International Journal of Engineering Research
Volume No.7, Issue Special 4, pp : 453-457

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

A Brief Review of the Recent Advances in the Field of Removal and Degradation of Organic Pollutant's Through Metal Inorganic Frameworks

Suraj Sharma, Shipra Bhardwaj, Kumud intodia
Department of Chemistry, Government Meera girls college, Udaipur

Abstract: Water purification has been a big global concern over the past few decades. Many toxic organic contaminants in waste water have been degraded through photocatalysis which is considered to be one of the most promising directions for solving the worldwide environment problems. Water contamination being a serious problem is continuously threatening both the quality of human lives and aquatic lives. The present review introduces an extensive and critical analysis of the most recent studies on the use of different photocatalyst for organic adsorption and photodegradation. Overall, the discussion is organized and based on the different photocatlyst which will target different organic contaminants discharged from various industries, domestic and agriculture waste water streams.

Keyword:- Metal inorganic frameworks, , Photodegradation, adsorption and waste water.

Introduction The rapid development of industrialization and urbanization as well as huge population increase, the urgent demand for acute storage of clean water source have attracted immense attention all over the world. One of the constant concerns in waste water treatment facilities is to comply and cope with the new and changing regulations. Degradation and removal of organic contaminants required several treatments because each one has its own advantages and disadvantage.

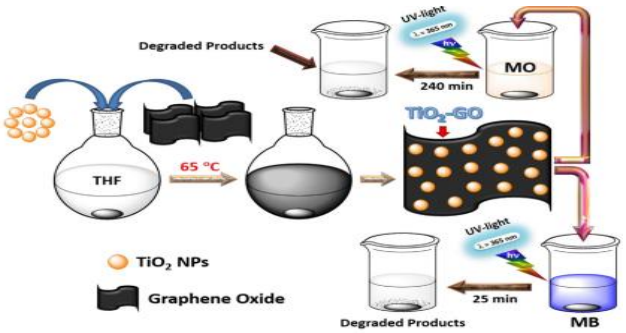
The combination of processes such as adsorption, physiochemical oxidation, biological oxidation and membrane separation had been extensively studied for water purification but photocatalysis had been considered as one of the best options for waste water treatment. It has great potential and efficiency by using sunlight to remove the various organic contaminants and harmful bacteria. As an easily accessible, safe and renewable energy source, natural sunlight is the ideal source to supply energy for photocalysis.

As we know that dyes are difficult to degrade, these are chemically stable, non biodegradable and exist as substance that possesses toxic and carcinogenic characteristics. For these type of degradation Advance Oxidation Processes (AOPs) is the best method which is including methods such as ozonation, photocatalysis, electrochemical oxidation, fenton and fenton like process. Almost all following methods are utilizing hydroxyl radical (.OH) as a highly oxidizing agent which is having redox potential of 2.8ev but researchers reported some other oxidizing agent like sulfate radical (So4.-), permanganate (MnO4-), hypochlorite (ClO-), chlorine dioxide (ClO2) and ozone (O3) for textile water treatment.

For photocatalytic performance TiO2 is the most widely studied photocatalyst. TiO2 is cost effective, nontoxic and unique photocatalytic efficiency as well as high stability but pure TiO2 has some drawbacks like it has large band gap and absorb a small portion of U.V. radiation. Modify TiO2 become great substance for degradation process. Researchers investigated lots of photocatalyst to retain the growing contamination. This review summarizes the recent progress in the design and fabrication of visible light responsive photocatalyst via various synthetic strategies, including the modification of traditional photocatalyst by doping, dye sensitization and forming a hetrostructures.

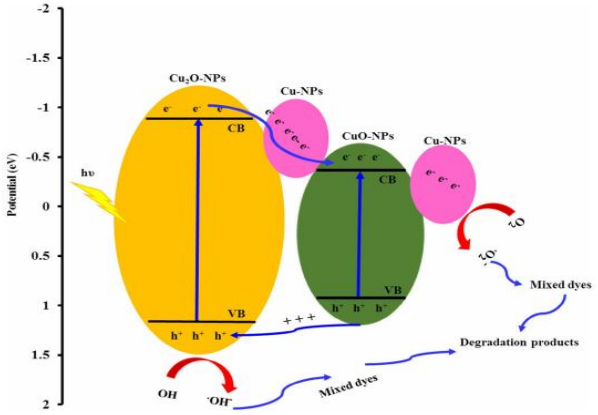
Literature survey Shi-Feng Yang et al. [1] reported the visible-light-sensitive Ag/AgCl/SrTiO3 composites have been successfully fabricated via precipitation reaction followed by photoreduction. Compared with the pristine SrTiO3 and Ag/AgCl NPs, the Ag/AgCl/SrTiO3 composites possessed higher photocatalytic degradation for organic pollutants under visible light irradiation. The enhanced photocatalytic efficiency might arise from the SPR with strong visible light absorbance and efficient charge separation on the surface. The obtained photocatalysts showed good stability and recyclability in the process of photodegradation. The composition of plasmonic Ag/AgCl/SrTiO3 photocatalysts in this paper could provide insights into the design and development of other excellent ideal photocatalysts in environment and energy issues.

Raji Atchudana et al. [2] studied that the potential graphene oxide grafting titanium dioxide nnanocomposite (photocatalyst) was via simple solvothermal method. All the characterization techniques strongly support that the synthesized TiO2-GO nanocomposite was constructed well with stable and high pure. The resulting TiO2-GO nanocomposite used as an active photocatalyst for the (methylene blue (MB) and methyl orange (MO)) degradation in an aqueous medium under UV-light irradiation. The synthesized TiO2-GO nanocomposite displayed significantly enhanced photocatalytic activity toward MB and MO degradation in a neutral aqueous solution under UV-light irradiation than that of synthesized bare titanium dioxide nanoparticles (TiO2 NPs) (photocatalyst). The resulting TiO2-GO heterostructure achieves a maximum degradation efficiency of 100% (25 min of irradiation) and 84% (240 min of irradiation) corresponding to the MB and MO respectively. Thus, the synthesized TiO2- GO nanocomposite can be a promising candidate for the degradation of anthropogenic (MB and MO) dyes.



ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

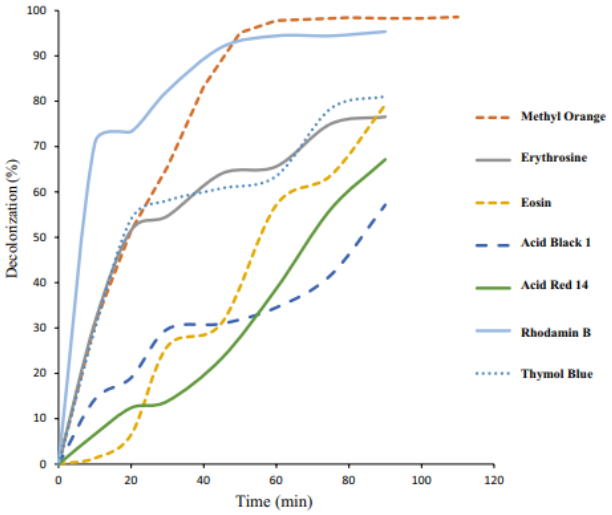
Schematic illustration of the synthesis of TiO2-GO nanocomposite and degradation process of MB and MO. Soleiman Mosleh et al. [3] investigated ultrasonication is a low cost green method for preparation of homogenous nanoparticles rather than conventional approaches CuO/CuO2/Cu nanoparticles were prepared by sonochemical combined thermal synthesis method and used as new photocatalyst. A novel rotating reactor for photocatalytic degradation processes based on application of blue LED as irradiation sources instead of UV lamps were described. Advantage of this reactor is the appropriate light distribution that caused the enough photocatalysts activity. Experiments were performed to photodegradation of binary mixture of safranin O (SO) and methylene blue (MB) dyes Central composite design (CCD) was used to investigate the individual and interaction effects of the parameters on the photocatalytic degradation percentage. Using of this reactor lead to the high photodegradation percentage of 98.1% and 91.91% for SO and MB, respectively. Operation parameters optimization using CCD indicate that optimum values of photocatalyst dosage, rotational speed, initial SO and MB concentration, flow rate, and time of reaction were 0.3 g/L, 900 rpm, 10 and 10 mg/L, 0.3 L/min and 90 min, respectively. Finally, results showed that synergistic effects induced by forming Cu2O/CuO heterojunction containing Cu-NPs co-cocatalyst greatly accelerate electron transfer and effectively retard the reduction of CuO by photo-generated electrons.



Photocatalytic dye degradation mechanism over the CuO/Cu2O/Cu photocatalyst

Li Fanga et al. [4] by using Fe(NO3)3•9H2O, Er(NO3)3•6H2O, Ni(NO3)3•6H2O, PVA and CO(NH2)2 as main raw materials, it is successful to do the preparation of Ni2+ Doped ErFeO3 by microwave process. This experiment showed that Ni2+ Doped ErFeO3 can enhance the visible light photocatalytic activity and the best molar ratio is 0.02. The Ni2+ Doped ErFeO3 nanoparticles exhibited excellent visible-light photocatalytic activity for the decomposition of MO. Therefore, Ni2+ Doped ErFeO3 is expected to be a potential visible-light-driven photocatalyst in the sunlight-induced photocatalytic degradation of wastewater.

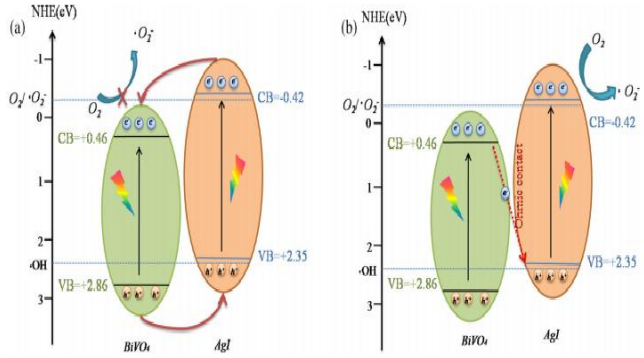
Mojgan Ghanbari et al [5] studied that Ag2CdI4 nanostructures had been made up from reaction of CdI2 and AgI2 in solid states reaction. The morphology of product on presence and absence of surfactant have been investigated. Results show that in presence of CTAB nanoparticles shapes prism structures. The photocatalytic properties of nanoparticles under UV light had been investigated for degradation of different dyes and results show that a good catalytic activities.



Chiranjit Kulsi et al. [6] synthesized Bi2Se3 and Ni doped Bi2Se3 by solvothermal method and investigated its photocatalytic performance. The excellent photocatalytic activity of the doped sample can be attributed to the higher light absorption characteristics in the visible region and separation efficiency of electron–hole pair. Complete degradation of malachite green (MG) dye was achieved within five minutes with Ni doped Bi2Se3 in presence of H2O2 with rate constant value 1.21 min-1 under visible-light illumination. Explanation of the remarkable photocatalytic degradation has been presented based on the modification of band structure of bismuth selenide by doping with nickel. Scavenger test show degradation of MG is dominated by .OH oxidation process and oxidation action of generated .O2 - radicals.

Dan-Lin Guan et al. [7] synthesized a Z-scheme AgI/BiVO4 catalyst successfully via a simple deposition-precipitation method. In comparison with other obtained samples and previous reported catalysts (modified with AgI) the BA3 (contained 9.09% of AgI) displayed superior photocatalytic activity towards E. coil and OTC-HCl under visible light, and the corresponding removal rate can reach 100% and 80%, respectively. It is clear that the effective charge separation of the AgI/BiVO4 and Z-scheme transfer could be responsible for the enhancement of photocatalytic activity. The results of trapping experiments revealed that the O2 and h+ were the dominant reactive species during photo-inactivation process, and the leakage of K+ played a key role for cell membrane destruction and bacteria inactivation. Additionally, the cycle experiments indicated that the catalyst possessed great stability and recyclability. This work suggested that the AgI/BiVO4 photocatalyst could regard as a promising material for wastewater depuration (especially with highly concentrated pathogenic microorganisms and antibiotics).

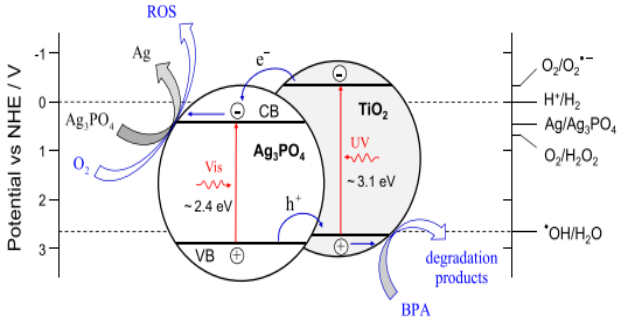
ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018



Schematic diagram of the mechanism over AgI/BiVO4 (a) conventional model and (b) Z- scheme hetrojunction system

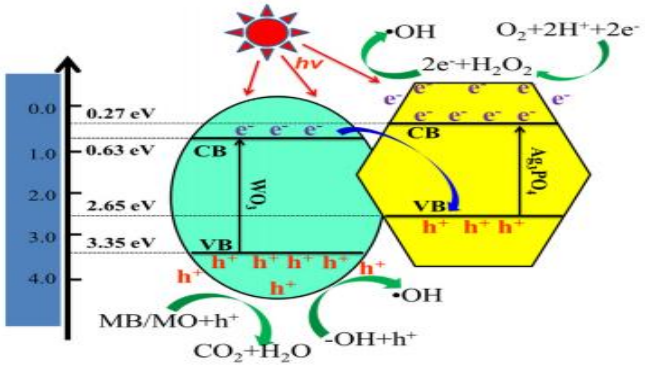
Shrine Maria Nithya and Misook Kang [8] prepared cubic spinel CuCo2O4 with urchin-like architecture by hydrothermal method. The photocatalytic efficiency of CuCo2O4 was explained by the degradation of methyl orange in presence of solar light irradiation. The complete degradation of methyl orange was successfully achieved. Photoelectrochemical measurement supports the photodegradation process. These results explore the new insights in the photocatalytic activity of CuCo2O4 for environmental application.

Mir Edris Taheri et al. [9] investigated the degradation of bisphenol A driven by simulated solar radiation over Ag3PO4 and Ag3PO4/TiO2 photocatalysts. The main conclusions extracted from this work are as follows: (1) Ag3PO4 and its composites with P25 TiO2 are highly responsive in the visible spectral region and this renders them particularly suitable for the photocatalytic remediation of waters contaminated by micro-pollutants using solar light as a renewable energy source. (2) The composite photocatalysts consist of relatively large, nearly spherical Ag3PO4 crystallites with an average diameter of ca 2 m, which are decorated with much smaller P25 TiO2 particles (~20 nm). The two materials are in intimate contact and maintain their individual structural and optical characteristics, implying the absence of chemical interactions between them. (3) The Ag3PO4/TiO2 photocatalysts exhibit substantially greater activity than that of the individual components. This is explained by considering the favourable relative positions of the valence band and conduction band edges of the two semiconductors, which facilitate interfacial charge transfer and, concomitantly, suppression of the electron-hole recombination rate. Evidence is provided that synergy exists between Ag3PO4 and TiO2, which is not the case when Ag3PO4 is combined with photocatalytically inactive metal oxides such as -Al2O3 or ZrO2. (4) Optimal activity for the title reaction was observed for the Ag3PO4/TiO2(75:25) photocatalyst which, under the present experimental conditions, is able to completely degrade BPA (at the g/L level in pure water) within just few minutes under UV, visible or solar irradiation, with the apparent rate constant beingmore than 2 and 3.5 times higher than that of pure Ag3PO4 or P25 TiO2, respectively. (5) Typical to most heterogeneous phhotocatalytic systems, conversion at a given irradiation period increases with increasing catalyst concentration in the range 50–500 mg/L or with decreasing BPA concentration in the range 2200–440 g/L. The apparent reaction rate is not affected appreciably by the presence of bicarbonate or humic acid in solution butis significantly decreased when the reaction takes place in drinking water or wastewater matrices, presumably due to certain non-target species behaving as scavengers. (6) Prolonged exposure to light results in partial deactivation of both Ag3PO4 and Ag3PO4/TiO2 catalysts due to irreversible reduction of silver orthophosphate to metallic silver by photogenerated electrons. Deactivation is less pronounced for the TiO2-containing samples and seems to depend on the BPA concentration and the water matrix employed.



Simplified diagram showing the band edge positions of the Ag3PO4/TiO2 composite, the energy levels of certain redox couples and the photo-induced reactions that may take place under the present experimental conditions.

Jinsuo Lu et al. [10] successfully synthesized a novel 1W/1Ag composite by hydrothermal method through two steps and employed in degrading two kinds of organic dye contaminant under visible light. Compared with pure Ag3PO4 and WO3, 1W/1Ag exhibited notably excellent photocatalytic efficiency. The degradation of MB and MO obeyed the pseudo-first-order kinetics. The enhanced photocatalytic performance and stability were attributed to the direct Z-scheme heterojunction structure and synergic effect of Ag3PO4and WO3, which could be benefit to efficient electron–hole separation and enhanced light energy conversion efficiency. Under visible light illumination, the photoexcited electrons in the conduction band of WO3 and retained holes in the valence band of Ag3PO4 are quickly combined. Meanwhile, the photogenerated holes in the valence band of WO3 played a major role in oxidation reactions. Undoubtedly, the developing of 1W/1Ag not only improves the reaction activity, but also effectively reduces the cost of the Ag3PO4 based photocatalyst, which would be a desired alternative as a simple, efficient, and promising photocatalyst material for waste water treatment.



Proposed mechanism for the direct Z- scheme charge carrier transfer process in the 1W/1Ag composite

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

Mojgan Ghanbari et al. [11] synthesized successfully a novel nanocomposite, Cu2CdI4/CuI via simple hydrothermal method. XRD analysis showed that the product was mainly composed of Cu2CdI4/CuI and there are no other materials. Different morphologies of the product were obtained by changing different parameters such as mole ratio, hydrothermal time and temperature. It was found that each parameter has a significant effect on the product size and morphology. The optical property of the product was obtained by DRS spectra and it was found that the product can active in visible range. Finally, due to 2.8 ev band gap of the nanocomposite, the photocatalytic activity of the product was studied using methyl orange, methyl blue and Acid Black as dyes and the results showed that the product can decompose both dyes in high value.

Prem Singh Saud et al. [12] successfully synthesized Carbon quantum dots anchored TiO2 (CQDs/TiO2) composite nanofibers by combining electrospinning and hydrothermal methods. The as-synthesized CQSs/TiO2 composite nanofibers displayed much enhanced photocatalytic activity in the degradation of MB as well as destruction of E. coli as compared to pristine TiO2 nanofiber under the visible light irradiation. The above demonstration revealed that as-prepared materials have potential as economically friendly photocatalyst for waste water remediation due to its reusability.

CONCLUSITION

1.Different types of photocatalyst like oxide, iodides, doped, and composites were be prepared successfully through hydrothermal, precipitation, solid state, ultrasonication, and solvothermal methods.

2.These catalysts are characterized through different analytical techniques like XRD, EDS, FESEM, and FETEM etc.

3.Harmful substance in water degraded and removed from water by the photocatalyst.

4.The photocatlysis is the best way to clean the waste water for further utilization like irrigation, domestic and industrial purpose.

REFERENCES

i. Yanga SF, Niua CG, Huangb DW, H Zhanga , Lianga C, Zenga GM. SrTiO3 nanocubes decorated with Ag/AgCl nanoparticles as photocatalysts with enhanced visible-light photocatalytic activity towards the degradation of dyes, phenol and bisphenol A. Environ Sci : Nano DOI: 10.1039/C6EN00597G.

ii. Atchudana R, Edisona TNJI, Perumalb S, Karthikeyanc D, Leea YR. Effective photocatalytic degradation of anthropogenic dyes using graphene oxide grafting titanium dioxide nanoparticles under UV-light irradiation J Photochem and Photobio A: Chem 333: 92–104, 2017.

iii. Mosleha S, Rahimia MR, Ghaedib M, Dashtianb K, Hajatic S. Sonochemical-assisted synthesis of CuO/Cu2O/Cu nanoparticles as efficient photocatalyst for simultaneous degradation of pollutant dyes in rotating packed bed reactor: LED illumination and central composite design optimization Ultrason Sonochem 40: 601–610, 2018

iv. Fanga L, Yangb Q, Xu M, Caod J, Tange P, Chen H. Preparation of nanosized Ni2+ doped ErFeO3 by microwave assisted process and its visible-light photocatalytic activity key engineering materials submitted. 748: 418-422, 2017. doi:10.4028/www.scientific.net/KEM.748.418.

v. Ghanbari M, Gholamrezaei S, Niasari MS, Abbasi A. Synthesis and characterization of Ag2CdI4 nanoparticles and photodegradation of organic dyes. J Mater Sci: Mater Electron, 2016. DOI 10.1007/s10854-016-6308.

vi. Kulsi C, Ghosh A, Mo,ndal A Kargupta K, Ganguly S, Banerjee D. Remarkable photo-catalytic degradation of malachite green by nickel doped bismuth selenide under visible light irradiation Appl Surf Sci https://doi.org/10.1016/j.apsusc.2016.09.063

vii. Guan DA, Niu CG, Wen XJ, Guo H, Deng CH, Zeng GM. Enhanced Escherichia coli inactivation and oxytetracycline hydrochloride degradation by a Z-scheme silver iodide decorated bismuth vanadate nanocomposite under visible light irradiation J. Colloid Interface Sci. 512: 272–281, 2018.

viii. Nithya SM and Kang M. Facile synthesis and photocatalytic activity of cubic spinel urchin-like copper cobaltite architecture. 2017 https://doi.org/10.1016/j.materresbull.2017.03.048

ix. Taheri MR, Petala A, Frontistis Z, Mantzavinos D, Kondarides DI. Fast photocatalytic degradation of bisphenol A by Ag3PO4/TiO2 composites under solar radiation. Catal Today https://doi.org/10.1016/j.cattod.2016.05.047

x. Lua J, Wang Y, Liua F, Zhang L, Chai S. Fabrication of a direct Z-scheme type WO3/Ag3PO4 composite photocatalyst with enhanced visible-light photocatalytic performances Appl Surf Sci 393: 180–190, 2017.

xi. Ghanbari M, Sabet M, Niasari MS. Synthesis of different morphologies of Cu2CdI4/CuI nanocomposite via simple hydrothermal method. J Mater Sci: Mater Electron, 2016. DOI 10.1007/s10854-016-5226-6.

xii. Saud PS, Pant B, Alam M, Ghouri ZK, Park M, Kim HY. Carbon quantum dots anchored TiO2 nanofibers: Effective photocatalyst for waste water treatment 2015 http://dx.doi.org/10.1016/j.ceramint.2015.06.007.

xiii. 13. Asghar A, Raman AAA, Daud WMAW. Advanced oxidation processes for in-situ production of hydrogen peroxide/hydroxyl radical for textile wastewater treatment: A review. J Clean Prod 2014. Doi 10.1016/j.jclepro.2014.09.010

xiv. Dong S, Feng J, Fan M, Pi Y, Hu L, Han X, Liu M, Sun J, Sun J. Recent developments in heterogeneous photocatalytic water treatment using visible light responsive photocatalysts- a review. RSC Adv 5: 14610, 2015.

xv. Cao X, Luo S, Liu C, Chen J. Synthesis of bentonite – supported Fe2O3 – doped TiO2 superstructures for highly promoted photocatalytic activity and recyclability. Adv powder technol 2017. http://ax.doi.org/10.1016/j.apt.2017.01.003.

xvi. Zhao X, Wu P, Lu D, Fang P, Liu M, Qian Z. synergistic effect of Fe2O3 and CeO2 co- modified titanate nanosheet heterojunction on enhanced photocatlytic degradation. J nanosheet res.19: 325, 2017.

xvii. Li Y, Wang P, Huang C, Yao W, Wu Q, Xu Q. Synthesis and photocatlytic activity on oxygen vacated TiO2. Appl catal B: environ 205: 489-497, 2017.

xviii. Zhou F, Yan C, Wang H, Zhou S, Komarneni S. Sepiolite – TiO2 nanocomposite for photocatalysis:Synthesis by microwave hydrothermal treatment versus calcinations. Appl clay sci 146: 246-253, 2017.

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

xix. Vaiano V, Sacco O, Sannino D, Ciambelli P. Process intensification in the removal of organic pollutants from waste water using innovative photocatalysts obtained coupling zinc phosphors with nitrogen doped semiconductor. J clean produc 100: 208-211, 2015.

xx. *Sivkumar P, Murusgesan B, Loganathan A, Sivakumar P. A review on decolourisation of dyes by photodegradation using various bismuth catalysts. J Taiwan Inst Chem Eng 45: 2300-2306, 2014.*