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Photoelectrocatalysis with PVB/TiO_2/Graphite Electrode: A Synergistic Approach for Paracetamol Degradation

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Highlights

Production of PVB/TiO_2/graphite photoelectrode by electrospinning.
The application of external potential favored the separation of photoinduced charges

Resumo/Abstract

This work presents the application of a photoelectrode composed of PVB/TiO_2/graphite in the degradation of the pharmaceutical compound paracetamol in aqueous medium, using advanced oxidative processes (AOPs) of photoelectrocatalysis. The electrode was produced by electrospinning from a polymeric solution containing 15% (w/v) PVB, 10% w/w TiO_2, and 5% graphite, using ethanol. The electrospinning parameters were: 14 kV voltage, needle-to-collector distance of 10 cm, and a flow rate of 1.0 mL/h. After electrospinning, the materials were subjected to calcination at 400 °C in a nitrogen atmosphere, an essential step to ensure membrane adhesion to the FTO plate and improve surface wettability, evidenced by the reduction of the contact angle from 66° to approximately 0°. Morphological characterization by scanning electron microscopy (SEM) revealed that, before calcination, the material presented cylindrical fibers with external granulations and an average diameter of 1.958 ± 0.395 µm (Figure 1(a)). After thermal treatment, degradation of PVB was observed, leaving only granules attributed to graphite and TiO_2 (Figure 1(b)). In the degradation assays (Figure 1(c)), irradiation was performed with a 10 W LED lamp (365 nm), positioned 2 cm from the solution, and the potential applied by chronoamperometry was 1.2 V. Experiments were conducted with the electrode under: absence of light, presence of light, and presence of light and potential. Light alone promoted 55% degradation due to the generation of electron/hole pairs (e^-/h^+) in the TiO_2 semiconductor, with the holes contributing to the formation of hydroxyl radicals and other reactive oxygen species. The application of external potential favored the separation of these photoinduced charges, reducing recombination and increasing the availability of oxidizing agents at the electrode/solution interface, which raised the degradation efficiency to 69%. Despite a slight performance reduction in the second cycle, energy-dispersive X-ray spectroscopy (EDX) analyses indicated no loss of TiO_2 to the medium, as verified in the electrode before and after the usage cycles, as well as in the solution, which showed no traces of the material.

(a) (b) (c)

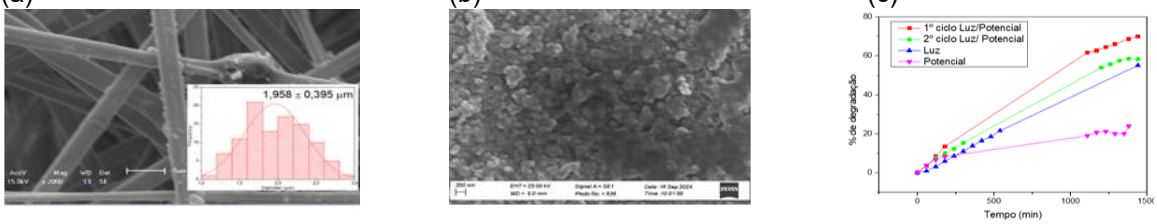

Figure 1: SEM images of electrospun PVB/Graphite/TiO_2 membranes: (a) before calcination and (b) after calcination. Magnification of 2000x. (c) Photoelectrodegradation study of paracetamol (5 mg/L) in 0.1 mol·L^{-1} Na_2SO_4 electrolyte solution.

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