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ÁREA: Environmental catalysis, photocatalysis and electrocatalysis

Evaluation of quinoline photodegradation from g-C_3N_4/TiO_2 heterostructured materials

Jhonatan D. M. Oliveira[1,*], Alan G. Camara[1], Santiago Arias[1], José Geraldo A. Pacheco[1], Celmy M. B. M. Barbosa[1]

1 Department of Chemical Engineering, Technology and Geosciences Center, Petroleum and Energy Research Institute (i-LITPEG), Refining and Clean Technology Laboratory (LabRefino/Lateclim), Federal University of Pernambuco, Recife, PE 50670-901, Brazil;

**jhonatan.oliveira@ufpe.br*

Resumo-Abstract

The commercial TiO_2-P25 is widely used in the photocatalytic degradation of recalcitrant organic compounds; however, it has a band-gap energy of 3.2 eV, meaning it is activated to generate unstable radicals only through ultraviolet radiation [1]. C-N based materials have often been used in heterojunctions with TiO_2, as they improve the optical and electronic properties of the photocatalyst [2]. The objective of this study is to evaluate the synthesis of a 10%g-C_3N_4/TiO_2 heterostructured material, obtained from melamine, and to compare it with commercial TiO_2 P25 in the photocatalytic degradation of quinoline. The catalyst was synthesized from 2 g of melamine dissolved in 40 mL of ethanol, followed by homogenization for 15 min. Then, 4.5 g of TiO_2 P25 was added, and the mixture was homogenized for 1 h. The system was heated to 60°C to evaporate the ethanol. Subsequently, thermal treatment was carried out in a muffle furnace at a heating rate of 5°C min^{-1}, reaching 500°C and maintaining that temperature for 180 min. The photocatalysis tests were conducted in a batch reactor containing 200 mL of quinoline solution, with a concentration of 20 mg L^{-1} at pH 6.5, and 0.5 g L^{-1} of catalyst under O_2 bubbling. The system was kept in the dark for 30 min to achieve adsorption equilibrium, followed by 120 min under artificial light simulating sunlight. The polychromatic light source (UV-A and UV-B) used was a 300W OSRAM E27 lamp, with an irradiance of 4.6 mW cm^{-2}. The material was characterized using XRD, TGA, and N_2 adsorption/desorption techniques. X-ray diffractograms confirmed the presence of TiO_2 in the anatase and rutile phases. TGA analysis revealed that the minimum temperature required for calcination to obtain 10%g-C_3N_4/TiO_2 is 500 °C. Between 550 °C and 700 °C, thermal decomposition of g-C_3N_4 may occur, leading to the formation of graphite and the release of N_2 [3]. The addition of g-C_3N_4 resulted in a slight decrease in the surface area of commercial TiO_2 P25 (S_{TiO_2} = 52 m^2 g^{-1} to 48 m^2 g^{-1} in 10%g-C_3N_4/TiO_2). Quinoline degradation after 90 min showed an efficiency of 37.2% by photolysis, 94.2% with commercial TiO_2 P25, and 92.4% with the 10%g-C_3N_4/TiO_2 composite, highlighting the high performance of the catalysts compared to simple photolysis. The heterostructured material showed excellent photocatalytic performance in quinoline degradation.

Keywords: band-gap, contamination, photocatalyst, heterojunction.

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