IMMOBILIZATION OF ZINC OXIDE IN CHITOSAN HYDROGEL MEMBRANE FOR PHOTODEGRADATION OF FOOD DYES

Oral

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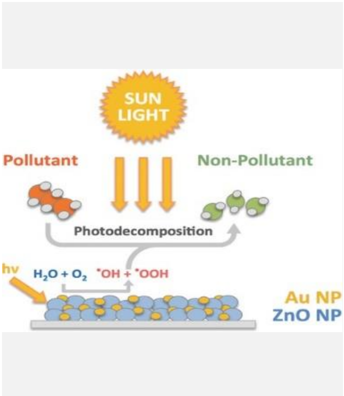

Zinc oxide is considered a promising photocatalyst due to its good performance in photocatalysis, being effective in treating resistant pollutants in the aquatic environment. Despite this, it has a wide band gap spectrum of the order of (3.2 eV), with a large exciton binding energy of 60 meV at room temperature, restricting its application under UV radiation. To achieve good performance, doping and immobilization methodologies have been used on different materials. Chitosan hydrogel membranes are ideal for the photocatalyst immobilization process due to the fact that they have advantages such as permeability, hydrophilic nature, natural product, low cost, biodegradable and high adsorbent power and the presence of different functional groups, such as hydroxyl and amino, which allow the use of different immobilization methods. In this brief literature review, the photocatalytic performance of zinc oxide immobilized in a polymeric matrix, such as a chitosan hydrogel membrane, was analyzed.

Introduction

The use of dyes in the food industry dates back several centuries and has been a practice, aiming to improve visual appeal and attractiveness to consumers. However, synthetic dyes from the azo group have complex molecular structures and are chemically stable and are not biodegradable and can accumulate in the aquatic environment, causing risks to aquatic life and human health [1].Toxicological studies on food colorings indicate different types of toxicity, such as carcinogenic, mutagenic and clastogenic activity [2]. Currently the most effective methods for treating resistant pollutants are advanced oxidation processes (AOPs). Photocatalysis technology is considered effective, low-cost and environmentally friendly. Photocatalysis involves redox reactions induced under electromagnetic radiation (UV or visible light) using photocatalitc materials.They are excited and produce electrons (h+) and reactive species O2 and H2O2 that react strongly with pollutants, degrading them, which means that a compound can be transformed in order to obtain as final products only carbon dioxide (CO2), water (H2O) and other non-toxic products, avoiding the production of waste [3].

Zinc oxide is a promising photocatalyst in environmental remediation processes, due to the fact that it has peculiar characteristics such as; a wide band gap in the order of (3.2 eV), with a large exciton binding energy of 60 meV at room temperature [4].

However, this photocatalyst material has certain disadvantages, such as high bandgap energy of 3.2 eV (restricting its application under UV radiation) and reduced porosity/surface area [5].

A large number of studies involving zinc oxide photocatalysts have referred to doping methods and/or composites to improve their activity, as the ZnO photocatalyst works satisfactorily when its bandgap is reduced [5]. However, immobilization of the photocatalyst is a viable alternative because the use of a catalyst in suspension has demonstrated disadvantages due to the difficulty of separating the medium after the process and has tended to block UV light by suspended particles. Therefore, immobilization increases the photocatalytic performance of the material, reduces operational costs, facilitates reuse and makes the process ecologically favorable, with greater efficiency [6]. Biopolymers such as chitosan have been an ideal support for the immobilization of catalysts. The justification is that supports for photocatalysts in general must be permeable to electromagnetic radiation to allow activation of the system [7], have adsorption capacity in the system, and, therefore, synergistic action of photodegradation processes. The chitosan biopolymer has these affinities. In view of this, a brief literature review presents studies on the application of photocatalysis and evaluates its efficiency in the degradation of polluting food dyes, using polymeric support such as chitosan hydrogel membrane for immobilization

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Methodology

The bibliographic research was carried out with a focus on studies on heterogeneous photocatalysis, on the approach to immobilizing photocatalysts on biodegradable polymers, in the Science Direct database, using the following keywords: "Photocatalysis" ¨biodegradable" "polymer"¨ ¨immobilization ¨.

The efficiency of photocatalytic degradation and the operational parameters and reuse of the composites were established and culminated in the discussion of the main articles related to the, Chitosan biopolymer as support for catalyst immobilization.

Results and Discussion

Application of zinc oxide in the photocatalysis of food dyes. [8], synthesized zinc oxide nanoparticles (ZnO-NPs) and evaluated their application in removing the yellow dye tartrazine (TY), using visible light and k = 0.0077 min^{-1}. It presented potential application for photodegradation of TY, reaching 78% degradation.

These results are explained by the large surface area, the differences in charge between the material and the pollutant, in this case, the presence of negative charges in the photocatalytic material that allowed greater adsorption of the pollutant. Operating parameters were also addressed, such as PH, material and pollutant concentration. For ideal parameters, the reaction percentage of photodegradation tends to be favored. This percentage, although satisfactory, deteriorates photocatalytic performance over time due to the loss of photocatalytic particles.

[9] studied the performance of ZnO immobilization on chitosan/cellulose microfibrils in the photocatalysis of methyl orange dye under 254nm UV irradiation, under favorable conditions of pH =6, the material was efficient around 97% in 300 min of reaction. These results are justified by the good adsorption of chitosan and the synergy effect between the photocatalyst and the biopolymer that exposes the pollutant on the surface of the membrane. Which allows the easy reaction of oxidizing agents produced in semi-metallic materials.

An analysis of the efficiency of pollutant degradation using a photocatalyst immobilized in chitosan polymer was carried out, and it was proven that there is a synergy effect between ZnO and the membrane, due to the considerable increase in pollutant degradation. [10] however, the influence of time, concentration and temperature parameters must be evaluated. studies, found that increasing the catalyst concentration promotes an increase in photocatalytic activity,

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The increase in the activity of the immobilized catalyst may be related to the surface area of the membrane that allows greater dispersion of ZnO in the networks formed by the chitosan molecule, providing a good reaction area for pollutant degradation..

Conclusions:

This review presented studies developed on ZnO photocatalyst immobilized on biopolymeric support, which are current trends applied in environmental remediation. It was observed that the biopolymer immobilization photocatalysis system showed excellent photocatalytic activity in the degradation of organic dyes. This is due to the high UV absorption and chemical stability of the photocatalyst and the high adsorbent power and presence of different functional groups, such as hydroxyl and amino of chitosan, which allow the use of a supporting substrate for immobilization and facilitates the reuse of the material.

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