

Review

University of Oslo-66: A Versatile Zr-Based MOF for Water Purification Through Adsorption and Photocatalysis

Lei Chen, Wenbo Pan, Ke Li *, Miaomiao Chen, Pan Li, Yu Liu, Zeyu Li and Hai Lu 

Key Laboratory of Song Liao Aquatic Environment, Ministry of Education, Jilin Jianzhu University, Changchun 130118, China; chenlei.jliae@hotmail.com (L.C.); panwenbo2023@163.com (W.P.); chenm192@163.com (M.C.); lipan990811@163.com (P.L.); 13407991833@163.com (Y.L.); lizeyu03212022@163.com (Z.L.); haimm110@126.com (H.L.)

* Correspondence: like123@163.com

Abstract: Metal–organic frameworks (MOFs) have garnered significant attention for water purification in recent years. In particular, UiO-66 (a member of the UiO-MOF family, developed at the University of Oslo) has emerged as a promising water purification material. UiO-66 exhibits excellent adsorption through electrostatic interaction, π – π stacking and Lewis acid–base coordination mechanisms. The photocatalytic degradation property was enhanced through metal doping, composite with semiconductor materials, defect engineering, etc., and the removal efficiency of pollutants was significantly improved. This review systematically describes the structure of UiO-66 and the synthesis methods of UiO-66, including solvothermal, microwave-assisted, mechanized and electrochemical methods, as well as the application of UiO-66 in the adsorption and photocatalytic degradation of various pollutants.

Keywords: MOFs; UiO-66; adsorption; photocatalysis



Academic Editors: Manuel

J. Chinchillas-Chinchillas, Priscy
Alfredo Luque Morales and Horacio
Edgardo Garrafa-Gálvez

Received: 26 March 2025

Revised: 7 April 2025

Accepted: 8 April 2025

Published: 9 April 2025

Citation: Chen, L.; Pan, W.; Li, K.;
Chen, M.; Li, P.; Liu, Y.; Li, Z.; Lu, H.
University of Oslo-66: A Versatile
Zr-Based MOF for Water Purification
Through Adsorption and Photocatalysis.
Processes **2025**, *13*, 1133. <https://doi.org/10.3390/pr13041133>

Copyright: © 2025 by the authors.
Licensee MDPI, Basel, Switzerland.
This article is an open access article
distributed under the terms and
conditions of the Creative Commons
Attribution (CC BY) license
(<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Water is essential to all life on Earth. However, water pollution, exacerbated by population growth, industrialization, and climate change, poses a persistent global challenge [1]. Contaminants, such as organic dyes [2], antibiotics [3], pesticides [4], heavy metal ions [5], pharmaceuticals and personal care products (PPCPs) [6], fluoride [7], and microplastics [8], affect human normal life and even threaten human health. These pollutants are often resistant to removal from water. Conventional removal methods include physical methods, chemical methods, and biological methods. Physical methods mainly include physical adsorption [9] and membrane separation [10]. Chemical methods mainly refer to advanced oxidation processes (AOPs), including Fenton oxidation, Fenton-like oxidation [11], ozonation [12], photocatalysis [13], and electrochemistry [14]. Biological methods mainly utilize the adsorption and decomposition capabilities of microorganisms to treat pollutants in water bodies [15]. Physical methods, like adsorption, can be limited by low selectivity, chemical processes, such as AOPs, often demand high energy or reagent inputs, and biological approaches may fail against non-biodegradable compounds.

Among these methods, physical adsorption and photocatalytic degradation are widely used for removing pollutants from water due to their adaptability to various contaminants. Adsorption employs high-surface-area materials to capture pollutants, offering a straightforward and cost-effective approach, while photocatalysis utilizes light-driven reactions to break down organic contaminants into harmless byproducts [9,13]. However,

the effectiveness of these techniques depends heavily on the properties of the materials employed, prompting the exploration of advanced materials tailored for water purification.

Metal–organic frameworks (MOFs) are a class of porous coordination polymers with periodic crystal structures formed by self-assembly of metal ions or metal clusters and organic ligands [16]. MOFs are distinguished by a large BET (Brunauer–Emmett–Teller) surface area [17], which supports numerous active sites, low density [18], high chemical and thermal stability [19], and precisely adjustable crystal structures [20] and pore sizes [21], yielding exceptional adsorption capacity [22], as well as unique optoelectronic properties [23]. These attributes enable MOFs to be widely applied in diverse fields, including adsorption [24], energy storage [25], gas adsorption and separation [26], gas transportation [27], chemical sensing [28], biosensing [29], and photocatalysis [30].

In addition to the features mentioned above, MOFs exhibit additional versatility.

1. MOFs can form a variety of topological structures, including cubic [31], tetrahedral [32], octahedral [33], as well as more complex three-dimensional network structures [34]. Figure 1 shows the structure of the regular tetrahedron and octahedron of UiO-66(Zr) [35]. By strategically choosing metal nodes and organic ligands, MOFs with specific topological structures can be tailored to meet targeted applications.

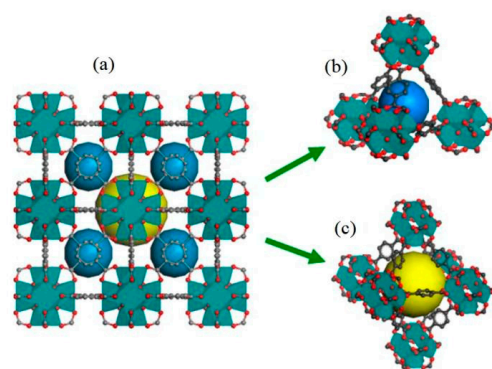


Figure 1. (a) Illustration of the UiO-66(Zr) structure. (b) Tetrahedral cavities. (c) Octahedral cavities. The blue sphere and yellow sphere represent the void regions inside the tetrahedral and octahedral cages, respectively. Hydrogen atoms on the organic linkers were omitted for clarity [35].

2. MOFs can have their structures and properties adjusted and optimized through various modification methods to enhance their performance across applications. For instance, doping metal ions [36] can alter the electronic structure and catalytic activity of MOFs. MOFs can also be combined with inorganic nanomaterials; compounding with carbon nanotubes [37] or graphene [38] can enhance their electron conduction performance, while integration with TiO_2 [39], $\text{g-C}_3\text{N}_4$ [40], etc., can improve their photocatalytic performance. Similarly, MOFs can be paired with organic polymers; when combined with polyimide [41], they form a film material with enhanced mechanical properties and gas separation capabilities, suitable for gas separation membranes, and related technologies.
3. There are numerous synthesis methods for MOFs, including the solvothermal method [42], hydrothermal method [43], microwave-assisted synthesis method [44], ultrasound-assisted synthesis method [45], electrochemical synthesis method [46], and mechanochemical synthesis method [47]. These approaches allow precise control over synthesis conditions, producing MOFs with tailored properties suited to specific needs. In recent years, MOFs have gained increasing attention for their ability to treat water pollution. Among these MOFs, UiO-66 particularly stands out due to its exceptional stability and versatility in water treatment applications. The subsequent section delves into UiO-66's structure and synthesis evolution, building on this foundation.

In recent years, more and more MOF materials have been studied, and MOFs have been widely used to treat water pollution. Among the many MOFs, UiO-66 stands out. Therefore, this review focuses on the structure of UiO-66 and the applications of UiO-66 in the removal of various pollutants in water.

2. UiO-66 Structure and Synthesis Evolution

2.1. Structure

Among the numerous MOFs, UiO-66 is a member of the UiO-MOF family developed at the University of Oslo [48]. UiO-66's three-dimensional network is composed of Zr^{4+} ions as its metal nodes coordinated with terephthalate (BDC^{2-}) acting as organic ligands [49]. Figure 2 shows the structure of UiO-66 [50]. This robust framework exhibits a high degree of structural integrity, characterized by $\text{Zr}_6\text{O}_4(\text{OH})_4$ clusters linked by 1,4-benzenedicarboxylate (BDC^{2-}) units, forming a cubic lattice with tetrahedral and octahedral cavities.

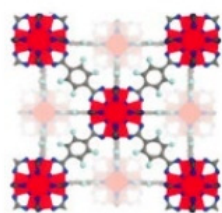


Figure 2. UiO-66 Zr-MOF with 1,4-benzenedicarboxylate (BDC^{2-}) as linker [50].

The synthesis of UiO-66 has evolved significantly into three major stages. Lillerud and co-workers first reported the synthesis of UiO-66 by mixing zirconium tetrachloride salt with terephthalic acid (H_2BDC) into $\text{N,N}'$ -dimethylformamide (DMF) [51]. Early synthesis strategies for UiO-66 involved highly dilute metal and ligand concentrations, without modulators or deprotonating agents. The absence of modulators or deprotonating agents, coupled with the higher concentrations, produces a rapid reaction, resulting in no three-dimensional mesh structure being formed, thus producing a gel product rather than a powder MOF. Consequently, the second stage focuses on modulators or deprotonators, enabling the development of high-quality Zr-based MOFs. Finally, in the third stage, it was found that new methods introducing defects could greatly improve the various properties of the material [52]. These developments are explored further in the synthesis methods detailed below. Several synthesis methods of UiO-66 are summarized in Table 1.

2.2. Synthesis Evolution

Research progressions have revealed that UiO-66 with large particle size and high crystallinity can be obtained by using modulators in the synthesis procedures. For example, the addition of a modulator benzoic acid can affect the size and morphology of UiO-66. And with increasing concentration of the modulator, the products change from intergrown to individual crystals [53]. In addition, the adjustment of other factors, such as temperature and metal-linker ratio, also affect the performance of UiO-66. A study found that increasing the temperature and metal-linker ratio brought the material closer to the ideal state [54]. Modulators compete with the coordination interaction between the metal (Zr^{4+}) and the linker BDC^{2-} in a reversible fashion, and in this way, they can also generally be carboxylic acids [55].

Up to now, the solvothermal method is most often used to prepare UiO-66 with high crystallinity and good morphology, but the synthesis time of the solvothermal method is long, and it is difficult to achieve mass production. The microwave-assisted synthesis method is simple and can synthesize UiO-66 in a short time. Compared with the traditional solvothermal method, it takes only a few hours. In addition, the mechanochemical synthesis

method uses less solvents and can achieve large-scale production. There are also other methods, such as the continuous flow method, which enables continuous manufacturing through a flow reactor. Different synthesis methods have unique advantages.

2.2.1. Solvothermal Method

The solvothermal method was the first approach to successfully prepare UiO-66 [51]. This method overcomes the limitations of dissolving some reactants at room temperature. In a typical solvothermal synthesis method, ZrCl_4 and terephthalic acid (H_2BDC) are dissolved in N,N' -dimethylformamide (DMF). The mixture is then transferred to a Teflon-lined autoclave, sealed at 120°C and heated for 24 h. After cooling to room temperature, it is filtered and washed with DMF several times and dried at room temperature [56]. Variations in polarity, dielectric constant, functional groups, and viscosity of the solvent can influence the reaction pathway, leading to diverse product sizes and morphologies [57]. Therefore, the solvothermal method can produce products with uniform size, high crystallinity, and well-defined topologies.

2.2.2. Microwave-Assisted Method

Compared with the traditional solvothermal method, the main advantage of the microwave-assisted method is that the synthesis time is much shorter [58]. Microwaves interact with polar solvents, generating localized heating (“hot spots”) that significantly promote nucleation events [57]. Fan et al. reported that it only takes 2–2.5 h to synthesize UiO-66 by this method [59]. Compared with the traditional heating method, the microwave-assisted method provides more uniform and efficient heating, lowering energy costs and enabling scalability for batch production [60].

2.2.3. Mechanochemical Method

UiO-66 is synthesized by liquid-phase-assisted grinding (LAG), by milling the pre-assembled methacrylate cluster $\text{Zr}_6\text{O}_4(\text{OH})_4(\text{C}_3\text{H}_5\text{CO}_2)_{12}$ (Zr_6M) to H_2BDC in a stoichiometric ratio of 1:6. The reaction uses methanol (MeOH) or N,N -dimethylformamide (DMF) as the liquid additive, and η (the ratio of liquid volume to reactant weight) ranges from $0.5\ \mu\text{L}/\text{mg}$ to $0.78\ \mu\text{L}/\text{mg}$. The process occurs in a poly (methyl methacrylate) (PMMA) jar mounted on a modified Retsch MM400 (Deutsches Elektronensynchrotron (DESY), Hamburg, Germany) mill operating at 30 Hz using stainless steel milling media [61].

2.2.4. Evaporation

The characteristics of synthesizing MOFs by the evaporation method are that the synthesis conditions are mild, but the reaction time is relatively long. Shearer et al. added ZrCl_4 , H_2BDC , H_2O , and acetic acid to a flask containing N,N' -dimethylformamide. The mixture was stirred to obtain a clarified solution and then heated at 100°C for 14 days with no solvent loss. The resulting crystalline powder was separated from the solvent by centrifugation, thoroughly washed three times with N,N' -dimethyl formamide, and then dried overnight in an oven set at 60°C to obtain UiO-66 [62].

2.2.5. Continuous Flow

The continuous flow method greatly increases the specific surface area of the reaction medium, thus effectively enhancing mass transfer, resulting in a large number of UiO-66 generation [63]. Rubio-Martinez et al. first proposed pumping DMF with ZrCl_4 and 1,4-tricarboxylic acid (BDC) in a coil reactor for heating, mixing and then passing through a back pressure regulator into a sealed container. The product was washed by DMF, then immersed in methanol for 2 days, and finally, UiO-66 was obtained [64].

2.2.6. Electrochemical Method

Electrochemical synthesis can be divided into two kinds: anode deposition and cathode deposition [65]. In anode deposition, a critical concentration of metal ions is released through anodic dissolution to form MOF film on the metal anode. In cathode deposition, a solution containing metal ions, ligands, and so-called probase is in contact with the cathode surface. Film deposition relies on an increase in pH near the cathode surface, where the electrochemical reduction of probase leads to local base formation and subsequent deprotonation of ligands, resulting in the formation of MOFs [66]. In one study, Farha et al. prepared UiO-66 membranes by electrochemical method [67].

Table 1. Synthetic methods for UiO-66.

Synthetic Method	Temp (°C)	Activation Solvent	Ref.
Solvothermal	120	DMF	[56]
Solvothermal	120	Methanol	[68]
Solvothermal	120	Ethanol	[69]
Solvothermal	120	Acetone	[70]
Solvothermal	120	Chloroform	[71]
Solvothermal	50	DMF	[72]
Solvothermal	70	DMF	[72]
Solvothermal	90	DMF	[72]
Solvothermal	110	DMF	[72]
Microwave-assisted	-	Ethanol	[59]
Mechanochemical	-	Methanol	[61]
Evaporation	100	DMF	[62]
Continuous flow	130	Methanol	[64]
Electrochemical	80	Ethanol	[67]

3. Application of UiO-66 in Water Purification

3.1. Removal of Pollutants from Water by Adsorption Method

In the field of water pollution treatment, adsorption is an important treatment technology, and UiO-66, as a water-stable MOF, has emerged as an effective adsorbent for removing organic dyes from aqueous solutions [73]. Figure 3 describes the mechanism of MOF surface adsorption to remove harmful substances [74]. The adsorption mechanism of UiO-66 involves several pathways. Firstly, the abundant pore structure formed by metal nodes and organic ligands in its structure provides a large number of adsorption sites [75], which can be mutually attracted to pollutant molecules in water through physical adsorption, such as van der Waals forces and π - π stacking [76]. Secondly, the Lewis acidic site in the metal center and some groups on the organic ligand can undergo chemical adsorption with specific pollutants [77] so as to achieve efficient capture of pollutants.

UiO-66 has a regular and precisely designable pore structure, which can be customized according to the pollutant molecule size to achieve precise adsorption of specific pollutants [77]. In addition, UiO-66 has higher chemical stability and can still maintain structural stability and adsorption performance under different pH values and temperatures [78]. Herein, this paper describes the application of UiO-66 adsorption to remove organic dyes, antibiotics, heavy metal ions, fluoride and microplastics from water. Examples of the removal of various pollutants by UiO-66 adsorption are shown in Table 2.

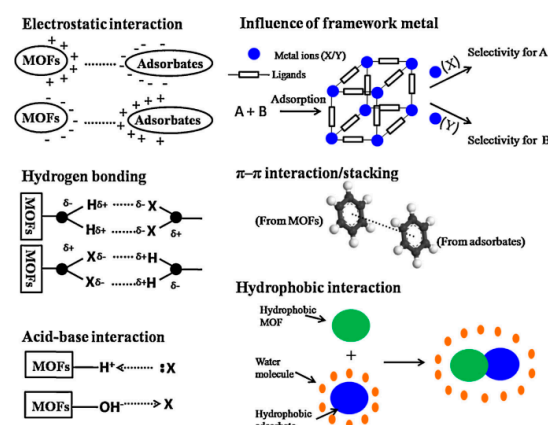


Figure 3. Schematic diagram of possible mechanisms for adsorptive removal of hazardous materials over MOFs [74].

3.1.1. Organic Dyes

Organic dyes are widely used in textile, leather, paper, and printing industries [79], which are one of the most toxic pollutants in water resources [80]. Organic dyes are highly toxic, carcinogenic and mutagenic, resulting in reduced irrigation and drinking water. Organic dyes can even lead to various health problems, such as dermatitis, breathing difficulties, headaches and cancer [81].

UiO-66 demonstrates adsorption properties for many organic dyes, such as methylene blue [82], Rhodamine B [83], methyl orange [84], etc. UiO-66 adsorbs organic dyes by electrostatic action. For example, Embaby et al. synthesized UiO-66 by the microwave-assisted method. It was found that the surface of UiO-66 was positively charged, so it had stronger electrostatic interaction with anionic dyes and thus had better adsorption performance for anionic dyes [80,85]. Ediaty et al. found that the crystallinity or irregularity of UiO-66 will provide an adsorption process with more active sites [86]. Mousavi et al. found that physical properties, such as surface charge, BET surface area, pore size and total pore volume, of UiO-66 could be improved by Soxhlet extraction and centrifugal activation with different activation methods and solvents [87]. The experimental results show that the materials obtained by Soxhlet extraction with ethanol as activator have higher crystallinity and larger BET and total pore volume. The material obtained by Soxhlet extraction with acetone as the activator shows amorphous structure in XRD pattern, which is due to the collapse of the crystal structure after soaking in a Soxhlet device. Although the characteristic peak of the material obtained by centrifuge activation with acetone is consistent with UiO-66, the intensity of the peak is reduced. The sample activated by chloroform as an activator has too much weight loss in adsorbing water.

3.1.2. Antibiotics

Antibiotics are widely employed in human and veterinary medicine and agriculture to fight diseases caused by bacteria [88]. Antibiotics mainly include tetracycline, sulfanilamide, beta-lactam, quinolone and penicillin [89]. The overuse of antibiotics has led to their widespread presence in aquatic environments, which can induce the development of drug-resistant bacteria, posing potential risks to ecosystems and human health.

UiO-66 can effectively adsorb a variety of antibiotics in water, such as tetracycline, sulfonamide antibiotics and so on [90]. Studies have shown that UiO MOFs are excellent at removing various concentrations of antibiotics from water [57]. In addition to electrostatic and hydrogen bonding, the adsorption mechanism is also related to the interaction between the specific functional groups of antibiotic molecules and the active sites on the surface of UiO-66 [91]. In addition to electrostatic and hydrogen bonding, the adsorption mecha-

nism is also related to the interaction between the specific functional groups of antibiotic molecules and the active sites on the surface of UiO-66 [92].

Alsaedi et al. found in their study that the removal rate of UiO-66 to doxycycline in a water environment could reach 90% of the initial concentration. The isothermal data are consistent with the Langmuir model. The pseudo-second-order model can best describe the kinetic data. This showed that UiO-66 had similar antibiotic adsorption performance to other porous materials [88]. Azhar et al. studied for the first time the adsorption of sulfachlorpyrazine (SCP) on ZIF-67 and UiO-66. It was found that UiO-66 is a feasible adsorbent for wastewater treatment with higher adsorption capacity, faster kinetics and simpler recycling than ZIF-67 [93].

3.1.3. Heavy Metal Ions

Heavy metal ions (such as Cd^{2+} , Ni^{2+} and Cr^{6+}) pose a serious threat to the environment and human health because of their high toxicity and non-degradability. They are non-biodegradable and tend to accumulate in living organisms [94].

Studies have shown that UiO-66 has high adsorption capacity for Pb (II), Cd (II), Cr (VI), U (VI) and other heavy metal ions. UiO-66 as an adsorbent is superior to other adsorbents in removing heavy metal ions from water due to its short adsorption time, good water stability and high adsorption capacity. Moreover, the surface chemistry and functional groups of UiO-66 are highly responsive to the pH of the solution, resulting in enhanced adsorption of heavy metal ions [95].

Wang et al. notably reported UiO-66 achieving an exceptionally high arsenic adsorption capacity of 303 mg/g, significantly surpassing other reported adsorbents [96]. Other derivatives modified by UiO-66 also have significant adsorption effects on other heavy metal ions.

3.1.4. Fluoride

Fluoride is an essential environmental element, but its excessive accumulation in the environment can have a wide range of fatal consequences for human, plant and animal health. In humans, low doses of fluoride (<1 mg/L) are beneficial for normal bone and tooth development, but high global levels (>1.5 mg/L) and prolonged exposure and ingestion of fluoride can lead to bone and tooth damage and dysfunction [97].

Zhao et al. studied and compared the water stability MOFs of MIL-53 (Fe), MIL-53 (Al), MIL-53 (Cr), MIL-68 (Al), CAU-1, CAU-6, UiO-66 (Hf), UiO-66 (Zr), ZIF-7, ZIF-8 and ZIF-911 in fluorine solution. It was found that UiO-66 had the best effect on fluoride removal, and the adsorption capacity was 41.36 mg g⁻¹, which was higher than most reported adsorbents [98].

3.1.5. Microplastics

Microplastics (MPs) are plastic particles, films, and fibers with a diameter of <5 mm [99]. Microplastics have become a serious global environmental challenge due to their low degradability, ease of transport and accumulation, and ecotoxicity [100]. Microplastics also can cause physical harm, metabolic disorders, neurotoxicity and reproductive damage [101]. MOFs can remove microplastics from water. A schematic representation of the mechanisms facilitating MP degradation is shown in Figure 4 [8].

Wu et al. reported that UiO-66 effectively catalyzed the decomposition of polyethylene terephthalate (PET) microplastics into terephthalic acid (TA) and monomethyl terephthalate (MMT) within 24 h at 260 °C, achieving yields of 98% under 1 atm H₂ and 81% under 1 atm Ar. Unlike polypropylene (PP) or polyethylene (PE), UiO-66 (Zr) retained catalytic activity under these conditions, confirming its superior efficiency as a PET degradation catalyst [102].

Chen et al. developed a foam material based on zirconium basic metal organic framework (Zr-MOF). The microplastics were removed using materials obtained by the acetone-assisted method. The electrostatic interaction between the positive charge of Zr-MOF nanoparticles and the negative charge of microplastics, the hydrogen bonding between functional groups or defects and microplastics, the pore structure of melamine foam (MF) and the water stability of the material all contribute to the removal of microplastics [103].

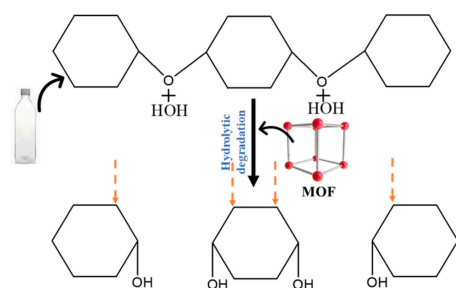


Figure 4. Hydrolytic-mediated microplastics degradation by MOF [8].

Table 2. Overview of UiO-66 used in adsorptive removal of various pollutants.

Pollutant	Q _e (mg/g)	Adsorptive Mechanism	Ref.
Methylene blue (MB)	91	Electrostatic interaction	[82]
Rhodamine B (Rh B)	75.85	Electrostatic interaction	[83]
Methyl red (MR)	384	Electrostatic interaction	[84]
Malachite green (MG)	133	π - π interactions, electrostatic interaction, and hydrogen bonding	[84]
Methylene blue (MB)	370	π - π interactions, electrostatic interaction, and hydrogen bonding	[84]
Alizarin red S (ARS)	400	Electrostatic interaction	[85]
Methyl orange (MO)	188.6	Electrostatic interaction	[86]
Congo red (CR)	147.1	Electrostatic interaction	[86]
Methylene blue (MB)	107.5	Electrostatic interaction, π - π interactions	[86]
Methylene blue (MB)	79.78	Electrostatic interaction	[104]
Methyl orange (MO)	70.79	Electrostatic interaction	[104]
Rhodamine B (Rh B)	25.94	Electrostatic interaction	[104]
Acid red 52 (AR52)	5.42	Electrostatic interaction	[104]
Doxycycline	156.25	Electrostatic interaction	[88]
Sulfachlorpyrazine (SCP)	417	π - π interactions, electrostatic interaction	[93]
Oxytetracycline (OTC)	21.22	Electrostatic interaction	[105]
Norfloxacin	134.5	π - π interactions, electrostatic interaction, and hydrogen bonding	[106]
Tetracycline (TC)	208.68	π - π interactions and hydrogen bonding	[107]
Sulfamethoxazole (SMX)	25	π - π interactions, electrostatic interaction, and hydrogen bonding	[108]
As (V)	303	Complexation (coordination)	[96]
As (III)	143.95	Electrostatic interaction	[107]
Pb (II)	19.40	Complexation (coordination)	[109]
Sb (V)	127.5	Electrostatic interaction	[110]
Pb (II)	48.7	Complexation (coordination)	[111]
Hg (II)	59	Complexation (coordination)	[112]
Cr (VI)	36.4	Electrostatic interaction	[113]
Au (III)	53.6	Electrostatic interaction	[114]
Fluoride	41.36	Complexation (coordination)	[98]
Polyethylene terephthalate (PET)	226.8	Hydrogen bonding	[102]
Melamine foam (MF)	955	Electrostatic attraction, hydrogen bonding, and van der Waals force	[103]

3.2. Removal of Pollutants from Water by Photocatalysis

Since Mahata et al. first proposed MOF as a photocatalyst in 2006 [115], MOF has become a promising material for water pollution remediation, and more and more MOF materials have emerged as photocatalysts. Photocatalytic reactions can be divided into three key steps: (i) light absorption and charge carrier (electron and hole) generation, (ii) separation and transfer of photogenerated charges, and (iii) surface chemical reactions [116]. Figure 5 shows the basic process of photocatalysis [117].

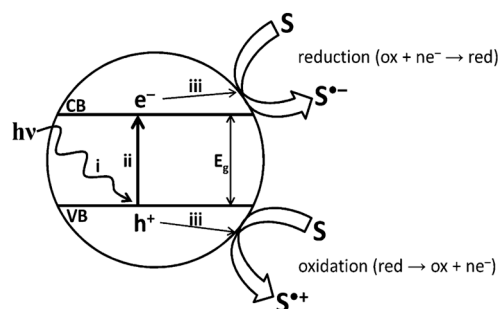


Figure 5. Elementary steps occurring in a photocatalytic event [117].

Since Garcia et al. discovered that UiO-66 has photocatalytic hydrogen production activity under ultraviolet irradiation [118], UiO-66 has received extensive attention in the field of photocatalysis. Under ultraviolet (UV) irradiation, energy can be transferred from the organic linker BDC^{2-} to the Zr-oxygen group in UiO-66, and in the presence of metal center Zr and organic linkers BDC^{2-} , UiO-66 can be photoexcited to generate photogenerated electron-hole pairs, and photogenerated electrons transfer from photoexcited BDC^{2-} to Zr oxo clusters in UiO-66 to generate Zr^{3+} [117].

However, the photocatalytic performance of pure UiO-66 is limited, and it is necessary to improve the photocatalytic performance by some modification methods, such as ligand modification, doping metal ions, composite with semiconductor materials, and introduction of defects. The photocatalytic performance of the modified UiO-66 was significantly improved. Herein, this review will summarize UiO-66 photocatalytic removal of various pollutants from water. Table 3 summarizes the application of UiO-66 and its derivatives in photocatalytic removal of various pollutants.

3.2.1. Organic Dyes

UiO-66's photocatalytic applications are notably effective for organic dyes, where its integration with semiconductors forms heterogeneous multiphase photocatalysts with narrow-bandgap properties [119].

Zhang et al. prepared nanohybrids of UiO-66 and g- C_3N_4 nanosheets (CNUO) to degrade Rh B dye. The migration and separation rate of photogenerated electrons can be improved by adding proper amounts of g- C_3N_4 . The g- C_3N_4 forms a heterojunction with UiO-66, which expands the absorption range of visible light and improves the transmission efficiency of photogenerated charge carriers. At the same time, CNUO has a strong ability of photogenerated carrier migration and separation. Radical trapping experiments showed that H^+ , O_2 and $\cdot OH$ are the main active species of CNUO degrading Rh B [120]. Similarly, Yang et al. first used the solvothermal method to prepare $TiO_2@UiO-66$ for removing methyl orange (MO). The photocatalytic activity of the $TiO_2@UiO-66$ composite is higher than that of the two monomer materials, and the degradation rate of MO can reach 97.59%. The close contact interface of TiO_2 and UiO-66 can effectively separate and transfer photogenerated carriers. During the degradation of MO, $TiO_2@UiO-66$ showed significantly enhanced photo-

genic electron transport ability, inhibited the recombination of electron holes, and could be reused [121].

3.2.2. Antibiotics

UiO-66 modified by metal doping can change its band structure, boost carrier density and reduce the recombination of electron holes.

Yin et al. prepared Cu-UiO-66 by the one-pot metal doping method and investigated the removal of ciprofloxacin (CIP) by Cu-UiO-66 under photocatalysis. The doping of copper increased the photocurrent and reduced the interfacial charge transfer resistance, thus improving the charge separation efficiency. The photocatalytic performance of Cu-UiO-66 is 3.7 times that of pure UiO-66 [122].

Cao et al. studied the preparation of Co-UiO-66 photocatalytic tetracycline (TC) removal from water by the solvothermal method. Through the doping Co modification, the light absorption of UiO-66 is expanded, the charge separation is promoted, and the photocatalytic performance is improved. The removal rate of TC by Co-UiO-66 was more than 94%, and the photocatalytic capacity was 6.9 times that of pure UiO-66 [123].

3.2.3. Hexavalent Chromium (Cr (VI))

Hexavalent chromium (Cr (VI)), a common heavy metal ion, has been widely used in paint, leather and other fields [124]. Cr (VI) is a serious threat to human health due to its toxicity [125]. UiO-66 has a suitable reduction potential (about -0.55 V vs. NHE), which can be used as a good photocatalyst for photocatalytic reduction. Under light irradiation, organic linkers can be excited to further produce photo-induced electrons, and the Zr-O clusters serve as the active sites for photocatalytic Cr (VI) reduction [124].

Yao et al. found that UiO-66 with Cr (VI) adsorption is responsive to visible light, and Cr (VI) can be further removed by photosensitizing photocatalytic reduction under visible light [126]. Jiao He et al. showed that UiO-66 could adsorb Cr (VI) at neutral pH while catalyzing the reduction of Cr (VI) by visible light [127]. Meanwhile, it was proposed to improve the photocatalytic performance by changing the surface electrostatic properties of UiO-66.

Table 3. Overview of UiO-66 and its derivatives used in photocatalytic removal of various pollutants.

Pollutant	Photocatalysts	Efficiency (%)	Time (min)	Ref.
Rhodamine B (Rh B)	g-C ₃ N ₄ /UiO-66	96.08	360	[120]
Methyl orange (MO)	TiO ₂ @UiO-66	97.59	150	[121]
Rhodamine B (Rh B)	UiO-66	69	360	[120]
Rhodamine B (Rh B)	UiO-66	14.55	12	[128]
Methylene blue (MB)	NH ₂ -UiO-66/ZnO	96.7	60	[129]
Malachite green (MG)	NH ₂ -UiO-66/ZnO	98	60	[129]
Ciprofloxacin (CIP)	Cu/UiO-66	93	120	[122]
Tetracycline (TC)	Co/UiO-66	94	60	[123]
Ciprofloxacin (CIP)	Bi ₂ MoO ₆ /UiO-66-NH ₂	96	90	[130]
Oxytetracycline (OTC)	MnO ₂ /UiO-66	49.9	60	[131]
Oxytetracycline (OTC)	UiO-66	40.2	60	[131]
Sulfameter	Fe@UiO-66	89.9	300	[132]
Tetracycline (TC)	ZnO@NH ₂ -UiO-66	61.9	30	[133]
Cr (VI)	UiO-66	99	360	[127]
Cr (VI)	g-C ₃ N ₄ /UiO-66	99	40	[134]
Cr (VI)	UiO-66-NH ₂	99	180	[135]
Cr (VI)	UiO-66	8	80	[136]
Cr (VI)	UiO-66-NH ₂	20	60	[137]

4. Conclusions and Future Outlook

UiO-66, as a representative Zr-based MOF, has demonstrated remarkable potential in water purification owing to its exceptional structural stability, tunable porosity, and versatile functionality. This paper systematically summarizes its applications in both adsorbing and photocatalytically degrading diverse water pollutants, including organic dyes, antibiotics, heavy metal ions, fluoride, and microplastics. The adsorption mechanisms, such as electrostatic interactions, π - π stacking, and Lewis acid–base coordination, enable UiO-66 to achieve high adsorption capacities and selectivity for targeted contaminants. Furthermore, its photocatalytic activity, enhanced by strategies like metal doping, defect engineering, and semiconductor hybridization, allows efficient degradation of pollutants under light irradiation. The evolution of synthesis methods—solvothermal, microwave-assisted, mechanochemical, and others—has optimized UiO-66's crystallinity, defect density, and scalability, laying a foundation for practical applications.

Despite these advances, the current research on UiO-66 is still in the laboratory stage, and its quantification into industrial production is still limited, which has a certain impact on the environment. This limitation contributes to environmental concerns, as large-scale production often requires substantial energy and solvent inputs. Therefore, in future research, we should pay attention to developing energy-saving, solvent-free and large-scale synthesis technologies to reduce production costs and environmental impacts. At the same time, the development of UiO-66 and its derivatives should be generated by various modification means, which can remove more types of pollutants. Additionally, investigating UiO-66's long-term stability under harsh environmental conditions and optimizing its regeneration protocols are critical steps to ensure its durability and reusability in practical settings.

In conclusion, UiO-66, as an emerging MOF material, faces numerous challenges in water treatment, yet its potential for future development remains substantial. With ongoing advancements, researchers are poised to unlock more applications for UiO-66, offering significant opportunities to enhance human well-being and global sustainability. As efforts progress toward scalable synthesis, enhanced functionality, and operational longevity, UiO-66 stands to play a pivotal role in addressing pressing water purification challenges, aligning with the growing demand for sustainable environmental solutions.

Author Contributions: Conceptualization, L.C., M.C. and K.L.; methodology, P.L., Y.L. and Z.L.; writing—original draft preparation, K.L. and W.P.; writing—review and editing, K.L. and W.P.; visualization, H.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Science and Technology development plan project of Jilin Province (20240601029RC) and the Education Department of Jilin Province (No. JJKH20250991KJ).

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Ahmadijokani, F.; Molavi, H.; Rezakazemi, M.; Tajahmadi, S.; Bahi, A.; Ko, F.; Aminabhavi, T.M.; Li, J.-R.; Arjmand, M. UiO-66 metal–organic frameworks in water treatment: A critical review. *Prog. Mater. Sci.* **2022**, *125*, 100904. [[CrossRef](#)]
2. Zango, Z.U.; Jumbri, K.; Sambudi, N.S.; Abu Bakar, H.H.; Garba, Z.N.; Isiyaka, H.A.; Saad, B. Selective adsorption of dyes and pharmaceuticals from water by UiO metal–organic frameworks: A comprehensive review. *Polyhedron* **2021**, *210*, 115515. [[CrossRef](#)]
3. Zhu, S.; Sun, C.; Fang, Z.; Qin, M.; Zhu, Z.; Qu, J.; Zheng, H. Copper-supported MOF-derived carbon materials for highly efficient antibiotics removal. *J. Environ. Chem. Eng.* **2024**, *12*, 113756. [[CrossRef](#)]

4. Mondol, M.M.H.; Jhung, S.H. Adsorptive removal of pesticides from water with metal–organic framework-based materials. *Chem. Eng. J.* **2021**, *421*, 129688. [\[CrossRef\]](#)
5. Mohan, B.; Kamboj, A.; Virender; Singh, K.; Priyanka; Singh, G.; Pombeiro, A.J.L.; Ren, P. Metal-organic frameworks (MOFs) materials for pesticides. heavy metals, and drugs removal: Environmental safety. *Sep. Purif. Technol.* **2023**, *310*, 123175. [\[CrossRef\]](#)
6. Luo, Y.; Huang, G.; Li, Y.; Yao, Y.; Huang, J.; Zhang, P.; Ren, S.; Shen, J.; Zhang, Z. Removal of pharmaceutical and personal care products (PPCPs) by MOF-derived carbons: A review. *Sci. Total Environ.* **2023**, *857*, 159279. [\[CrossRef\]](#)
7. Song, J.; Yu, Y.; Han, X.; Yang, W.; Pan, W.; Jian, S.; Duan, G.; Jiang, S.; Hu, J. Novel MOF (Zr)-on-MOF (Ce) adsorbent for elimination of excess fluoride from aqueous solution. *J. Hazard. Mater.* **2024**, *463*, 132843. [\[CrossRef\]](#)
8. Nikhar, S.; Kumar, P.; Chakraborty, M. A review on microplastics degradation with MOF: Mechanism and action. *Next Nanotechnol.* **2024**, *5*, 100060. [\[CrossRef\]](#)
9. Al-Muttair, A.K.; Al Easawi, N.A.; Mustafa, S.A. Using Adsorption as Means to Treat Water Pollution. *J. Biotechnol. Res. Cent.* **2022**, *16*, 37–47. [\[CrossRef\]](#)
10. Martini, S. Membrane technology for water pollution control: A review of recent hybrid mechanism. *J. Rekayasa Kim. Lingkung.* **2022**, *17*, 83–96. [\[CrossRef\]](#)
11. Liu, H.; Tang, S.; Wang, Z.; Zhang, Q.; Yuan, D. Organic cocatalysts improved Fenton and Fenton-like processes for water pollution control: A review. *Chemosphere* **2024**, *353*, 141581. [\[CrossRef\]](#) [\[PubMed\]](#)
12. Lim, S.; Shi, J.L.; von Gunten, U.; McCurry, D.L. Ozonation of organic compounds in water and wastewater: A critical review. *Water Res.* **2022**, *213*, 118053. [\[CrossRef\]](#)
13. Dai, Q.; Gao, G.; Tang, J.; Jiang, R.; Sun, S.; Ye, Y.; Li, S.; Xie, R.; Zhang, J. The MIL-125 (Ti)/Co₃O₄ towards efficiently removing tetracycline by synergistic adsorption-photocatalysis roles. *Mater. Des.* **2025**, 113608. [\[CrossRef\]](#)
14. Martínez-Huitle, C.A.; Rodrigo, M.A.; Sirés, I.; Scialdone, O. A critical review on latest innovations and future challenges of electrochemical technology for the abatement of organics in water. *Appl. Catal. B Environ.* **2023**, *328*, 122430. [\[CrossRef\]](#)
15. Zhu, C.; Huang, H.; Chen, Y. Recent advances in biological removal of nitroaromatics from wastewater. *Environ. Pollut.* **2022**, *307*, 119570. [\[CrossRef\]](#)
16. Rojas, S.; Rodríguez-Diéguez, A.; Horcajada, P. Metal–organic frameworks in agriculture. *ACS Appl. Mater. Interfaces* **2022**, *14*, 16983–17007. [\[CrossRef\]](#)
17. Salama, R.S.; El-Sayed, E.-S.M.; El-Bahy, S.M.; Awad, F.S. Silver nanoparticles supported on UiO-66 (Zr): As an efficient and recyclable heterogeneous catalyst and efficient adsorbent for removal of indigo carmine. *Colloids Surf. A Physicochem. Eng. Asp.* **2021**, *626*, 127089. [\[CrossRef\]](#)
18. Qu, N.; Sun, H.; Sun, Y.; He, M.; Xing, R.; Gu, J.; Kong, J. 2D/2D coupled MOF/Fe composite metamaterials enable robust ultra-broadband microwave absorption. *Nat. Commun.* **2024**, *15*, 5642. [\[CrossRef\]](#) [\[PubMed\]](#)
19. He, Z.; Wu, H.; Shi, Z.; Duan, X.; Ma, S.; Chen, J.; Kong, Z.; Chen, A.; Sun, Y.; Liu, X. Mussel-inspired durable superhydrophobic/superoleophilic MOF-PU sponge with high chemical stability, efficient oil/water separation and excellent anti-icing properties. *Colloids Surf. A Physicochem. Eng. Asp.* **2022**, *648*, 129142. [\[CrossRef\]](#)
20. Song, K.; Liang, S.; Zhong, X.; Wang, M.; Mo, X.; Lei, X.; Lin, Z. Tailoring the crystal forms of the Ni-MOF catalysts for enhanced photocatalytic CO₂-to-CO performance. *Appl. Catal. B Environ.* **2022**, *309*, 121232. [\[CrossRef\]](#)
21. Wang, Y.; Xu, J.; Lin, X.; Wang, B.; Zhang, Z.; Xu, Y.; Suo, Y. Facile synthesis of MOF-5-derived porous carbon with adjustable pore size for CO₂ capture. *J. Solid State Chem.* **2023**, *322*, 123984. [\[CrossRef\]](#)
22. Xiang, W.; Wang, Q.; Li, Z.; Dong, J.; Liu, J.; Zhang, L.; Xia, T.; He, Y.; Zhao, D. Water-stable methyl-modified MOF and mixed matrix membrane for efficient adsorption and separation of cationic dyes. *Sep. Purif. Technol.* **2024**, *330*, 125268. [\[CrossRef\]](#)
23. Song, J.; Liu, C.K.; Piradi, V.; Chen, C.; Zhu, Y.; Zhu, X.; Li, L.; Wong, W.Y.; Yan, F. Large-Area Fabrication of Hexaazatrinaphthylene-Based 2D Metal-Organic Framework Films for Flexible Photodetectors and Optoelectronic Synapses. *Adv. Sci.* **2024**, *11*, 2305551. [\[CrossRef\]](#)
24. Sağlam, S.; Türk, F.N.; Arslanoğlu, H. Use and applications of metal-organic frameworks (MOF) in dye adsorption: Review. *J. Environ. Chem. Eng.* **2023**, *11*, 110568. [\[CrossRef\]](#)
25. Peng, Y.; Xu, J.; Xu, J.; Ma, J.; Bai, Y.; Cao, S.; Zhang, S.; Pang, H. Metal-organic framework (MOF) composites as promising materials for energy storage applications. *Adv. Colloid Interface Sci.* **2022**, *307*, 102732. [\[CrossRef\]](#)
26. Kazemi, A.; Pordsari, M.A.; Tamtaji, M.; Afshari, M.H.; Keshavarz, S.; Zeinali, F.; Baesmat, H.; Zahiri, S.; Manteghi, F.; Ghaemi, A. Unveiling the power of defect engineering in MOF-808 to enhance efficient carbon dioxide adsorption and separation by harnessing the potential of DFT analysis. *Chem. Eng. J.* **2024**, *494*, 153049. [\[CrossRef\]](#)
27. Li, C.; Qi, A.; Ling, Y.; Tao, Y.; Zhang, Y.-B.; Li, T. Establishing gas transport highways in MOF-based mixed matrix membranes. *Sci. Adv.* **2023**, *9*, eadf5087. [\[CrossRef\]](#)
28. Hammad, S.F.; Abdallah, I.A.; Bedair, A.; Abdelhameed, R.M.; Locatelli, M.; Mansour, F.R. Metal organic framework-derived carbon nanomaterials and MOF hybrids for chemical sensing. *TrAC Trends Anal. Chem.* **2024**, *170*, 117425. [\[CrossRef\]](#)

29. Mohanty, B.; Kumari, S.; Yadav, P.; Kanoo, P.; Chakraborty, A. Metal-organic frameworks (MOFs) and MOF composites based biosensors. *Coord. Chem. Rev.* **2024**, *519*, 216102. [[CrossRef](#)]
30. Khan, M.S.; Li, Y.; Li, D.-S.; Qiu, J.; Xu, X.; Yang, H.Y. A review of metal-organic framework (MOF) materials as an effective photocatalyst for degradation of organic pollutants. *Nanoscale Adv.* **2023**, *5*, 6318–6348. [[CrossRef](#)]
31. He, W.; Liu, Y.; Huang, Z.; Tu, W.; Liu, R.; Chen, M. Cubic MOF coated stainless steel mesh with underwater superoleophobicity for highly efficient oil/water separation. *Mater. Chem. Phys.* **2023**, *297*, 127346. [[CrossRef](#)]
32. Zhan, Y.; Cao, J.; Wang, Y.; Li, X.; Li, Y.; Zeng, H.; Huang, W.; Cheng, H.; Gao, S.; Li, L. Au/Ag@ ZIF-8 nanocomposite as solid phase extraction adsorbent and SERS substrate for tacrolimus label-free therapeutic drug monitoring in human serum. *Talanta* **2025**, *281*, 126813. [[CrossRef](#)] [[PubMed](#)]
33. Chi, J.; Li, Q.; Wei, L.; Shi, R.; Liu, X.; Zhang, Q.; Liu, K.; Li, Z.; Xiao, Z.; Wang, L. Occupying in Metal–Organic Frameworks’ Pores: Vein-Like PANI Cross-Coupled Hierarchical Porous UiO-66 Flexible Electrode for Supercapacitor Application. *Adv. Funct. Mater.* **2025**, *35*, 2413546. [[CrossRef](#)]
34. Rong, H.; Song, P.; Gao, G.; Jiang, Q.; Chen, X.; Su, L.; Liu, W.-L.; Liu, Q. A three-dimensional Mn-based MOF as a high-performance supercapacitor electrode. *Dalton Trans.* **2023**, *52*, 1962–1969. [[CrossRef](#)]
35. Ramsahye, N.; Gao, J.; Jobic, H.; Llewellyn, P.; Yang, Q.; Wiersum, A.; Koza, M.; Guillermin, V.; Serre, C.; Zhong, C. Adsorption and diffusion of light hydrocarbons in UiO-66 (Zr): A combination of experimental and modeling tools. *J. Phys. Chem. C* **2014**, *118*, 27470–27482. [[CrossRef](#)]
36. Abdel-Mageed, A.M.; Rungtaweeworanit, B.; Parlinska-Wojtan, M.; Pei, X.; Yaghi, O.M.; Behm, R.J.R. Highly active and stable single-atom Cu catalysts supported by a metal–organic framework. *J. Am. Chem. Soc.* **2019**, *141*, 5201–5210. [[CrossRef](#)]
37. Zhang, L.; Tang, J.; Li, J.; Li, Y.; Yang, P.; Zhao, P.; Fei, J.; Xie, Y. A novel dopamine electrochemical sensor based on 3D flake nickel oxide/cobalt oxide@ porous carbon nanosheets/carbon nanotubes/electrochemical reduced of graphene oxide composites modified glassy carbon electrode. *Colloids Surf. A Physicochem. Eng. Asp.* **2023**, *666*, 131284. [[CrossRef](#)]
38. Nazir, M.A.; Javed, M.S.; Islam, M.; Assiri, M.A.; Hassan, A.M.; Jamshaid, M.; Najam, T.; Shah, S.S.A.; ur Rehman, A. MOF@ graphene nanocomposites for energy and environment applications. *Compos. Commun.* **2024**, *45*, 101783. [[CrossRef](#)]
39. Bathla, A.; Lee, J.; Younis, S.A.; Kim, K.-H. Recent advances in photocatalytic reduction of CO₂ by TiO₂–and MOF–based nanocomposites impregnated with metal nanoparticles. *Mater. Today Chem.* **2022**, *24*, 100870. [[CrossRef](#)]
40. Durmus, Z.; Maijenburg, A.W. A review on graphitic carbon nitride (g-C₃N₄)–metal organic framework (MOF) heterostructured photocatalyst materials for photo (electro) chemical hydrogen evolution. *Int. J. Hydrogen Energy* **2022**, *47*, 36784–36813. [[CrossRef](#)]
41. Zhang, Y.; Jia, H.; Wang, Q.; Ma, W.; Yang, G.; Xu, S.; Li, S.; Su, G.; Qu, Y.; Zhang, M. Optimization of a MOF blended with modified polyimide membrane for high-performance gas separation. *Membranes* **2021**, *12*, 34. [[CrossRef](#)] [[PubMed](#)]
42. Wang, H.; Dai, Y.; Wang, Y.; Yin, L. One-pot solvothermal synthesis of Cu–Fe–MOF for efficiently activating peroxydisulfate to degrade organic pollutants in water: Effect of electron shuttle. *Chemosphere* **2024**, *352*, 141333. [[CrossRef](#)]
43. Iqbal, M.Z.; Aziz, U.; Aftab, S.; Wabaidur, S.M.; Siddique, S.; Iqbal, M.J. A hydrothermally prepared lithium and copper MOF composite as anode material for hybrid supercapacitor applications. *ChemistrySelect* **2023**, *8*, e202204554. [[CrossRef](#)]
44. Fernández-Andrade, K.J.; Fernández-Andrade, A.A.; Zambrano-Intriago, L.Á.; Arteaga-Perez, L.E.; Alejandro-Martin, S.; Baquerizo-Crespo, R.J.; Luque, R.; Rodríguez-Díaz, J.M. Microwave-assisted MOF@ biomass layered nanomaterials: Characterization and applications in wastewater treatment. *Chemosphere* **2023**, *314*, 137664. [[CrossRef](#)]
45. Yi, J.; Lee, G.; Park, S.S. Solvent-Induced Structural Rearrangement in Ultrasound-Assisted Synthesis of Metal–Organic Frameworks. *Small Methods* **2024**, *8*, 2400363. [[CrossRef](#)]
46. Ren, H.; Wei, T. Electrochemical synthesis methods of metal-organic frameworks and their environmental analysis applications: A review. *ChemElectroChem* **2022**, *9*, e202200196. [[CrossRef](#)]
47. Khosroshahi, N.; Bakhtian, M.; Safarifard, V. Mechanochemical synthesis of ferrite/MOF nanocomposite: Efficient photocatalyst for the removal of meropenem and hexavalent chromium from water. *J. Photochem. Photobiol. A Chem.* **2022**, *431*, 114033. [[CrossRef](#)]
48. Kadhon, M.; Al-Furaiji, M.; Salih, S.; Al-Obaidi, M.A.; Abdullah, G.H.; Albayati, N. A review on UiO-66 applications in membrane-based water treatment processes. *J. Water Process Eng.* **2023**, *51*, 103402. [[CrossRef](#)]
49. Pourmadadi, M.; Eshaghi, M.M.; Ostovar, S.; Shamsabadipour, A.; Safakhah, S.; Mousavi, M.S.; Rahdar, A.; Pandey, S. UiO-66 metal-organic framework nanoparticles as gifted MOFs to the biomedical application: A comprehensive review. *J. Drug Deliv. Sci. Technol.* **2022**, *76*, 103758. [[CrossRef](#)]
50. Kandiah, M.; Usseglio, S.; Svelle, S.; Olsbye, U.; Lillerud, K.P.; Tilset, M. Post-synthetic modification of the metal–organic framework compound UiO-66. *J. Mater. Chem.* **2010**, *20*, 9848–9851. [[CrossRef](#)]
51. Cavka, J.H.; Jakobsen, S.; Olsbye, U.; Guillou, N.; Lamberti, C.; Bordiga, S.; Lillerud, K.P. A new zirconium inorganic building brick forming metal organic frameworks with exceptional stability. *J. Am. Chem. Soc.* **2008**, *130*, 13850–13851. [[CrossRef](#)] [[PubMed](#)]

52. Winarta, J.; Shan, B.; McIntyre, S.M.; Ye, L.; Wang, C.; Liu, J.; Mu, B. A decade of UiO-66 research: A historic review of dynamic structure, synthesis mechanisms, and characterization techniques of an archetypal metal–organic framework. *Cryst. Growth Des.* **2019**, *20*, 1347–1362. [\[CrossRef\]](#)
53. Schaate, A.; Roy, P.; Godt, A.; Lippke, J.; Waltz, F.; Wiebcke, M.; Behrens, P. Modulated synthesis of Zr-based metal–organic frameworks: From nano to single crystals. *Chem.–A Eur. J.* **2011**, *17*, 6643–6651. [\[CrossRef\]](#)
54. Shearer, G.C.; Chavan, S.; Ethiraj, J.; Vitillo, J.G.; Svelle, S.; Olsbye, U.; Lamberti, C.; Bordiga, S.; Lillerud, K.P. Tuned to perfection: Ironing out the defects in metal–organic framework UiO-66. *Chem. Mater.* **2014**, *26*, 4068–4071. [\[CrossRef\]](#)
55. Wu, H.; Chua, Y.S.; Krungleviciute, V.; Tyagi, M.; Chen, P.; Yildirim, T.; Zhou, W. Unusual and highly tunable missing-linker defects in zirconium metal–organic framework UiO-66 and their important effects on gas adsorption. *J. Am. Chem. Soc.* **2013**, *135*, 10525–10532. [\[CrossRef\]](#)
56. Melillo, A.; Cabrero-Antonino, M.; Navalón, S.; Álvaro, M.; Ferrer, B.; García, H. Enhancing visible-light photocatalytic activity for overall water splitting in UiO-66 by controlling metal node composition. *Appl. Catal. B Environ.* **2020**, *278*, 119345. [\[CrossRef\]](#)
57. Amani, V.; Norouzi, F.; Akrami, Z. A review of UiO-based MOF detection and removal strategies for antibiotics in water. *New J. Chem.* **2024**, *48*, 18600–18617. [\[CrossRef\]](#)
58. Liang, W.; Babarao, R.; D’Alessandro, D.M. Microwave-Assisted Solvothermal Synthesis and Optical Properties of Tagged MIL-140A Metal–Organic Frameworks. *Inorg. Chem.* **2013**, *52*, 12878–12880. [\[CrossRef\]](#)
59. Vakili, R.; Xu, S.; Al-Janabi, N.; Gorgojo, P.; Holmes, S.M.; Fan, X. Microwave-assisted synthesis of zirconium-based metal organic frameworks (MOFs): Optimization and gas adsorption. *Microporous Mesoporous Mater.* **2018**, *260*, 45–53. [\[CrossRef\]](#)
60. Mahmoud, M.M. Microwave-assisted fast synthesis of MOF-801. *Next Mater.* **2025**, *6*, 100316. [\[CrossRef\]](#)
61. Germann, L.S.; Katsenis, A.D.; Huskić, I.; Julien, P.A.; Uzarevic, K.; Etter, M.; Farha, O.K.; Friscic, T.; Dinnebier, R.E. Real-time in situ monitoring of particle and structure evolution in the mechanochemical synthesis of UiO-66 metal–organic frameworks. *Cryst. Growth Des.* **2019**, *20*, 49–54. [\[CrossRef\]](#)
62. Shearer, G.C.; Forselv, S.; Chavan, S.; Bordiga, S.; Mathisen, K.; Bjørgen, M.; Svelle, S.; Lillerud, K.P. In situ infrared spectroscopic and gravimetric characterisation of the solvent removal and dehydroxylation of the metal organic frameworks UiO-66 and UiO-67. *Top. Catal.* **2013**, *56*, 770–782. [\[CrossRef\]](#)
63. Batten, M.P.; Rubio-Martinez, M.; Hadley, T.; Carey, K.-C.; Lim, K.-S.; Polyzos, A.; Hill, M.R. Continuous flow production of metal-organic frameworks. *Curr. Opin. Chem. Eng.* **2015**, *8*, 55–59. [\[CrossRef\]](#)
64. Rubio-Martinez, M.; Batten, M.P.; Polyzos, A.; Carey, K.-C.; Mardel, J.I.; Lim, K.-S.; Hill, M.R. Versatile, high quality and scalable continuous flow production of metal-organic frameworks. *Sci. Rep.* **2014**, *4*, 5443. [\[CrossRef\]](#)
65. Stassen, I.; Styles, M.; Van Assche, T.; Campagnol, N.; Fransaeer, J.; Denayer, J.; Tan, J.-C.; Falcaro, P.; De Vos, D.; Ameloot, R. Electrochemical Film Deposition of the Zirconium Metal–Organic Framework UiO-66 and Application in a Miniaturized Sorbent Trap. *Chem. Mater.* **2015**, *27*, 1801–1807. [\[CrossRef\]](#)
66. Liu, X. Metal-organic framework UiO-66 membranes. *Front. Chem. Sci. Eng.* **2020**, *14*, 216–232. [\[CrossRef\]](#)
67. Hod, I.; Bury, W.; Karlin, D.M.; Deria, P.; Kung, C.W.; Katz, M.J.; So, M.; Klahr, B.; Jin, D.; Chung, Y.W. Directed growth of electroactive metal-organic framework thin films using electrophoretic deposition. *Adv. Mater.* **2014**, *26*, 6295–6300. [\[CrossRef\]](#) [\[PubMed\]](#)
68. Wang, Y.; Zhang, S.; Zhao, Y.; Bedia, J.; Rodriguez, J.; Belver, C. UiO-66-based metal organic frameworks for the photodegradation of acetaminophen under simulated solar irradiation. *J. Environ. Chem. Eng.* **2021**, *9*, 106087. [\[CrossRef\]](#)
69. Mirzaei, K.; Jafarpour, E.; Shojaei, A.; Khasraghi, S.S.; Jafarpour, P. An investigation on the influence of highly acidic media on the microstructural stability and dye adsorption performance of UiO-66. *Appl. Surf. Sci.* **2023**, *618*, 156531. [\[CrossRef\]](#)
70. Bůžek, D.; Adamec, S.; Lang, K.; Demel, J. Metal–organic frameworks vs. buffers: Case study of UiO-66 stability. *Inorg. Chem. Front.* **2021**, *8*, 720–734. [\[CrossRef\]](#)
71. Molavi, H.; Zamani, M.; Aghajanzadeh, M.; Kheiri Manjili, H.; Danafar, H.; Shojaei, A. Evaluation of UiO-66 metal organic framework as an effective sorbent for Curcumin’s overdose. *Appl. Organomet. Chem.* **2018**, *32*, e4221. [\[CrossRef\]](#)
72. Tan, Y.; Zhang, W.; Gao, Y.; Wu, J.; Tang, B. Facile synthesis and supercapacitive properties of Zr-metal organic frameworks (UiO-66). *RSC Adv.* **2015**, *5*, 17601–17605. [\[CrossRef\]](#)
73. Ahmadijokani, F.; Ahmadi pouya, S.; Haris, M.H.; Rezakazemi, M.; Bokhari, A.; Molavi, H.; Ahmadi pour, M.; Pung, S.-Y.; Klemeš, J.I.J.R.; Aminabhavi, T.M. Magnetic nitrogen-rich UiO-66 metal–organic framework: An efficient adsorbent for water treatment. *ACS Appl. Mater. Interfaces* **2023**, *15*, 30106–30116. [\[CrossRef\]](#)
74. Hasan, Z.; Jhung, S.H. Removal of hazardous organics from water using metal-organic frameworks (MOFs): Plausible mechanisms for selective adsorptions. *J. Hazard. Mater.* **2015**, *283*, 329–339. [\[CrossRef\]](#) [\[PubMed\]](#)
75. Zhang, A.; Liu, B.; Liu, M.; Xie, Z.; Wang, D.; Feng, G. The adsorption properties of defect controlled metal-organic frameworks of UiO-66. *Sep. Purif. Technol.* **2021**, *270*, 118842. [\[CrossRef\]](#)
76. Li, J.; Ma, X.; Lan, J.; Huang, Z.; Li, T.; Wang, B.; Wu, L.; Liang, L.; Duan, X.; Kong, Z. Selectivity adsorption mechanism of different phenolic organic pollutants on UiO-66 by molecular dynamics simulation. *J. Mol. Liq.* **2024**, *398*, 124228. [\[CrossRef\]](#)

77. Driscoll, D.M.; Troya, D.; Usov, P.M.; Maynes, A.J.; Morris, A.J.; Morris, J.R. Geometry and energetics of CO adsorption on hydroxylated UiO-66. *Phys. Chem. Chem. Phys.* **2019**, *21*, 5078–5085. [\[CrossRef\]](#)
78. Kandiah, M.; Nilsen, M.H.; Usseglio, S.; Jakobsen, S.; Olsbye, U.; Tilset, M.; Larabi, C.; Quadrelli, E.A.; Bonino, F.; Lillerud, K.P. Synthesis and stability of tagged UiO-66 Zr-MOFs. *Chem. Mater.* **2010**, *22*, 6632–6640. [\[CrossRef\]](#)
79. Zhao, D.; Cai, C. Cerium-based UiO-66 metal-organic framework for synergistic dye adsorption and photodegradation: A discussion of the mechanism. *Dye. Pigment.* **2021**, *185*, 108957. [\[CrossRef\]](#)
80. Beydaghdari, M.; Hooriabad Saboor, F.; Babapoor, A.; Karve, V.V.; Asgari, M. Recent advances in MOF-based adsorbents for dye removal from the aquatic environment. *Energies* **2022**, *15*, 2023. [\[CrossRef\]](#)
81. Al-Ghouti, M.A.; Sweleh, A.O. Optimizing textile dye removal by activated carbon prepared from olive stones. *Environ. Technol. Innov.* **2019**, *16*, 100488. [\[CrossRef\]](#)
82. Mohammadi, A.; Alinejad, A.; Kamarehie, B.; Javan, S.; Ghaderpoury, A.; Ahmadpour, M.; Ghaderpoori, M. Metal-organic framework UiO-66 for adsorption of methylene blue dye from aqueous solutions. *Int. J. Environ. Sci. Technol.* **2017**, *14*, 1959–1968. [\[CrossRef\]](#)
83. He, Q.; Chen, Q.; Lü, M.; Liu, X. Adsorption behavior of rhodamine B on UiO-66. *Chin. J. Chem. Eng.* **2014**, *22*, 1285–1290. [\[CrossRef\]](#)
84. Ahmadijokani, F.; Mohammadkhani, R.; Ahmadipouya, S.; Shokrgozar, A.; Rezakazemi, M.; Molavi, H.; Aminabhavi, T.M.; Arjmand, M. Superior chemical stability of UiO-66 metal-organic frameworks (MOFs) for selective dye adsorption. *Chem. Eng. J.* **2020**, *399*, 125346. [\[CrossRef\]](#)
85. Embaby, M.S.; Elwany, S.D.; Setyaningsih, W.; Saber, M.R. The adsorptive properties of UiO-66 towards organic dyes: A record adsorption capacity for the anionic dye Alizarin Red S. *Chin. J. Chem. Eng.* **2018**, *26*, 731–739. [\[CrossRef\]](#)
86. Hidayat, A.R.P.; Zulfa, L.L.; Widyanto, A.R.; Abdullah, R.; Kusumawati, Y.; Ediaty, R. Selective adsorption of anionic and cationic dyes on mesoporous UiO-66 synthesized using a template-free sonochemistry method: Kinetic, isotherm and thermodynamic studies. *RSC Adv.* **2023**, *13*, 12320–12343. [\[CrossRef\]](#) [\[PubMed\]](#)
87. Mousavi, D.V.; Ahmadipouya, S.; Shokrgozar, A.; Molavi, H.; Rezakazemi, M.; Ahmadijokani, F.; Arjmand, M. Adsorption performance of UiO-66 towards organic dyes: Effect of activation conditions. *J. Mol. Liq.* **2021**, *321*, 114487. [\[CrossRef\]](#)
88. Alsaedi, M.; Alothman, G.; Alnajrani, M.; Alsager, O.; Alshimri, S.; Alharbi, M.; Alawad, M.; Alhadlaq, S.; Alharbi, S. Antibiotic adsorption by metal-organic framework (UiO-66): A comprehensive kinetic, thermodynamic, and mechanistic study. *Antibiotics* **2020**, *9*, 722. [\[CrossRef\]](#)
89. Wei, Z.; Liu, J.; Shangguan, W. A review on photocatalysis in antibiotic wastewater: Pollutant degradation and hydrogen production. *Chin. J. Catal.* **2020**, *41*, 1440–1450. [\[CrossRef\]](#)
90. Li, G.; Zhang, Y.; Hu, X.; Tan, W.; Li, J.; Su, D.; Wang, H.; Yang, M. A study on the performance of a novel adsorbent UiO-66 modified by a nickel on removing tetracycline in wastewater. *Chemosphere* **2023**, *338*, 139399. [\[CrossRef\]](#)
91. Huang, L.; Shen, R.; Shuai, Q. Adsorptive removal of pharmaceuticals from water using metal-organic frameworks: A review. *J. Environ. Manag.* **2021**, *277*, 111389. [\[CrossRef\]](#) [\[PubMed\]](#)
92. Iqbal, A.; Ullah, H.; Iqbal, M.; Khan, M.S.; Ullah, R.S.; Gul, Z.; Rehman, R.; Altaf, A.A.; Ullah, S. MOF UiO-66 and its composites: Design strategies and applications in drug and antibiotic removal. *Environ. Sci. Pollut. Res.* **2025**, *1–28*. [\[CrossRef\]](#) [\[PubMed\]](#)
93. Azhar, M.R.; Abid, H.R.; Periasamy, V.; Sun, H.; Tade, M.O.; Wang, S. Adsorptive removal of antibiotic sulfonamide by UiO-66 and ZIF-67 for wastewater treatment. *J. Colloid Interface Sci.* **2017**, *500*, 88–95. [\[CrossRef\]](#)
94. Zhai, L.; Zheng, X.; Liu, M.; Wang, X.; Li, W.; Zhu, X.; Yuan, A.; Xu, Y.; Song, P. Tuning surface functionalizations of UiO-66 towards high adsorption capacity and selectivity eliminations for heavy metal ions. *Inorg. Chem. Commun.* **2023**, *154*, 110937. [\[CrossRef\]](#)
95. Lei, Y.; Xie, J.; Quan, W.; Chen, Q.; Long, X.; Wang, A. Advances in the adsorption of heavy metal ions in water by UiO-66 composites. *Front. Chem.* **2023**, *11*, 1211989. [\[CrossRef\]](#) [\[PubMed\]](#)
96. Wang, C.; Liu, X.; Chen, J.P.; Li, K. Superior removal of arsenic from water with zirconium metal-organic framework UiO-66. *Sci. Rep.* **2015**, *5*, 16613. [\[CrossRef\]](#) [\[PubMed\]](#)
97. Ghosh, S.; Malloum, A.; Igwegbe, C.A.; Ighalo, J.O.; Ahmadi, S.; Dehghani, M.H.; Othmani, A.; Gökkuş, Ö.; Mubarak, N.M. New generation adsorbents for the removal of fluoride from water and wastewater: A review. *J. Mol. Liq.* **2022**, *346*, 118257. [\[CrossRef\]](#)
98. Zhao, X.; Liu, D.; Huang, H.; Zhang, W.; Yang, Q.; Zhong, C. The stability and defluoridation performance of MOFs in fluoride solutions. *Microporous Mesoporous Mater.* **2014**, *185*, 72–78. [\[CrossRef\]](#)
99. Zhao, B.; Rehati, P.; Yang, Z.; Cai, Z.; Guo, C.; Li, Y. The potential toxicity of microplastics on human health. *Sci. Total Environ.* **2024**, *912*, 168946. [\[CrossRef\]](#)
100. Rafa, N.; Ahmed, B.; Zohora, F.; Bakya, J.; Ahmed, S.; Ahmed, S.F.; Mofijur, M.; Chowdhury, A.A.; Almomani, F. Microplastics as carriers of toxic pollutants: Source, transport, and toxicological effects. *Environ. Pollut.* **2024**, *343*, 123190. [\[CrossRef\]](#)
101. Meng, Y.; Kelly, F.J.; Wright, S.L. Advances and challenges of microplastic pollution in freshwater ecosystems: A UK perspective. *Environ. Pollut.* **2020**, *256*, 113445. [\[CrossRef\]](#) [\[PubMed\]](#)

102. Wu, Y.; Wang, X.; Kirlikovali, K.O.; Gong, X.; Atilgan, A.; Ma, K.; Schweitzer, N.M.; Gianneschi, N.C.; Li, Z.; Zhang, X. Catalytic degradation of polyethylene terephthalate using a phase-transitional zirconium-based metal–organic framework. *Angew. Chem. Int. Ed.* **2022**, *61*, e202117528. [[CrossRef](#)]
103. Chen, Y.-J.; Chen, Y.; Miao, C.; Wang, Y.-R.; Gao, G.-K.; Yang, R.-X.; Zhu, H.-J.; Wang, J.-H.; Li, S.-L.; Lan, Y.-Q. Metal–organic framework-based foams for efficient microplastics removal. *J. Mater. Chem. A* **2020**, *8*, 14644–14652. [[CrossRef](#)]
104. Konno, H.; Tsukada, A. Size- and ion-selective adsorption of organic dyes from aqueous solutions using functionalized UiO-66 frameworks. *Colloids Surf. A Physicochem. Eng. Asp.* **2022**, *651*, 129749. [[CrossRef](#)]
105. He, T.; Wang, Y.; Han, R.; Li, X.; Cui, S.; Yang, J. Hierarchical porous UiO-66 composites modified by dual competitive strategy for adsorption of oxytetracycline. *J. Environ. Chem. Eng.* **2024**, *12*, 111662. [[CrossRef](#)]
106. Wei, F.; Liu, H.; Ren, Q.; Yang, L.; Qin, L.; Chen, H.; Ma, Y.; Liang, Z.; Wang, S. Preparation of Zr-MOF for the removal of Norfloxacin from an aqueous solution. *Inorg. Chem. Commun.* **2023**, *153*, 110819. [[CrossRef](#)]
107. Zhang, X.; Dong, Q.; Wang, Y.; Zhu, Z.; Guo, Z.; Li, J.; Lv, Y.; Chow, Y.T.; Wang, X.; Zhu, L. Water-stable metal–organic framework (UiO-66) supported on zirconia nanofibers membrane for the dynamic removal of tetracycline and arsenic from water. *Appl. Surf. Sci.* **2022**, *596*, 153559. [[CrossRef](#)]
108. Ouyang, J.; Chen, J.; Ma, S.; Xing, X.; Zhou, L.; Liu, Z.; Zhang, C. Adsorption removal of sulfamethoxazole from water using UiO-66 and UiO-66-BC composites. *Particuology* **2022**, *62*, 71–78. [[CrossRef](#)]
109. Ali, S.; Zuhra, Z.; Abbas, Y.; Shu, Y.; Ahmad, M.; Wang, Z. Tailoring defect density in UiO-66 frameworks for enhanced Pb (II) adsorption. *Langmuir* **2021**, *37*, 13602–13609. [[CrossRef](#)]
110. Peng, M.; You, D.; Shi, H.; Shao, P.; Ren, W.; Yang, L.; Sheng, X.; Shao, J.; Ding, X.; Ding, L.; et al. Disclosing the role of defective UiO-66 over Sb(V) removal: A joint experimental and theoretical study. *Chem. Eng. J.* **2022**, *448*, 137612. [[CrossRef](#)]
111. Morcos, G.S.; Ibrahim, A.A.; El-Sayed, M.M.; El-Shall, M.S. High performance functionalized UiO metal organic frameworks for the efficient and selective adsorption of Pb (II) ions in concentrated multi-ion systems. *J. Environ. Chem. Eng.* **2021**, *9*, 105191. [[CrossRef](#)]
112. Lam, I.T.Y.; Yuan, Y.; Bang, K.-T.; Choi, S.-J.; Shin, D.-M.; Lu, D.; Kim, Y. Towards the fastest kinetics and highest uptake of post-functionalized UiO-66 for Hg 2+ removal from water. *Nanoscale* **2023**, *15*, 10558–10566. [[CrossRef](#)]
113. Wang, Y.; Zhang, N.; Chen, D.; Ma, D.; Liu, G.; Zou, X.; Chen, Y.; Shu, R.; Song, Q.; Lv, W. Facile synthesis of acid-modified UiO-66 to enhance the removal of Cr (VI) from aqueous solutions. *Sci. Total Environ.* **2019**, *682*, 118–127. [[CrossRef](#)]
114. Wu, C.; Zhu, X.; Wang, Z.; Yang, J.; Li, Y.; Gu, J. Specific recovery and in situ reduction of precious metals from waste to create MOF composites with immobilized nanoclusters. *Ind. Eng. Chem. Res.* **2017**, *56*, 13975–13982. [[CrossRef](#)]
115. Mahata, P.; Madras, G.; Natarajan, S. Novel photocatalysts for the decomposition of organic dyes based on metal–organic framework compounds. *J. Phys. Chem. B* **2006**, *110*, 13759–13768. [[CrossRef](#)] [[PubMed](#)]
116. Ren, X.; Philo, D.; Li, Y.; Shi, L.; Chang, K.; Ye, J. Recent advances of low-dimensional phosphorus-based nanomaterials for solar-driven photocatalytic reactions. *Coord. Chem. Rev.* **2020**, *424*, 213516. [[CrossRef](#)]
117. Dhakshinamoorthy, A.; Asiri, A.M.; Garcia, H. Metal–organic framework (MOF) compounds: Photocatalysts for redox reactions and solar fuel production. *Angew. Chem. Int. Ed.* **2016**, *55*, 5414–5445. [[CrossRef](#)] [[PubMed](#)]
118. Gomes Silva, C.; Luz, I.; Llabres i Xamena, F.X.; Corma, A.; García, H. Water stable Zr–benzenedicarboxylate metal–organic frameworks as photocatalysts for hydrogen generation. *Chem.–A Eur. J.* **2010**, *16*, 11133–11138. [[CrossRef](#)]
119. Shi, L.; Wang, T.; Zhang, H.; Chang, K.; Ye, J. Electrostatic Self-Assembly of Nanosized Carbon Nitride Nanosheet onto a Zirconium Metal–Organic Framework for Enhanced Photocatalytic CO₂ Reduction. *Adv. Funct. Mater.* **2015**, *25*, 5360–5367. [[CrossRef](#)]
120. Zhang, X.; Yang, Y.; Huang, W.; Yang, Y.; Wang, Y.; He, C.; Liu, N.; Wu, M.; Tang, L. g-C₃N₄/UiO-66 nanohybrids with enhanced photocatalytic activities for the oxidation of dye under visible light irradiation. *Mater. Res. Bull.* **2018**, *99*, 349–358. [[CrossRef](#)]
121. Yang, J.; Chang, X.; Wei, F.; Lv, Z.; Liu, H.; Li, Z.; Wu, W.; Qian, L. High performance photocatalyst TiO₂@ UiO-66 applied to degradation of methyl orange. *Discov. Nano* **2023**, *18*, 112. [[CrossRef](#)] [[PubMed](#)]
122. Yin, L.; Wang, D.; Li, X.; He, Y.; Liu, X.; Xu, Y.; Chen, H. One-pot synthesis of oxygen-vacancy-rich Cu-doped UiO-66 for collaborative adsorption and photocatalytic degradation of ciprofloxacin. *Sci. Total Environ.* **2022**, *815*, 151962. [[CrossRef](#)] [[PubMed](#)]
123. Cao, J.; Yang, Z.-H.; Xiong, W.-P.; Zhou, Y.-Y.; Peng, Y.-R.; Li, X.; Zhou, C.-Y.; Xu, R.; Zhang, Y.-R. One-step synthesis of Co-doped UiO-66 nanoparticle with enhanced removal efficiency of tetracycline: Simultaneous adsorption and photocatalysis. *Chem. Eng. J.* **2018**, *353*, 126–137. [[CrossRef](#)]
124. Li, Y.-H.; Wang, C.-C.; Yi, X.-H.; Chu, H.-Y. UiO-66 (Zr)-based functional materials for water purification: An updated review. *Environ. Funct. Mater.* **2023**, *2*, 93–132. [[CrossRef](#)]
125. Shen, B.; Dong, C.; Ji, J.; Xing, M.; Zhang, J. Efficient Fe(III)/Fe(II) cycling triggered by MoO₃ in Fenton reaction for the degradation of dye molecules and the reduction of Cr(VI). *Chin. Chem. Lett.* **2019**, *30*, 2205–2210. [[CrossRef](#)]

126. Chen, Q.; Feng, Y.; Tian, R.; Chen, J.; Wang, A.; Yao, J. Defect rich UiO-66 with enhanced adsorption and photosensitized reduction of Cr (VI) under visible light. *Ind. Eng. Chem. Res.* **2019**, *58*, 21562–21568. [[CrossRef](#)]
127. He, J.; Zhou, H.; Peng, Q.; Wang, Y.; Chen, Y.; Yan, Z.; Wang, J. UiO-66 with confined dyes for adsorption and visible-light photocatalytic reduction of aqueous Cr(VI). *Inorg. Chem. Commun.* **2022**, *140*, 109441. [[CrossRef](#)]
128. Tong, X.; Yang, Z.; Feng, J.; Li, Y.; Zhang, H. BiOCl/UiO-66 composite with enhanced performance for photo-assisted degradation of dye from water. *Appl. Organomet. Chem.* **2018**, *32*, e4049. [[CrossRef](#)]
129. Teng, D.; Zhang, J.; Luo, X.; Jing, F.; Wang, H.; Chen, J.; Yang, C.; Zang, S.; Zhou, Y. Remarkably Enhanced Photodegradation of Organic Pollutants by NH₂UiO-66/ZnO Composite under Visible-Light Irradiation. *J. Renew. Mater.* **2022**, *10*, 2378–2391. [[CrossRef](#)]
130. Su, Q.; Li, J.; Wang, B.; Li, Y.; Hou, L.A. Direct Z-scheme Bi₂MoO₆/UiO-66-NH₂ heterojunctions for enhanced photocatalytic degradation of ofloxacin and ciprofloxacin under visible light. *Appl. Catal. B Environ.* **2022**, *318*, 121820. [[CrossRef](#)]
131. Zhou, Y.; Feng, S.; Duan, X.; Zheng, W.; Shao, C.; Wu, W.; Jiang, Z.; Lai, W. MnO₂/UiO-66 improves the catalysed degradation of oxytetracycline under UV/H₂O₂/PMS system. *J. Solid State Chem.* **2021**, *300*, 122231. [[CrossRef](#)]
132. Lin, Y.; Zhang, Y.; Li, G. Promotion of sulfameter degradation by coupling persulfate and photocatalytic advanced oxidation processes with Fe-doped MOFs. *Sep. Purif. Technol.* **2022**, *282*, 119632. [[CrossRef](#)]
133. Du, Q.; Wu, P.; Sun, Y.; Zhang, J.; He, H. Selective photodegradation of tetracycline by molecularly imprinted ZnO@NH₂-UiO-66 composites. *Chem. Eng. J.* **2020**, *390*, 124614. [[CrossRef](#)]
134. Yi, X.-H.; Ma, S.-Q.; Du, X.-D.; Zhao, C.; Fu, H.; Wang, P.; Wang, C.-C. The facile fabrication of 2D/3D Z-scheme g-C₃N₄/UiO-66 heterojunction with enhanced photocatalytic Cr (VI) reduction performance under white light. *Chem. Eng. J.* **2019**, *375*, 121944. [[CrossRef](#)]
135. Feng, Y.; Chen, Q.; Cao, M.; Ling, N.; Yao, J. Defect-tailoring and titanium substitution in metal–organic framework UiO-66-NH₂ for the photocatalytic degradation of Cr (VI) to Cr (III). *ACS Appl. Nano Mater.* **2019**, *2*, 5973–5980. [[CrossRef](#)]
136. Qiu, J.; Zhang, X.; Xie, K.; Zhang, X.-F.; Feng, Y.; Jia, M.; Yao, J. Noble metal nanoparticle-functionalized Zr-metal organic frameworks with excellent photocatalytic performance. *J. Colloid Interface Sci.* **2019**, *538*, 569–577. [[CrossRef](#)]
137. Zhou, Y.-C.; Xu, X.-Y.; Wang, P.; Fu, H.; Zhao, C.; Wang, C.-C. Facile fabrication and enhanced photocatalytic performance of visible light responsive UiO-66-NH₂/Ag₂CO₃ composite. *Chin. J. Catal.* **2019**, *40*, 1912–1923. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.