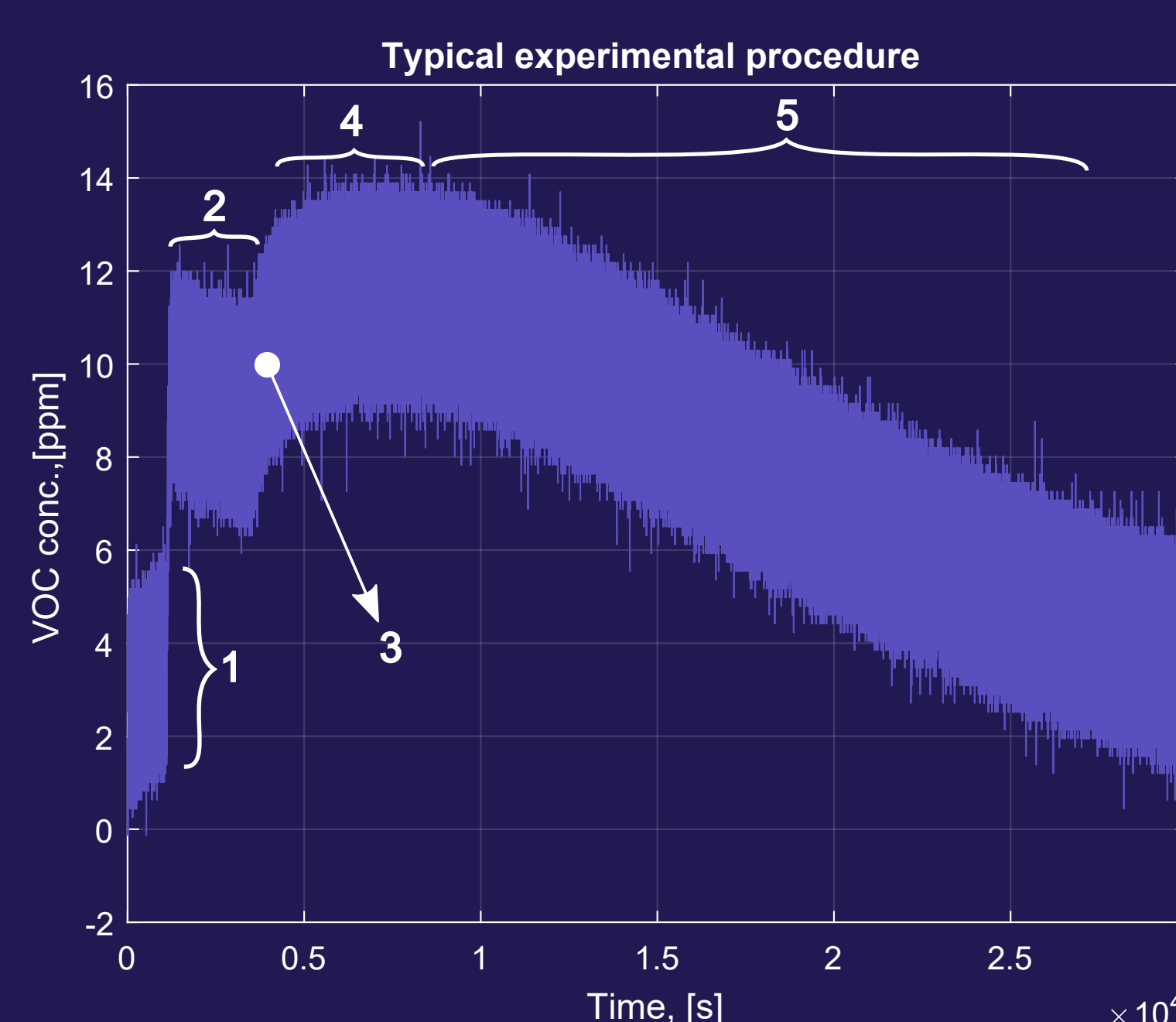


Experimental setup

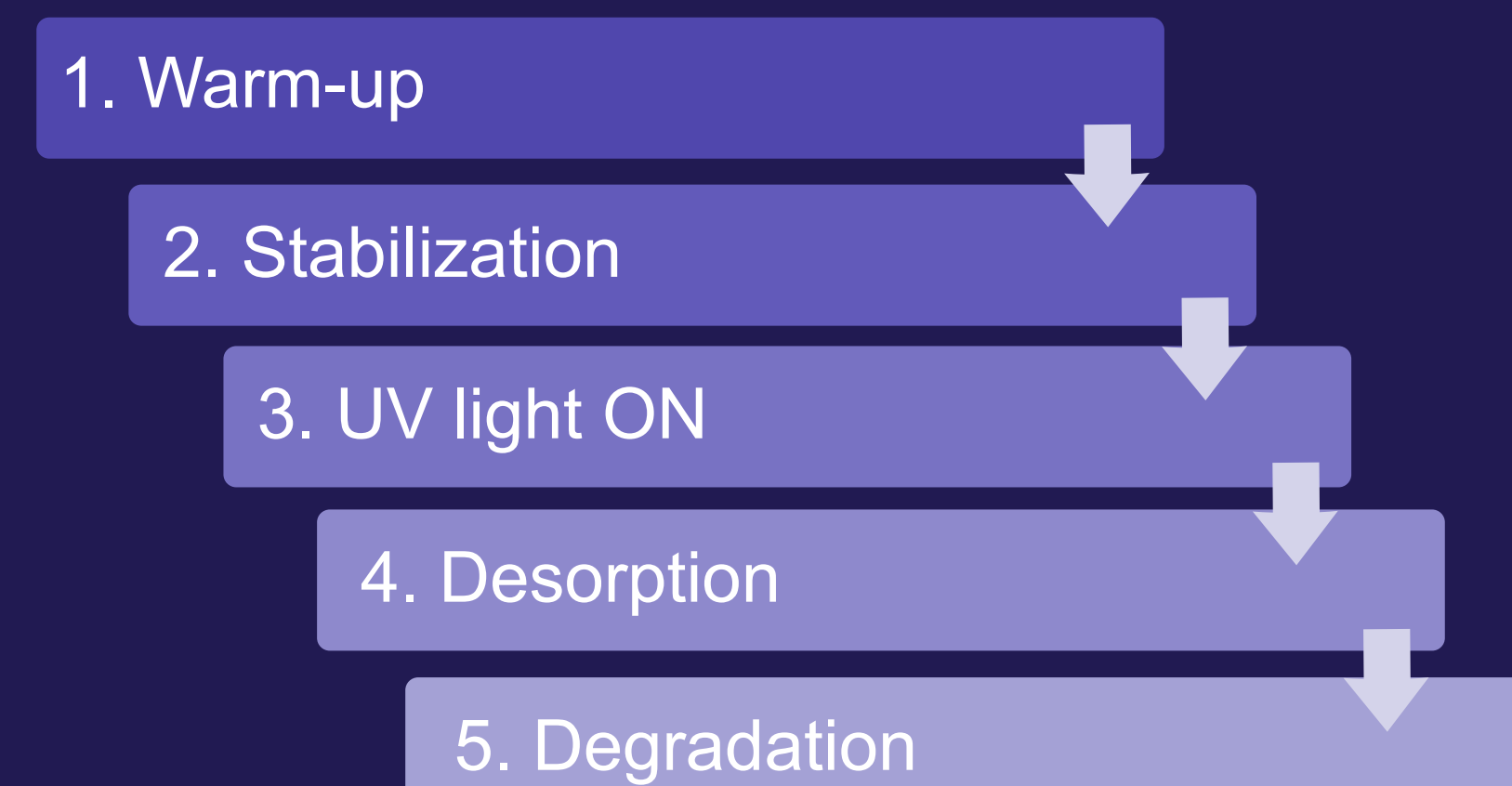


Method

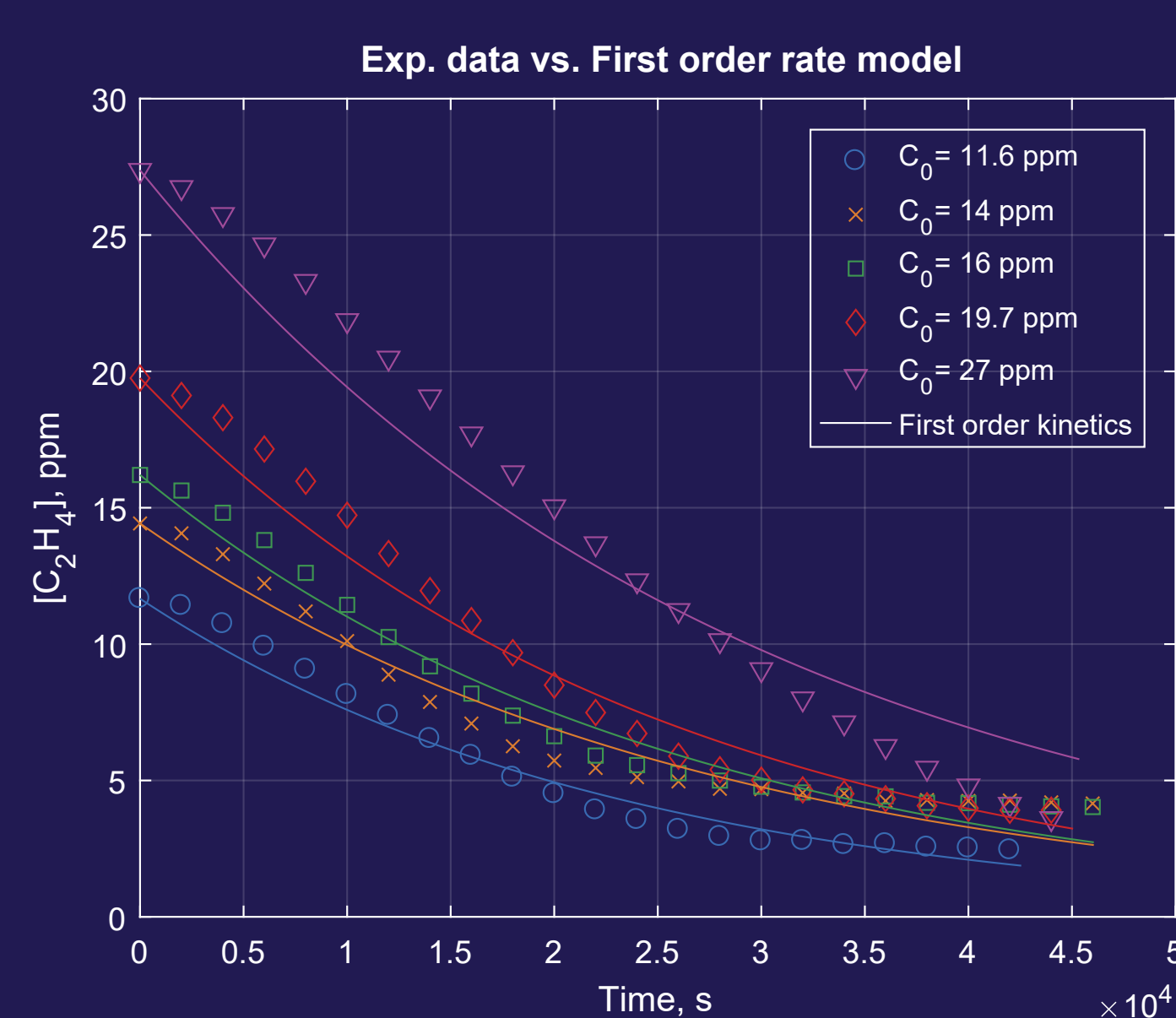
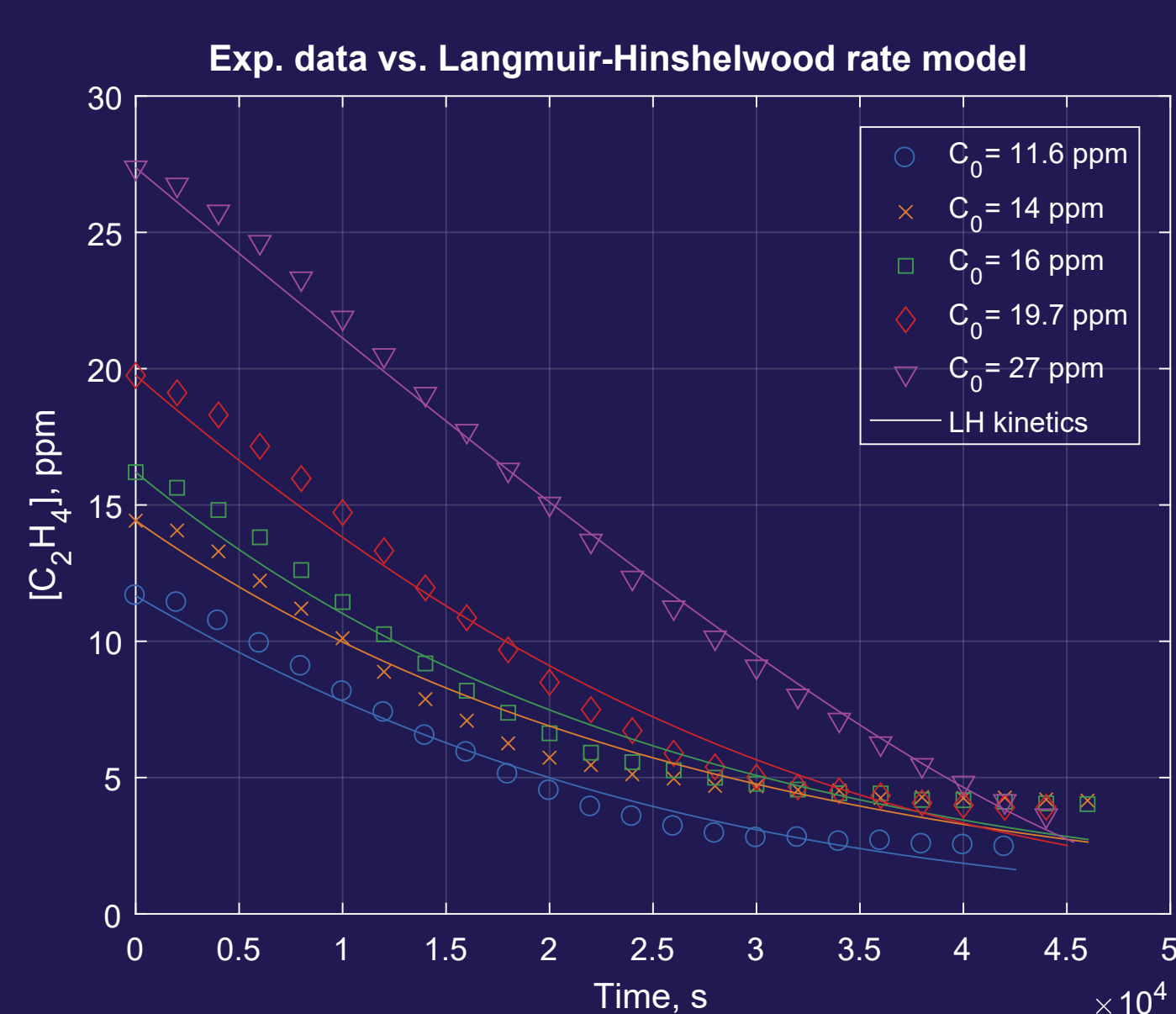
- Proposed 5-step experimental methodology



	C _{in} [ppm]	I _{UV} [W/m ²]	q _{in} [cm ³ /min]	RH [%]
Effect of C _{in}	11.6 - 27	60	310 - 510	80
Effect of I _{UV}	10	3.9 - 5.1	510	80



Results and Conclusions

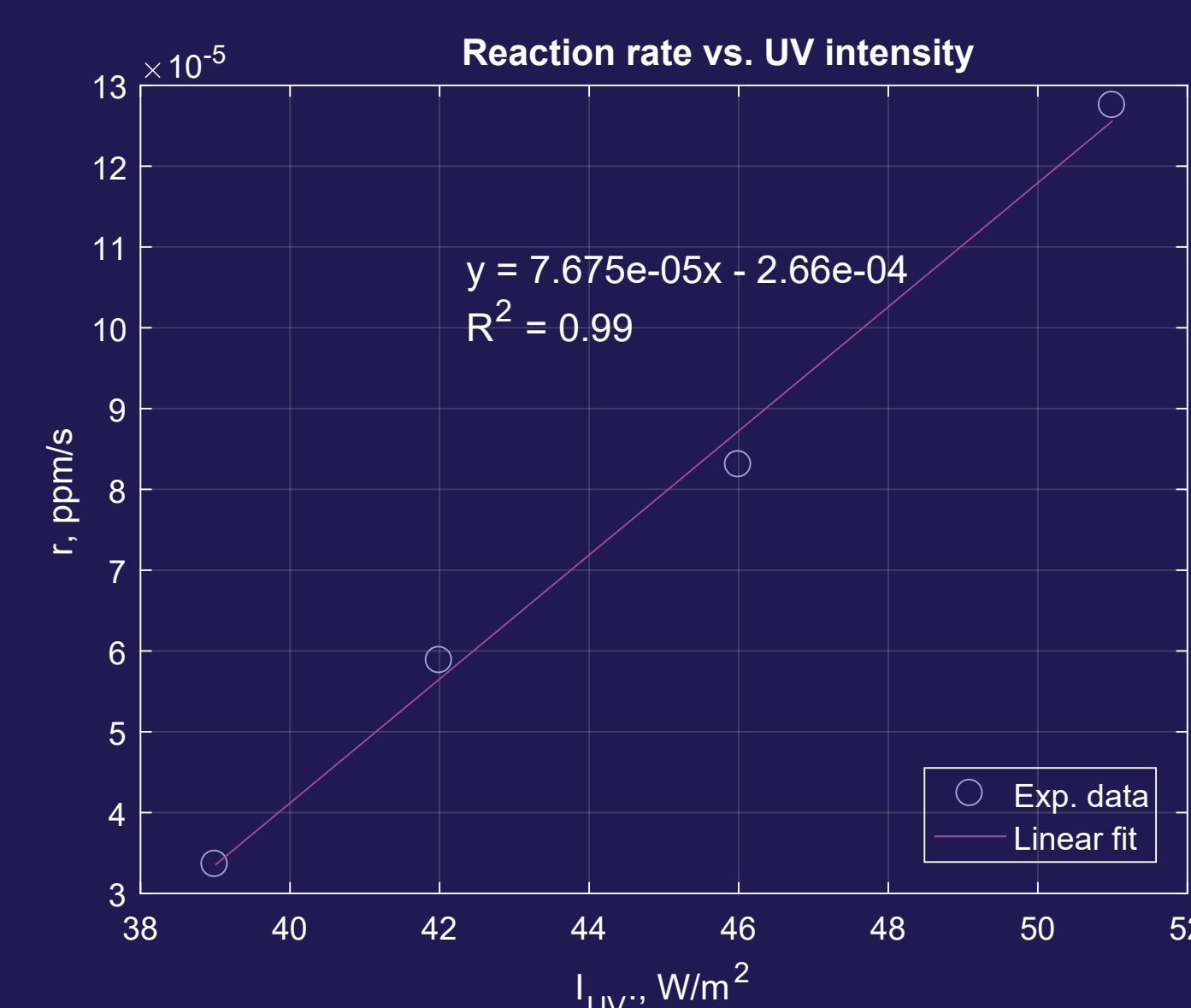
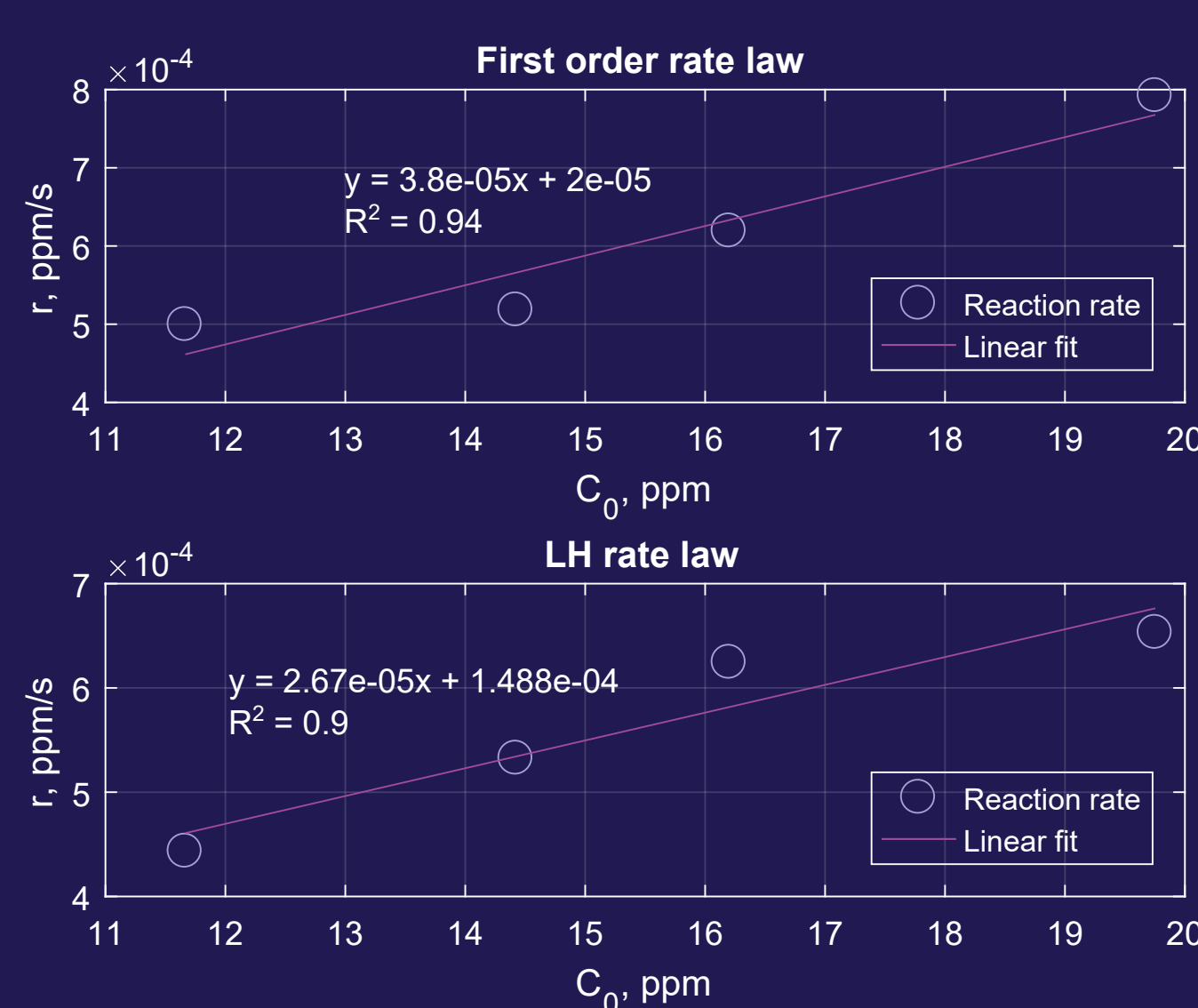


- Both the first order reaction model and the LH model represent the photodegradation of C₂H₄ over TiO₂ thin films satisfactorily

$$-r = \frac{dC}{dt} = \frac{k_r K_{abs} C}{1 + K_{abs} C} \quad -r = \frac{dC}{dt} = k_{app} C$$

- Modeling with LH kinetics requires the use of the Lambert W-function, which is computationally heavy

$$z = f^{-1}(ze^z) = W(ze^z)$$



- Low pollutant molar concentrations → K_{abs}C << 1 → first-order kinetics

↳ disadvantage: k_r and K_{abs} are treated as one, thus determining separate values becomes complicated

- Determined constants and prediction models = intrinsic

- r vs. C_{in} } Linear dependence
- r vs. I_{UV} }

Acknowledgements

