Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as Deemed-to-be University under section 3 of UGC Act, 1956)
(Vide Notification No. F.9-5/2000 - U.3, Ministry of Human Resource Development, Govt. of India, dated 4th July 2002)
Accredited by NAAC
NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL
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Ref No.SMS-2018-O-24 Date: 04/11/2019

TO

Mr. Dr. R. Velavan,

Professor / Physics,

BIHER.

BHARATH INSTITUTE OF HIGHER EDUCATION & RESEARCH (Declared as Deemed to be University U/S 3 of UGC Act 1956) 04 NOV 2019 OFFICE OF THE DEAN-RESEARCH Selaiyur, Chennai-600 073. INDIA

Thro: Concern Head of the Department

Greetings!!!

We are happy to announce that the Research Advisory Committee has approved your proposal for Seed Money Scheme-2018 which was presented by you. You are requested to complete the proposal and send the progress report to the Dean Research in the prescribed time period.

Title of the Project: Research Investigation on mixed metal oxide nanocomposites for the application of photocatalytic degradation

Seed Money Amount: Rs.1, 00,000/- (Rupees One Lakh Only)

Approved on: 02/11/2019

Payment details:

Voucher No.24 **Dated: 08/11/2019**

With Regards

04/11/2019

Dean-Research

Bharath University

SELAIYUR, CHENNAI - 600 073, TAMIL NADU, INDIA.

CASH / PAYMENT VOUCHER

Date 08/11/19

V.No. 024

Debit _____ Amount

Rs. 1,00,000/-

PAID TO Mr. R. Velavan

RUPEES one Lakh only.

TOWARDS Seed Money scheme - 2018.

Authorised by **Finance Manager** **Cashier/Accountant** **Payee's Signature**

FORMAT FOR PROPOSAL SUBMISSION

1. Details of Principal Investigator

Name	: Dr. R. Velavan
Designation	: Professor and Head
Highest Qualifications	: Ph.D.
Department	: Physics
E-mail	: hod.physics@bharathuniv.ac.in
Contact no	: 9791661272
Date of Joining)	: 18 Feb 2015

2. Details of Co-Principal Investigator:

Name	: Dr. C.Rathika Thayakumari
Designation	: Associate Professor
Highest Qualifications	: Ph.D.
Department	: Physics
E-mail	: rathikak06@gmail.com
Contact no	: 9884775298
Date of Joining	: 10 Jan 2013

Technical details

1. Introduction:

Organic dyes are the major water pollutants, contaminating the water resources like surface water and ground water. Wastewater from chemical industries, printing industries, paper industries and textile industries are the leading threats for the water contamination. Wastewater should be treated or degraded within the industries and send out as an effluent, resulting minimal impact to the environment. Several techniques are available to degrade the organic dye molecules but the photocatalytic treatment is the cheapest and versatile technique to degrade the organic dye molecules. Numerous photocatalysts are available in the market but functioning in the presence of sunlight is a challenging task rather than the UV light. Based on the band gap, semiconductor nanomaterials are favourable materials to obtain the photocatalyst to function in the presence of sunlight. The band gap of the semiconducting material can be modified by doping or composite formation using mixed metal oxides.

The main objective of the project is to utilise the semiconductor nanomaterials, namely mixed metal oxides TiO_2 / $CeO_2$to degrade the dyes or chemical waste of the textile industries. Further, to come up with cheapest mixed metal oxide nanomaterials other than the TiO_2 / CeO_2, mainly for the wastewater treatment of small-scale industries and large scale industries. .

2. Review of status of Research and Development in the subject

Ali Imran has worked on TiO2 / ZnO mixed metal oxide to degrade the Flumequine Antibiotic. In his work, the catalysts ZnO, TiO2, Ti/Zn and Ti/Zn/Sep have been studied for catalytic degradation in which Ti/Zn/Sep provided outstanding performance with 85% degradation efficiency, decomposing FLQ.

Bloom et al., has studied the degradation of P-cresol using ZnO, TiO2, TiO2 / ZnO and PANI capped TiO2 / ZnO. They have observed the capping agent PANI has enhanced the photocatalytic activity to a larger extent, say 99% degradation efficiency.

NiO has been introduced into ZnSn-mixed metal oxide composites (MMOCs) with various Ni contents via a simple co-precipitation/sintering route. The influences of introduction of NiO on light absorption and ethanol sensing properties of ZnSn-MMOCs have been investigated. The obtained ternary NiZnSn-MMOCs exhibit extended adsorption to visible light area and lower energy band gap values. Consequently, their sensitivities and responses to ethanol have been enhanced by the introduction of NiO at certain range compared to binary ZnSn-MMOCs, which is attributed to the visible light responsive component of NiO and the p-n heterostructures between NiO and ZnSn-MMOCs. The ternary NiZnSn-MMOCs with the optimal content of NiO reveal high sensitivity of 180–200 ppm of ethanol at 225 °C and quick response time to low concentration of ethanol .

Ag-, Ce- and Ga-promoted Cu–Mg–Al hydrotalcite derived mixed metal oxides were obtained by standard coprecipitation, followed by calcination. The obtained Ag(Ce, Ga)– Cu–Mg–Al–O_x mixed metal oxides were characterized. The loading of Ag_y-, Ce_y-, or Ga_y– Cu_5–Mg_{66-y}–Al_{29} (y = 0–1) had a clear effect on the catalytic performances. For materials with low metal loadings ($y \leq 0.25$), the redox properties determined the catalytic performances in NH_3-SCO. The formation of easily reducible CuO_x played a crucial role for enhanced catalytic activity at lower temperatures, with a drop in the selectivity to N_2 at higher temperatures. Higher metal loading ($y \geq 0.5$) led to the formation of surface and bulk copper oxide species, and other aggregated metal oxide phases, which enhanced the catalytic activity for Ag–Cu–Mg–Al–O_x, and diminished activity for Ce(Ga)–Cu–Mg–Al– O_x *[2]*

Mugunthan et al., has worked in TiO2 / SnO2 mixed metal oxide photocatalyst to degrade diclofenac. They have prepared the mixed metal oxide (Ti-Sn) in different molar ratio 1:1, 5:1, 10:1, 20:1 and 30:1 using hydrothermal method. The work claims 20:1 ratio of TiO2 / SnO2 as the potential catalyst to degrade diclofenac effectively.

Shweta Mehta et al proposed a mixed metal oxide as a catalyst and demonstrate it's ability to not only activate the MeOH molecule upon

adsorption but also dissociate O-H and one of it's C-H bonds. MeOH activation is compared on two prominent facets of $ZnAl_2O_4$ viz. (2 2 0) and (311). While spontaneous O-H bond dissociation is observed on both facets, C-H bond dissociates only on the (311) surface. Multiple factors like atomic arrangement and steps on the surface, coordination of surface atoms, and their effective charges have a combined effect on MeOH activation. The (311) surface offers higher catalytic activity in comparison with (2 2 0) surface. Having a stepped surface, availability of multiple sites, and variation in the charge distribution are some of the reasons for better catalytic performance of (311) facet. Effect of orientation of MeOH with respect to the surface adds both, information and complexity to the problem [3].

Jayishnu Singla et al proposed the removal of nitrogen-based contaminants present in urine wastewater has become a considerable matter of concern because of its potentially harmful effects on human health and can cause alterations to aquatic life. Hence to avoid its dangerous effects, electro-assisted technology was employed for the voidance of this metabolite with the doped-mixed metal oxide. The influence of various input factors such as time, pH, current density and NaCl dose on treatment efficiency in terms of percent degradation and energy consumption were evaluated using response surface methodology. Electrolysis results showed that 95.35% degradation of uric acid was achieved at optimized conditions. In addition, to reduce the treatment time further, attempts have been made by incorporating dual effect i.e. Photoelectrocatalysis. The anode used for multiple runs were proven to be effectively stable through XRD and SEM/EDS. Analysis of treated uric acid solution was validated in terms of COD (92%) and TOC (89%) reduction. The transformation products of uric acid were identified through LC–MS. Based on these intermediates and literature survey, an oxidative mechanism for uric acid has been proposed [5].

Designing of novel semiconductor materials or enhance the potential of existing materials for the removal of the environmental pollutants is growing area of scientific interest. In this paper, novel binary $ZnO.La_2O_3$ (ZL) and ternary mixed metal oxides $ZnO.La_2O_3.CeO_2$ (ZLC) are synthesized using hydrothermal and solution combustion approach. The synthesized materials are characterized by the various techniques such as XRD, FESEM, UV-DRS and BET surface analyzer to uncover the structural, morphological and optical properties of the materials. The

photocatalytic activity was evaluated by taking Rhodamine B dye as a model pollutant and 125 W mercury vapor lamp was used as light source. Despite the low crystallinity, hydrothermally synthesized samples possess better activity as compared to the solution combustion synthesized samples, which is attributed to their regular morphology and large surface area. The large surface area provide t he more active sites and the regular morphology enhance the lifetime of the charge carriers by helping in migration of the photoinduced species. The hydrothermally synthesized sample showed 94.99% degradation of RhB on irradiation for about 160 min in basic medium. Experiments were performed using different scavengers to find the role of the active species in the degradation process [6].

2.1 International Status: NIL

2.2 National Status: NIL

2.3 Importance of the proposed project in the context of current status including scientific objective

Most of the studies are explored with TiO2 and other metal oxide nanocomposites, but TiO2 / CeO2 nanocomposite has not been explored completely. The present study will focus on TiO2/CeO2 completely with all parameters, varied with time, molar concentration of metal oxide, and dopant concentration.

3. Progress/achievement so far, if any

Our lab is focusing on mixed metal oxides embedded on Graphene for supercapacitor application and photocatalytic degradation. In addition, our lab is interest to pursue to research investigation on mixed metal oxide nanocomposites for the photocatalytic applications. Initial literature have been completed.

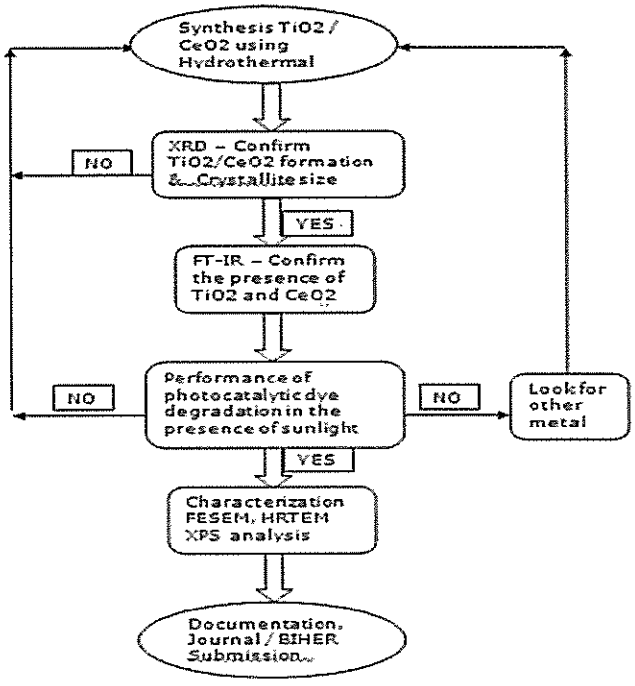
4. Work Plan:

4.1 Methodology:

Based on properties of individual metal oxides and atomic radius, various mixed metal oxides are identified for the present studies. Mixed metal oxides TiO2 / CeO2 and TiO2 / ZrO2 nanocomposites will be synthesized using microwave method and hydrothermal method. Synthesis of mixed metal oxide nanomaterials will be confirmed using powder X-ray diffraction and characterized using Field Emission Scanning Electron microscope (FESEM). Moreover, the synthesized samples will be verified as an efficient photocatalytic degradation material using UV-Vis spectrophotometer. Most of the dyes are chromophoric in nature, resulting high absorption of light. The photocatalytic degradation will lead to convert the coloured sample to colourless. Several parameters like concentration of the prepared samples, different dyes and its concentration, time duration, temperatures, and stirring will be taken into account for the efficient photo catalytic degradation. Materials for the study will be purchased from Merck and Sigma chemicals of Analytical grade

Dyes chosen for the present study Methylene blue (MB) and Rhodamine

Flow chart depicts the work plan of the proposal



4.2 Time Schedule of activities giving milestones through BAR diagram. (Maximum 1/2 page)

Milestone achievements	1 -3 months	4-9 months	9-12 months
➢ Synthesis of Mixed metal oxides(TiO2 / CeO2 & TiO2 / ZrO2)			
➢ Characterization of Mixed metal oxides using XRD, FT-Raman, FESEM& HRTEM			
➢ Optimization of the Synthesis			
➢ Efficiency of the photo catalytic degradation by varying parameters			
➢ Documents Submission to BIHER			

4.3 Expected outcome within the time period of Seed Money Scheme

- Our present study will help us to identify the potential, toxic free, cost effective photocatalysts to degrade the organic dye molecules efficiently in a short period of time.

- The obtained cheaper photocatalyst can be scaled up and used directly in both the small scale and large scale industries to degrade the organic molecules.

5. **Suggested Plan of action stating the name of funding agency where the project will be communicated for financial support within the time period of project.**

DST – SERB is the choice of funding agency to apply for the financial support to extend this project for a wide range of mixed metal oxides. Further the financial support will help us to accelerate our finding to deliver few mixed metal oxides for photocatalytic degradation.

6. **Bibliography: Nil**

7. **List of Projects submitted/implemented by the Investigators (Separate for Pi and Co-PI)**

7.1 Details of Projects submitted to various funding agencies: NIL

Sl. No.	Title	Cost in lakhs	Month of submission	Role as PI/ Co-PI	Agency	Status
1						

7.2 Details of Projects under implementation - NIL

Sl. No.	Title	Cost in lakhs	Duration	Role as PI/ Co-PI	Agency
	NA	NA	NA		

7.3 Details of Projects completed during the last 5 years - NIL

Sl. No.	Title	Cost in lakhs	Duration	Role as PI/ Co-PI	Agency
	NA	NA	NA		

8. List of publications published by the Investigators, if any:

Principal Investigator Publications

1 Ramakrishnan, B., Velavan Ramasamy, Qasba, P. K. (2006) "Structural snapshots of beta-1,4-galactosyltransferase-I along the kinetic pathway" J.Mol.Biol. 357, 1619-1633.

2 Velavan Ramasamy, Ramakrishnan, B., Boeggeman, E., Ratner, D.M., Seeberger, P.H. and Qasba, P. K. (2005) "Oligosaccharide preferences of beta1,4-galactosyltransferase-I: crystal structures of Met340His mutant of human beta1,4-galactosyltransferase-I with a pentasaccharide and trisaccharides of the N-glycan moiety" J.Mol.Biol. 353, 53-67.

3 Ramakrishnan, B., Boeggeman, E., Velavan Ramasamy and Qasba, P.K. (2004) "Structure and catalytic cycle of β-1,4-galactosyltransferase" Curr. Opin. Struc. Biol. 14, 593-600.

4 Velavan Ramasamy, Ramakrishnan, B., Boeggeman, E. and Qasba, P.K. (2003) "The role of tryptophan 314 in the conformational changes of β1,4-Galactosyltransferase-I", J. Mol. Biol. 331, 1065-1076.

5 Manju Bansal, Sandeep Kumar and R.Velavan (2000) "HELANAL - A program to characterise helix geometry in proteins" J. Biom. Struc. Dyn. 17, 811-819.

6 R. Velavan, K. Sivakumar, U.S. Pathak, K.S. Jain and H.K. Fun, (1997) "Two Substituted [1,2,4] triazole derivatives", Acta Cryst. C53, 1615-1617.

7 R. Velavan, K. Sivakumar, U.S. Pathak, K.S. Jain, S. Singh and H K. Fun (1995) "4-Phenyl-6,7,8,9 tetrahydro-[1]benzothieno-[3,2-e] [1,2,4] triazolo [4,3-a] pyrimidine-5(4H)-one" Acta Cryst.C51, 2092-2094.

8 R. Velavan, K. Sivakumar and M. Anbu (1995) "(E)-4-Nitrobenzaldehydrazone", Acta Cryst. C51, 1227-1229.

9 R. Velavan, P. Suresh Kumar, K. Sivakumar and S. Natarajan (1995) "Vanillin-I", ActaCryst.C51, 1131-1133.

Co- Principal Investigator Publications

1. **C. Rathika Thaya Kumari**, M. Nageshwari, P. Jayaprakash, P. Sangeetha, S. Sudha, M. Lydia Caroline, Investigation on growth, optical, thermal, mechanical, dielectric, LDT studies of sulphanilic acid monohydrate: A promising third-order nonlinear optical material, Journal of Nonlinear Optical Physics and Materials, 26 (2017) 1750020-1750040.
2. **C. Rathika Thaya Kumari**, P. Jayaprakash, M. Nageshwari, M. Peer Mohamed, P. Sangeetha, M. Lydia Caroline, Growth, optical, photoluminescence, dielectric, second and third order nonlinear optical studies of benzoyl valine acentric crystal , Molecular Crystals And Liquid Crystals, 658 (2017) 186-197.
3. **C. Rathika Thaya Kumari**, M. Nageshwari, R. Ganapathi Raman, M. Lydia Caroline, Crystal growth, spectroscopic, DFT Computational and third harmonic generation studies of Nicotinic acid, Journal of Molecular structure, 1163 (2018) 137-146.
4. M. Nageshwari, **C. Rathika Thaya Kumari**, G. Vinitha, M. Peer Mohamed, S. Sudha, M. Lydia Caroline, Crystal growth, structural, spectral, thermal, dielectric, linear and nonlinear optical characteristics of a new organic acentric material: L-methionine-succinic acid (2/1), Journal of Molecular structure 1155 (2018) 101-109.
5. M. Nageshwari, **C. Rathika Thaya Kumari,** P. Sangeetha, G. Vinitha, M. Lydia Caroline, Third order nonlinear optical, spectral, dielectric, laser damage threshold, and photo luminescence characteristics of an efficacious semi organic acentric crystal: L-Ornithine Monohydrochloride, Chinese Journal of Physics, 56 (2018) 502-519 .
6. M. Nageshwari,**C. Rathika Thaya Kumari**, G. Vinitha, S. Muthu, M. Lydia Caroline, Growth and characterization of L-Serine: A promising organic acentric crystal, Journal of Material science: Materials in electronics, Physica B, 541(2018) 32-42.
7. Growth and Characterization of L-histidiniumfumarate fumaric acid monohydrate single crystal: A promising second and third order nonlinear optical material, M. Peer Mohamed, S. Sudha, P. Jayaprakash, G. Vinitha, M. Nageshwari, P. Sangeetha, **C. Rathika Thaya Kumari,** M. Lydia Caroline, **Chinese Journal of Physics**, 60 / 581-597, August 2019.

9. Budget

Sl. No.	Head	Amount in INR
1	Minor Equipment/software (Generic Name with minimum required accessories, make & model & cost in Indian Rupees)(Mention other PI(s) name, Department with whom joint purchase is proposed) Microwave Autoclave -100 ml Pestle and Mortar agate (2 no's)	 10000 7000 10000
2	Consumables (Like ICs, application boards, chemicals, testing charges, tools, etc.) Chemicals& Glassware and silica crucibles Characterization (XRD, FT-RAMAN, SEM, TEM and Photocatalytic degradation	 38000 20000
3	Travel support for the purpose of research work.	5000
4	Contingency	10000
5	Others	
	Total	100000

10. Name of at least two subject experts from the Institute and one from the outside Institute with their contact details:

Experts

1) Dr.Mani
Prof and Head
Department of Civil
BIHER

2) Dr.M.Arivanandhan
Associate Professor
Center for Nanoscience and Technology
Anna University Chennai -25

CERTIFICATE FROM THE INVESTIGATOR

Project Title: **Research Investigation on mixed metal oxide nanocomposites for the application of photocatalytic degradation**

It is certified that

1. I do hereby agree to submit a complete proposal for financial support to the external funding agency within the time period of SMS-2018
2. I undertake that spare time on equipment procured in the project will be made available to other users.
3. I agree to submit a certificate from Institutional Biosafety Committee, if the project involves the utilization of genetically engineered organisms. I also declare that while conducting experiments, the Biosafety Guidelines of Department of Biotechnology, Department of Health Research, GOI would be followed in to.
4. I agree to submit ethical clearance certificate from the concerned ethical committee, if the project involves field trails/experiments/exchange of specimens, human & animal materials etc.
5. I agree to abide by the terms and conditions of SMS-2018, BIHER,Chennai.

Name and signature of Principal Investigator

(Dr. R.VELAVAN)

Name and signature of Co-Principal Investigator

(Dr. C. RATHIKA THAYAKUMARI)

Date: 11-09-2019

Place: Chennai

Forwarded by Head of the Department

Signature of the Head

PROJECT EVALUATION FORMAT

Recommendation Sheet

Name of the Investigator	Dr.R.Velavan
Name of the Co-Investigator	
Name of the Department	PHYSICS
Title of project	**Research Investigation on mixed metal oxide nanocomposites for the application of photocatalytic degradation**
Recommendation of the evaluation committee (Recommended/Revision/Not Recommended)	— Recommended —
Financial allocation recommended	Rs. 1,00,000 —

Sl. No.	Head	Amount in INR
1	Minor Equipment/software (Generic Name with minimum required accessories, make & model & cost in Indian Rupees) Microwave Autoclave -100 ml Pestle and Mortar agate (2 no's)	 10000 7000 10000
2	Consumables (Like ICs, application boards, chemicals, testing charges, tools etc.) Chemicals& Glassware and silica crucibles Characterization (XRD, FT-RAMAN, SEM, TEM and Photocatalytic degredation	 38000 20000
3	Travel support for the purpose of research work.	5000
4	Contingency	10000
5	Others	
	Total	100000

Name and Signature of the Research Advisory Committee members with date

(Dr. P. Naveenchandran)

Internal Quality Assurance Cell IQAC Selaiyur Chennai