UGC MAJOR RESEARCH PROJECT

F.No:41-288/2012 (SR) dated 13.07.2012

Summary of the Final Report

(2012-2015)

Project Title

Solar Photocatalytic mineralization of water Pollutants in industrial Effluents by advanced oxidation process Using Modified Catalysts

Principal Investigator : **Dr. M. Shanthi,**
Professor,
Department of chemistry,
Annamalai University,
Annamalainagar – 608 002,
Tamil Nadu, India.

Co-Investigator : **Dr.R.Baskaran,**
Assistant Professor ,
Department of Chemistry ,
Annamalai University ,
Annamalainagar – 608 002
Tamil Nadu, India.

UNIVERSITY GRANTS COMMISSION

BAHADUR SHAH ZAFAR MARG

NEW DELHI – 110 002

PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE

FINAL REPORT OF THE WORK DONE ON THE PROJECT

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR	: **Dr.M.Shanthi** Professor of Chemistry Annamalai University Annamalainagar-608 002
2. NAME AND ADDRESS OF THE INSTITUTION	: Department of Chemistry Annamalai University Annamalainagar-608 002
3. UGC APPROVAL NO. AND DATE	: UGC, New Delhi No.F.No: 41-288/2012 (SR) dated 13.07.2012
4. DATE OF IMPLEMENTATION	: 1st August 2012
5. TENURE OF THE PROJECT	: Three Years (2012-2015)
6. TOTAL GRANT ALLOCATED	: Rs. 10, 68, 300/-
7. TOTAL GRANT RECEIVED	: Rs. 9, 74, 600/-
8. FINAL EXPENDITURE	: Rs. 9,73,529/-
9. TITLE OF THE PROJECT	: **Solar Photocatalytic mineralization of water Pollutants in industrial Effluents by advanced oxidation process Using Modified Catalysts**

10 .Objectives undertaken during the project period from 01.08.2012 to 31.07.2015

- Fifty two, metal /non-metal, metal halide, Sulfide modified, Co-doped Nano and Semiconductor - photocatalysts have been prepared using different methods.
- Photocatalytic activities of these catalysts have been tested in the degradation of dyes and other toxic pollutants using solar and UV light.
- Among these, highly efficient catalysts were characterized by high resolution transmission electron microscopy (HR-TEM), scanning electron microscopy (SEM), field-emission scanning electron microscopy (FE-SEM), particle size analysis, energy dispersive spectroscopy (EDS), Element dot color maping (EdCM), X-ray diffraction (XRD), Brunauer-Emmett-Teller (BET) measurements, diffuse reflectance spectroscopy (DRS), photoluminescence (PL), and Fourier transform infrared (FT-IR) spectra.
- Effects of experimental parameters on the degradation were analyzed to find out the optimum conditions for maximum efficiency.
- GC-MS analysis of solution during degradation had been carried out to identify the intermediates and a reaction pathway had been proposed.
- In addition to the proposed objectives further work has been carried out for the treament of industrial effluent. . Industrial effluents from RR Industry, Tanfac Industry and Muruga Textile Dye Industry were obtained. Initially bench scale experiments have been carried out to find out the optimum conditions. Under optimum conditions effluents were treated in the pilot scale solar photoreactor fabricated in our laboratory.

11.ACHIEVEMENTS FROM THE PROJECT :

- Different types of photocatalysts were synthesised by using different methods. (Sol-gel method, Co-precipitation method, Precipitation – thermal decomposition method, Depositon – Precipitation method, Sonochemical method)
- Established their efficiencies with various water pollutants in industrial effluents using solar and UV light source
- Their efficiences were analysed under various experimental conditions and the optimum level was fixed
- Confirmed the mineralization using chemical oxygen demand (COD) methods
- Pollutant degradation mechanism has been proposed
- Industrial effluents from RR Industry, Tanfac Industry and Muruga Textile dye Industry were obtained. Intially bench scale experiments have been carried out to find out the optimum conditions. Under optimum conditions effluents were treated in the pilot scale solar photoreactor fabricated in our laboratory.

12.. SUMMARY OF THE FINDINGS :

Conventional methods of industrial effluent treatment such as activated sludge method, adsorption, and precipitation will not mineralize the pollutants, where as advance oxidation process (AOPs) completely mineralize the pollutants. AOP using semiconductor photocatalyst has several advantages. Semiconductor photocatalysts are non-toxic, stable and reusable. Modification of these catalysts will enhance their photocatalytic activity both in UV and solar light.

We had prepared 52 modified photocatalysts, comprising of 11 metal doped, 2 non-metal doped, 4 metal halide loaded , 19 Co-doped, 6 sulfide loaded semiconductors, 5 coupled semiconductors, 1 nano-photocatalysts and 4 Semiconductors. Photocatalytic activities of these catalysts have been tested in the degradation of dyes and other toxic pollutants using UV and solar light.

Among these, highly efficient catalysts were characterized by high resolution transmission electron microscope (HR-TEM), scanning electron microscope (SEM), field-emission scanning electron microscope (FE-SEM), particle size analysis, energy dispersive spectroscopy (EDS), element dot color maping (EDCM), X-ray diffraction (XRD), Brunauer-Emmett-Teller (BET) surface area measurements, diffusion reflectance spectroscopy (DRS), X-ray photoelectron spectroscopy (XPS), photoluminescence (PL), and Fourier transform infrared spectrometry (FT-IR). Characterization studies revealed the morphology, solar light activity, particle size and the presence of doped elements in the catalyst.

We had investigated the effects of experimental parameters on the degradation of pollutants and reported the optimum conditions for maximum efficiency of the catalysts. GC-MS analysis of solution during degradation had been carried out to identify the intermediates and a reaction pathway had been proposed.

We had fabricated a solar photoreactor in our laboratory for pilot scale treatment of industrial effluent and placed in the open terrace. Industrial effluents from RR Industry, Tanfac Industry and Muruga Textile Dye Industry were obtained. Initially bench scale experiments have been carried out to find out the optimum conditions. Under optimum conditions about 10 litres of these industrial effluents were treated in the pilot scale photoreactor. This process is found to be efficient for the treatment of these industrial effluents.Pilot scale solar photoreactor will be much beneficial for industries to test the feasibility of treating their effluents in a large scale.

13. CONTRIBUTION TO THE SOCIETY :

The widespread presence of various organic pollutants in industrial effluents results in a potentially serious environment problem nowdays. In photocatalysis, the pollutants are completely mineralized to harmless CO_2, H_2O and mineral acids. The solar photocatalysis can

provide clean and green eco-friendly technology for the treatment of industrial effluent.The study would provide the data on various solar photocatalysts and their efficiencies in the detoxification of industrial wastewater. The industries can utilize the results for the design of effluent treatment plants.

LIST OF PUBLICATIONS

1. P. Dhatshanamurthi, B. Subash, A. Senthilraja, V. Kuzhalosai, B. Krishnakumar, **M.Shanthi "**Synthesis and characterization of ZnS-TiO_2 photocatalysts and their excellent sun light driven catalytic activity for degradation of PRSS dye" (a model pollutant) with dye sensitized mechanism, ***Journal of Nano science and Nano Technology,*** 13, **(2013),** 1–10.

2. P. Dhatshanamurthi, B. Subash, B. Krishnakumar and **M.Shanthi** "Highly active ZnS loaded TiO_2 photocatalyst for mineralization of phenol red sodium salt under UV-A light" ***Indian Journal of Chemistry*** Vol. 53A, **(2014),** 820-823.

3. P. Dhatshanamurthi, B. Subash, **M. Shanthi** "Investigation on UV-A light photocatalytic degradation of an azo dye in the presence of CdO/TiO_2 coupled semiconductor", ***Materials Science in Semiconductor Processing,*** 35 **(2015)** 22–29.

4. P. Dhatshanamurthi, **M. Shanthi** "Li and Ag Co-Doped ZnO Photocatalyst for Degradation of RO 4 Dye Under Solar Light Irradiation" ***Journal of Nanoscience and Nanotechnology*****.** 15 **(2015)** 1-10.

5. D. Rajamanickam, P. Dhatshanamurthi and **M. Shanthi** "Enhanced photocatalytic efficiency using sunset yellow, an azo dye under day light illumination of NiS/TiO_2 composite catalysts" **Materials Research Bulletin** 61, **(2014)** 439–447

6. D. Rajamanickam, P. Dhatshanamurthi and **M. Shanthi** "Preparation and characterization of SeO_2/TiO_2 composite photocatalyst with excellent performance for sunset yellow azo dye degradation under natural sunlight illumination" ***Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy***, 138, **(2015)** 489-498.

7. V. Kuzhalosai, B. Subash, A. Senthilraja, P. Dhatshanamurthi, **M. Shanthi** "Synthesis, Characterization and photocatalytic properties of SnO_2-ZnO composite under UV-A light" ***Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy,*** 115 **(2013)** 876-882.

8. B. Subash, A. Senthilraja, P. Dhatshanamurthi, M. Swaminathan, **M. Shanthi** "Solar active photocatalyst for effective degradation of RR 120 with dye sensitized mechanism", ***Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy,*** 115 **(2013)** 175-182.

9. A. Senthilraja, B. Subash, P. Dhatshanamurthi, M. Swaminathan and **M. Shanthi,** Photocatalytic Detoxification of Acid Red 18 by modified ZnO Catalyst under Sunlight Irradiation, **Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy,** 38 **(2015)** 31-37.