Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Recent advances in metal oxide photocatalysts for photocatalytic degradation of organic pollutants: A review on photocatalysts modification strategies

R.S.R. Mohd Zaki [a,b], R. Jusoh [a], I. Chanakaewsomboon [c], H.D. Setiabudi [a,b,*]

[a] Faculty of Chemical & Process Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia
[b] Centre for Research in Advanced Fluid & Processes, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300, Gambang, Kuantan, Pahang, Malaysia
[c] Faculty of Environmental Management, Prince of Songkla University, 15 Kanjanavanich Rd., Hat Yai, Songkhla 90110, Thailand

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Photocatalysis
Photocatalyst
Metal oxide
Organic compounds

ABSTRACT

Wastewater from industries that predominantly consist of organic pollutants significantly contributes to water pollution and harms the environment, demanding urgent solutions. Among the available wastewater treatment technologies, photocatalysis has garnered considerable interest due to its high efficiency, cleanliness, and sustainability. However, metal oxide photocatalysts, despite extensive study, possess limitations such as agglomeration, rapid electron-hole recombination, and photo corrosion. These limitations hinder the practical design and synthesis of photocatalysts. To address these challenges, researchers have explored various photocatalyst modification approaches, including doping with noble or non-noble metals, crystal facet engineering, physical deposition, dye sensitization, and the implementation of the Z-scheme photocatalyst system. These modifications aim to enhance the catalytic properties of photocatalysts and improve the degradation of organic pollutants. This review article highlights recent advances in the modification strategies of metal oxide photocatalysts for the photocatalytic degradation of organic pollutants. The future prospect and conclusions were also discussed. This review is expected to provide an in-depth understanding of metal oxide photocatalyst development, thus accelerating the evolution of photocatalytic degradation of pollutants.

1. Introduction

Water is one of the necessary elements for the sustainability of humans, animals, and nature, whereby clean drinking water is vital to sustaining a healthier life. However, rapid urbanization has negatively impacted the environment, in which the presence of pollutants beyond permitted limits causes significant adverse effects [1]. The common pollutants found in wastewater are organic pollutants, including phenols, pesticides, chloro-compounds, nitrogen-containing compounds, Rhodamine B (RhB), and dyes [2,3]. The industries that are responsible for generating a high volume of organic pollutants are leather [4], textile [5], paints [6], dyes [7], pharmaceuticals industries [8], petroleum/refineries [9], as well as pulp and paper industry [10–13]. A high concentration of these organic compounds in the environment significantly affects the human brain, lungs, kidneys, liver, heart, and spleen [14,15]. This is due to the properties of the organic compound, which are carcinogenicity, mutagenic, and teratogenic, resulting in cytotoxic effects on humans and nature [10,16]. Therefore, effective wastewater treatment has become a goal to be explored. Several methods have been explored for wastewater treatment, including physical, biological, ultrafiltration [17], ion exchange [18], adsorption [19], and photocatalysis [20]. Among others, photocatalysis has received much interest owing to its sustainability and promising performance in removing and breaking organic pollutants [21,22].

An increasing interest in photocatalytic degradation can be observed in Scopus papers' evolution from 2000 to 2022 (Fig. 1). In particular, 59,760 documents on photocatalytic degradation were recorded in the Scopus database as of September 2022 by using search criteria of the article title, abstract, and keyword. From 2000 to 2022, an annual increase in the number of publications is observed, with more than 43%, in total. Apart from that, it is observed that the number of review articles increases year

* Corresponding author.
E-mail address: herma@ump.edu.my (H.D. Setiabudi).

https://doi.org/10.1016/j.matpr.2023.07.102