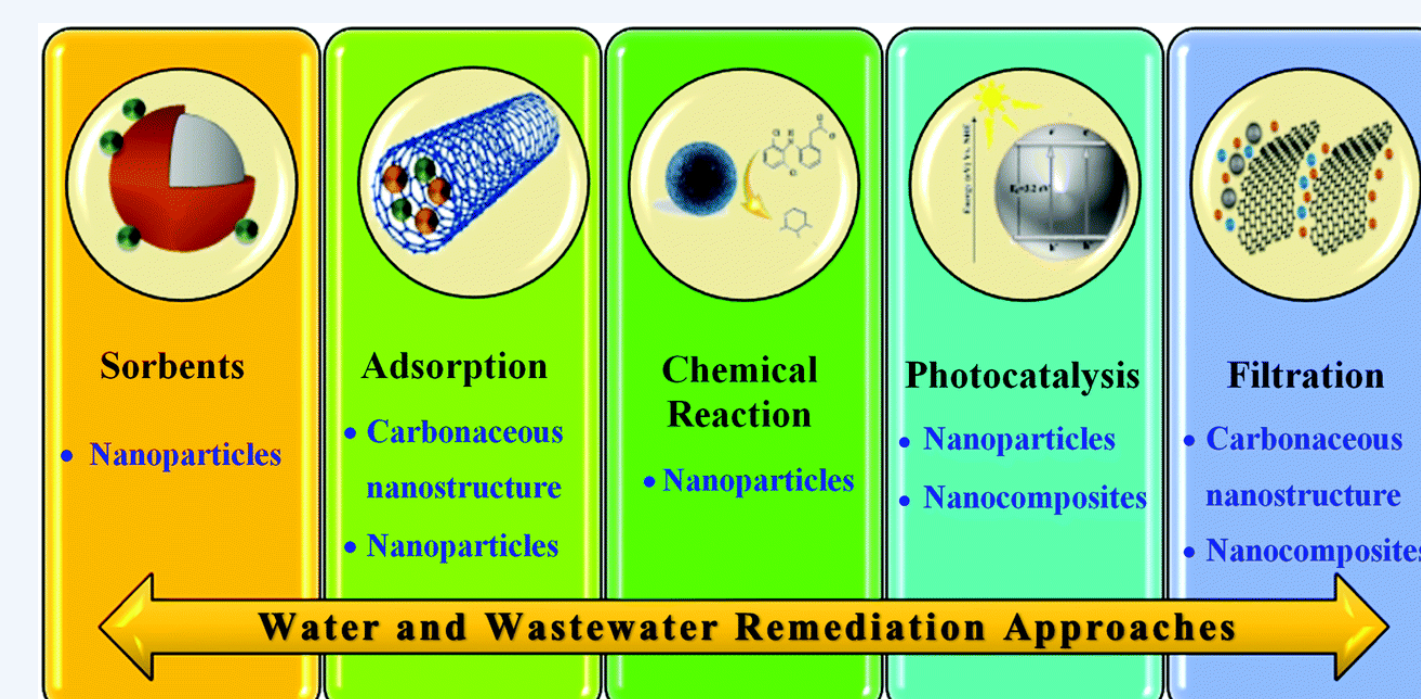


INTRODUCTION

Refinery waste products, such as polyaromatic hydrocarbons (PAH), fail to be extracted from refinery effluents via filtration and adsorption, posing a threat on human health and the environment. Unlike bacterial-mediated oxidation, the use of semiconductor photocatalysis and advanced oxidative processes is a potential solution to this issue as the catalyst can be recycled and no harsh chemical oxidants are needed. Metal oxides as semiconductors, specifically more basic ones, have been proven to be highly effective in PAH degradation. Various synthetic routes were investigated in addition to different semiconductor supports. Zinc oxide is favoured due to its basicity in nature and larger particle size for efficient recyclability. Given the benefits of semiconductor photocatalysis compared to current PAH degradation methods, this study seeks to determine the most effective method to synthesize and design more efficient nanoparticle catalysts for photooxidative degradation.



Taghipour, S. et al. *New J. Chem.* **2019**, 43, 7902-7927.

METHODS

Synthesis of Au Nanoparticles Doped Metal Oxides

HAuCl₄•xH₂O, metal oxide, I-2959

UVA light
5 hr

Wash



Reagents: 1 μM PAH, H₂O₂

Solvent: 30/70 Methanol/H₂O

Catalyst: 10 mg AuNP/metal oxide

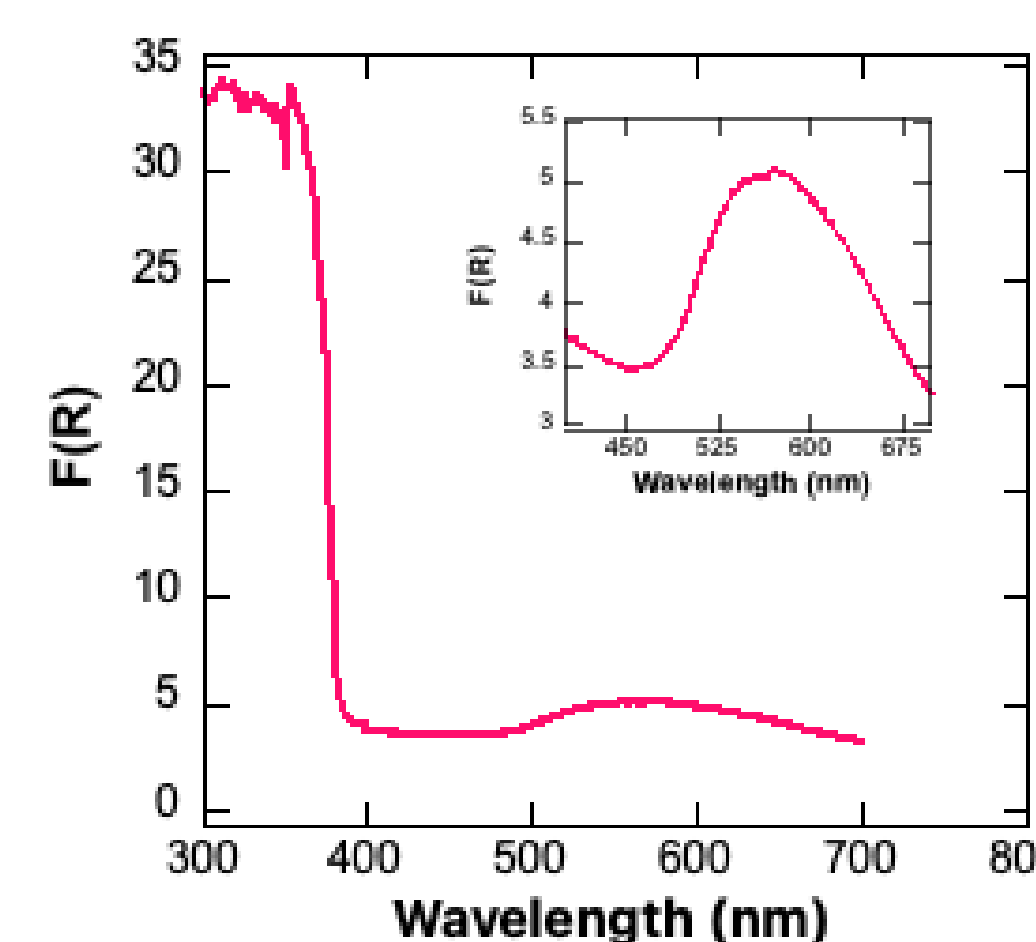
Conditions: Green light irradiation (λ_{max} 530 nm) w/ stirring

Instrumentation: Luzchem LEDi photoreactor; HPLC analysis

CHARACTERIZATION

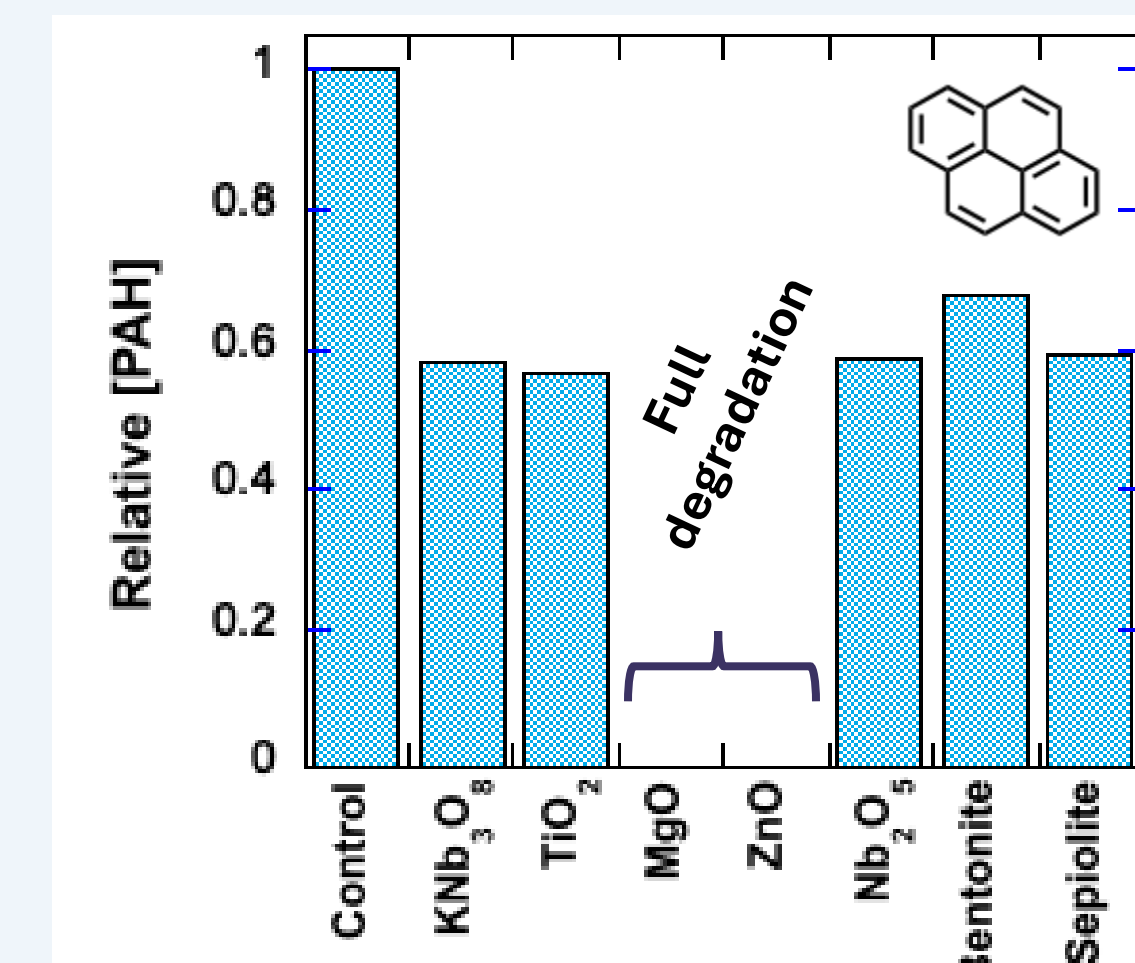


TEM of Supported AuNP on metal oxide
Ave. size ~ 15-17 nm

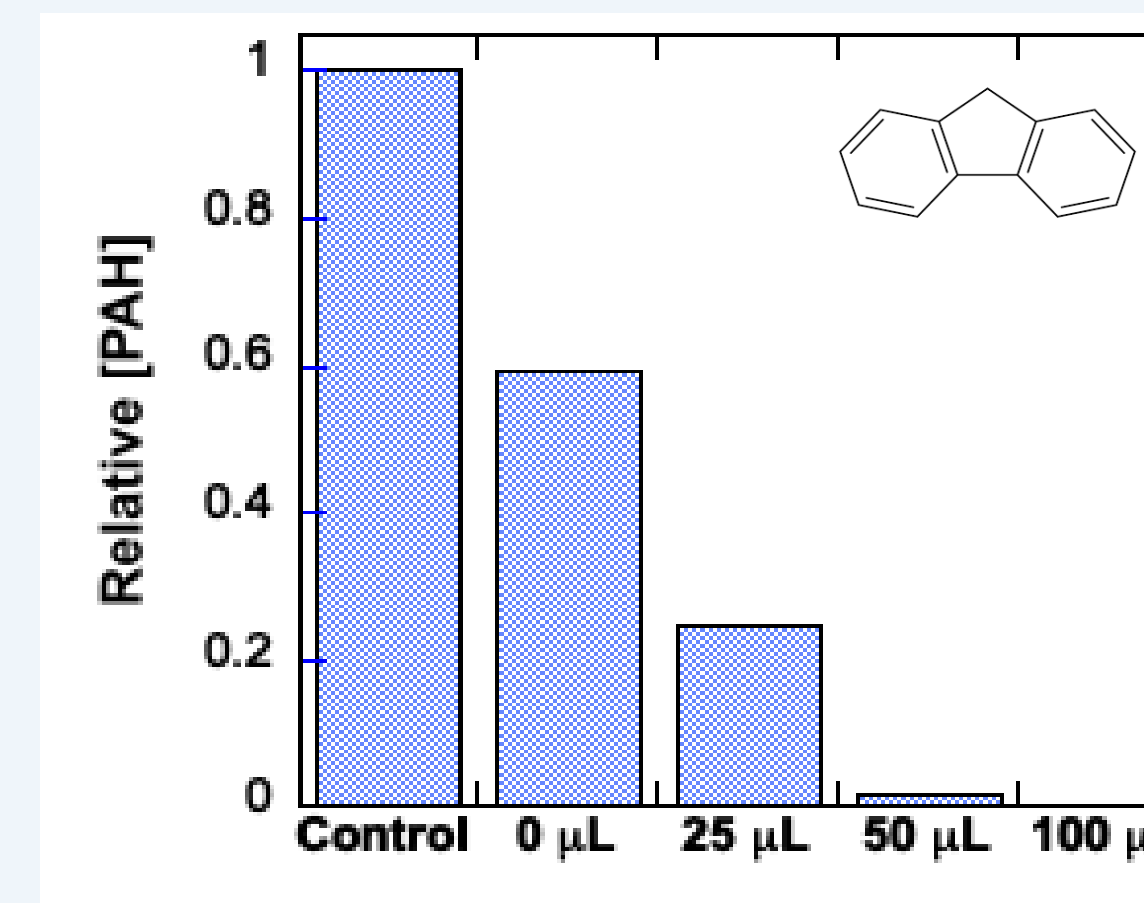


Two bands:
340 nm = ZnO E_{gap}
540 nm = AuNP SPR

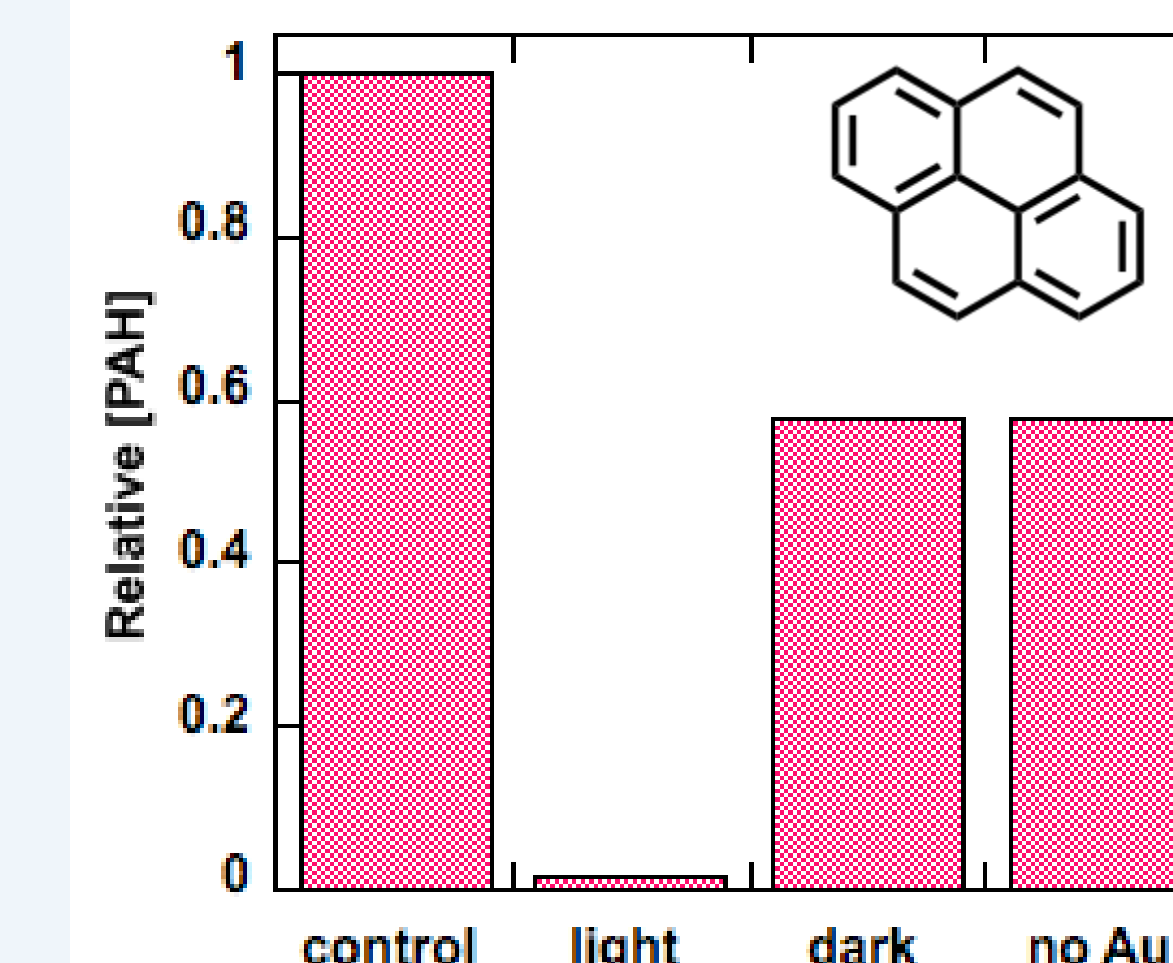
RESULTS



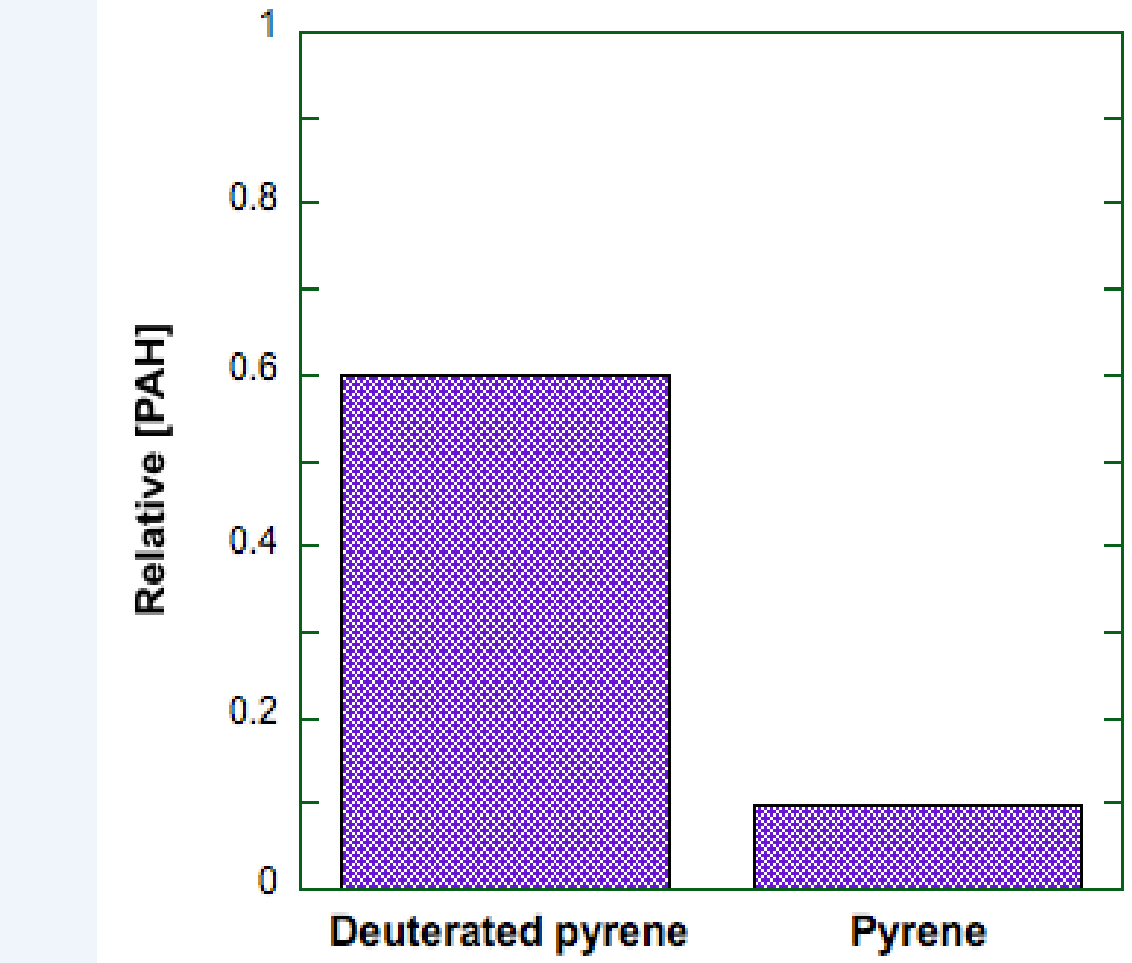
Metal oxide supports that exhibit basic characteristics are more effective at photoremediation over 40 min LED exposure.



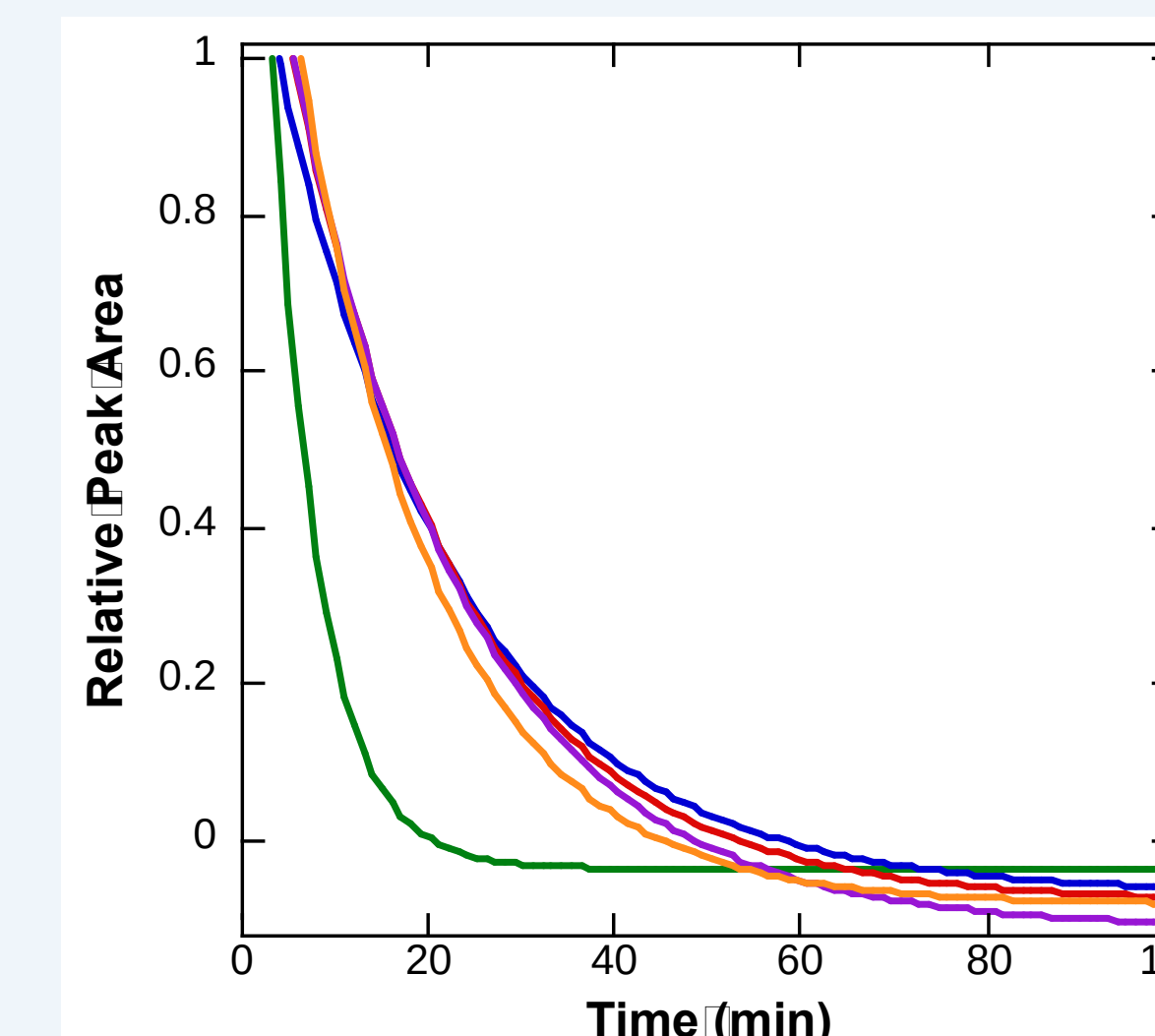
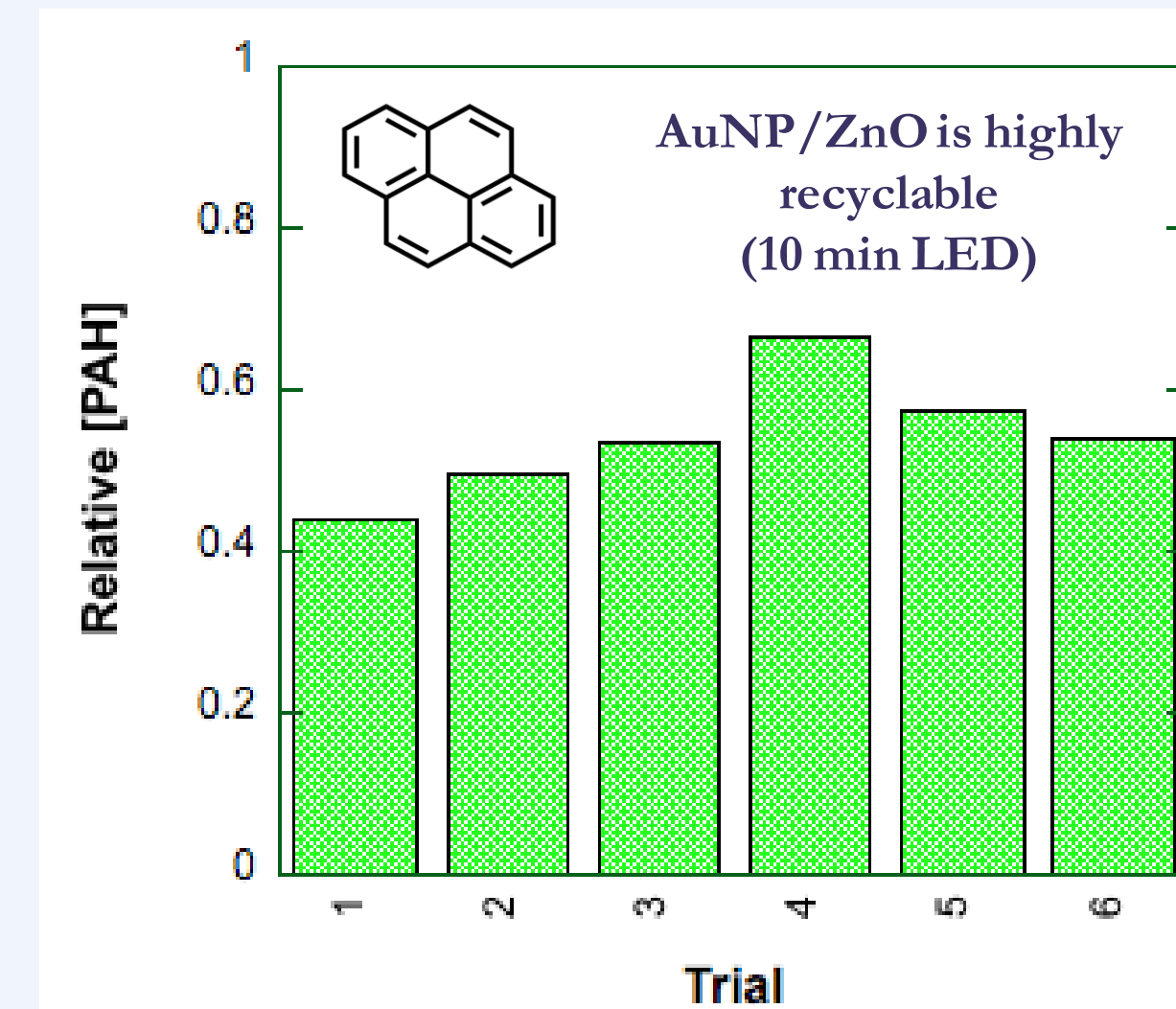
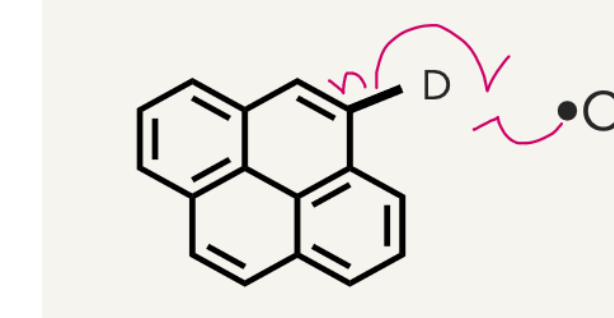
H₂O₂ is required for effective PAH photodegradation;
1 hr LED exposure, Catalyst: AuNP/ZnO



In the absence of light, little PAH degradation is observed.
1 hr LED exposure, Catalyst: AuNP/ZnO



Reactive oxygen species play a key role in degradation mechanism – illustrated by diminished remediate using deuterated substrate.



PAH					
% degradation (60 min)	95	97	98	99	96

Photocatalysts has been proven effective in fully degrading various PAHs in under 60 minutes

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Dept. of Physics
TEM Data

ACADIA
UNIVERSITY



CONCLUSIONS/FUTURE WORK

- Heterogeneous AuNP catalysts show good promise for catalytic pollution removal
- Green LED irradiation of the reaction mixture shows a great improvement on PAH decomposition
- Basicity of the metal oxide semiconductor clearly plays a critical role in the photocatalytic decomposition
- Photocatalytic degradation shows wide versatility in PAH degradation under 60 minutes of green LED exposure, with zinc oxide supports showing optimal results

Future Work:

- Test various experimental parameters: illumination intensity, full time trials on ZnO with various PAHs, effect of pH, wavelength of light
- Attempt to further extend the light response of the catalyst using Au nanorods under red and UV light
- Examine the effects of photodegradation under UV light and investigate the mechanism of PAH degradation