





Research Papers

MOF-derived Co_3O_4 @P-doped carbon nitride/ α - Fe_2O_3 nanocomposite as a dual Z-scheme photocatalyst for persulfate mediated Bisphenol-A degradation

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Highlights

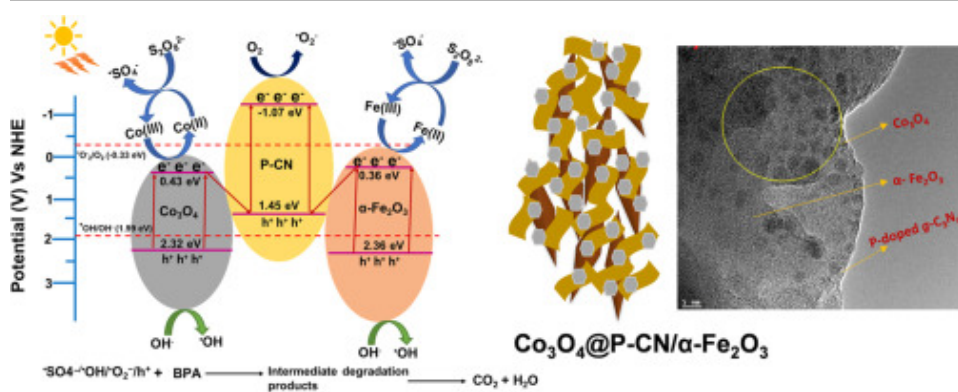
- Co_3O_4 /phosphorus-doped g- C_3N_4 / α - Fe_2O_3 ternary composite derived using MOF precursors.
- Ternary composite exhibits dual Z-scheme photocatalytic degradation mechanism.
- Ternary composite shows higher degradation efficiency of 99.3 %.
- Ternary composite possesses high structural stability and reusability.

Abstract

In this study, a Co_3O_4 /phosphorus-doped g- C_3N_4 / α - Fe_2O_3 (Co_3O_4 @P-CN/ α - Fe_2O_3) composite was synthesized by a two-step method using respective MOF precursors. Initially, amine-functionalized Fe-

MOF (Fe-MIL-88b) was co-condensed with phosphonitrilic trimer and melamine in the presence of triethylamine, resulting in a crosslinked polymer of phosphazene-coated Fe-MIL88b (Pz/Fe-MIL-88b). Subsequent Pz/Fe-MIL-88b calcination at 550 °C yielded a P-doped g-carbon nitride (P-CN)/ α -Fe₂O₃ composite. Furthermore, ZIF-67 was co-doped with the P-CN/ α -Fe₂O₃ composite through ultrasonic dispersion, followed by thermal calcination at 350 °C, yielding Co₃O₄@P-CN/ α -Fe₂O₃. However, the hybrid ternary composite exhibited a dual Z-scheme heterojunction in persulfate (PS)-mediated bisphenol-A (BPA) degradation under visible light. Co₃O₄@P-CN/ α -Fe₂O₃ demonstrated superior degradation efficiency (99.3 %) with rapid photocatalytic kinetics (0.0663 min⁻¹) for BPA degradation compared to the binary composite and P-CN. The magnetic Co₃O₄@P-CN/ α -Fe₂O₃ composite exhibited high structural stability and reusability, achieving over 95 % BPA degradation after five cycles under visible light.

Graphical abstract



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Introduction

Over the past decade, many petrochemicals, textiles, and pharmaceutical industrial effluents have significantly contaminated aquatic systems, posing substantial environmental toxicity and human health [1,2]. As a result, detoxifying such effluents poses a significant challenge, requiring an advanced process that is economically viable, sustainable, and eco-friendly[3]. The combination of advanced oxidation (AO) with photocatalysis has gained extensive acknowledgment for its efficacy in addressing environmental issues, particularly compared to traditional methods [[3], [4], [5]]. Specifically, the activation of sulfate radicals ($\text{SO}_4^{\cdot-}$) in a peroxymonosulfate (PMS) or Persulfate (PS)-mediated AO process has garnered considerable attention for the detoxification of organic contaminants [6,7]. The photocatalytic oxidation process generates free radicals such as hydroxyl (OH^{\cdot}) and sulfate ($\text{SO}_4^{\cdot-}$) radicals. These radicals reduce the recombination of photogenerated electron-hole pairs by trapping electrons, thereby enhancing catalytic efficiency for degrading organic pollutants [7,8]. Furthermore, the AO process relies predominantly on the catalyst and PS or PMS medium to degrade contaminants in visible light conditions [9]. Consequently, the AO process holds significant promise for developing a novel hybrid catalyst for pollutant removal in visible light sources.