Fabrication of graphitic carbon nitride-based nanocomposites photocatalyst for degradation of organic pollutants: A Review

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1. Introduction

Nowadays, waste-water remediation has been taken as a significant challenge because of the existence of large organic compounds from various industries and remains one of the most difficult challenges to remove these from wastewater. Hazardous wastes from effluent, which affects human health. Due to the over-growth of the global population and water scarcity has become the main problem for human beings[1,2]. The major problem is the purification and recycling of wastewater. Several purification methods for wastewater remediation have been used in recent decades, such as flocculation, ion exchange, sedimentation, molecular sieves, membrane filtration, liquid precipitation, reverse osmosis, and chlorine nation physiochemical techniques, etc (fig.1) [3]. However, these techniques of purification are not economical, time-consuming, required high energy, and insufficient for the absolute elimination of wastewater pollutants [4–6]. Thus, the advanced oxidation method (AOP) has paid a lot of attention to the decomposition of pollutants from wastewater by different purification techniques due to its more efficient and cost-effective[7]. The method in which organic contaminants are eliminated by oxidizing the organic waste to several methods such as ozonation, photo-Fenton reaction, ultra-sonication, and photocatalysis, etc. Among these treatment strategies, photocatalysis has attracted much interest in wastewater purification due to high performance, mile reaction status, good redox potential, and energy conservation. Photocatalysis is a well-known advanced oxidation process that has attracted researchers’ attention [8–14].

In the photocatalysis process, semiconductor metal oxides (TiO₂, CuO, Fe₂O₃, ZnO) are used as a photocatalyst. Among the most popular photocatalysts for semiconductors, ZnO and TiO₂ have drawn tremendous attention due to their high biocompatibility, high activity, low cost, nontoxicity, physical and chemical stability, high photosensitivity, and availability. ZnO and TiO₂ NPs have been widely used for the degradation of organic pollutants[15]. However, ZnO and TiO₂ NPs have a wide bandgap (~3.2 eV) and therefore only UV light-responsive with wavelengths under 387-388 nm is absorbed only 4–7 percent of all solar radiation [15,16]. Therefore, as per expectations, the photocatalytic behavior of ZnO and TiO₂ has not been yet achieved primarily due to weak solar energy conversion performance, high recombination rate for electron-hole pairs, low separation rate, and photogenerated electron migration. Therefore, a great deal of work has been made to harvest more energy from sunlight and enhancing solar spectrum absorption. Several techniques have been considered to modify the photocatalytic
properties, such as surface modification with metals, doping of metals and non-metal components, binding with visible light active semiconductors, etc. The synthesis of the visible light active composite photocatalyst is another effective approach for enhancing the light absorption property of ZnO and TiO₂. Many reports are available on surface modification of the ZnO and TiO₂ with narrow band gaps semiconductor, including BiOI, V₂O₅, CdS, CuO. g-C₃N₄ has been used as photocatalysts for the fabricate visible-light responsive composite[17–23].

Recently, graphitic carbon nitride (g-C₃N₄) is a visible-light-responsive, metal-free, robust earth-abundant semiconductor photocatalyst, has attracted much attention in the interdisciplinary area because of its facile synthesis from low-cost precursors appropriate electronic bandgap (~2.7 eV), very low cytotoxicity, chemically inactive (in the base, solvent, acid), and high physicochemical stability which significantly enhanced the photocatalytic efficiency of ZnO and TiO₂ by reducing its bandgap as well as by increasing electron-hole recombination period. although g-C₃N₄, has a variety of properties and promising applications like other nanoparticles, when g-C₃N₄ is directly used in water bodies, it is also prone to aggregation, and settlement, which seriously limits its applications[24–26].

In this review, we summarized the different fabrication methods of ZnO–g-C₃N₄ and TiO₂–g-C₃N₄ nanocomposite with their potential uses in wastewater treatment. Firstly, we have mentioned the introduction of g-C₃N₄ and its limitations as a photocatalyst. Various precursors and methods were also discussed for the synthesis of nanocomposites (ZnO–g-C₃N₄ and TiO₂–g-C₃N₄) with enhancing photocatalytic activity toward the organic pollutant. The photocatalysis coupled mechanism of ZnO–g-C₃N₄ and TiO₂–g-C₃N₄ nanocomposite was also mentioned in this review.

![Flowchart of Conventional Methods for Wastewater Treatment](image)

**Fig.1:** Conventional methods for wastewater treatment and their limitation

2. graphitic carbon nitride (g-C₃N₄)

Through the direct thermal calcination process of various organic precursors urea, guanidinium chloride, melamine, thiourea, guanidine thiocyanate, cyanide, and dicyandiamide the metal-free g-C₃N₄ was manufactured[20,27–30]. Wang and co-workers initially synthesized g-C₃N₄ for a hydrogen (H₂) assessment reaction. The g-C₃N₄, is a polymer and consisting mostly of carbon and nitrogen via tri-s-triazine units. The g-C₃N₄ is not only the most stable but also has individual surface properties (surface versatility, electron-rich properties, and H-bonding pattern) among all allotropes of carbon nitriles in the atmosphere, which are important for many photocatalytic applications[31]. The C–N layers in the g-C₃N₄ also have a laminar structure with mild interactions with van der Waals. Due to its special composition and excellent properties, graphite-like carbon nitride (g-C₃N₄) commonly used in photocatalysis, fuel cells, hydrogen extraction, oxygen reduction. g-C₃N₄ is a 2D layered substance based on tri-s-triazine units related...
as primary building blocks to planar amino groups. Several 'nitrogen pots' form the tri-s-triazine modules, in which six lone-pair nitrogen electrons have a negative charge feature, and =N-H-N-H groups on the g-C$_3$N$_4$ surface have abundant active sites[22].

Disadvantages of g-C$_3$N$_4$ as photocatalyst

Graphitic carbon nitrides were widely impressed by their emerging use in energy production and ecological problems as the most stable allotrope among several carbon materials. However, its photocatalytic activity is insufficient because of (1) the minimum surface area and rapid recombination rate of electron-hole pairs, (2) the hinder electron charge separation, (3) the poor performance of electron (e$^-$) and hole (h$^+$) separation. (4) During the construction of g-C$_3$N$_4$, a high degree of polycondensation provided a nonporous morphology and low surface area. (5) only blue light absorbed by g-C$_3$N$_4$ from the solar spectrum, reducing the application of the full solar spectrum[32].

Steps to overcome the limitations

To resolve these challenges, the required co-catalyst is linked to the g-C$_3$N$_4$ has been reported to be an important route for the development of the photocatalytic activity. Enhance photocatalytic activity depend on the surface area, numerous active sites, porous structure, and particle size which expanded the ability for light harvesting, the key strategies for surface modification of g-C$_3$N$_4$ with nonmetal doping, carbon materials, and metal oxide has been used to developed visible light active photocatalyst.

3. Surface modification of g-C$_3$N$_4$ with metal Oxide (ZnO and TiO$_2$) and their application

3.1 Fabrication of ZnO-g-C$_3$N$_4$ nanocomposite and its photocatalytic activity

Wang Y. et al has been reported that ZnO-g-C$_3$N$_4$ photocatalyst was fabricated from melamine and ZnO via a monolayer-dispersed method. The photocatalyst ZnO-g-C$_3$N$_4$ has notable improved photocatalytic activity under visible light irradiation with excellent anti-photo corrosion ability was described by [33], Jia-Xin Sun et al. have been prepared the ZnO-g-C$_3$N$_4$ composite photocatalysts from melamine and zinc acetate by a calcination process. The photocatalytic activity of ZnO-g-C$_3$N$_4$ for the photodegradation of methyl Orange and p-nitrophenol was improved more than 3 and 6 times than pure g-C$_3$N$_4$ under visible light irradiation. it was indicating a synergistic effect of ZnO and g-C$_3$N$_4$[34]. ZnO-g-C$_3$N$_4$ was prepared using zinc chloride and melamine by thermal treatment through the deposition-precipitation process, the enhanced photocatalytic properties of it have been examined through photooxidation of RhB and photoreduction of Cr$^{3+}$ under visible light irradiation [15].

Prasad S. et al. has been synthesized ZnO-g-C$_3$N$_4$ nanocomposite by a simple hydrothermal one-pot method from a solution containing g-C$_3$N$_4$ and ZnO precursors. FE-SEM and TEM images reveal that the flower-like ZnO is bound to the g-C$_3$N$_4$ surface in a composite. The increased photocatalytic activity of ZnO-g-C$_3$N$_4$ is mostly due to excited electrons being transferred from the g-C$_3$N$_4$ CB to that of ZnO. After several runs using the same catalyst, there was no apparent loss of photocatalytic performance. Thus, This ZnO-g-C$_3$N$_4$ composite photocatalyst is a favorable material for the degradation of organic compounds [14]. To form a heterojunction ZnO-g-C$_3$N$_4$ photocatalyst with a core-shell configuration, g-C$_3$N$_4$ nanosheets were coupled with oxygen-defective ZnO nanorods (OD-ZnO). The OD-ZnO-g-C$_3$N$_4$ heterojunction has improved visible-light absorption, the efficiency of charge generation and separation, as well as prolonged lifetime, leading to increased photocatalytic activities under visible-light illumination for the degradation of 4-chlorophenol with 4-time reusability and stability has been reported by Wang J and coworkers[35].

Zinc acetate and urea have been used for the synthesis of ZnO-g-C$_3$N$_4$ nanocomposites from single-step calcination with two-dimensional shape, and porous sheet-like carbon-doped morphology confirmed by SEM, TEM, and XPS analysis. It composite has been used for degradation of MB and MO under visible light irradiation which 14 times higher than that of g-C$_3$N$_4$ and ZnO[36]. Zn(Ac)$_2$·2H$_2$O and ZnO Nps have been used for the fabrication of core-shell ZnO-g-C$_3$N$_4$ photocatalyst by a simple two-step calcination process. It has been shown to enhance photodegradation efficiency 5 times higher than g-C$_3$N$_4$ and ~35 times higher than ZnO under visible-light and more stability due to reduced charge recombination. Photocatalytic activity of ZnO-g-C$_3$N$_4$ nanocomposite was measured
by photodegradation of Rhodamine B with 90% within 50 min under visible light irradiation after 5 cycles of reused[37]. The ZnO-g-C₃N₄ nanocomposite with different ratios of g-C₃N₄ was successfully developed using the melamine and zinc acetate by a single-step thermal condensation process. The ZnO-g-C₃N₄ nanocomposites have been shown to increased photocatalytic activity towards the degradation of Direct Blue 199 dye under UV light irradiation. This result was revealed that the efficient interfacial interaction between ZnO and g-C₃N₄ enhances the efficiency of degradation. Also, the nanocomposite showed excellent stability over 5 cycles[12].

Chen Q and his co-workers have reported flower-like morphology of ZnO and the ultra-thin few-layer of g-C₃N₄ nanosheet were used to synthesis of ZnO-g-C₃N₄ nanocomposite by ball milling method, it was beneficial to the enhancement of the photocatalytic activity. The heterojunctions developed between ZnO and g-C₃N₄ during the mechanical process. Thus, decreased the photogenerated carrier recombination rate and increased the photocatalytic activity of the hybrids of ZnO-g-C₃N₄ towards UV light[38]. In-situ precipitation method has been used for the synthesis of ZnO-g-C₃N₄ composites using g-C₃N₄ nanosheet and zinc acetate [13].

Mohammad A et al. has been used facial in-situ one-pot solid-state thermal decomposition method for fabrication of ZnO-g-C₃N₄ composite in which [Zn(hmp)(H₂O)(μ-Cl)]Zn[μ-Cl](Cl)] was used as a single-source molecular precursor (SSMP) for ZnO and urea for graphic carbon nitride. Further, enhanced and fast photo-catalytic degradation of Chicago sky blue (CSB), Congo red (CR), and methylene blue (MB) under the UV light[3]. ZnO-g-C₃N₄ composites material was constructed by a one-step facile method with thiourea, urea, and dicyandiamide (DCDA) precursors for g-C₃N₄ and ZnO. They have been studied the interaction between ZnO and g-C₃N₄ precursors during the thermal polycondensation process[39]. ZnO-g-C₃N₄ nanocomposites prepared in 2D/1D by the sonication-assisted hydrothermal method have been used for fabrication of 2D/1D ZnO-g-C₃N₄ nanocomposites which used in the photodegradation of RhB 99% with 20 min and chlorophenol 90% within 40 min under sunlight irradiation[40]. The djembe-like ZnO nanoparticles were prepared by a surfactant-assisted hydrothermal process[41]. In 2020 Devina et al. has been prepared ZnO-g-C₃N₄ composite by one-step thermal polymerization of urea and zinc carbonate basic dihydrate [Zn(NO₃)₂·[Zn(OH)₂]₃] to produce a superior photocatalyst, the ZnO-g-C₃N₄ was displayed an advanced morphology, improved surface area (116 m²/g), stronger visible light absorption efficiency, and decreased band distance, photogenerated electron-hole pairs, and decreased photo-induced charge recombination frequency. g-C₃N₄-ZnO has enhanced photocatalytic activity towards methylene blue dye (90%) and shows more than 3-time reusability[42]. The photocatalytic photodegradation efficiency of ZnO-g-C₃N₄ is mentioned in tabular form for various organic pollutant as per the previous reported works (Table 1).

| Method                  | Pollutant | Conc. of catalyst (mg) | Conc. of pollutant (mg/L) | Degradation time (min) | Light source | Degradation efficiency (%) | Reusability | References |
|-------------------------|-----------|------------------------|---------------------------|------------------------|--------------|--------------------------|-------------|------------|
| monolayer-dispersed     | MB        | 30 mg                  | 100 mL, 10 mg/L           | 300                    | UV irradiation | 72.30%                  | 3.5 times   | [33]       |
| simple calcination      | p-DN       | 400 mg                 | 100 mL, 4 mg/L            | 80 and 300             | Xe-lamp (XQ-500W, China) | 97% and 30%  | 5 and 6     | [34]       |
| deposition precipitation method | MB          | 500 mg                 | 25 mL, 4.5 mg/L          | 100                    | 500 W xenon lamp | 97.40%                | 5 times     | [15]       |
| one pot hydrothermal process | MB          | 200 mg                 | 100 mL, 1 mg/L          | 90                     | mercury vapor lamp | 100                  | 5 times     | [14]       |
| single-step and scalable synthesis method | MB and MO | much better            | 5 times                  | [36]                   |
| two-step calcination.   | RhB       | 20 mg                  | 50 mL, 5 mg/L           | 50                     | visible light (>400 nm) | 90                 | 5           | [37]       |
| simple single-step process | Direct Blue 199 | 100                  | 500 W mercury lamp and 500 W xenon lamp | 99%                  | 5 times | [12]       |
Urea and zinc hydroxide | solution conversion method | 4-chlorophenol (4-CP) | 100 mg | 100 mL, 10 mg/L | 60 | 500 W Xenon lamp | 95% | 5 times | [35]

Urea and ZnO | ball milling | RhB | 50 mg | 50 mL, 10 mg/L | 120 | 500 W Xenon lamp | 51.30% | 4 | [38]

Urea and Zinc acetate dihydrate | spray pyrolysis | MB malachite green | 50 mL, 10 mg/L | 75 min and 45 min | tungsten halogen lamp (500 W) | 97% and 95% | [51]

Urea and SSMP | one pot solid state thermal decomposition | MB | 20 mg | 100 mL, 10 mg/L | 150 | Uv light | 85.99% | [3]

Urea and ZnO | a one-step facile method | MB | 50 mL, 10 mg/L | 150 | Visible light | ~98% | [39]

Melamine and zinc acetate dihydrate | sonication assisted hydrothermal method | RhB | 100 mg | 100 mL, 5 mg/L | 20 | Sunlight | 99% | 5 | [40]

urea and zinc carbonate basic dihydrate | one-step thermal polymerization of | MB | 1 mg | 250 mL, 10 mg/L | 120 | 200 W tungsten lamp | 90% | 5 | [42]

Melamine and Zinc acetate dihydrate | surfactant-assisted hydrothermal | MB | 5 mg | 100 mL, 10 mg/L | 800 | 500 W Xenon lamp | ~95% and ~97% | 5 | [41]

3.2 Fabrication of TiO₂-g-C₃N₄ nanocomposite and its photocatalytic activity

Zhao S et al. has been synthesized a visible light-responsive TiO₂-g-C₃N₄ photocatalyst with g-C₃N₄ and TiO₂ by a hydrolysis method, thus increased the capability of photogenerated charge separation which enhanced degradation of phenol under visible light irradiation [43]. Melamine and commercial TiO₂ were used for the fabrication of TiO₂-g-C₃N₄ visible light responsive photocatalyst by the heating process. The TiO₂-g-C₃N₄ had the highest adsorption ability and photocatalytic efficiency towards the degradation of methylene blue under visible light, when visible light irradiation emitted on the g-C₃N₄ surface, conduction band electron of g-C₃N₄ transfer through heterojunction in TiO₂-conduction band of TiO₂ due to absorbed visible light and successful isolation of photogenerated electron-hole pairs, thus the TiO₂-g-C₃N₄ nanocomposites display enhanced degradation efficiency [44].

Zhang M et al. has been used a simple annealing method to developed TiO₂-g-C₃N₄ nanocomposites from titanic acid nanotube and bulk g-C₃N₄. In this process, the titanic acid nanotube was dehydrated in the novel-TiO₂ while bulk g-C₃N₄ was oxidized in the air to formed very thin g-C₃N₄ nanosheets that could provide a wide specific surface area [45]. Polyethylene glycol (PEG) and cetyl trimethyl ammonium bromide (CTAB) have been used for the fabrication of mesoporous photocatalyst with a large specific surface area (591.93 m²/g) and excellent photocatalytic activity [46]. Zhang B and co-workers have been used a simple molten salt-assisted in-situ route method for developed TiO₂-g-C₃N₄ heterostructures with highly porous morphology and enhanced surface area [47]. Y. Wang et al. has been prepared a cotton fabric coated with TiO₂ and g-C₃N₄ nanosheet by LBL self-assembly technique. these fabrics introduced more active sites. Meanwhile, the loose and porous structure of fabrics has a high adsorption capacity toward pollutants and impels active species in the photocatalysis process to easily absorb toxins then degrade into degradation products (CO₂ and H₂O). As a result, the coated fabric has shown excellent photocatalytic activity [48]. The photocatalytic photodegradation efficiency of TiO₂-g-C₃N₄ has been mentioned in systematic tabular form for various organic pollutants under visible light irradiation (Table 2).
Table 2. photocatalytic degradation efficiency of TiO$_2$-g-C$_3$N$_4$ towards organic pollutant under visible light irradiation

| Precursors used for fabrication of TiO$_2$-g-C$_3$N$_4$ | Method | Pollutant | Conc. of catalyst (mg) | Conc. of pollutant (mg/L) | Degradation time (min) | Light source | Degradation efficiency (%) | References |
|------------------------------------------------------|--------|-----------|------------------------|---------------------------|------------------------|-------------|-----------------------------|------------|
| Melamine and TiO$_2$ | Facile box-mimetic | RhB | 30 mg | 30 ml, 10 mg/L | 300 | 500 W xenon lamp | 50% | [52] |
| Melamine and dicyandiamide and titanium (IV) butoxide | melt-infiltration | RhB | 50 mg | 50 ml, 10 mg/L | 60 | 500 W xenon lamp | 100 | [53] |
| Melamine and tetrabutyl titanate | Facile calcination | RhB | 40 mg | 30 ml, 10 mg/L | 80 | 350 W xenon arc lamp | 100% | [54] |
| Melamine and titanium tetrachloride | Hydrolysis approach | Phenol | 100 mg | 20 ml, 5 mg/L | 60 | 500 W DHP Xenon short arc lamp | 96.60% | [43] |
| Melamine and titanium hexadecylamine | Thermal treatment | Acid Blue | 83 | 100 mg | 100 ml, 10 mg/L | 90 | 300 W metal halide lamp | 100 | [46] |
| Melamine and TiO$_2$ | Molten salt assisted | MO | 60 mg | 60 ml, 10 mg/L | 90 min | 300 W Xe lamp | 80% and 95% | [55] |
| Melamine and TiO$_2$ | sol-gel technique | MB | 100 mg | 100, 10 mg/L | 360 | 500 W Xenon lamp | >90% | [56] |
| Urea and TiO$_2$ | simple wet-imregnation | Acid orange | 75 mg | 75 ml, 5 mg/L | 60 | 250 W tungsten halogen lamp | 80% | [50] |
| Urea and TiO$_2$ | | | | | | | | |
| Urea and Tetrabutyl titanate | | | | | | | | |
| Urea and Titanium tetrabutoxide (TTP) | Infiltration and thermal | Phenol | 80 mg | 160 ml, 10 mg/L | 60 | 500 W Hg lamp | 84% | [57] |

4. Proposed photocatalytic mechanism of hybrid nanocomposite

Based on reported literature, we were concluded that the graphitic carbon nitride-based composite has enhanced photocatalytic activity than pure g-C$_3$N$_4$ and metal oxide (ZnO and TiO$_2$), due to large surface areas, enhanced visible light-harvesting capacity, low bandgap, synergistic effect, decrease recombination of the photogenerated electrons and holes and increased efficiency of photogenerated electron-hole pair separation. Also, all beneficial factors are correlated with the development of interface hybrid structure between a metal oxide and g-C$_3$N$_4$. During photocatalysis, more active sites are experienced in nanocomposite due to high surface area. Due to its large band difference, the pure semiconductor metal oxide cannot be excited (3.17-3.2 eV) to produce electron-hole pairs, only g-C$_3$N$_4$ is stimulated by visible light. As the edge potential of the conduction band of g-C$_3$N$_4$ is more negative than that of metal oxide, the photoexcited electrons in the g-C$_3$N$_4$ CB are passed to the metal oxide CB and then to the photocatalyst surface (fig. 2). Since the photocatalytic process proceeds primarily through the production of electron-hole pairs (e$^-$, h$^+$), superoxide anion radical(s$^-$O$_2$) and hydroxyl radicals (OH) are of considerable importance to study the actual active species involved in organic pollutant degradation[39–42]. For the identified the main active species involved in photocatalytic activity many scavengers have been used for this studies as ammonium oxalate for holes (h$^+$), isopropanol, methanol, tert-butyl alcohol for hydroxyl (OH) radicals, benzoquinone, benzoquinone, ascorbic acid for superoxide anion radicals(s$^-$O$_2$) and potassium dichromate for electrons (e$^-$)[15,42,49].
N. Kumaresan et al. has reported that the synergetic effect of ZnO-g-C3N4 nanocomposite is explained very well in the photocatalytic mechanism. Due to the large band difference, pure ZnO semiconductor cannot be excited itself under sunlight, therefore, g-C3N4 is stimulated by sunlight to produce electron-hole pairs by exciting electrons ($e^-$) from the valence band (VB) of g-C3N4 to its conduction band (CB) and leave holes (h+) in the valence band of g-C3N4. Further CB electron passed to ZnO CB due to arrangement of CB potential. Also, CB of ZnO is reacted with O2 molecules and then generated superoxide radicals ($O_2^-$). Consequently, the hole moved from VB of ZnO to VB of g-C3N4 and reacts with H2O molecules to generate *OH radicals. Thus, in ZnO-g-C3N4 electron-hole pair recombination is delayed. The superoxide radical ($O_2^-$) and hydroxyl radicals ($OH$) reacts with RhB/4-CP and degrade it into CO2 and H2O[40].

R.A. Senthil and his co-workers have been described the photocatalytic activity Z-scheme mechanism of TiO2-g-C3N4, according to them both photocatalysts are excited by the visible light irradiation. Subsequently, g-C3N4 CB potential is more negative than that of TiO2. Hence, the photogenerated electron on the CB of g-C3N4 can transfer to CB of TiO2 via interface bonding. Furthermore, the TiO2 VB potential is more positive than that of g-C3N4 which helps in the transfer of photogenerated holes on the TiO2 VB to the g-C3N4 VB via heterojunction. Thus, the e- and h+ are collected on TiO2 VB and g-C3N4 CB. Thus, reduced electron-hole pair recombination. Which enhances the photocatalytic activity of hybrid toward the photodegradation of dye[50].

5. Conclusion

Most efforts are focused on enhancing the photocatalytic activity of g-C3N4 and to developed hybrid photocatalysts. Graphitic carbon nitride-based composite photocatalyst have also shown promising results in the oxidative degradation of organic compounds, providing economic components for photocatalytic applications. Reports have indicated that the addition of metal oxide (ZnO and TiO2) improves the photocatalytic activity of g-C3N4. The ZnO-g-C3N4 and TiO2-g-C3N4 composites can be accepted as robust, eco-friendly as well as sustainable photocatalysts for the degradation of organic pollutants. This review briefly summarised the fabrication method of ZnO-g-C3N4 and TiO2-g-C3N4 composites with their photocatalysis degradation efficiency against organic pollutants offers good prospects for water treatment. Several types of research have been proposed various methods for in-situ fabrication of ZnO-g-C3N4 and TiO2-g-C3N4 with different precursors to produce a visible light responsive photocatalyst and with enhance photocatalytic activity towards several organic pollutants but the adsorption capacity of ZnO-g-C3N4 and TiO2-g-C3N4 composites towards heavy metals ions is not yet well mapped.
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