

Shining Light on Ciprofloxacin Removal: How Reaction Conditions Shape Photodegradation Efficiency

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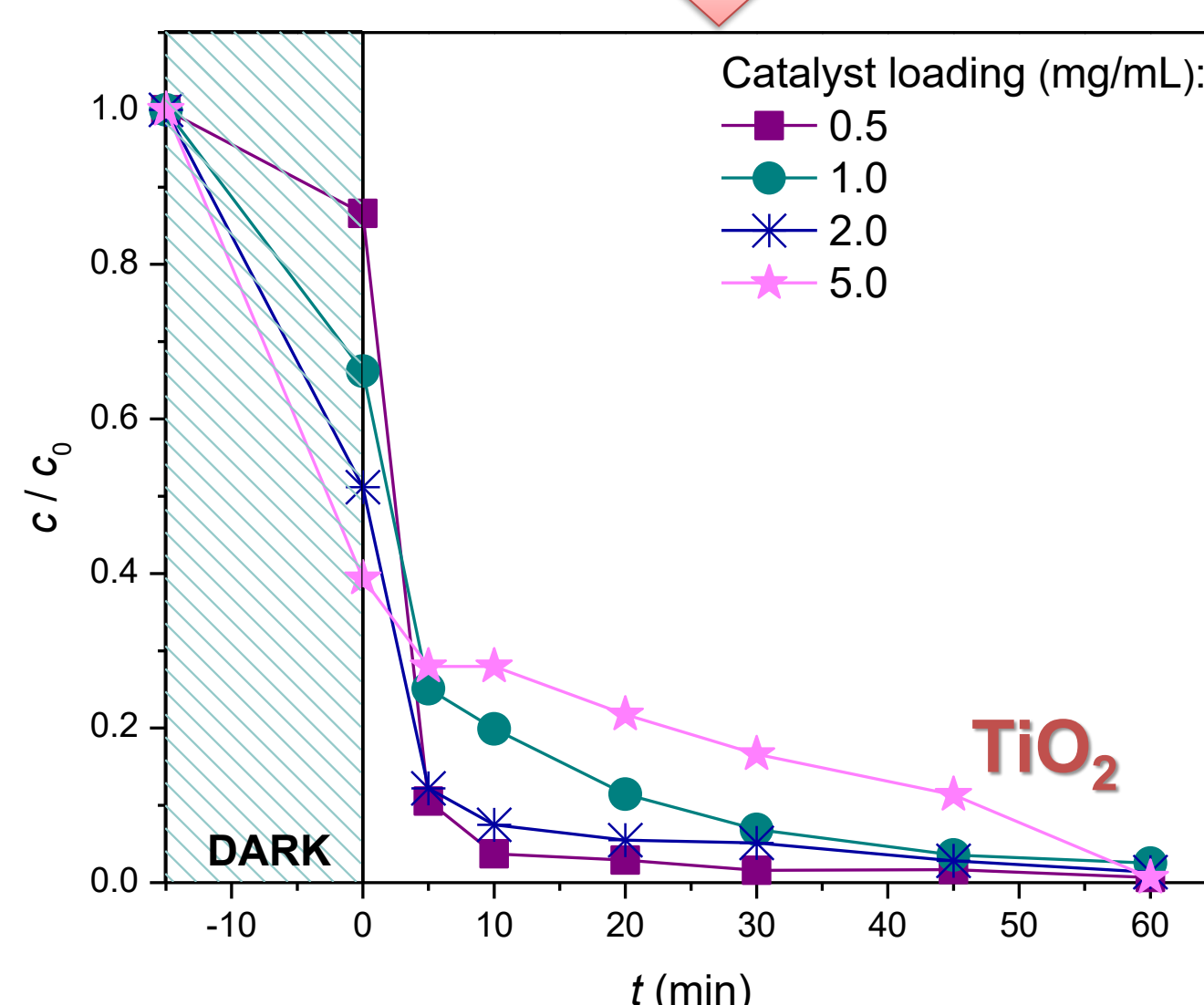
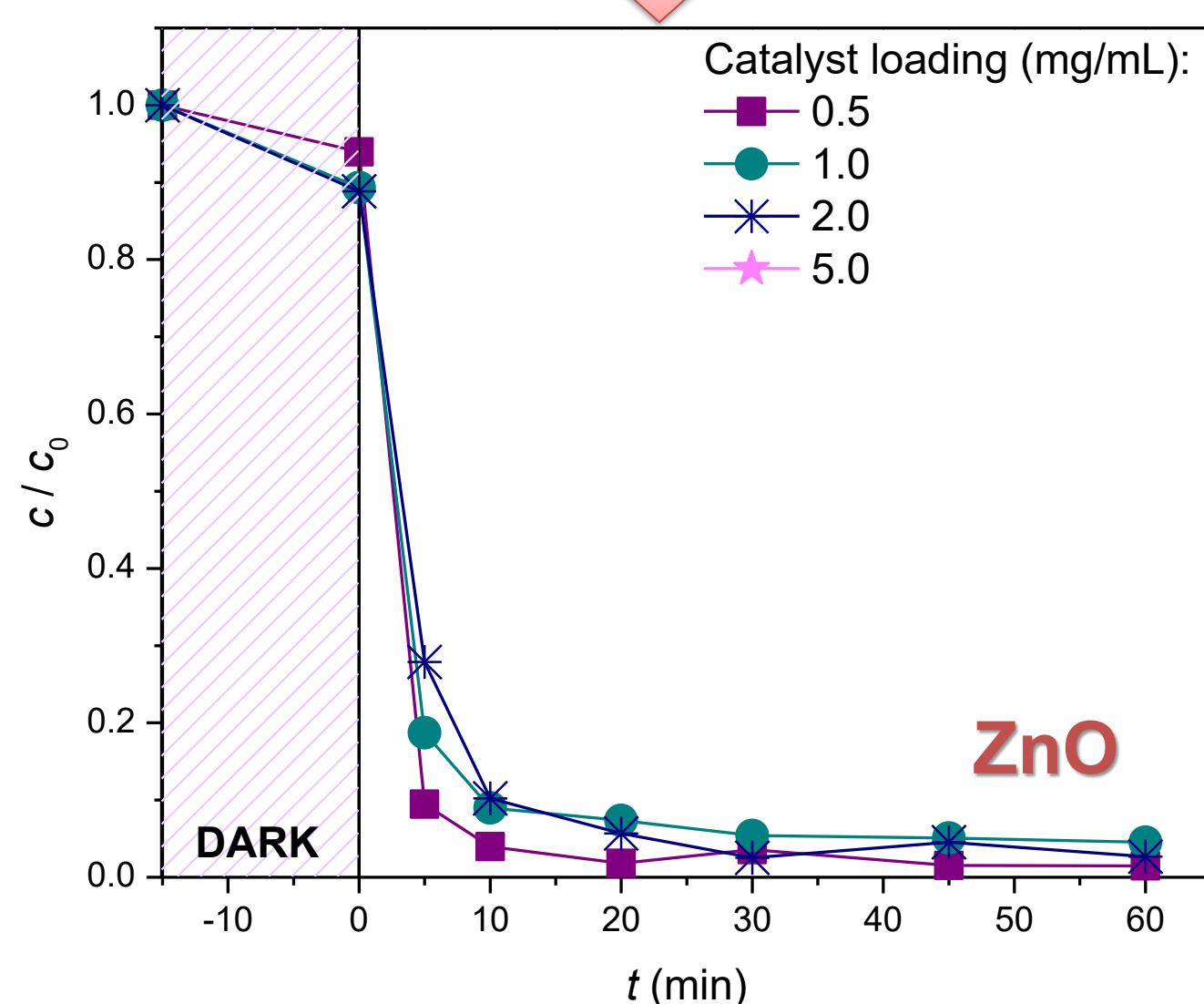
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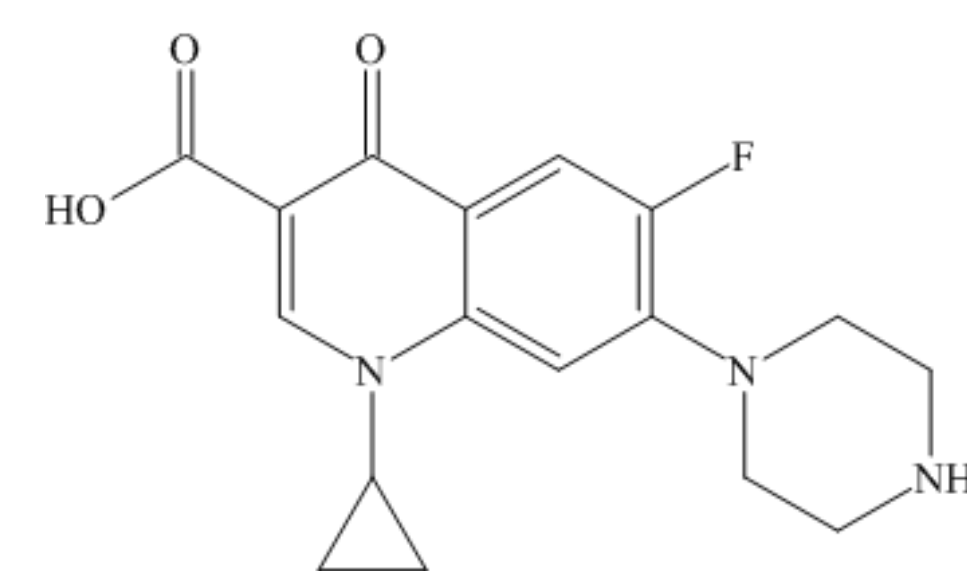
Pharmaceuticals are increasingly detected in environmental matrices, with ciprofloxacin (CIP) among the most persistent due to its extensive clinical use and poor removal in conventional treatment systems. Growing regulatory pressure to reduce emissions, highlights the need for advanced, sustainable remediation strategies. Advanced oxidation processes, capable of generating highly reactive oxygen species under mild conditions, offer an effective approach for degrading recalcitrant pharmaceutical contaminants such as CIP.

CIP photodegradation under simulated sunlight was examined using heterogeneous photocatalysis. Degradation kinetics were evaluated with respect to **catalyst type (ZnO and TiO₂)**, **catalyst loading (0.5–5.0 mg/mL)**, **initial CIP concentration (0.025–0.125 mM)**, and **photoreactor configuration**. Complete CIP removal was achieved within 60 min for both catalysts. Higher catalyst loadings slightly decreased efficiency, with optimal performance at 0.5 mg/mL. Increasing initial CIP concentration also reduced degradation rates, with the best results at 0.025 mmol/L. The xenon lamp reactor showed superior activity due to its 26-fold higher UVA intensity compared to the halogen system. **ZnO reuse** over three cycles revealed a gradual decline in performance, likely caused by surface fouling from adsorbed degradation products.

Effect of the catalyst type (ZnO and TiO₂) and loading on the CIP (0.05 mM) removal efficiency under simulated sunlight



Structural formula of ciprofloxacin



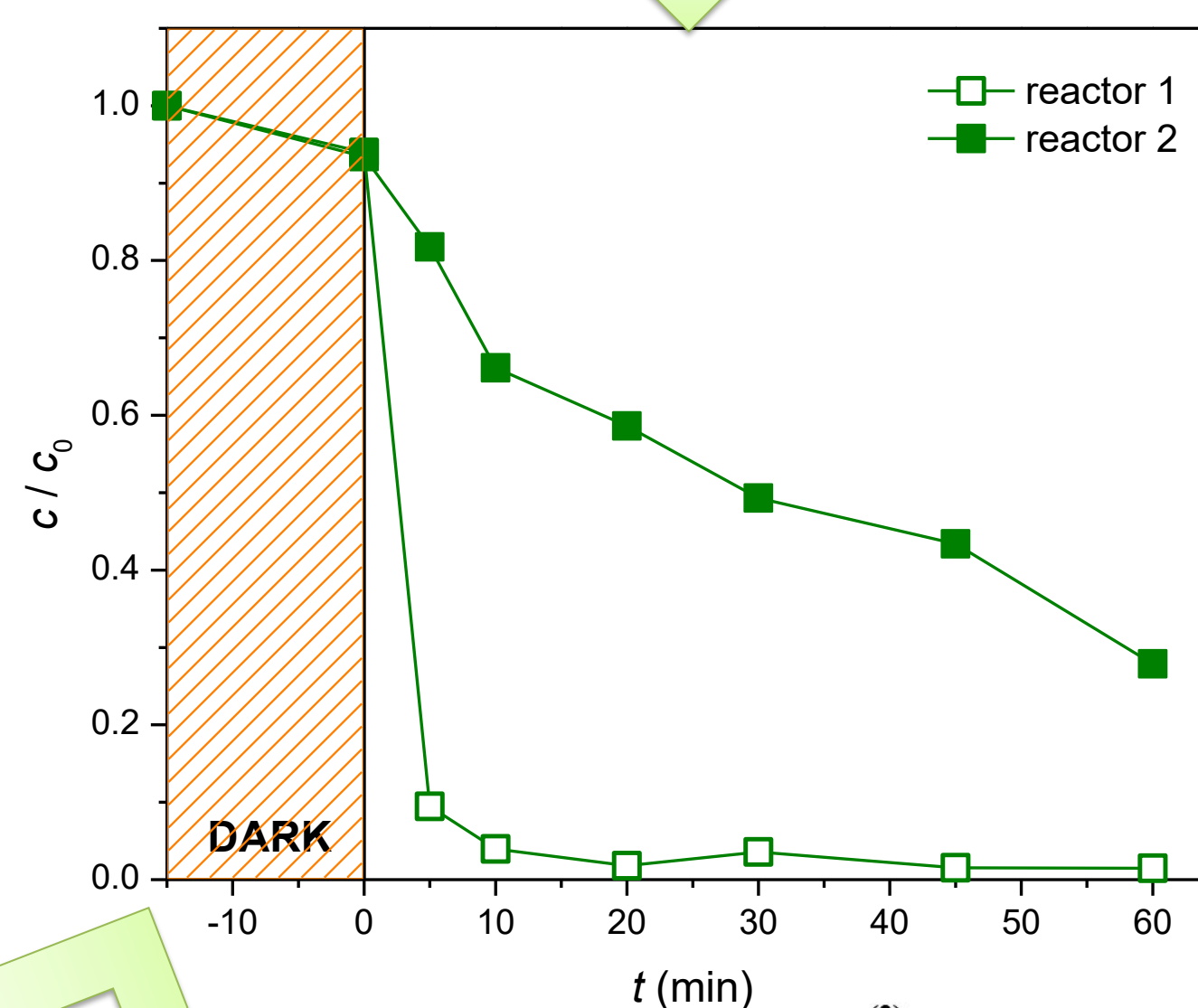
Commercial formulation of ciprofloxacin



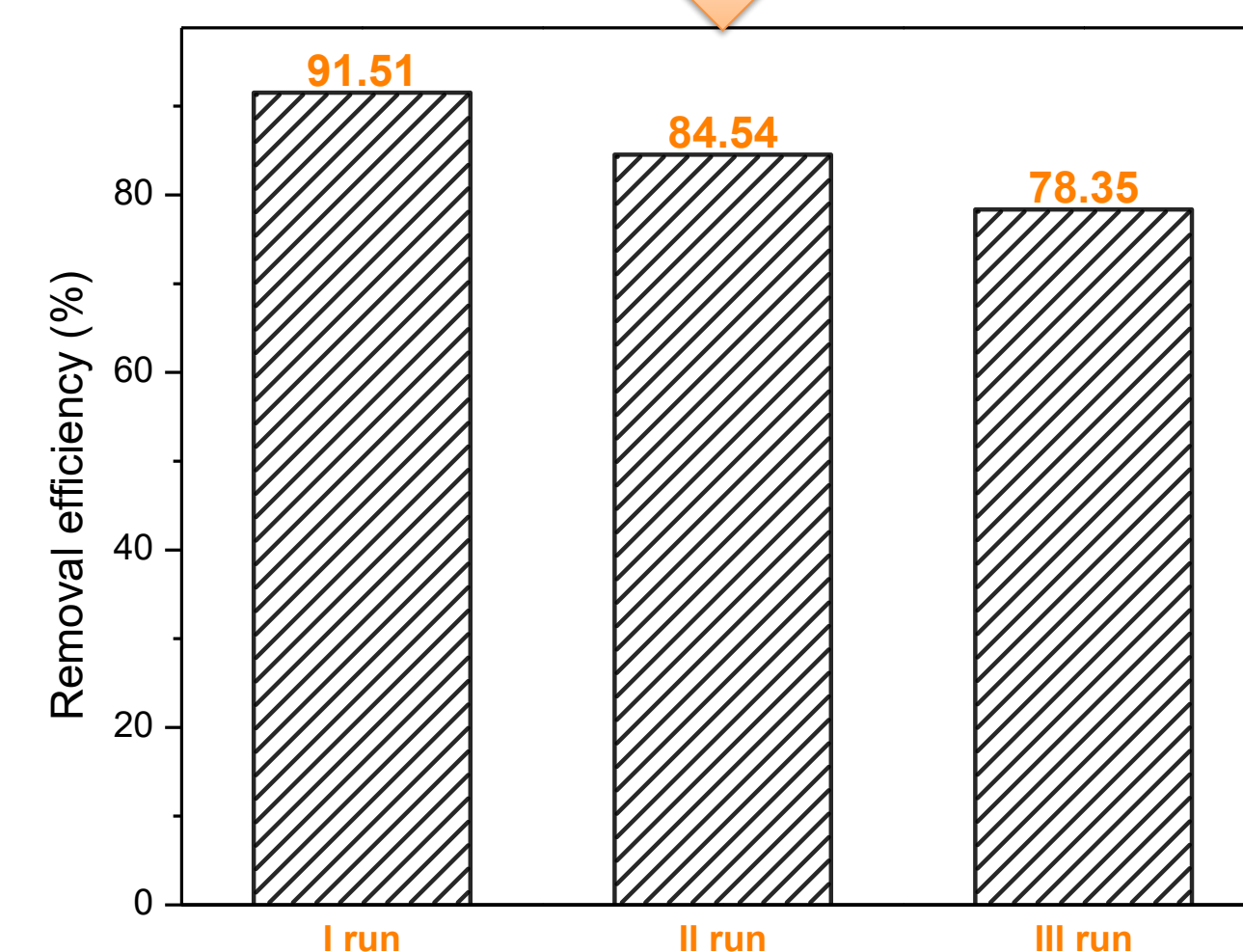
Effect of the initial CIP concentration on the removal efficiency in the presence of ZnO (0.5 mg/mL) under simulated sunlight



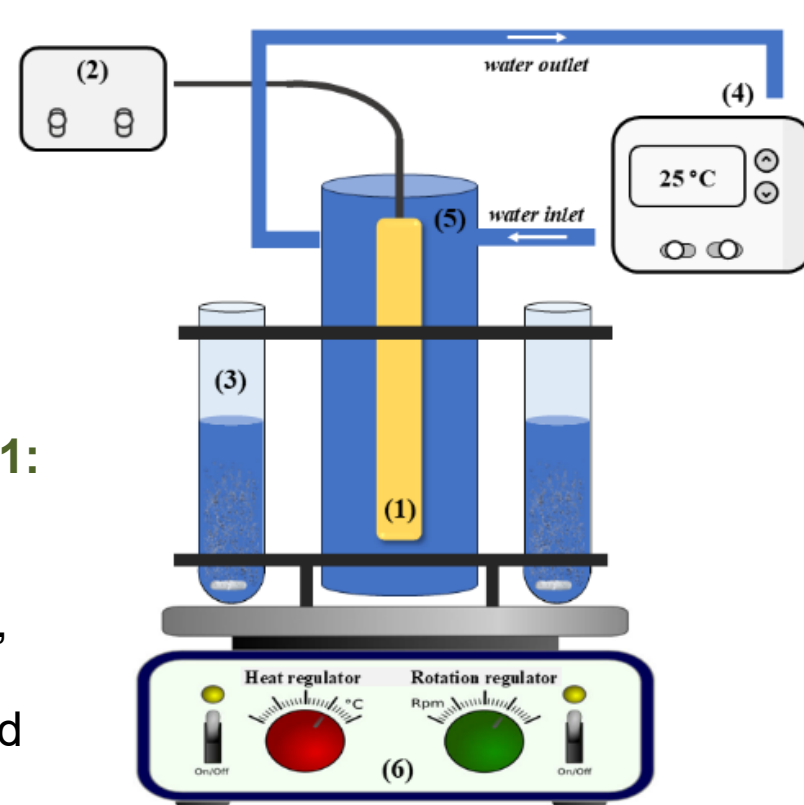
Removal efficiency of CIP (0.05 mM) using ZnO (0.5 mg/mL) and two different photoreactors under simulated sunlight



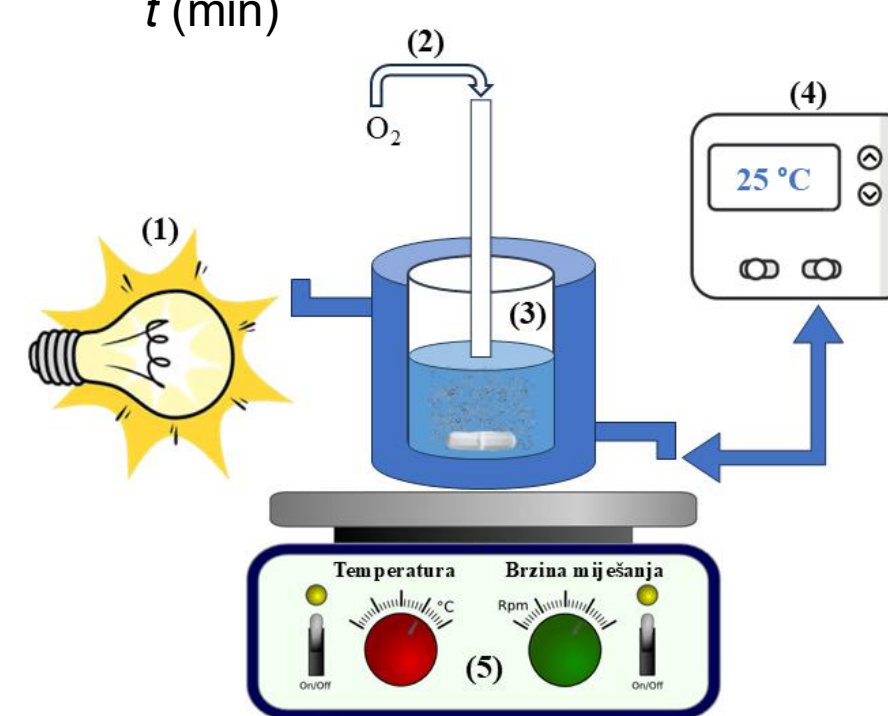
ZnO reusability test



Parts of photoreactor 1: irradiation source (1), lamp controller (2), photochemical cell (3), thermostat (4), quartz cold trap (5), and magnetic stirrer (6)



Parts of photoreactor 2: irradiation source (1), oxygen inlet (2), photochemical cell with a water circulating jacket (3), circulatory thermostat (4), and magnetic stirrer (5)



Acknowledgements

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