Dual-Component Structures for Selective Pollutant Decomposition via Photocatalysis

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RESEARCH QUESTION:

Can unique additively manufactured composite structures show increased decomposition of a particular compound of interest (COI)?

BACKGROUND & MOTIVATION:

- This project proposes a novel way to decompose harmful gas pollutants into a valuable source of green energy
- The COI is a toxic gas that can be produced naturally and in industrial processing[1]
- Photocatalysis can help manage the particular COI focused on in this study[2]

CATALYST MANUFACTURING:

- 3 catalytic structure types created:
  - base catalyst (PC 1)
  - modified catalysts (PC 2, PC 3)
- Ink prepared using 95 wt% active material
- Rheological properties established for smooth flow
- Printed by a direct ink writing (DIW) process and CAD assistance

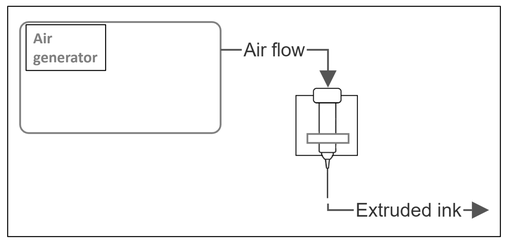


Figure 1. Schematic for 3D printing via DIW process.

REACTION SETUP:

- Volumetric flow rate, temperature established via gas generator
- Flow through bypass for initial concentration reading
- Valve switches flow to reactor for experimental data collection
- Effluent gas analyzed using digital gas analyzer

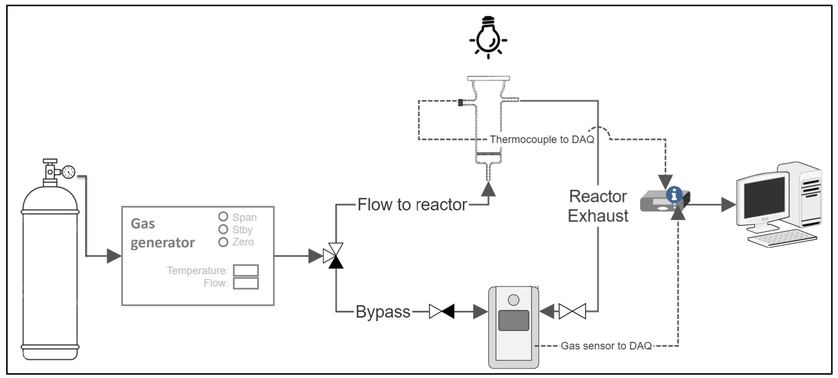


Figure 2. Reactor and data analysis setup for H_2S flow through 3D-printed monolithic structures

ANALYSIS:

Quantifying Potential Decomposition

- Consistent catalyst formulation establishes dependability in data comparison
- Background adsorption tests completed
- Comparative data between PC 1 and modified PCs 2 & 3 to show enhanced performance
- Concentration changes in COI and gaseous byproducts monitored

General decomposition mechanism using a photocatalyst[3]

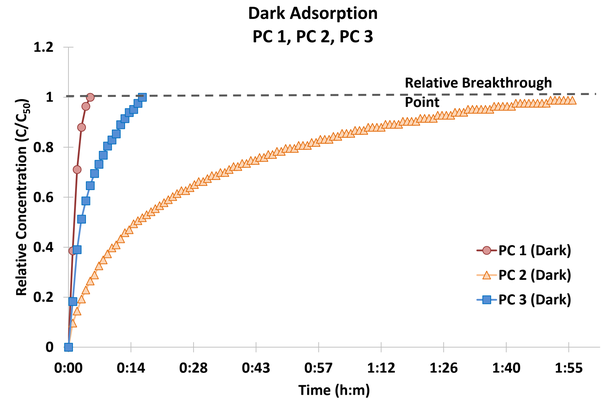
$PC + h\nu \rightarrow PC\ (e^- + h^+)$

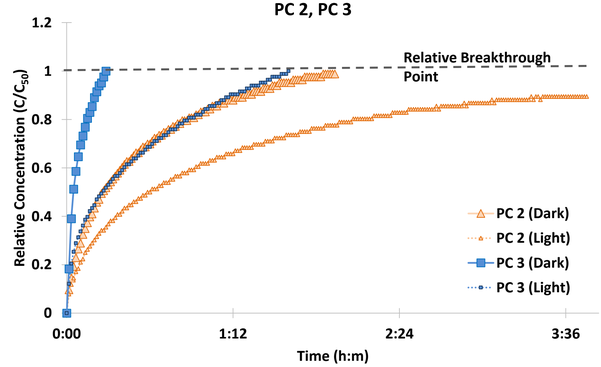
$COI + 2\ h^+ \rightarrow X + 2\ Y^+$

$2\ Y^+ + 2\ e^- \rightarrow Y$

RESULTS AND DISCUSSION

- Background studies identified potential losses to reactor
- Empty reactor tests indicate no photolytic decomposition





- Demonstrated adsorbent-modified catalysts can be printed using DIW using appropriate rheology
- Modifications to PC 1 show increased adsorbent capacity
- Light-based tests of PCs 2 and 3 suggest gas destruction
- PC 2 indicates highest COI decomposition potential

REFERENCES:
1. Baldovi, H. G.; Albero, J.; Ferrer, B.; Mateo, D.; Alvaro, M.; García, H., *ChemSusChem*, **2017**, *10* (9), 1996–2000.
2. Dan, M., Yu, S., Li, Y., Wei, S., Xiang, J., & Zhou, Y., *Journal of Photochemistry and Photobiology C: Photochemistry Reviews*, **2020**, *42*, 100339.
3. Niederberger, M.; Schreck, M. *Chem. Mater.*, **2019,** *31*, 597-618.

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