Coordination Chemistry Reviews 510 (2024) 215834

Contents lists available at ScienceDirect

Coordination Chemistry Reviews

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

Review

Recent advances on synthesis and photocatalytic applications of MOF-derived carbon materials: A review

Riyadh Ramadhan Ikreedeegh [a,b,c,*], Md. Arif Hossen [d,e], Areen Sherryna [f], Muhammad Tahir [a,*]

[a] Chemical and Petroleum Engineering Department, UAE University, P.O. Box 15551, Al Ain, United Arab Emirates
[b] Department of Analysis and Quality Control, Sarir Oil Refinery, Arabian Gulf Oil Company, El Kish, P.O. Box 263, Benghazi, Libya
[c] Libyan Advanced Center for Chemical Analysis, Libyan Authority for Scientific Research, Tripoli, Libya
[d] Faculty of Civil Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Pahang, Malaysia
[e] Institute of River, Harbor and Environmental Science, Chittagong University of Engineering and Technology, 4349 Chattogram, Bangladesh
[f] Faculty of Chemical and Energy Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Johor, Malaysia

ARTICLE INFO

Keywords:
MOF-derived carbon materials
Synthesis
Morphology control
Photocatalytic CO_2 reduction
Hydrogen production
Pollutants degradation

ABSTRACT

Owing to their exceptional advantages, MOF-derived carbon materials (MDCMs) have gained a great interest as promising nanomaterials for environmental and energy photocatalytic applications. Numerous research activities were stimulated accordingly which focused mainly on the properties, synthesis, classifications, structural modulation and applications of their based materials as potential photocatalysts. All these aspects were comprehensively covered and critically discussed in this review in a way that has not been presented previously. Initially, the review outlines the main fundamentals of the photocatalysis process through the utilization of MDCMs. Then, the main properties and characteristics of MDCMs are highlighted. Furthermore, the recent advances in the synthesis approaches and the structural modulation of MDCMs are discussed in depth. Moreover, the main applications of MDCMs including photocatalytic CO_2 reduction, H_2 production and degradation of pollutants are summarized, considering only the recent studies reported in the past decade. Eventually, the conclusions and future recommendations for the usage of MDCMs in the fields of energy and environmental remediation are presented.

1. Introduction

The industrial revolution has led to a detrimental increase in global energy requirements while the excessive consumption of fossil fuels, which represent almost 80 % of our energy resources, has led to several environmental problems including global warming, climate change, sea level rise, acid rains, losses of biodiversity and health-related issues [1–5]. Hence, looking for clean and sustainable technologies for environmental remediation and energy production is highly needed in the future. Among all the current technologies, photocatalysis has gained a huge interest due to its low cost, sustainability, eco-friendliness and mild reaction conditions [6–10]. This strategy utilizes solar light energy for the conversion of greenhouse gases, water and organic pollutants into valuable fuels and chemicals through the usage of a semiconductor material known as photocatalyst. However, this photocatalyst plays a key role in this photochemical process and hence numerous studies and researches have been reported for designing photocatalyst materials with high photocatalytic efficiency [11–15]. Carbon-based materials represent promising candidates in this field due to their high surface area, high chemical stability and high electronic conductivity. However, conventional synthesis methods of these materials such as pyrolysis of organic compounds or biomass materials, high-temperature hydrothermal and solvothermal methods and vapor phase decomposition methods suffer from certain issues including, morphologies, specific surface area and pore size control which limit their applications [16,17]. To overcome these limitations, carbon materials derived from metal-organic frameworks (MOFs) have been introduced and become a research hotspot in the recent years as illustrated in Fig. 1 **(a)** [18–21]. The first attempt of using metal–organic framework as a template for the synthesis of porous carbon was reported by Liu and coworkers [22].

The MOF-derived carbon materials (MDCMs) show several advantages over other carbon materials, such as uniform structures, high

* Corresponding authors at: Chemical and Petroleum Engineering Department, UAE University, P.O. Box 15551, Al Ain, United Arab Emirates (Riyadh Ramadhan Ikreedeegh)..
E-mail addresses: ikreedeegh@graduate.utm.my, riyadhkridiegh@gmail.com (R. Ramadhan Ikreedeegh), muhammad.tahir@uaeu.ac.ae (M. Tahir).

https://doi.org/10.1016/j.ccr.2024.215834
Received 17 December 2023; Accepted 22 March 2024
Available online 5 April 2024