MAR THOMA COLLEGE FOR WOMEN, PERUMBAVOOR

(Affiliated to Mahatma Gandhi University, Kottayam. Re - Accredited by NAAC with 'B+')

Kerala 683 542
0484 2522723
Fax 0484 2520823
E mail : mtcwpbr@yahoo.in

DECLARATION

This is to certify that the following research papers have been published by the faculty of our college in the journals notified on the UGC Care List during the last five years. This document contains the details of publications during 2017–2022.

Dr. Vinod V.

MAR THOMA COLLEGE FOR WOMEN ★ PERUMBAVOOR-683542 ★

Principal

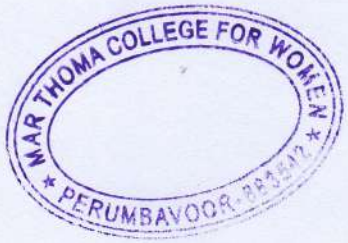
DR. SUJO MARY VARGHESE
Principal-in-charge
Mar Thoma College For Women
Perumbavoor - 683 542

Year	2022	2021	2020	2019	2018	2017
No: of Publications	5	9	7	14	3	1

Sl.No:	Title of paper	Year
1	Enhanced photocatalytic activity of nZnO/n+Al:ZnO homojunction with an overlayer of Al_2O_3 nanoballs	2022
2	Transparent heterojunctions of Cu-based delafossites n-$CuInO_2$/p-$CuGaO_2$ by reactive evaporation method for transparent electronic applications	2022
3	Non-canonical Conformal Attractors for Single Field Inflation	2022
4	Domination parameters of generalized Sierpiński graphs	2022
5	Perfect Italian Domination Number of Graphs	2022
6	Effect of sublethal concentration of formalin on haematological and biochemical parameters of Oreochromis niloticus.	2021
7	Transforming the Ich-Du to the Ich-Es: The Migrant as "Terrorist" in Kabir Khan's New York and Kamila Shamsie's Home Fire	2021
8	Optoelectronic properties of polycyclic Benzenoid hydrocarbons of various sizes and shapes for donor-π-acceptor systems: a DFT study	2021
9	An Exploratory Sequel of the Regulatory Role of Salinity in Freshwater Fish	2021
10	Respiratory stress of salinity on Oreochromisniloticus.	2021
11	Shampoos as a Mosquito Controller-A Preliminary Toxicity Study on Its Larvicidal Potential.	2021
12	Fabrication of ternary composites with polymeric carbon nitride/MoS 2/reduced graphene oxide ternary hybrid aerogel as high-performance electrode materials for supercapacitors	2021
13	Organic Compound with Potential for X-ray Imaging Applications	2021
14	Empire Drink and Beverage Culture: Tea	2021
15	The Archived Empire: Records Mirroring the Planter Capitalism in Travancore	2020
16	Electrical conductivity tuning in p-type transparent conducting $AgGaO_2$ and in quaternary $AgInGaO_2$ thin films	2020
17	A New Class of Non-canonical Conformal Attractors for Multi-field Inflation	2020

18	Spatial Distribution and Contamination Assessment of Trace Metals in the Coral Reef Sediments of Kavaratti Island in Lakshadweep Archipelago, Indian Ocean	2020
19	Geochemical fractionation of trace elements in the coral reef sediments of the Lakshadweep Archipelago, Indian Ocean	2020
20	Colonial Making of Munnar: Local History	2020
21	Native Labour and the Making of European Plantations in Colonial India: Perspectives from Travancore	2020
22	Photocatalytic colour enhancement of Methylene Blue and Rhodamine B dyes by coupled TitaniaTenorite nanocomposites	2019
23	Urban Financial inclusion–A descriptive study	2019
24	Stuctural and optical properties of synthesized poly (methyl methacrylate) (PMMA) and lanthanide B-diketonate	2019
25	The Noval synthesis and luminescence studies of CuO and Fe_2O_3 embedded) 8-hydroxyquinoline) zinc nano composites	2019
26	The Impact of Mobile - Commerce: A Swot Analysis	2019
27	Spatial variability of biochemical composition in coral reef sediments of Kavaratti and Pitti Islands, Lakshadweep	2019
28	The Other Side of India-Partition: The Decanonisation of the Patriarchs	2019
29	Realising mutated hilltop inflation in supergravity	2019
30	Role of hydrographical parameters and total organic carbon on mercury allocation along the riverine transect of Beypore, south-west coast of India	2019
31	Biochemical composition of sedimentary organic matter in the coral reefs of Lakshadweep Archipelago, Indian Ocean	2019
32	Spatial variation of phosphorus fractionation in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean	2019
33	Spatial variation of trace element concentration and contamination assessment in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean	2019
34	Female Planters and European Socialisation: An Example from Kannan Devan Hills South India	2019
35	Financial Exclusion and its various causes	2019
36	Traumatic Transnationalism: The Refugee as Transnational Subaltern in Mohsin Hamid's Exit West	2018

37	Exploring the photoluminescence emission behaviour of vacuum deposited Sb2O3 thin film having randomly oriented thorn like structures	2018
38	Enhanced room temperature gas sensing of aligned Mn_3O_4 nanorod assemblies functionalized by aluminum anodic membranes	2018
39	Dielectric relaxation and AC conductivity mechanism of eco-friendly Fe_2O_3 hexagonal nanomorphotype	2017



MAR THOMA COLLEGE FOR WOMEN PERUMBAVOOR

3.3.1

Number of research papers published per teacher in the Journals notified on UGC care list during the period 2017-2022

CRITERION 3

RESEARCH, INNOVATIONS AND EXTENSION

2017-2022

DETAILS OF PUBLICATIONS IN JOURNALS BY FACULTY

INDEX

	graphene oxide ternary hybrid aerogel as high-performance electrode materials for supercapacitors		
13	Organic Compound with Potential for X-ray Imaging Applications	2021	35
14	Empire Drink and Beverage Culture: Tea	2021	36
15	The Archived Empire: Records Mirroring the Planter Capitalism in Travancore	2020	40
16	Electrical conductivity tuning in p-type transparent conducting AgGaO2 and in quaternary AgInGaO2 thin films	2020	44
17	A New Class of Non-canonical Conformal Attractors for Multi-field Inflation	2020	45
18	Spatial Distribution and Contamination Assessment of Trace Metals in the Coral Reef Sediments of Kavaratti Island in Lakshadweep Archipelago, Indian Ocean	2020	46
19	Geochemical fractionation of trace elements in the coral reef sediments of the Lakshadweep Archipelago, Indian Ocean	2020	48
20	Colonial Making of Munnar: Local History	2020	49
21	Native Labour and the Making of European Plantations in Colonial India: Perspectives from Travancore	2020	53
22	Photocatalytic colour enhancement of Methylene Blue and Rhodamine B dyes by coupled TitaniaTenorite nanocomposites	2019	57
23	Urban Financial inclusion–A descriptive study	2019	63
24	Stuctural and optical properties of synthesized poly (methyl methacrylate) (PMMA) and lanthanide B-diketonate	2019	68
25	The Noval synthesis and luminescence studies of CuO and Fe2O3 embedded) 8-hydroxyquinoline) zinc nano composites	2019	69

26	The Impact of Mobile - Commerce: A Swot Analysis	2019	71
27	Spatial variability of biochemical composition in coral reef sediments of Kavaratti and Pitti Islands, Lakshadweep	2019	74
28	The Other Side of India-Partition: The Decanonisation of the Patriarchs	2019	75
29	Realising mutated hilltop inflation in supergravity	2019	78
30	Role of hydrographical parameters and total organic carbon on mercury allocation along the riverine transect of Beypore, south-west coast of India	2019	79
31	Biochemical composition of sedimentary organic matter in the coral reefs of Lakshadweep Archipelago, Indian Ocean	2019	80
32	Spatial variation of phosphorus fractionation in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean	2019	82
33	Spatial variation of trace element concentration and contamination assessment in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean	2019	84
34	Female Planters and European Socialisation: An Example from Kannan Devan Hills South India	2019	85
35	Financial Exclusion and its various causes	2019	90
36	Traumatic Transnationalism: The Refugee as Transnational Subaltern in Mohsin Hamid’s Exit West	2018	93
37	Exploring the photoluminescence emission behaviour of vacuum deposited Sb2O3 thin film having randomly oriented thorn like structures	2018	97
38	Enhanced room temperature gas sensing of aligned Mn3O4 nanorod assemblies functionalized by aluminum anodic membranes	2018	98

39	Dielectric relaxation and AC conductivity mechanism of eco-friendly Fe2O3 hexagonal nanomorphotype	2017	101

Principal - in - charge
Mar Thoma College For Women
Perumbavoor - 683 542

MAR THOMA COLLEGE FOR WOMEN
PERUMBAVOOR-683542

PAPER

Enhanced photocatalytic activity of nZnO/n^+Al:ZnO homojunction with an overlayer of Al_2O_3 nanoballs

Surya Mary A[1], Julie Ann Joseph[1], Bindu G Nair[2], Rajani Jacob[3], Stephen K Remillard[4], Forest D Rulison[4], Sadasivan Shaji[5] and Rachel Reena Philip[6]

Published 2 February 2022 • © 2022 IOP Publishing Ltd

Journal of Physics D: Applied Physics, Volume 55, Number 17

Citation Surya Mary A *et al* 2022 *J. Phys. D: Appl. Phys.* **55** 175108

DOI 10.1088/1361-6463/ac4c22

reenatara@gmail.com

[1] Thin Film Research Lab, Department of Physics, Union Christian College, Aluva 683102, Kerala, India

[2] Government Polytechnic College, Perumbavoor 683544, Kerala, India

[3] Mar Thoma College for Women, Perumbavoor 683542, Kerala, India

[4] Department of Physics, Hope College, Holland, MI 49423, United States of America

[5] Facultad de Ingenieria Mecanica y Electrica Universidad Autonoma de Nuevo Leon, Av. Universidad s/n, Cd.v Universitaria, San Nicolas de los Garza, Nuevo Leon 66455, Mexico

[6] Author to whom any correspondence should be addressed.

Sadasivan Shaji https://orcid.org/0000-0001-7745-0796

Rachel Reena Philip https://orcid.org/0000-0001-8210-0045

1. Received 13 November 2021
2. Accepted 17 January 2022
3. Published 2 February 2022

Method: Single-anonymous
Revisions: 1
Screened for originality? Yes

Abstract

This paper reports improvement in the degradation efficiency of ZnO for the organic dye methylene blue by constructing a homojunction of nZnO and n^{+}Al doped ZnO with an overlayer of alumina nanoballs. The thin film junction is fabricated by the simple, cost-effective two stage electrochemical method of anodization followed by electrochemical doping at room temperature. Structural, optical, morphological and electrical analyses are done to elucidate the corresponding properties of each layer as well as of the junction. The compositional depth profile is obtained by the Rutherford backscattering technique. Valence band x-ray photoelectron spectroscopy in conjunction with optical data is used for designing the schematic of the junction formation. The rectification ratio of the thin film junction is determined to be $\sim 10^{2}$ from voltage–current data.

Vacuum 197 (2022) 110808

Contents lists available at ScienceDirect

Vacuum

journal homepage: www.elsevier.com/locate/vacuum

Transparent heterojunctions of Cu-based delafossites n-$CuInO_2$/p-$CuGaO_2$ by reactive evaporation method for transparent electronic applications

Chinnu Esthan, Bindu G. Nair, A. Surya Mary, Julie Ann Joseph, Linu Mary Joseph, Rajani Jacob, V.K. Shinoj, Rachel Reena Philip *

Thin Film Research Lab, Department of Physics, Union Christian College, Aluva, Kerala, India

ARTICLE INFO

Keywords:
Transparent conducting oxide
Thin film
Delafossite
Reactive evaporation method
Heterojunction diode

ABSTRACT

Fabrication of Transparent Conducting Cu-based p-n junction n-$CuInO_2$/p- $CuGaO_2$ by oxygen plasma assisted reactive evaporation method is reported herein for the first time. The p-n diode formed of p-$CuGaO_2$ of transmittance ~94% and conductivity ~1.45×10^{-3} S/cm and n-$CuInO_2$ of transmittance ~66% and conductivity ~2.05×10^{-3} S/cm manifests a rectification ratio ~164 at 4 V with turn on voltage ~3.61 V and an ideality factor ~4.1 and a transmittance ~76% at 618 nm wavelength. The optical bandgap of n-$CuInO_2$ is ~3.34eV whereas that of p-$CuGaO_2$ is ~3.61eV. The high rectification ratio along with good transmittance of the p-n junction gives it footing as a promising active device in transparent electronics.

1. Introduction

In recent years, the field of "Invisible electronics" [1] has a variety of applications in numerous technology related applications like functional smart windows, organic light emitting diodes, transparent flat panel displays etc. [2–4]. Recently, there is large interest in transparent conducting oxides (TCO's) -metal oxides which possess simultaneous behavior of good electrical conductivity and high optical transmittance in the visible spectrum [5–7]. Many researchers have reported the special structure of Cu-based and Ag-based delafossite TCOs suitable for optoelectronic applications in which the former possesses an "amphoteric behavior" in conductivity basically in $CuInO_2$ [8]. Hence, the fabrication of active devices based on both p-type and n-type delafossite TCOs is of great demand in this era of invisible electronics. The development of a p-type transparent conducting delafossite $CuAlO_2$ reported by Kawazoe et al. [9] invited the initial attention of researchers to the use of delafossites [10].

Both $CuInO_2$ and $CuGaO_2$ are potential candidates for the fabrication of transparent p-n junction diodes. Yanagi et al. reports the unique feature of capability of bipolarity in $CuInO_2$ [11]. There are reports on the manufacturing industry of transparent diodes using p-n heterojunctions based on delafossites and ZnO with configurations like $CuAlO_2$/ZnO [12], $CuYO_2$/ZnO [13] ZnO/$CuGaO_2$ [15] etc. Recent report by Mivolil et al. demonstrates the possibility of ZnO/$CuGaO_2$ heterojunction for space borne applications [15]. Since it has been reported that the introduction of different compounds as layers of heterojunction results in a lattice mismatch which affects the device performance, many approaches are put forward to fabricate p-n homojunction diodes of various Cu-based n and p layers [16–18]. In 2001, Yanagi et al. fabricated p-n homojunction using $CuInO_2$:Ca as p-layer and $CuInO_2$:Sn as n-layer having forward to reverse current ratio ~10 with transmittance 60–80% [11]. As part of the research carried out in our lab to elucidate the role of Cu based delafossite in transparent electronics industry, Bindu et al. developed prototypes of thin film p-n homojunction diodes with configurations FTO/n-CIO/p-Ca.CIO/Ag and FTO/n-Sn.CIO/p-Ca.CIO/Ag, where the former showed better rectification and a junction with FTO/n-Sn.CIO/p-Al.CIO/Ag having rectification ratio of ~9.0 at 0.8 V and turn on voltage 0.62 V [8,18]. Also, Rahman et al. was successful in developing a thin film p-n homojunction diode with a very high rectification ratio ~612 with configuration n-CIO/p-Ca.CIO on FTO by oxygen plasma assisted reactive evaporation method [16].

In this research work, we report the fabrication of transparent heterojunction diode with configuration FTO/n-$CuInO_2$/P-$CuGaO_2$/Ag by oxygen plasma assisted reactive evaporation method with rectification ratiõ164 at 4 V. Literature survey shows that development of diodes with the junction between $CuInO_2$ and $CuGaO_2$ is not reported till date, to the best of our knowledge. This study highlights the importance of $CuGaO_2$ as a promising p-type candidate for the fabrication of transparent thin film diodes in semiconductor industry.

* Corresponding author.
E-mail address: reenatara@gmail.com (R.R. Philip).

https://doi.org/10.1016/j.vacuum.2021.110808
Received 30 July 2021; Received in revised form 3 December 2021; Accepted 6 December 2021
Available online 9 December 2021

Prepared for submission to JCAP

Non-canonical Conformal Attractors for Single Field Inflation

Tony Pinhero and Supratik Pal

Physics and Applied Mathematics Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700 108, India

E-mail: tonypinheiro2222@gmail.com, supratik@isical.ac.in

Abstract. We extend the idea of conformal attractors in inflation to non-canonical sectors by developing a non-canonical conformally invariant theory from two different approaches. In the first approach, namely, $\mathcal{N} = 1$ supergravity, the construction is more or less phenomenological, where the non-canonical kinetic sector is derived from a particular form of the Kähler potential respecting shift symmetry. In the second approach i.e., superconformal theory, we derive the form of the Lagrangian from a superconformal action and it turns out to be exactly of the same form as in the first approach. Conformal breaking of these theories results in a new class of non-canonical models which can govern inflation with modulated shape of the T-models. We further employ this framework to explore inflationary phenomenology with a representative example and show how the form of the Kähler potential can possibly be constrained in non-canonical models using the latest confidence contour in the $n_s - r$ plane given by recent Planck and BICEP/Keck results.

AKCE International Journal of Graphs and Combinatorics

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/uakc20

Domination parameters of generalized Sierpiński graphs

Jismy Varghese, V. Anu & Lakshmanan S. Aparna

To cite this article: Jismy Varghese, V. Anu & Lakshmanan S. Aparna (2022): Domination parameters of generalized Sierpiński graphs, AKCE International Journal of Graphs and Combinatorics, DOI: 10.1080/09728600.2022.2138630

To link to this article: https://doi.org/10.1080/09728600.2022.2138630

AKCE INTERNATIONAL JOURNAL OF GRAPHS AND COMBINATORICS
https://doi.org/10.1080/09728600.2022.2138630

Domination parameters of generalized Sierpiński graphs

Jismy Varghese[a], V. Anu[b], and Lakshmanan S. Aparna[c]

[a]School of Computer Science, DePaul Institute of Science and Technology, Angamaly, Kerala, India; [b]Department of Mathematics, St. Peter's College, Kolenchery, Kerala, India; [c]Department of Mathematics, Cochin University of Science and Technology, Cochin, Kerala, India

ABSTRACT

In this paper, we obtain the Italian domination number, perfect Italian domination number and double Roman domination number of generalized Sierpiński graph $S(G,2)$, where G is a cycle C_n, $n \geq 4$, a complete bipartite graph $K_{1,q}$ or $K_{2,q}$, $q \geq 2$ and a bistar $B_{m,n}$, $m,n \geq 3$.

KEYWORDS

Italian domination; perfect Italian domination; double Roman domination; generalized Sierpiński graphs

AMS SUBJECT CLASSIFICATION

05C69; 05C76

1. Introduction

Let G be a simple graph with vertex set $V(G)$ and edge set $E(G)$. If there is no ambiguity in the choice of G, then we write $V(G)$ and $E(G)$ as V and E, respectively. The number of vertices and edges of the graph G are denoted by $n(G)$ and $m(G)$, respectively. The *open neighbourhood* of a vertex $v \in V$ is the set $N(v) = \{u : uv \in E\}$ and the vertices in $N(v)$ are called the neighbours of v. $|N(v)|$ is called the *degree* of the vertex v in G and is denoted by $d_G(v)$, or simply $d(v)$. The vertices with degree one are called leaves, whereas the vertices with degree $n-1$ are called *universal vertices*. Let C_n denote a cycle on n vertices and $K_{p,q}$ denote a complete bipartite graph on $p+q$ vertices, where one partition contains p vertices and other partition contains q vertices. The bistar $B_{m,n}$ is the graph obtained by joining the center vertices of $K_{1,m}$ and $K_{1,n}$ by an edge.

Let f be a function defined on the vertex set of a graph G. The weight of f is defined as $f(V) = \sum_{v \in V} f(v)$. A Roman dominating function on G is a function $f : V(G) \to \{0,1,2\}$ such that every vertex $u \in V$ with $f(u) = 0$ has at least a neighbor $v \in N_G(u)$ satisfying $f(v) = 2$. The Roman domination number of G, denoted by $\gamma_R(G)$, is the minimum weight among all Roman dominating functions on G. Cockayne, Dreyer, S. M. Hedetniemi and S. T. Hedetniemi [14] introduced the concept of Roman Domination in graphs, and since then a lot of related variations and generalizations have been studied (see [7, 11–13]).

An Italian dominating function – IDF (perfect Italian dominating function – PID-function) of a graph G is a function $f : V(G) \to \{0,1,2\}$ satisfying the condition that for every $v \in V$ with $f(v) = 0$, we have $\sum_{u \in N(v)} f(u) \geq 2$ ($\sum_{u \in N(v)} f(u) = 2$), i.e., either v is adjacent to at least one vertex u with $f(u) = 2$ or at least two vertices x and y with $f(x) = f(y) = 1$ (i.e., all the neighbours of v are assigned the weight 0 by f except for exactly one vertex u for which $f(u) = 2$ or for exactly two vertices u and w for which $f(u) = f(w) = 1$). The Italian domination number, $\gamma_I(G)$ (perfect Italian domination number, $\gamma_I^p(G)$) is the minimum weight of an Italian dominating function [24] (perfect Italian dominating function [23]). The Italian dominating function with weight $\gamma_I(G)$ is called a γ_I-function [10]. The sum of the weights of the vertices of H is denoted by $f(H)$, where H is any subgraph of G. i.e., $f(H) = \sum_{u \in V(H)} f(u)$. The study of Italian domination was initiated by Chellai et al. in [10] and they called Italian domination as Roman $\{2\}$-domination. Italian domination is fairly a new concept and there are only a handful of papers on Italian domination. Interested readers may refer to [2, 17, 18, 20, 22, 24, 26, 28] and [35]. In [29], the exact value of perfect Italian domination number for Cartesian product of some special graphs is obtained. A relation between the Roman domination number and the perfect Italian domination number of a graph G is obtained and the corresponding realization problem is also solved. In [32], the authors characterize the graphs G with $\gamma_I^p(G)$ equal to 2 and 3 and determined the exact value of the parameter for several simple-structured graphs. It is also proved that it is NP-complete to decide whether a given bipartite graph admits a perfect Italian dominating function of weight k.

Given a graph $G = (V,E)$, a function $f : V \to \{0,1,2,3\}$ having the property that if $f(v) = 0$, then there exist $v_1, v_2 \in N(v)$ such that $f(v_1) = f(v_2) = 2$ or there exists $w \in N(v)$ such that $f(w) = 3$, and if $f(v) = 1$, then there exists $w \in$

CONTACT Jismy Varghese kvjismy@gmail.com School of Computer Science, DePaul Institute of Science and Technology, Angamaly 683 573, Kerala, India.

$N(v)$ such that $f(w) \geq 2$ is called a double Roman dominating function (DRDF). The double Roman domination number, $\gamma_{dR}(G)$, is the minimum among the weights of DRDFs on G. If $f : V \to \{0,1,2,3\}$ is a function defined on $V(G)$, then $\{v \in V(G) : f(v) = i\}$ is denoted by V_i^f. (If there is no ambiguity, V_i^f is written as V_i [9]. The study of double Roman domination was initiated by R. A. Beeler, T. W. Haynes and S. T. Hedetniemi in [9]. Interested readers may refer [3–6, 21, 34, 36] and [38]. Domination parameters in some classes of graphs have been studied by several authors (see [15, 16]).

Let $G = (V, E)$ be a non-empty graph of order $n \geq 2$, and t a positive integer. Let V^t be the set of words of length t on alphabet V. A word u of length t is denoted by $u_1u_2...u_t$. The graph $S(K_n, t), t \geq 1$, was introduced by Klavžar and Milutinović in [30] and was later called as Sierpiński graphs in [31]. $S(K_n, t)$ has vertex set V^t and $\{u, v\}$ is an edge if and only if there exists $i \in \{1, 2, ..., t\}$ such that: (i) $u_j = v_j$, if $j < i$; (ii) $u_i \neq v_i$; (iii) $u_j = v_i$ and $v_j = u_i$, if $j > i$. The vertices of the form $uuu...u$ are called extreme vertices of $S(K_n, t)$.

The generalized Sierpiński graph of a graph G, denoted by $S(G, t)$, is a graph with vertex set V^t and edge set $\{\{wu_iu_j^{r-1}, wu_ju_i^{r-1}\} : \{u_i, u_j\} \in E, i \neq j; r \in \{1, 2, ..., t\}; w \in V^{t-r}\}$ [19]. Note that $S(G, 1)$ is G itself. If $V = \{1, 2, ..., n\}$ is the vertex set of G, then in $S(G, 2)$ $V_i = \{ij : j = 1, 2, ..., n\}$ induces a copy of G for each $i \in \{1, 2, ..., n\}$. The subgraph induced by V_i is denoted by G^i, for $i \in \{1, 2, ..., n\}$. Figure 1 gives $S(C_5, 1)$ and $S(C_5, 2)$.

The value of various domination parameters of Sierpiński graphs were studied in [6, 27, 33] and [37]. The reader may refer to the survey paper [25]. For any graph theoretic terminology and notations not mentioned here, the readers may refer to [8].

The following results are useful in this paper.

Theorem 1.1. [10] *For a cycle C_n and a path P_n, $\gamma_I(C_n) = \lceil \frac{n}{2} \rceil$, $\gamma_I(P_n) = \lceil \frac{n+1}{2} \rceil$.*

Theorem 1.2. [32] *For a cycle C_n, $\gamma_I^p(C_n) = \lceil \frac{n}{2} \rceil$.*

Proposition 1.3. [9] *In a double Roman dominating function of weight $\gamma_{dR}(G)$, no vertex needs to be assigned the value 1.*

Proposition 1.4. [1] *For $n \geq 3$,*

$$\gamma_{dR}(C_n) = \begin{cases} n & \text{if } n \equiv 0, 2, 3, 4 \ (mod\ 6), \\ n+1 & \text{if } n \equiv 1, 5 \ (mod\ 6). \end{cases}$$

Proposition 1.5. [1] *For $n \geq 1$,*

$$\gamma_{dR}(P_n) = \begin{cases} n & \text{if } n \equiv 0 \ (mod\ 3), \\ n+1 & \text{if } n \equiv 1 \text{ or } 2 \ (mod\ 3). \end{cases}$$

In this paper, we obtain the exact values of the Italian domination number, the perfect Italian domination number and the double Roman domination number of the generalized Sierpiński graph $S(G, 2)$, where G is a cycle C_n, $n \geq 4$, a complete bipartite graph $K_{1,q}$ or $K_{2,q}$, $q \geq 2$ and a bistar $B_{m,n}$, $m, n \geq 3$.

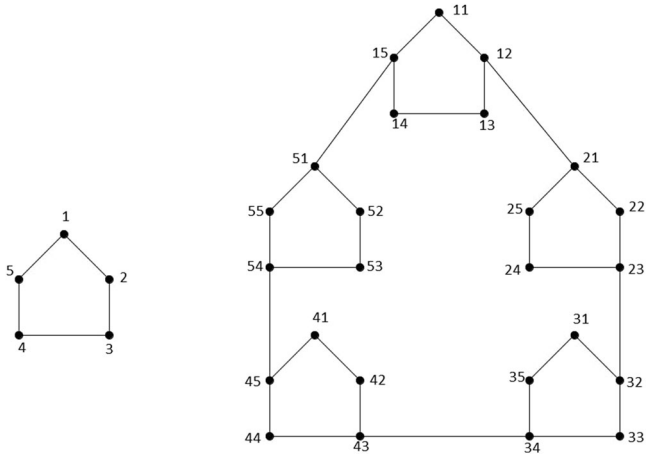


Figure 1. Sierpiński graphs $S(C_5, t), t = 1, 2$.

2. Main Results

For $n = 3$, $C_n \cong K_3$ and $\gamma_I(S(K_n, 2))$, $\gamma_I^p(S(K_n, 2))$ and $\gamma_{dR}(S(K_n, 2))$ were discussed in [27, 28] and [6], respectively. Hence, in this section, we consider C_n, for $n \geq 4$ only.

Theorem 2.1. *The Italian domination number of the generalized Sierpiński graph $S(C_n, 2)$ is $\gamma_I(S(C_n, 2)) = n\lceil \frac{n}{2} \rceil$, for $n \geq 4$.*

Proof. Let $V(C_n) = \{v_1, v_2, ..., v_n\}$. Then $S(C_n, 2)$ has the vertex set $\{v_iv_j : i, j \in \{1, 2, ..., n\}\}$ and edge set $\{(v_iv_j, v_iv_k) : v_jv_k \in E(C_n)\} \cup \{(v_iv_j, v_jv_i) : v_iv_j \in E(C_n)\}$. In $S(C_n, 2)$ there are n copies of C_n and we know that $\gamma_I(C_n) = \lceil \frac{n}{2} \rceil$. Therefore, if we take a γ_I-function in each copy of C_n, we get an IDF of $S(C_n, 2)$, so that $\gamma_I(S(C_n, 2)) \leq n\lceil \frac{n}{2} \rceil$.

For the reverse inequality, note that in C_n^i, v_iv_i is the extreme vertex and v_iv_{i-1} and v_iv_{i+1} are the vertices which are adjacent to C_n^{i-1} and C_n^{i+1}, respectively. The vertices other than v_iv_{i-1}, v_iv_i, v_iv_{i+1} form a path on $n-3$ vertices, say P_{n-3}^i. Therefore, $f(P_{n-3}^i - \{v_iv_{i-2}, v_iv_{i+2}\}) \geq \lceil \frac{n-5+1}{2} \rceil = \lceil \frac{n-4}{2} \rceil$. To Italian dominate v_iv_{i-2}, v_iv_i, v_iv_{i+2} (which do not have any adjacency outside C_n^i) we need minimum weight 2. Therefore, $f(C_n^i) \geq \lceil \frac{n-4}{2} \rceil + 2 = \lceil \frac{n}{2} \rceil$ so that $\gamma_I(S(C_n, 2)) \geq n\lceil \frac{n}{2} \rceil$. Hence, $\gamma_I(S(C_n, 2)) = n\lceil \frac{n}{2} \rceil$. □

Corollary 2.2. *The perfect Italian domination number of the generalized Sierpiński graph $S(C_n, 2)$ is $\gamma_I^p(S(C_n, 2)) = n\lceil \frac{n}{2} \rceil$, for $n \geq 4$.*

Proof. We know that $\gamma_I^p(C_n) = \lceil \frac{n}{2} \rceil$. The proof is similar to that of Theorem 2.1. □

Lemma 2.3. *If P_n is a path on n vertices, where n is a multiple of 3, then the weight of a γ_{dR}-function assigned to the end vertices is always zero.*

Proof. Let P_n be the path $v_1v_2...v_n$. Let f be any γ_{dR}-function with $f(v_1) = 1$. Then v_1 cannot double Roman dominate

any other vertex. Hence, $f(P_n - v_1) \geq n - 1 + 1 = n$, so that $f(P_n) \geq n + 1$ which is a contradiction.

Now let f be a γ_{dR}-function with $f(v_1) = 2$. If $f(v_2) \leq 1$, then none of the vertices of $P_n - \{v_1, v_2\}$ are double Roman dominated by vertices outside $P_n - \{v_1, v_2\}$. Consequently, $f(P_n - \{v_1, v_2\}) \geq n - 2 + 1 = n - 1$, so that $f(P_n) \geq n - 1 + 2 = n + 1$, which is a contradiction. If $f(v_2) > 1$ then we can find a DRDF g as follows. $g(v_1) = 0$, $g(v_2) = 3$ and $g(v_i) = f(v_i)$ for $i = 3, 4, \ldots, n$. Clearly, g is a DRDF with weight less than that of f, which is also a contradiction. Hence, we conclude that $f(v_1) \neq 2$.

Similarly, the case when $f(v_1) = 3$ also leads to a contradiction and so $f(v_1) = 0$. In the same manner, we can also prove that $f(v_n) = 0$. □

Lemma 2.4. *If C_n is a cycle, where n is an odd multiple of 3 then in any γ_{dR}-function, no vertex is assigned the weight 2.*

Proof. Let C_n be a cycle $v_1v_2\ldots v_n$ and let f be a γ_{dR}-function with at least one vertex assigned the weight 2. For definiteness, let $f(v_1) = 2$. If $f(v_2)$ is non-zero, then $f(v_1) + f(v_2) \geq 4$ and $f(C_n - \{v_1, v_2, v_3, v_n\}) \geq n - 4 + 1 = n - 3$, so that $f(C_n) \geq n - 3 + 4 = n + 1$ which is a contradiction. If $f(v_2) = 0$, then $f(v_3)$ must be non-zero. If $f(v_3) = 3$ then $f(v_1) + f(v_3) = 5$ and $f(C_n - \{v_1, v_2, v_3, v_4, v_n\}) \geq n - 5 + 1 = n - 4$ so that $f(C_n) \geq n - 4 + 5 = n + 1$ which is also a contradiction. Hence, $f(v_3) = 2$. Continuing this argument, we get $f(v_i) = 0$ or 2 according as i is even or odd, respectively, so that $f(C_n) = n + 1$ which is a contradiction. Hence, the result follows. □

Theorem 2.5. *The double Roman domination number of the generalized Sierpiński graph $S(C_n, 2)$ is*

$$\gamma_{dR}(S(C_n, 2)) = \begin{cases} n^2 - \frac{n}{2} & \text{if } n = 3k,\ k \geq 1 \text{ is even}, \\ n^2 - \frac{n}{3} & \text{if } n = 3k,\ k \geq 1 \text{ is odd}, \\ n(n-1) & \text{if } n = 3k+1,\ k \geq 1, \\ n^2 & \text{if } n = 3k+2,\ k \geq 1. \end{cases}$$

Proof. Let $V(C_n) = \{v_1, v_2, \ldots, v_n\}$. Then $S(C_n, 2)$ has the vertex set $\{v_iv_j : i, j \in \{1, 2, \ldots, n\}\}$ and edge set $\{(v_iv_j, v_iv_k) : v_jv_k \in E(C_n)\} \cup \{(v_iv_j, v_jv_i) : v_iv_j \in E(C_n)\}$. We consider the following cases.

Case 1: $n = 3k$, $k \geq 1$ is even.

Define the following function on $S(C_n, 2)$.

$$f(v_iv_j) = \begin{cases} 3 \text{ if } i = 2, 4, \ldots, n;\ j = i + 3l \pmod n;\ l = 1, 2, \ldots, k-1, \\ 2 \text{ if } i = 1, 3, \ldots, n-1;\ j = i + 1 + 2l \pmod n, \\ \quad l \geq 0 \text{ and } i = j = 2, 4, \ldots, n, \\ 0 \text{ otherwise}. \end{cases}$$

Clearly, f is a DRDF and $f(V) = 3\frac{n}{2}(k-1) + 2\frac{n}{2}\frac{n}{2} + 2\frac{n}{2} = n^2 - \frac{n}{2}$. Hence, $\gamma_{dR}(S(C_n, 2)) \leq n^2 - \frac{n}{2}$.

For the reverse inequality, note that in each C_n^i, v_iv_i is the extreme vertex and v_iv_{i-1} and v_iv_{i+1} are the only vertices adjacent to other copies of C_n. The remaining vertices (other than v_iv_{i-1}, v_iv_i, v_iv_{i+1}) form a path on $n - 3$ vertices, say P_{n-3}^i. Let f be any DRDF of $S(C_n, 2)$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) = 0$, then $f(v_iv_i) \geq 2$ and $f(P_{n-3}^i) \geq n - 3$, so that $f(C_n^i) \geq n - 3 + 2 = n - 1$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) = 2$, then one of $f(v_iv_{i-1})$ and $f(v_iv_{i+1})$ must be 2. For definiteness, let $f(v_iv_{i+1}) = 2$. Then $f(P_{n-3}^i - v_iv_{i+2}) \geq n - 4 + 1 = n - 3$. In this case, $f(v_iv_i) \geq 2$ so that $f(C_n^i) \geq n - 3 + 2 + 2 = n + 1$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) = 3$, then one of $f(v_iv_{i-1})$ and $f(v_iv_{i+1})$ is 3. For definiteness, let $f(v_iv_{i+1}) = 3$. Then $f(P_{n-3}^i - v_iv_{i+2}) \geq n - 4 + 1 = n - 3$ so that $f(C_n^i) \geq n$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) \geq 4$ then $f(P_{n-3}^i - v_iv_{i-2}, v_iv_{i+2}) \geq n - 5 + 1 = n - 4$ so that $f(C_n^i) \geq n$. Thus, in all cases, $f(C_n^i) \geq n - 1$ and if $f(C_n^i) = n - 1$ then $f(P_{n-3}^i) = n - 3$, $f(v_iv_{i-1}) = f(v_iv_{i+1}) = 0$ and $f(v_iv_i) = 2$. We claim that if $f(C_n^{i_0}) = n - 1$ then $f(C_n^{i_0+1}) \geq n$. Since $f(P_{n-3}^{i_0}) = n - 3$, then $f(v_{i_o}v_{i_0-2}) = f(v_{i_0}v_{i_0+2}) = 0$ by Lemma 2.3. Therefore, since $f(v_{i_o}v_{i_0-1}) = f(v_{i_0}v_{i_0+1}) = 0$, to double Roman dominate $v_{i_0}v_{i_0+1}$, $f(v_{i_0+1}v_{i_0}) \geq 2$ so that $f(C_n^{i_0+1}) \geq n$. Thus if $f(C_n^{i_0}) = n - 1$ then $f(C_n^{i_0+1}) \geq n$ so that $f(S(C_n, 2)) \geq n\frac{n}{2} + (n-1)\frac{n}{2} = n^2 - \frac{n}{2}$.

Case 2: $n = 3k$, $k \geq 1$ is odd.

As in case 1, for any γ_{dR}-function f of $S(C_n, 2)$ $f(C_n^i) \geq n - 1$ for each $i = 1, 2, \ldots, n$. We claim that if $f(C_n^{i_0}) = n - 1$, then both $f(C_n^{i_0-1})$ and $f(C_n^{i_0+1})$ is at least n. If $f(C_n^{i_0}) = n - 1$, then $f(v_{i_0}v_{i_0}) = 2$ and $f(v_{i_o}v_{i_0-1}) = f(v_{i_0}v_{i_0+1}) = 0$. So to double Roman dominate $v_{i_0}v_{i_0+1}$, $f(v_{i_0+1}v_{i_0})$ must be at least 2. If $f(v_{i_0+1}v_{i_0}) = 2$, then $f(C_n^{i_0+1}) \geq n + 1$ by Lemma 2.4 and so $f(v_{i_0+1}v_{i_0}) = 3$. If $f(v_{i_0+1}v_{i_0}) = 3$ then $f(v_{i_0+1}v_{i_0+2})$ must be zero in order to make $f(C_n^{i_0+1}) = n$. i.e., the only vertex which is outside $C_n^{i_0+1}$ and double Roman dominated by vertices in $C_n^{i_0+1}$ is $v_{i_0}v_{i_0+1}$. Similarly, $f(v_{i_0-1}v_{i_0}) = 3$, $f(C_n^{i_0-1}) = n$ and the only vertex which is outside $C_n^{i_0-1}$ and double Roman dominated by vertices in $C_n^{i_0-1}$ is $v_{i_0}v_{i_0-1}$. Thus, for three consecutive copies of C_n, at most one copy can have weight $n - 1$ and hence $f(S(C_n, 2)) \geq n^2 - \frac{n}{3}$.

Case 3: $n = 3k + 1$, $k \geq 1$.

Define the following function on $S(C_n, 2)$

$$f(v_iv_j) = \begin{cases} 3 \text{ if } i \in \{1, 2, \ldots, n\} \text{ and } j = i + 1 + 3l \pmod n; \\ \quad l = 0, 1, \ldots, k-1, \\ 0 \text{ otherwise}. \end{cases}$$

Clearly, f is a DRDF and $f(V) = n\ 3k = n(n-1)$. Hence, $\gamma_{dR}(S(C_n, 2)) \leq n(n-1)$.

For the reverse inequality, note that $f(C_n^i) \geq n - 1$ for all $i \in \{1, 2, \ldots, n\}$ as in above cases and hence $f(S(C_n, 2)) \geq n(n-1)$.

Case 4: $n = 3k + 2$, $k \geq 1$.

Define the following function on $S(C_n, 2)$.

$$f(v_iv_j) = \begin{cases} 3 \text{ if } i \in \{1, 2, \ldots, n\},\ j = i + 1 + 3l \pmod n, \\ \quad l = 0, 1, \ldots, k-1, \\ 2 \text{ if } i \in \{1, 2, \ldots, n\},\ j = i - 3 \pmod n, \\ 0 \text{ otherwise}. \end{cases}$$

Clearly, f is a DRDF and $f(V) = n(3k+2) = n^2$. Hence, $\gamma_{dR}(S(C_n, 2)) \leq n^2$.

For the reverse inequality, the proof is similar to case 3 except when $f(v_iv_{i-1}) + f(v_iv_{i+1}) \geq 4$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) = 4$, then $f(v_iv_{i-1}) = f(v_iv_{i+1}) = 2$ and hence $P^i_{n-3} \cup \{v_iv_{i-1}, v_iv_{i+1}\}$ can be considered as a path on $n-1$ vertices of which none of the vertices are double Roman dominated by vertices from copies of C_n other than C^i_n. Consequently, $f(C^i_n) \geq f(P^i_{n-3} \cup \{v_iv_{i-1}, v_iv_{i+1}\}) \geq n-1+1 = n$. If $f(v_iv_{i-1}) + f(v_iv_{i+1}) \geq 5$, then $f(P^i_{n-3} \cup \{v_iv_{i-2}, v_iv_{i+2}\}) \geq n-5$ and so $f(C^i_n) \geq n$. Thus in all cases, $f(C^i_n) \geq n$ and hence $f(S(C_n, 2)) \geq n^2$. □

When $p = 1$ and $q = 1$ $K_{p,q}$ is K_2 and it is proved in [28] that $\gamma_I(S(K_n, 2)) = 2n-1$. Therefore, $\gamma_I(S(K_{1,1}, 2)) = 3$ and also $\gamma^p_I(S(K_{1,1}, 2)) = 3$. Also in [6], it is found that $\gamma_{dR}(S(K_n, 2)) = 3n-1$ and hence $\gamma_{dR}(S(K_{1,1}, 2)) = 5$. When $p = 1$ and $q = 2$ then $K_{p,q} = P_3$ and it is a simple observation that $\gamma_I(S(P_3, 2)) = 5$, $\gamma^p_I(S(P_3, 2)) = 6$ and $\gamma_{dR}(S(P_3, 2)) = 8$. Hence, in the following theorems, we consider the case $p = 1$ and $q \geq 3$.

Theorem 2.6. *The Italian domination number of the generalized Sierpiński graph $S(K_{1,q}, 2)$ is $\gamma_I(S(K_{1,q}, 2)) = 2q+1$, $q \geq 3$.*

Proof. Let $v_1, v_2, \ldots, v_{q+1}$ be the vertices of $K_{1,q}$ where v_1 is the universal vertex. Define the following function on $S(K_{1,q}, 2)$ as follows.

$$f(v) = \begin{cases} 2 \text{ if } v = v_iv_1, \ i = 2, 3, \ldots, q+1, \\ 1 \text{ if } v = v_1v_1, \\ 0 \text{ otherwise.} \end{cases}$$

Clearly, f is an IDF and $f(V) = 2q+1$ and hence, $\gamma_I(S(K_{1,q}, 2)) \leq 2q+1$.

Since $q \geq 3$, each copy of $K^i_{1,q}$ for $i = 2, 3, \ldots, q+1$, contains three or more leaves. So to Italian dominate these vertices we need to assign weight at least 2 to the vertex v_iv_1. Now in $K^1_{1,q}$, the vertices v_1v_j, $j = 2, 3, \ldots, q+1$ are Italian dominated by v_jv_1. So the only vertex which is not Italian dominated in $K^1_{1,q}$ is v_1v_1. Hence, we have to assign weight 1 to v_1v_1, so that, $\gamma_I(S(K_{1,q}, 2)) \geq 2q+1$. Therefore, $\gamma_I(S(K_{1,q}, 2)) = 2q+1$. □

Theorem 2.7. *The perfect Italian domination number of the generalized Sierpiński graph $S(K_{1,q}, 2)$ is $\gamma^p_I(S(K_{1,q}, 2)) = 2(q+1)$, $q \geq 3$.*

Proof. Let $v_1, v_2, \ldots, v_{q+1}$ be the vertices of $K_{1,q}$ where v_1 is the universal vertex. Define the following function on $S(K_{1,q}, 2)$ as follows.

$$f(v) = \begin{cases} 2 \text{ if } v = v_iv_1, \ i = 2, 3, \ldots, q+1, \text{ and } v = v_1v_2, \\ 0 \text{ otherwise.} \end{cases}$$

Clearly, f is a PID function and $f(V) = 2q+2 = 2(q+1)$. Therefore, $\gamma^p_I(S(K_{1,q}, 2)) \leq 2(q+1)$.

In each $K^i_{1,q}$ for $i = 2, 3, \ldots, q+1$, there are q vertices which are not adjacent to vertices of other copies of $K_{1,q}$. Hence, for any γ^p_I-function f of $S(K_{1,q}, 2)$, $f(K^i_{1,q}) \geq 2$, $i = 2, 3, \ldots, q+1$. Also, it is optimum to assign the weight 2 to v_iv_1 where $i = 2, 3, \ldots, q+1$. Now, the only vertex which is not perfect Italian dominated is v_1v_1. We cannot give the weight 1 to v_1v_1, since, in this case $\sum_{u \in N(v_1v_i)} f(u) = 3$, for $i = 2, 3, \ldots, q+1$. Hence, we have to give weight to the vertices of $K^1_{1,q}$, so that $\sum_{u \in N(v_1v_1)} f(u) = 2$, which results in $f(K^1_{1,q}) = 2$. Therefore, $\gamma^p_I(S(K_{1,q}, 2)) \geq 2q+2 = 2(q+1)$. Hence, $\gamma^p_I(S(K_{1,q}, 2)) = 2(q+1)$. □

Theorem 2.8. *The double Roman domination number of the generalized Sierpiński graph $S(K_{1,q}, 2)$ is $\gamma_{dR}(S(K_{1,q}, 2)) = 3q+2$, $q \geq 3$.*

Proof. The proof is similar to that of Theorem 2.6 with the difference that the weights 2 and 1 are replaced by 3 and 2, respectively. □

When $p = q = 2$, $K_{p,q} = C_4$ and it is discussed in the section 2.

Theorem 2.9. *The Italian domination number of the generalized Sierpiński graph $S(K_{2,q}, 2)$ is $\gamma_I(S(K_{2,q}, 2)) = 2(q+2)$ for $p = 2$, $q \geq 3$.*

Proof. Let $V(K_{2,q}) = \{v_1, v_2, \ldots, v_{q+2}\}$ be the vertex set of $K_{2,q}$ and $d(v_1) = d(v_2) = q$. Define the following function on $S(K_{2,q}, 2)$ as follows.

$$f(v) = \begin{cases} 1 \text{ if } v = v_iv_1, \ v_iv_2, i \in \{1, 2, \ldots, q+2\}, \\ 0 \text{ otherwise.} \end{cases}$$

It can be easily verified that f is an IDF and $f(V) = 2(q+2)$. Therefore, $\gamma_I(S(K_{2,q}, 2)) \leq 2(q+2)$.

In each $K^i_{2,q}$ there are at least two vertices which are not adjacent to vertices of other copies of $K_{2,q}$. So to Italian dominate $K^i_{2,q}$ we need at least weight 2. Therefore, $\gamma_I(S(K_{2,q}, 2)) \geq 2(q+2)$. Hence, $\gamma_I(S(K_{2,q}, 2)) = 2(q+2)$. □

Proposition 2.10. *The perfect Italian domination number of generalized Sierpiński graph $S(K_{2,3}, 2)$ is $\gamma^p_I(S(K_{2,3}, 2)) = 11$.*

Proof. Let $\{v_1, v_2, v_3, v_4, v_5\}$ be the vertex set of $K_{2,3}$ where $\{v_1, v_2\}$ and $\{v_3, v_4, v_5\}$ are the partite sets of the vertex set. Define a function f on $S(K_{2,3}, 2)$ as follows.

$$f(v) = \begin{cases} 2 \text{ if } v = v_2v_5, \ v_5v_1, \\ 1 \text{ if } v_iv_j, \ i = 3, 4, \ j = 1, 2, \text{ and } v = v_1v_3, v_1v_4, v_2v_2, \\ 0 \text{ otherwise.} \end{cases}$$

It can be easily verified that f is a PID- function and $f(V) = 11$ so that $\gamma^p_I(S(K_{2,3}, 2)) \leq 11$. (This labeling is illustrated in Figure 2.)

In each copy of $K_{2,3}$ there are at least 2 vertices which are not adjacent to the vertices of other copies of $K_{2,3}$. Hence to perfect Italian dominate each $K^i_{2,3}$ we need

minimum weight 2. If possible, assume that $f(K^i_{2,3}) = 2$ for every $i = 1, 2, 3, 4, 5$. In particular, $f(K^1_{2,3}) = 2$. Since v_1v_1 and v_1v_2 are not adjacent to any vertices of other copies of $K_{2,3}$, these vertices must be perfect Italian dominated by the vertices of $K^1_{2,3}$. Then, one of the following cases may arise.

Case 1: $f(v_1v_1) = f(v_1v_2) = 1$.

Since $f(K^1_{2,3}) = 2$, $f(v_1v_j) = 0$. Since f is a PID function $\sum_{u\in N(v_1v_j)} f(v_1v_j) = 2$ and hence $f(v_jv_1) = 0$ for $j = 3, 4, 5$. Now, to perfect Italian dominate v_jv_1, we must have $\sum_{k=3}^{5} f(v_jv_k) = 2$, $j = 3, 4, 5$. This implies, there exists at least one vertex v_jv_k with $f(v_jv_k) = 0$. To perfect Italian dominate this v_jv_k, we must have $f(v_jv_2) = 2$, which is a contradiction to the fact that $f(K^j_{2,3}) = 2$.

Case 2: $\sum_{j=3}^{5} f(v_1v_j) = 2$.

Then for the vertices v_1v_3, v_1v_4 and v_1v_5 either two vertices have weight 1 or one vertex has weight 2.

***Subcase(a)*:** Two vertices have weight 1 and the third vertex has weight 0.

For definiteness, let $f(v_1v_3) = f(v_1v_4) = 1$ and $f(v_1v_5) = 0$. Now, to perfect Italian dominate v_1v_5 we must have $f(v_5v_1) = 2$. Since $f(K^5_{2,3}) = 2$, $f(v_5v_2) = 0$. To perfect Italian dominate v_5v_2 we must have $f(v_2v_5) = 2$. Since $f(K^2_{2,3}) = 2$, $f(v_2v_3) = f(v_2v_4) = 0$. To perfect Italian dominate v_2v_3 and v_2v_4 we must have $f(v_3v_2) = f(v_4v_2) = 2$. But the vertices v_3v_1 and v_4v_1 are not perfect Italian dominated. To perfect Italian dominate these vertices we need more weight, which contradicts the fact that $f(K^i_{2,3}) = 2$ for all i.

***Subcase(b)*:** One vertex has weight 2 and other vertices have weight 0.

For definiteness, let $f(v_1v_3) = 2$, and $f(v_1v_i) = 0$, for $i = 1, 2, 4, 5$. To perfect Italian dominate v_1v_4 and v_1v_5 we must have $f(v_4v_1) = f(v_5v_1) = 2$. Since $f(K^4_{2,3}) = f(K^5_{2,3}) = 2$, we have $f(v_4v_2) = f(v_5v_2) = 0$. To perfect Italian dominate v_4v_2 and v_5v_2 we must have $f(v_2v_4) = f(v_2v_5) = 2$, which is a contradiction to the fact that $f(K^2_{2,3}) = 2$.

Therefore, $\gamma^p_I(S(K_{2,3}, 2)) \geq 11$. Hence, $\gamma^p_I(S(K_{2,3}2)) = 11$. □

Theorem 2.11. *The perfect Italian domination number of the generalized Sierpiński graph $S(K_{2,q}, 2)$ is $\gamma^p_I(S(K_{2,q}, 2)) = 2(q + 3)$, for $p = 2$, $q \geq 4$.*

Proof. Let $V(K_{2,q}) = \{v_1, v_2, ..., v_{q+2}\}$ be the vertex set of $K_{2,q}$ where $\{v_1, v_2\}$ and $\{v_3, v_4, ..., v_{q+2}\}$ are the partite sets of $K_{2,q}$. Define a function on $S(K_{2,q}, 2)$ as follows.

$$f(v) = \begin{cases} 2 \text{ if } v = v_iv_3, \ i = 1, 2, \\ 1 \text{ if } v = v_iv_1, \ v_iv_2, \ i = 3, 4, ..., q + 2, \ v = v_iv_1, i = 1, 2, \\ 0 \text{ otherwise.} \end{cases}$$

Clearly, f is a PID-function and $f(V) = 2(q + 3)$ so that $\gamma^p_I(S(K_{2,q}, 2)) \leq 2(q + 3)$.

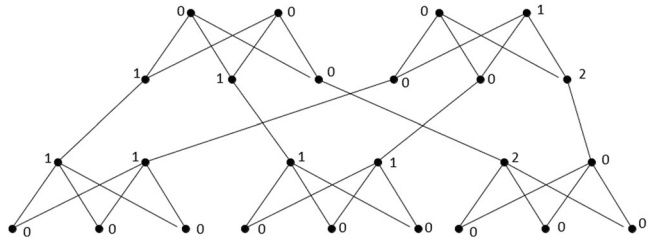


Figure 2. Illustration of $S(K_{2,3}, 2)$.

Since in each copy of $K^i_{2,q}$ there are at least two vertices which are not adjacent to vertices of other copies of $K_{2,q}$, we need at least weight 2 to perfect Italian dominate each $K^i_{2,q}$. If there are two copies of $K_{2,q}$ with $f(K^i_{2,q}) = 3$, then $f(S(K_{2,q}, 2)) = 2(q + 3)$. Therefore, if possible assume that, there exists exactly one copy of $K_{2,q}$ with $f(K^i_{2,q}) = 3$ and all other copies have weight 2. Then either $f(K^1_{2,q}) = 2$ or $f(K^2_{2,q}) = 2$. For definiteness, let $f(K^1_{2,q}) = 2$. Since both v_1v_1 and v_1v_2 are perfect Italian dominated by the vertices of $K^1_{2,q}$, one of the following cases arises.

Case 1: $f(v_1v_1) = f(v_1v_2) = 1$.

Since $f(K^1_{2,q}) = 2$, $f(v_1v_j) = 0$ for $j = 3, 4, ..., q + 2$. Since f is a perfect Italian dominating function $\sum_{u\in N(v_1v_j)} f(u) = 2$ so that $f(v_jv_1) = 0$ for $j = 3, 4, ..., q + 2$. To perfect Italian dominate v_jv_1, we must have $\sum_{u\in N(v_jv_1)} f(u) = 2$. This implies, there exists at least two vertices v_jv_k such that $f(v_jv_k) = 0$ for $j, k = 3, 4, ..., q + 2$, and hence $f(v_jv_2) = 0$, which implies $f(K^i_{2,q}) = 4$ for $i = 3, 4, ..., q + 2$, which is a contradiction.

Case 2: $\sum_{j=3}^{q+2} f(v_1v_j) = 2$.

Then for the vertices $v_1v_3, v_1v_4, ..., v_1v_{q+2}$ either two vertices have weight 1 or one vertex has weight 2.

***Subcase (a)*:** $f(v_1v_j) = 1$ for exactly two $j's$, and $f(v_1v_j) = 0$ for all other $j's$, $j = 3, 4, ..., q + 2$.

For definiteness, let $f(v_1v_3) = f(v_1v_4) = 1$. Since $f(K^1_{2,q}) = 2$, $f(v_1v_j) = 0$ for $j = 5, 6, ..., q + 2$. To perfect Italian dominate v_1v_j for $j = 5, 6, ..., q + 2$ we must have $f(v_jv_1) = 2$. Since $f(K^j_{2,q}) = 2$, $f(v_jv_2) = 0$. To perfect Italian dominate v_jv_2 we must have $f(v_2v_j) = 2$, for $j = 5, 6, ..., q + 2$. This implies, $f(K_{2,q}) > 4$, which is a contradiction.

***Subcase (b)*:** $f(v_1v_j) = 2$ for exactly one j and $f(v_1v_j) = 0$ for all other $j's$, $j = 3, 4, ..., q + 2$.

For definiteness, let $f(v_1v_3) = 2$ and $f(v_1v_j) = 0$ for $j = 4, 5, ..., q + 2$. To perfect Italian dominate v_1v_j we must have $f(v_jv_1) = 2$. Since $f(K^j_{2,q}) = 2$ we must have $f(v_jv_2) = 0$. To perfect Italian dominate v_jv_2 we must have $f(v_2v_j) = 2$. This implies that $f(K^2_{2,q}) > 6$, which is a contradiction.

Therefore, $\gamma^p_I(S(K_{2,q}, 2)) \geq 2q + 6$. Hence, $\gamma^p_I(S(K_{2,q}, 2)) = 2(q + 3)$. □

Theorem 2.12. *The double Roman domination number of generalized Sierpiński graph $S(K_{2,3},2)$ is $\gamma_{dR}(S(K_{2,3},2)) = 18$.*

Proof. Let $\{v_1, v_2, v_3, v_4, v_5\}$ be the vertex set of $K_{2,3}$ where $\{v_1, v_2\}$ and $\{v_3, v_4, v_5\}$ are the partite sets of the vertex set. Define a function f as follows.

$$f(v) = \begin{cases} 3 \text{ if } v = v_1v_3, v_2v_4, \ v_2v_5, \ v_3v_2, v_4v_1, \ v_5v_1, \\ 0 \text{ otherwise.} \end{cases}$$

Clearly, f is a DRDF and $\gamma_{dR}(S(K_{2,3},2)) \leq 18$.

To prove the reverse inequality, note that in each copy of $K_{2,3}$ in $S(K_{2,3},2)$ there are at least two vertices which are not adjacent to other copies of $K_{2,3}$. Hence, for any γ_{dR}-function f of $S(K_{2,3},2)$, $f(K^i_{2,3}) \geq 3$ for all $i \in \{1,2,...,5\}$ so that $f(S(K_{2,3},2)) \geq 15$. Therefore, in order to prove $\gamma_{dR}(S(K_{2,3},2)) = 18$, we need only to prove that there does not exist any DRDF with weight 15, 16 or 17.

Claim 1: There does not exist a DRDF f with $f(S(K_{2,3},2)) = 15$.

Proof of Claim 1: If there exists a DRDF f with $f(S(K_{2,3},2)) = 15$, then $f(v_1v_j) = 3$ for exactly one $j = 3,4,5$. For definiteness, let $f(v_1v_3) = 3$. Now to double Roman dominate v_1v_4 and v_1v_5, $f(v_4v_1)$ and $f(v_5v_1)$ must be three. Since, $f(K^4_{2,3}) = f(K^5_{2,3}) = 3$, v_4v_2 and v_5v_2 should be double Roman dominated by v_2v_4 and v_2v_5 respectively which makes $f(K^2_{2,3}) \geq 6$ which is a contradiction.

Claim 2: There does not exist a DRDF f with $f(S(K_{2,3},2)) = 16$.

Proof of Claim 2: If there exists a DRDF f with $f(S(K_{2,3},2)) = 16$, then $f(K^{i_0}_{2,3}) = 4$ for exactly one i_0 with $1 \leq i_0 \leq 5$ and $f(K^i_{2,3}) = 3$, for every $i \in \{1,2,...,5\}$, $i \neq i_0$. Then at least one among $f(K^1_{2,3})$ and $f(K^2_{2,3})$ must be 3. For definiteness, let $f(K^1_{2,3}) = 3$. Since $f(K^j_{2,3}) \leq 4$, for every $j = 2,3,4,5$, we get the same contradiction as in the proof of claim 1.

Claim 3: There does not exist a DRDF f with $f(S(K_{2,3},2)) = 17$.

Proof of Claim 3: If there exists a DRDF f with $f(S(K_{2,3},2)) = 17$, then the following two cases arise.

(i) $f(K^{i_0}_{2,3}) = 5$ for exactly one i_0 with $1 \leq i_0 \leq 5$ and $f(K^i_{2,3}) = 3$, for every $i \in \{1,2,...,5\}$, $i \neq i_0$.
(ii) $f(K^i_{2,3}) = 4$ for exactly two $i's$ say i_0, j_0 with $1 \leq i_0, j_0 \leq 5$ and $f(K^i_{2,3}) = 3$, for every $i \in \{1,2,...,5\}$, $i \neq i_0, j_0$.

In case (i) at least one among $f(K^1_{2,3})$ and $f(K^2_{2,3})$ must be 3. For definiteness, $f(K^1_{2,3}) = 3$. Then as in the proof of claim 1 we may take $f(v_1v_3) = f(v_4v_2) = f(v_5v_2) = 3$. If $f(K^4_{2,3}) = f(K^5_{2,3}) = 3$, then we get the same contradiction as in the proof of claim 1. Hence one among $f(K^4_{2,3})$ and $f(K^5_{2,3})$ must be 5. For definiteness let $f(K^4_{2,3}) = 5$. Since $f(K^5_{2,3}) = 3$, to double Roman dominate v_5v_2, $f(v_2v_5) = 3$. But v_2v_4 is not get double Roman dominated and hence $f(K^2_{2,3}) \geq 3$, which is a contradiction. Hence, we conclude that $\gamma_{dR}(S(K_{2,3},2)) \geq 18$. □

Now we obtain the Italian domination number, perfect Italian domination number and double Roman domination number of Sierpiński graph of bistar $B_{m,n}$, when $t = 2$.

Theorem 2.13. *The Italian domination number of the generalized Sierpiński graph $S(B_{m,n},2)$ is $\gamma_I(S(B_{m,n},2)) = 4(m+n+1)$, $m,n \geq 3$.*

Proof. Let $V(B_{m,n}) = \{v_1, v_2, ..., v_m, v_{m+1}, v_{m+2}, ..., v_{m+n}, v_{m+n+1}, v_{m+n+2}\}$ be the vertex set of $B_{m,n}$. Let $d(v_{m+n+1}) = m+1, d(v_{m+n+2}) = n+1$. Define a function f on $B_{m,n}$ as follows.

$$f(v) = \begin{cases} 2 \text{ if } v = v_{m+n+1}v_{m+n+2}, \ v_{m+n+2}v_{m+n+1} \text{ or} \\ \quad v = v_iv_{m+n+1}, \ v_iv_{m+n+2}, \ i \in \{1,2,...,m+n\}, \\ 0 \text{ otherwise.} \end{cases}$$

Clearly, f is an IDF and $f(V) = 4(m+n)+4 = 4(m+n+1)$ so that $\gamma_I(S(B_{m,n},2)) \leq 4(m+n+1)$.

In each $B^i_{m,n}$ for $i \in \{1,2,...,m+n\}$ there are $m+n$ leaves. To Italian dominate these copies we need at least weight 4. For that, it is optimum to assign weight 2 to the vertices v_iv_{m+n+1} and v_iv_{m+n+2}. In $B^{m+n+1}_{m,n}$ and $B^{m+n+2}_{m,n}$ there are only n and m leaves, respectively. To Italian dominate these vertices we need at least weight 2. Therefore, $\gamma_I(S(B_{m,n},2)) \geq 4(m+n)+2+2 = 4(m+n+1)$. Hence, $\gamma_I(S(B_{m,n},2)) = 4(m+n+1)$. □

Corollary 2.14. *The perfect Italian domination number of the generalized Sierpiński graph $S(B_{m,n},2)$ is $\gamma^p_I(S(B_{m,n},2)) = 4(m+n+1)$.*

Proof. In the proof of the above theorem we have defined an Italian dominating function with the property that every vertex with weight 0 is adjacent to exactly one vertex with weight 2. Therefore, $\gamma^p_I(S(B_{m,n},2)) \leq 4(m+n+1)$. We know that $\gamma_I(S(B_{m,n},2)) \leq \gamma^p_I(S(B_{m,n},2))$. Hence, $\gamma^p_I(S(B_{n,n},2)) = 4(m+n+1)$. □

Theorem 2.15. *The double Roman domination number of the generalized Sierpiński graph $S(B_{m,n},2)$ is $\gamma_{dR}(S(B_{m,n},2)) = 6(m+n+1)$, $m,n \geq 3$.*

Proof. The proof is similar to that of Theorem 2.13 with the difference that the weight 2 is replaced by 3. □

References

[1] Ahangar, H. A., Chellali, M, Sheikholeslami, S. M. (2017). On the double Roman domination in graphs. *Discrete Appl. Math.* 232: 1–7.
[2] Alizadeh, F., Maimani, H. R., Majd, L. P, Parsa, M. R. (2022). Roman {2}-domination in graphs and graph products. *Iran. J. Math. Sci. Inform.* In Press.

[3] Amjadi, J., Nazari-Moghaddam, V., Sheikholeslami, S. M, Volkmann, L. (2018). An upper bound on the double Roman domination number. *J. Comb. Optim.* 36(6): 1–9.

[4] Anu, V, Aparna, L. S. (2018). Double Roman domination number. *Discrete Appl. Math.* 244: 198–204.

[5] Anu, V, Aparna, L. S. (2021). Impact of some graph operators on double Roman domination number. *Int. J. Comb. Graph Theory Appl.* 6(1): 97–105.

[6] Anu, V, Aparna, L. S. (2020). The double Roman domination number of generalized Sierpiński graphs. *Discrete Math. Algorithms Appl.* 12(4): Article 2050047.

[7] Aparna, L. S, Amala, B. (2022). Variations of Roman domination in Kneser graphs. Manuscript.

[8] Balakrishnan, R, Ranganathan, K. (1999). *A Text Book of Graph Theory*. New York: Springer.

[9] Beeler, R. A., Haynes, T. W, Hedetniemi, S. T. (2016). Double Roman domination. *Discrete Appl. Math.* 211(1): 23–29.

[10] Chellali, M., Haynes, T. W., Hedetniemi, S. T, McRae, A. A. (2016). Roman {2}-domination. *Discrete Appl. Math.* 204: 22–28.

[11] Chellai, M., Rad, N. J., Sheikholeslami, S. M, Volkmann, L. (2020). Roman domination in graphs. In: Haynes, T.W., Hedetniemi, S.T., Henning, M. A., eds. *Topics in Domination in Graphs*. Berlin/Heidelberg: Springer, pp. 365–409.

[12] Chellali, M., Jafari Rad, N., Sheikholeslami, S. M, Volkmann, L. (2020). Varieties of Roman Domination II. *AKCE Int. J. Graphs Comb.* 17(3): 966–984.

[13] Chellai, M., Rad, N. J., Sheikholeslami, S. M, Volkmann, L. (2021). Varieties of Roman Domination, Structures of Domination in Graphs. In: Haynes, T.W., Hedetniemi, S.T., Henning, M. A., eds. *Topics in Domination in Graphs*. Berlin/Heidelberg: Springer, pp. 273–307.

[14] Cockayne, E. J., Dreyer, P. A., Jr, Hedetniemi, S. M, Hedetniemi, S. T. (2004). Roman domination in graphs. *Discrete Math.* 278: 1–3.

[15] Deepalakshmi, J., Marimuthu, G., Somasundaram, A, Arumugam, S. (In press). Domination parameters of a splitting graph of a graph. *Commun. Comb. Optim*.

[16] Desormeaux, W. J., Haynes, T. W, Henning, M. A. (2018). Domination parameters of a graph and its complement. *Discuss. Math. Graph Theory* 38(1): 203–215.

[17] Gao, H., Xi, C., Li, K., Zhang, Q, Yang, Y. (2019). The Italian domination number of generalized Petersen graphs P(n,3). *Mathematics* 7(8): 714. Article 714.

[18] Gao, H., Xu, T, Yang, Y. (2019). Bagging approach for Italian domination in $C_n \square P_m$. *IEEE Access*.

[19] Gravier, S., Kovše, M, Parreau, A. (2011). Generalized Sierpinski Graphs 1. https://www.semanticscholar.org/paper/Generalized-Sierpinski-graphs-1-Gravier-Kovse/3c21ce24174d1cdf788e2988702c1e81dc686436.

[20] Hajibaba, M, Rad, N. J. (2019). On domination, 2-domination and Italian domination numbers. *Util. Math.* 111: 271–280.

[21] Hao, G., Chen, X, Volkmann, L. (2019). Double Roman domination in digraphs. *Bull. Malays. Math. Sci. Soc.* 42(5): 1907–1920.

[22] Haynes, T. W., Henning, M. A, Volkman, L. (2020). Graphs with large Italian domination number. *Bull. Malays. Math. Sci. Soc.* 43(6): 4273–4287.

[23] Haynes, T. W, Henning, M. A. (2019). Perfect Italian domination in trees. *Discrete Appl. Math.* 260: 164–177.

[24] Henning, M. A, Klostermeyer, W. F. (2017). Italian domination in trees. *Discrete Appl. Math.* 217: 557–564.

[25] Hinz, A. M., Klavžar, S, Zemljič, S. S. (2017). A survey and classification of Sierpiński-type graphs. *Discrete Appl. Math.* 217: 565–600.

[26] Jismy, V, Aparna, L. S. (2022). Impact of vertex addition on Italian domination number. *Indian J. Discrete Math.* 8(1): 11–20.

[27] Jismy, V., Anu, V, Aparna, L. S. (2021). Italian domination and perfect Italian domination on Sierpiński graphs. *J. Discrete Math. Sci. Cryptogr.* 24(7): 1885–1894.

[28] Jismy, V, Aparna, L. S. (2021). Italian domination on Mycielskian and Sierpiński graphs. *Discrete Math. Algorithms Appl.* 13(4): Article 2150037.

[29] Jismy, V, Aparna, L. S. (2022). Perfect Italian domination number of graphs. *Palest. J. Math.* 11(1): 260–270.

[30] Klavžar, S, Milutinović, U. (1997). Graphs S(n,k) and a variant of the tower of Hanoi problem. *Czechoslov. Math. J.* 47(1): 95–104.

[31] Klavžar, S., Milutinović, U, Petr, C. (2002). 1-Perfect codes in Sierpiński graphs. *Bull. Austral. Math. Soc.* 66(3): 369–384.

[32] Lauri, J, Mitillos, C. (2020). Perfect Italian domination on planar and regular graphs. *Discrete Appl. Math.* 285: 676–687.

[33] Liu, C. A. (2020). Domination in Sierpiński Graphs $S(K_n, t)$. *arXiv:2008.09807v1*.

[34] Mojdeh, D. A., Masoumi, I, Volkman, L. (2022). Restrained double Roman domination of a graph. *RAIRO-Oper. Res.* 56(4): 2293–2304.

[35] Poureidi, A, Rad, N. J. (2020). On the algorithmic complexity of Roman {2}-domination. *Iran. J. Sci. Technol. Trans. Sci.* 44(3): 791–799.

[36] Poklukar, D. R, Zerovnik, J. (2022). On the double Roman domination in generalized Petersen graphs $P(5k, k)$. *Mathematics* 10(1): Article 119.

[37] Ramezani, F., Rodríguez-Bazan, E. D, Rodríguez-Velázquez, J. A. (2017). On the Roman domination number of generalized Sierpiński graphs. *Filomat* 31(20): 6515–6528.

[38] Yang, H, Zhou, X. (2020). Some properties of double Roman domination. *Discrete Dyn. Nat. Soc.* 2020: 1–5. Article 6481092.

Palestine Journal of Mathematics

Vol. 11(1)(2022) , 260–270

Perfect Italian Domination Number of Graphs

Jismy Varghese and Aparna Lakshmanan S.

MSC 2010 Classification: primary: 05C69, secondary: 05C76

Keywords: Roman domination number, Perfect domination number, Perfect Italian domination number, Cartesian product, Mycielskian of a graph.

Abstract: In this paper, an upper bound for the perfect Italian domination number of the cartesian product of any two graphs is obtained and the exact value of this parameter for cartesian product of some special graphs are obtained. We have also proved that for any two positive integers a, b there exists a graph G and an induced subgraph H of G such that $\gamma_I^p(G) = a$ and $\gamma_I^p(H) = b$. Relationship of the perfect Italian domination number with the Roman domination number and the perfect domination number of a graph G are obtained and the corresponding realization problems are also solved. We have also obtained the perfect Italian domination number of the Mycielskian of a graph in terms of the perfect domination number of the graph. Some open problems related to this parameters are also included.

1 Introduction

Let G be a simple graph with vertex set $V(G)$ and edge set $E(G)$. If there is no ambiguity in the choice of G, then we write $V(G)$ and $E(G)$ as V and E respectively. A subset $S \subseteq V(G)$ of vertices is called a dominating set if every $v \in V(G)$ is either an element of S or is adjacent to an element of S [12]. The domination number, $\gamma(G)$ is the minimum cardinality of a dominating set of G. A dominating set S is a perfect dominating set if $|N(v) \bigcap S| = 1$ for each $v \in V - S$, where $N(v)$ is the collection of all vertices that are adjacent to the vertex v. The perfect domination number, $\gamma_p(G)$ is the minimum cardinality of a perfect dominating set of G [12].

The weight of a function f defined on the vertex set V of a graph G, $f(V)$ is $\sum_{u \in V} f(u)$. A map $f : V(G) \to \{0, 1, 2\}$ is a Roman dominating function for a graph G if for every vertex v with $f(v) = 0$, there exists at least one vertex $u \in N(v)$ such that $f(u) = 2$. The minimum weight of a Roman dominating function on G is called the Roman domination number of G, $\gamma_R(G)$ [4].

An Italian dominating function, of a graph G is a function $f : V(G) \to \{0, 1, 2\}$ satisfying the condition that for every $v \in V(G)$ with $f(v) = 0$, $\sum_{u \in N(v)} f(u) \geq 2$, i.e., either v is adjacent to a vertex u with $f(u) = 2$ or to at least two vertices x and y with $f(x) = f(y) = 1$. The Italian domination number of G, $\gamma_I(G)$ is the minimum weight of an Italian dominating function on G [10].

A function $f : V(G) \to \{0, 1, 2\}$ is a perfect Italian dominating function (abbreviated as PID-function) on G if for every vertex $v \in V(G)$ with $f(v) = 0$, $\sum_{u \in N(v)} f(u) = 2$. The perfect Italian domination number of G, $\gamma_I^p(G)$, is the minimum weight of a PID-function of G. A PID-function of G with weight $\gamma_I^p(G)$ is called a $\gamma_I^p(G)$-function of G [11].

We also denote a function $f : V(G) \to \{0, 1, 2\}$ as $f = (V_0^f, V_1^f, V_2^f)$ or simply (V_0, V_1, V_2), where V_i is the set of all vertices which are assigned the value i for $i = 0, 1, 2$. For any subgraph H of G, the sum of the weights of the vertices of H is denoted by $f(H)$. i.e., $f(H) = \sum_{u \in V(H)} f(u)$. In [9] the authors characterize the graphs G with $\gamma_I^p(G)$ equal to 2 and 3 and determined the exact value of the parameter for several simple structured graphs. It is also proved that it is NP-complete to decide whether a given bipartite graph admits a perfect

Italian dominating function of weight k. The perfect Italian domination number of Sieriński graphs and generalized Sierpiński graphs are studied in [8] and [7] respectively.

For disjoint graphs G and H, the join $G + H$ has vertex set $V(G) \cup V(H)$ and edge set $E(G) \cup E(H) \cup \{uv : u \in V(G) \text{ and } v \in V(H)\}$ [12]. The Cartesian product of two graphs G and H, $G\Box H$ has vertex $V(G) \times V(H)$ and two vertices (u_1, v_1) and (u_2, v_2) are adjacent if either $u_1 = u_2$ and $v_1v_2 \in E(H)$ or $v_1 = v_2$ and $u_1u_2 \in E(G)$ [5]. It is a simple observation that $G\Box H$ can be partitioned as $|V(H)|$ copies of G and $|V(G)|$ copies of H.

The Mycielskian of a graph G, $M(G)$ is the graph with vertex set $V(G) \cup V'(G) \cup \{w\}$ where $V'(G) = \{u_i : v_i \in V(G)\}$ and edge set $E(G) \cup \{v_iu_j : v_iv_j \in E(G)\} \cup \{wu_i : u_i \in V'(G)\}$. The double Roman domination number and the Italian domination number of the Mycielskian of a graph have been studied in [2] and [6].

The following observations are simple.

Observation 1. For a graph with no edge and n vertices, $\gamma_I^p(G) = n$.

Observation 2. For any complete bipartite graph $K_{p,q}$,

$$\gamma_I^p(K_{p,q}) = \begin{cases} 4, & p, q \geq 3, \\ 2, & otherwise. \end{cases}$$

Observation 3. For complete graph K_m, $\gamma_I^p(K_m) = 2$.

Observation 4. For every graph G, $\gamma(G) \leq \gamma_I(G) \leq \gamma_I^p(G)$.

Observation 5. Let G be a graph. $\gamma_I^p(G) = 2$ if and only if $G = H_1 \vee H_2$ where $H_1 = K_1, K_2 \text{ or } 2K_1$.

Proof. If $\gamma_I^p(G) = 2$, in a PID-function of G, either a vertex v is assigned the value 2 and all the remaining vertices are adjacent to v or two vertices v and w are assigned the value 1 and all the remaining vertices are adjacent to both v and w. The adjacency between v and w is optional. Therefore, G is $K_1 \vee H_2,\ K_2 \vee H_2 \text{ or } 2K_1 \vee H_2$. The converse is a simple observation. □

All notations and terminology not mentioned here are from [3].

2 Cartesian Product

In this section, we have obtained an upper bound for the Cartesian product of two graphs in terms of the original graph. Exact values for some special classes are also obtained.

Theorem 2.1. *For any graphs G and H*

$$\gamma_I^p(G\Box H) \leq min\{|V(H)|\gamma_I^p(G), |V(G)|\gamma_I^p(H)\}.$$

Proof. Let g be γ_I^p-function of G. Let $f : V(G) \times V(H) \to \{0, 1, 2\}$ be γ_I^p-function of $G\Box H$ defined by $f(u, v) = g(u)$, for every $u \in V(G)$ and $v \in V(H)$. Then a vertex (u, v) has weight zero, then it has neighbors with weight exactly two and all other vertices which are adjacent to (u, v) has weight zero. Therefore, f is a γ_I^p-function, and $\gamma_I^p(G\Box H) \leq |V(H)|\gamma_I^p(G)$. Using the same arguments we can prove that $\gamma_I^p(G\Box H) \leq |V(G)|\gamma_I^p(H)$. Therefore,

$$\gamma_I^p(G\Box H) \leq min\{|V(H)|\gamma_I^p(G), |V(G)|\gamma_I^p(H)\}.$$

□

There are examples of pairs of graphs for which equality and strict inequality of the above theorem are attained. For instance, let $G = P_4$ and $H = P_2$. Then $\gamma_I^p(G\Box H) = 4 < 6 =$

$min\{|V(H)|\gamma_I^p(G), |V(G)|\gamma_I^p(H)\}$ and let $G = K_{1,3}$ and $H = P_3$. Then $\gamma_I^p(G\Box H) = 6 = min\{|V(H)|\gamma_I^p(G), |V(G)|\gamma_I^p(H)\}$.

The following theorem proved in [1] is used in the proof of Theorem 2.3

Theorem 2.2. *([1].)* $\gamma_I(P_2\Box P_n) = n$.

Theorem 2.3.

$$\gamma_I^p(P_2\Box P_n) = \begin{cases} n+1;\ if\ n\ =\ 1,3,5 \\ n;\ otherwise. \end{cases}$$

Proof. Let $f = (V_0, V_1, V_2)$ be the γ_I^p function of $P_2\Box P_n$. Let $u_1, u_2, u_3, ..., u_n$ be the vertices of the first copy of P_n and $v_1, v_2, v_3, ..., v_n$ be the vertices of the second copy of P_n. We know that $\gamma_I(P_2\Box P_n) = n$ and by observation 4, $\gamma_I(G) \leq \gamma_I^p(G)$. Therefore, $\gamma_I^p(P_2\Box P_n) \geq n$.

When $n = 2$, $P_2\Box P_n$ is C_4 and $\gamma_I^p(C_4) = 2$.

When $n = 3$, define f as follows.

$$f(u) = \begin{cases} 2;\ u = v_3, \\ 1;\ u = u_1, v_2, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(P_2\Box P_n) = 4$.

When $n = 4$, define f as follows.

$$f(u) = \begin{cases} 1;\ u = u_2, u_3, v_1, v_4, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(P_2\Box P_n) = 4$.

When $n = 5$, define f as follows.

$$f(u) = \begin{cases} 2;\ u = u_5 \\ 1;\ u = u_1, u_4, v_2, v_3, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(P_2\Box P_n) = 6$.

When $n = 6$, define f as follows.

$$f(u) = \begin{cases} 1;\ u = u_2, u_3, u_6, v_1, v_4, v_5, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(P_2\Box P_n) = 6$.

When $n \geq 7$, and n is odd, define f as follows.

$$f(u) = \begin{cases} 2;\ u = u_j,\ j \equiv 4(mod6) \\ 1;\ u = u_j,\ j \equiv 1(mod6), \\ \quad u = v_j,\ j \equiv 0(mod2); \\ 0;\ otherwise. \end{cases}$$

When n is even, define f as follows

$$f(u) = \begin{cases} 1;\ u = u_j,\ j \equiv 0, 1(mod4), \\ \quad u = v_j,\ j \equiv 2, 3(mod4); \\ 0;\ otherwise. \end{cases}$$

Clearly, in each case, f is a γ_I^p-function and $f(V) = n$. Hence the theorem.

□

Theorem 2.4. *If m and n are positive integers then*

$$\gamma_I^p(K_m \square K_n) = \begin{cases} n;\ if\ m = n \\ min\{2m, 2n\};\ otherwise. \end{cases}$$

Proof. Let $f = (V_0, V_1, V_2)$ be the γ_I^p-function of $K_m \square K_n$. As we have already mentioned in the introduction $K_m \square K_n$ can be viewed as m rows of K_n and n columns of K_m. Let $u_{i,j}$, $i = 1, 2, ..m$ and $j = 1, 2, ...n$ be the vertices of $K_m \square K_n$.

Case 1: $m = n$.

Define f as follows.

$$f(u_{ij}) = \begin{cases} 1;\ i = j, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(K_n \square K_n) \leq n$.

Claim: Exactly one vertex in each copy of K_n has weight 1.

If possible assume that there exists a copy of K_n in which all vertices have weight 0. Then these vertices are dominated by vertices from corresponding columns. Then each column should have weight 2, i.e., $f(V) = 2n > n$.

If possible assume that there exist a copy of K_n which has weight at least 2. Then either there is a vertex with weight 2 or two vertices with weight 1 each in that row.

Case (a): Let u_{ij} and u_{ik} be the two vertices with weight 1.

Then in the i^{th} row either all other vertices have weight 1 or all other vertices have weight 0. If all other vertices are assigned zero then vertices in the corresponding column is zero. In order to dominate these vertices we have to assign weight 2 in each row. Then $f(V) = 2n > n$. If all other vertices are assigned weight 1, then to dominate any vertex with weight 0 in any other row we have to assign a vertex with weight 1 in each row. Then $f(V) = 2n - 1 > n$.

Case(b): Let u_{ij} be a vertex in i^{th} row that has weight 2.

Similar to case(a), we can prove that, in this case also $f(V) = 2n > n$.
Therefore, weight of each row is one and hence, $\gamma_I^p(K_n \square K_n) = n$.

Case 2: $m \neq n$.

Without loss of generality, let $m < n$. Define f as follows.

$$f(u_{ij}) = \begin{cases} 2;\ i = 1, 2, ...m\ and\ j = 1, \\ 0;\ otherwise. \end{cases}$$

Then $\gamma_I^p(K_m \square K_n) \leq 2m = min\{2m, 2n\}$.

If for every γ_I^p-function f, $\sum_{j=1}^{n} f(u_{ij}) = 2$, for each i, then $\gamma_I^p(K_m \square K_n) = 2m$. Therefore, assume that there exists a γ_I^p-function f such that $\sum_{j=1}^{n} f(u_{ij}) < 2$ for some $i = k$. Therefore, $\sum_{j=1}^{n} f(u_{kj}) = 0$ or 1.

If $\sum_{j=1}^{n} f(u_{kj}) = 0$ then to dominate u_{kj} for $j = 1, 2, ...n$, $\sum_{i=1}^{\cup} f(u_{ij}) = 2$ which implies $f(V) = 2n > 2m$, which is a contradiction to the fact that f is a γ_I^p-function.

If $\sum_{j=1}^{n} f(u_{kj}) = 1$ then there exists l such that $f(u_{kj}) = 0$, if $j \neq l$ and $f(u_{kl}) = 1$. But then to dominate $u_{kj},\ j \neq l$, $\sum_{i=1}^{m} f(u_{ij}) = 1$. i.e., exactly one vertex in each column has weight 1 and all other vertices have weight 0. But number of rows is less than number of columns. Therefore, there are more than one vertex with weight 1 in at least one row, say $i = k^{'}$. But, then $\sum_{j=1}^{n} f(u_{k^{'}j}) = 2$ or n. If $\sum_{j=1}^{n} f(u_{k^{'}j}) = 2$ then exactly two vertices in the $(k^{'})^{th}$ row have weight 1 and all others have weight 0. Also, the column containing this 0's must be full of 0's. But this contradicts the fact that $\sum_{i=1}^{m} f(u_{ij}) = 1$, for all $j \neq l$. Therefore, $\sum_{j=1}^{n} f(u_{k^{'}j}) = n$. But then $f(V) = n + m - 1 \geq m + 1 + m - 1$ (since, $n \geq m + 1$) $= 2m$.

Therefore, if $m \neq n$ then $\gamma_I^p(K_m \square K_n) = 2m$, where $m < n$.

□

3 Realization problems

Theorem 3.1. *Given any two positive integers $a,\ b \geq 3$, there exist a graph G and induced subgraph H of G such that $\gamma_I^p(G) = a$ and $\gamma_I^p(H) = b$.*

Proof. We consider the following three cases.
Case 1: $b \leq a$.

Let $G = P_{2a-1}$ and $H = P_{2b-1}$. Then $\gamma_I^p(G) = \lceil \frac{2(a-1)+1}{2} \rceil = a$, and $\gamma_I^p(H) = \lceil \frac{2(b-1)+1}{2} \rceil = b$.

Case 2: $b > a$.

Let $v_1, v_2, ...v_{2b-1}$ be a path on $2b-1$ vertices. Construct G as follows. Let u and v be two vertices adjacent to $v_{2a-3}, v_{2a-2}, ...v_{2b-1}$ and let v_{2a-4} be adjacent to v alone. Clearly, $\gamma_I^p(G) = \lceil \frac{2a-5+1}{2} \rceil + 2 = a$. Also $H = P_{2b-1}$ is an induced subgraph and $\gamma_I^p(H) = b$. □

Lemma 3.2. *For any graph G, $\gamma_R(G) \leq 2\gamma_I^p(G) - 1$.*

Proof. Let $f = (V_0^f, V_1^f, V_2^f)$ be a γ_I^p-function of G. Let $u \in V_1^f$. Define $g = (V_0^f, u, V_1^f \cup V_2^f - u)$. Since every vertex in V_0^f is adjacent to exactly one vertex in V_2^f or two vertices in V_1^f, in g every vertex in V_0^g will have at least one neighbor with weight 2. Therefore, this assignment gives a Roman dominating function. Now $g(V) = 2(|V_1^f \cup V_2^f|) - 1 \leq 2\gamma_I^p(G) - 1$. Therefore, $\gamma_R(G) \leq 2\gamma_I^p(G) - 1$. □

If $\gamma_R(G) = 1$, G is K_1, and $\gamma_I^p(G) = 1$ and vice versa. Similarly, if $\gamma_R(G) = 2$ then G has a universal vertex and $\gamma_I^p(G) = 2$, but the converse is not true. If $\gamma_R(G) = 3$ and $\gamma_I^p(G) = 2$, then let $G = K_{2,n}$.

Theorem 3.3. *Given $a, b \geq 3$ such that $a \leq 2b - 1$, then there exists a graph G such that $\gamma_R(G) = a$ and $\gamma_I^p(G) = b$.*

Proof. We consider the following cases.

Case a: $a \geq 3$, $b \geq a + 1$ and a is odd.

Consider $K_p^c \vee P_{b-3}$, where p is arbitrarily large. Attach a vertex u to every vertex of $K_p^c \vee P_{b-3}$ and a pendent vertex v to an end vertex of P_{b-3}. Then $\gamma_R(G) = 3$ where γ_R-function f can be defined as $f(u) = 2,\ f(v) = 1$ and $f(v_i) = 0$ for all other vertices. Also, $\gamma_I^p(G) = b$ where γ_I^p-function g can be defined as $g(u) = 2,\ g(v) = 1$ and all the vertices of P_{b-3} has weight 1. If we attach a P_3 to the vertex u by an edge then $\gamma_R(G) = 3 + 2 = 5$ and $\gamma_I^p(G) = b + 2$. Similarly, by attaching P_{3k} to the already attached P_3, we can get $\gamma_R(G) = 3 + 2k$ and $\gamma_I^p(G) = b + 2k, b > a$.

Case b: $a \geq 4$, $b \geq a + 1$ and a is even.

Consider $K_p^c \vee P_{b-4}$, where p is arbitrarily large. Attach a vertex u to every vertex of $K_p^c \vee P_{b-4}$ and attach both the vertices p and q of K_2 to an end vertex of P_{b-4}. Then $\gamma_R(G) = 4$, where γ_R-function f can be defined as $f(u) = 2$ and $f(p) = f(q) = 1$. Also, $\gamma_I^p(G) = b$, where γ_I^p-function g can be defined as $g(u) = 2,\ g(p) = g(q) = 1$ and all the vertices of P_{b-4} has weight 1. Attach a P_3 with u by an edge then $\gamma_R(G) = 4 + 2$ and $\gamma_I^p(G) = b + 2$. Similarly, by attaching P_{3k} as in the previous case we can get $\gamma_R(G) = 4 + 2k$ and $\gamma_I^p(G) = b + 2k, b > a$.

Case c: $a = b$ and a is odd.

Consider P_{2a-1}. Let $v_1, v_2, v_3, ..., v_{2a-1}$ be the vertices of P_{2a-1}. Let u be a vertex which is attached to $v_2, v_4, v_6, ...v_{2a-2}$ and also v_1 and v_{2a-1}. Then $\gamma_R(G) = a$, where γ_R-function f can be defined as $f(u) = 2$, $f(v_3) = f(v_5) = f(v_7) = ... = f(v_{2a-3}) = 1$, $f(v) = 0$, for all other vertices and $\gamma_I^p(G) = a$, where γ_I^p-function g can be defined as $g(v_1) = g(v_3) = g(v_5) = ... = g(v_{2a-1}) = 1$, $g(v) = 0$, for all other vertices. In particular, when $a = 5$ the graph is given in Figure 1.

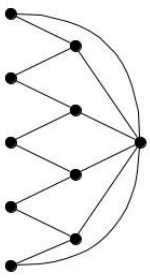


Figure 1. A graph with $a = b = 5$

Similarly, we can construct all graphs with $\gamma_R(G) = \gamma_I^p(G)$ when $\gamma_R(G)$ is odd. So we have constructed all graphs with $a \leq b$.

Case d: $a > b$.

Let G be the graph constructed as follows. Let $v_1, v_2, , ..., v_b$ be a set of independent vertices. Corresponding to every pair $(v_i, v_j), i \neq j$ let u_{ij} be a vertex adjacent to v_i and v_j alone. Then $\gamma_I^p(G) = b$, where $f(v_i) = 1$, for all $i = 1, 2, 3, ..., b$ and $f(u_{ij}) = 0$, for all $i, j \in \{1, 2, 3, ..b\}$ and $i \neq j$ is a γ_I^p-function of G. But $\gamma_R(G) = 2b - 1$, where $g(v_i) = 2$, for $i = 1, 2, 3, ..., b - 1$ and $g(v_b) = 1$ is a γ_R-function. In particular, when $a = 7$ and $b = 4$, the graph is given in Figure 2.

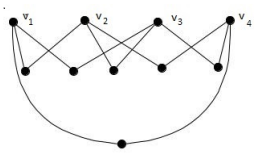


Figure 2. A graph with $a = 7$ and $b = 4$

Now, if we delete one vertex from the ${}^bC_2$ vertices, $\gamma_I^p(G)$ will not change, whereas $\gamma_R(G)$ reduces by 1. (Note that $h(v_k) = 2$ for all $k \in \{1, 2, 3, ..., b\} \setminus \{i\}$ and $h(v_i) = 1$ is a $\gamma_R(G)$-function of G). Proceeding like this we can reduce $\gamma_R(G)$ up to $\gamma_I^p + 1$. Hence the theorem.

□

4 Relation with perfect domination number

In this section, we study the relationship between perfect Italian domination number and perfect domination number of a graph. The following are simple observations.

Observation 6: $\gamma_I^p(G) \leq 2\gamma_p(G)$.

Proof. Let P be a γ_p-set of G. Then

$$f(v) = \begin{cases} 2;\ if\ v \in P, \\ 0;\ otherwise. \end{cases}$$

is a PID-function. Therefore, $\gamma_I^p(G) \leq 2\gamma_p(G)$. □

Observation 7: If there exists a γ_I^p-function of G such that $V_1 = \phi$ then $\gamma_I^p(G) = 2\gamma_p(G)$.

Proof. If there exists a γ_I^p-function of G such that $V_1 = \phi$, then the vertices which are assigned the value 2 forms a γ_p-set. Therefore, $\gamma_p(G) \leq \frac{1}{2}\gamma_I^p(G)$. Hence, $\gamma_I^p(G) \geq 2\gamma_p(G)$ and by observation 6, $\gamma_I^p(G) = 2\gamma_p(G)$. □

We know that the Italian domination number of a graph G lies between $\gamma(G)$ and $2\gamma(G)$. Here we have proved that $\gamma_I^p(G) \leq 2\gamma_p(G)$. It is most expected that $\gamma_p(G)$ serves as a lower bound for $\gamma_I^p(G)$. But this is not true and $\gamma_I^p(G)$ can be arbitrarily smaller than $\gamma_p(G)$. The following theorem settles the corresponding realization problem.

Theorem 4.1. *Given any two positive integers a, and b such that $b \leq 2a$ there exists a graph G such that $\gamma_p(G) = a$ and $\gamma_I^p(G) = b$.*

Proof. Let a and b be any two positive integers such that $b \leq 2a$.

Case 1: $a \leq b \leq 2a - 1$.

Consider k copies of P_5, say $v_{i1}v_{i2}v_{i3}v_{i4}v_{i5}$ for $i = 1, 2, ...k$, where $v_{i1} = v_{j1}$, for all $i, j \in \{1, 2, ..., k\}$. Then $\gamma_I^p(G) = 2k + 1$, where γ_I^p-function f can be defined as $f(v_{i1}) = f(v_{i3}) = f(v_{i5}) = 1$, for all $i = 1, 2, ..., k$ and 0, otherwise. Also $\gamma_p(G) = k + 1$, where the perfect dominating set consist of the vertices v_{i1} and v_{i4}, $i = 1, 2, ..., k$. If we extend the path $v_{11}v_{12}v_{13}v_{14}v_{15}$ to a path of length $2l + 5$, then $\gamma_I^p(G) = 2k + 1 + l$ and $\gamma_p(G) = k + 1 + l$. Let $k = b - a$ and $l = 2a - b - 1$, so that $\gamma_p(G) = a$ and $\gamma_I^p = b$.

Case 2: $b = 2a$.

Let G be the graph $P_a : v_1v_2, ..., v_a$, with atleast two pendent vertices attached to every $v_i,\ i = 1, 2, ..., a$. Then $\gamma_I^p(G) = 2a$ and $\gamma_p(G) = a$.

Case 3: $a > b$.

Subcase (a): $b - a$ is even.

Let $G = K_2^c + kK_2$. Then $\gamma_I^p(G) = 2$, where vertices of K_2^c is assigned the value 1 and others 0, is the γ_I^p-function of G. But the γ_p-set contains all the vertices of the graph and hence $\gamma_p(G) = 2k + 2$. By attaching a path of length $2l$ to one of the vertices of K_2^c, as in case 1, we get $\gamma_I^p(G) = 2 + l$ and $\gamma_p(G) = 2k + 2 + l$. Let $k = \frac{a-b}{2}$ and $l = b - 2$ so that $\gamma_p(G) = a$ and $\gamma_I^p = b$.

Subcase (b): $b - a$ is odd.

Let $G = K_2^c + (K_3 \cup kK_2)$. Then as in the previous case, $\gamma_I^p(G) = 2$ and $\gamma_p(G) = 2k + 5$. By attaching a path of length $2l$ to one of the vertices of K_2^c, we get $\gamma_I^p(G) = 2 + l$ and $\gamma_p(G) =$

$2k + 5 + l$. Let $k = \frac{a-b-3}{2}$ and $l = b - 2$ so that $\gamma_p(G) = a$ and $\gamma_I^p = b$.

□

5 Mycielskian of a graph

In this section, we study the relationship between the perfect Italian domination number of Mycielskian of a graph and the perfect domination number of the graph.

Theorem 5.1. *For a connected graph G,* $\gamma_I^p(M(G)) \leq 2\gamma_p(G) + 1$.

Proof. Let P be a γ_p-set of G. Let $P' = \{u_i, v_i : v_i \in P\} \cup \{w\}$. Define a PID-function as follows.

$$f(v) = \begin{cases} 1;\ if\ v \in\ P', \\ 0;\ otherwise. \end{cases}$$

Then $f(M(G)) = 2\gamma_p(G) + 1$. Therefore, $\gamma_I^p(M(G)) \leq 2\gamma_p(G) + 1$. □

Although, many graph classes satisfy equality, it may be noted that there are infinite number of families of graph which satisfy strict inequality. If we consider the graph $G = K_2^c \bigvee kK_2$, then $\gamma_I^p(M(G)) = 6$ and $\gamma_p(G) = 2k + 2$, so that the difference can be arbitrarily large. An illustration where $k = 2$ is given in Figure 3, in which $f(v_3) = f(v_4) = f(u_1) = f(u_2) = 1$ and $f(w) = 2$ gives a γ_I^p-function of $M(G)$.

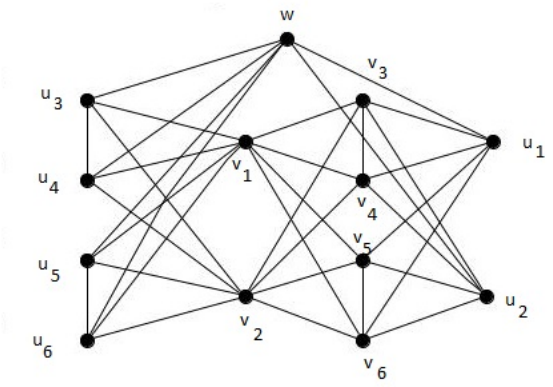


Figure 3. $M(K_2^c \vee 2K_2)$.

Theorem 5.2. *If G has a* γ_I^p*-function such that* $V_1 = \phi$*, then* $\gamma_I^p(M(G)) = \gamma_I^p(G)+1 = 2\gamma_p(G)+1$.

Proof. Assume that G has a γ_I^p-function f such that $V_1^f = \phi$. We can define a perfect Italian dominating function $g : V(M(G)) \to \{0, 1, 2\}$ as follows.

$$g(v) = \begin{cases} 1;\ for\ v = v_i\ and\ u_i\ such\ that\ f(v_i) = 2\ and\ v = w, \\ 0;\ otherwise. \end{cases}$$

Therefore, $\gamma_I^p(M(G)) \leq \gamma_I^p(G) + 1$.

To prove the reverse inequality, let f be a PID-function of $M(G)$.

Case 1: $\sum_{i=1}^{n} f(u_i) \neq 2$.

Define $g : V(G) \to \{0, 1, 2\}$ as follows.

$$g(v_i) = \begin{cases} 2;\ if\ f(v_i) + f(u_i) = 2, \\ 1;\ if\ f(v_i) + f(u_i) = 1, \\ 0;\ otherwise. \end{cases}$$

Note that $f(v_i) + f(u_i) \leq 2$, for every $i = 1, 2, ..., n$. Then g is a PID-function of G, since $N_G(v_i) = N_{M(G)}(u_i) \bigcap V(G)$.

Case 2: $\sum_{i=1}^{n} f(u_i) = 2$.

In this case, either there exists one vertex u_i with $f(u_i) = 2$ or there exist two vertices u_i and u_j with $f(u_i) = f(u_j) = 1$.

Subcase(a): There exists one vertex u_i with $f(u_i) = 2$.

Without loss of generality let $f(u_1) = 2$ and $f(u_i) = 0$, for all $i = 2, 3, ..., n$. If possible assume that there exists a $v_i \in N(u_1)$ such that $f(v_i) = 0$. But, we have $f(u_i) = 0$ which implies that $\sum f(N(u_i)) = 2$ and hence, $\sum f(N(v_i)) = \sum f(N(u_i)) + f(u_1) - f(w) = 2$. This implies, $f(w) = 2$. Therefore, $\sum_{x \in N(u_i) - \{w\}} f(x) = 0$, for all $i = 2, 3, ..., n$. This implies $f(x) = 0$ for $x \in N(v_i)$, for all $i = 2, 3, ..., n$. But, then $v_i's$ are perfect Italian dominated by u_i. This means v_1 is a universal vertex of G and also $f(M(G)) \geq 4$. But, $g(v_1) = g(u_1) = g(w) = 1$ is a PID-function of $M(G)$ with weight 3, which is a contradiction to the fact that f is a γ_I^p-function of $M(G)$. Therefore, none of the vertices in $V(G)$ is perfect Italian dominated by u_1. Therefore, f restricted to G is a PID-function of G and $f(G) \leq f(M(G)) - 2$. Therefore, $\gamma_I^p(G) \leq \gamma_I^p(M(G)) - 2$ so that, $\gamma_I^p(M(G)) \geq \gamma_I^p(G) + 2$, which is a contradiction to the fact that $\gamma_I^p(M(G)) \leq \gamma_I^p(G) + 1$. Therefore, such a case dose not exist.

Subcase(b): There exist two vertices u_i and u_j with $f(u_i) = f(u_j) = 1$.

Without loss of generality, let $f(u_1) = f(u_2) = 1$ and $f(u_i) = 0$, for all $i = 3, 4, ..., n$. As in the above case, there dose not exist $v_i \in N(u_1) \bigcup N(u_2), i \neq 1, 2$ such that $f(v_i) = 0$. If $v_1,\ v_2 \notin N(u_1) \bigcup N(u_2)$, then again f/G is a PID-function of G and hence $\gamma_I^p(G) \leq \gamma_I^p(M(G)) - 2$, which is not possible. Therefore, assume that $v_1,\ v_2 \in N(u_1) \bigcup N(u_2)$. i.e., $v_1 \in N(u_2)$ and $v_2 \in N(u_1)$. If $f(v_1) = f(v_2) = 0$ then define $g : V(G) \to \{0, 1, 2\}$ as follows.

$$g(v_i) = \begin{cases} f(v_i);\ i \neq\ 1, 2, \\ 1;\ i = 1, \\ 0;\ i = 2. \end{cases}$$

If $f(v_1) = 0$ and $f(v_2) \neq 0$ then define $g : V(G) \to \{0, 1, 2\}$ as follows.

$$g(v_i) = \begin{cases} f(v_i);\ i \neq\ 2, \\ f(v_2) + 1; i = 2. \end{cases}$$

The case $f(v_1) \neq 0$ and $f(v_2) = 0$ can be delt similarly. If both $f(v_1)$ and $f(v_2)$ are non-zero then f/G is a PID-function, which again leads to a contradiction. In all the cases $\gamma_I^p(G) \leq \gamma_I^p(M(G)) - 1$. Therefore, $\gamma_I^p(M(G)) = \gamma_I^p(G) + 1$.
By Observation 7, we know that $\gamma_I^p(G) = 2\gamma_p(G)$. Therefore, $\gamma_I^p(M(G)) = 2\gamma_p(G) + 1$. □

Corollary 5.3. *For any graph G with a universal vertex,* $\gamma_I^p(M(G))) = 3$.

6 Conclusion and Open Problems

In this paper, we have already given some examples of graphs which satisfy $\gamma_I^p(G) = 2\gamma_p(G)$. Let G be a graph with n vertices and let $\Im = \{H_i : i = 1, 2, ..., n\}$ be a family of n graphs (not necessarily non-isomorphic). We define the corona of G with $\Im$, $G \odot \Im$ as the graph with

vertex set $V(G) \cup V(H_i)$, $i = 1, 2, ..., n$ and edge set $E(G) \cup E(H_i) \cup \{v_i u : u \in V(H_i)$, for all $i = 1, 2, ..., n\}$. When $H_i = H$, for all i, $G \odot \Im$ reduces to the usual corona of G and H, $G \odot H$. $G \odot \Im$ satisfies, $\gamma_I^p(G \odot \Im) = 2\gamma_p(G \odot \Im)$, if $|V(H_i)| > 1$ for all $i = 1, 2, ...n$. Any supergraph of the above graph obtained by adding edges between $H_i's$, to some extend, also satisfy the above equality.

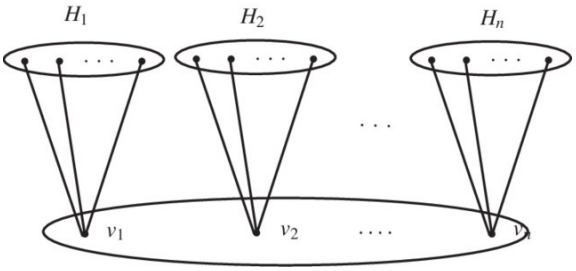


Figure 4. Structure of $G \odot \Im$.

Though we have infinitely many graphs which satisfy this equality, the charecterization problem is still open.

Problem 1: Characterize graphs for which $\gamma_I^p(G) = 2\gamma_p(G)$.

In Theorem 5.2 we have proved that, if G has a γ_I^p-function such that $V_1 = \phi$, then $\gamma_I^p(M(G)) = \gamma_I^p(G) + 1 = 2\gamma_p(G) + 1$. Let G be the graph $P_3 \odot K_1$. Here, $\gamma_p(G) = 3$, $\gamma_I^p(G) = 4$ and $\gamma_I^p(M(G)) = 7 = 2\gamma_p(G) + 1$. But there dose not exist a γ_I^p-function of G in which $V_1 = \phi$. Therefore, the converse of the theorem is not true for the equality $\gamma_I^p(M(G)) = 2\gamma_p(G) + 1$. But we strongly belive that the converse of the Theorem 5.2 is true for $\gamma_I^p(M(G)) = \gamma_I^p(G) + 1$. So we have the following open problems.

Problem 2: Characterize graphs for which $\gamma_I^p(M(G)) = 2\gamma_p(G) + 1$.

Problem 3: Prove the converse of Theorem 5.2 for the equality $\gamma_I^p(M(G)) = \gamma_I^p(G) + 1$. ie; if $\gamma_I^p(M(G)) = \gamma_I^p(G) + 1$, then there exists a γ_I^p-function of G for which $V_1 = \phi$.

We know that, if there exists a γ_I^p-function of G such that $V_1 = \phi$ then $\gamma_I^p(G) = 2\gamma_p(G)$. Therefore, if we can prove Problem 3 and if Class A and Class B are the classes of graphs which satisfies Problem 1 and 2 respectively, then the intersection of Class A and Class B is precisely the collection of graphs for which there exists a γ_I^p-function such that $V_1 = \phi$.

References

[1] F. Alizade, H. R. Maimani, L. Parsaei Majd, M. Rajabi Parsa, *Roman {2}-domination in graphs and graph products* , arXiv:1701.01416 (2017).

[2] V. Anu, S. Aparna Lakshmanan, *Double Roman Domination Number*, Discrete Appl. Math., 244 (2018), 198-204.

[3] R. Balakrishnan, K. Ranganathan, *A Text Book of Graph Theory*, Springer, New York, (1999).

[4] E. J. Cockayne, P. A. Dreyer, S. M. Hedetniemi, S. T. Hedetniemi, *On Roman domination in graphs*, Discrete Math., 278 (2004), 11-22.

[5] M.S.Jacobson, L.F.Kinch, *On domination number of product graphs:I*, Ars Combinatoria, 18 (1983), 33-44.

[6] V. Jismy, S. Aparna Lakshmanan, *Italian Domination on Mycielskian and Sierpiński Graphs,* Discrete Math., Algorithms and Appl., https://doi.org/10.1142/S1793830921500373.

[7] V. Jismy, V. Anu, S. Aparna Lakshmanan, *Italian Domination and Perfect Italian domination on Sierpiński Graphs*, J. Discrete. Math. Sci. Cryptogr., 24(7) (2021), 1885 - 1894.

[8] V. Jismy, V. Anu, S. Aparna Lakshmanan, *Domination parameters on Sierpiński Graphs*, (communicated).

[9] J. Lauri, C. Mitillos, *Perfect Italian Domination on Planar and Regular Graphs*, Discrete Appl. Math., 285(2020), 676-687.

[10] Musthapha Chellai, Teresa W. Haynes, Stephen T. Hedetniemi, Alice A McRae, *Roman {2}-domination*, Discrete Appl. Math., 204 (2016), 22-28.

[11] Teresa W. Haynes, Michael A. Henning, *Perfect Italian Domination in Trees*, Discrete Appl. Math., 260 (2019), 164-177.

[12] Teresa W.Haynes, Stephen T. Hedetniemi, Peter J. Slater, *Fundamentals of Domination in Graphs*, Marcel Dekker, Inc.New York, 1998.

Author information

Jismy Varghese, School of Computer Science, DePaul Institute of Science and Technology, Angamaly - 683 573, Kerala, India.
E-mail: kvjismy@gmail.com

Aparna Lakshmanan S., Department of Mathematics, Cochin University of Science and Technology, Cochin - 22, Kerala, India.
E-mail: aparnals@cusat.ac.in, aparnaren@gmail.com

UTTAR PRADESH JOURNAL OF ZOOLOGY

42(11): 53-66, 2021
ISSN: 0256-971X (P)

EFFECT OF SUBLETHAL CONCENTRATION OF FORMALIN ON HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS OF *Oreochromis niloticus*

A. U. ARUN[1*], V. S. YEDUKRISHNAN[1], SHALU SOMAN[1], REEMY SARA MATHAI[2], BLESSY V. RAJAN[3] AND R. REVATHY[4]

[1]Department of Zoology, St. **Peter's College, Kolenchery**, India.
[2]Department of Zoology, Marthoma College for Women, Perumbavoor, India.
[3]Department of Zoology, St. **Xavier's College, Vaikom**, India.
[4]Department of Zoology, Nirmala College, Muvattupuzha, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author AUA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors VSY and SS managed the analyses of the study. Authors RSM, BVR and RR managed the literature searches. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Juan Carlos Troiano, Professor, University of Buenos Aires, Argentina.
Reviewers:
(1) Nermeen Nemr Welson, Beni Suef University, Egypt.
(2) Hanan Hafez Omar, Tanta University, Egypt.

Received: 10 March 2021
Accepted: 16 May 2021
Published: 21 May 2021

Original Research Article

ABSTRACT

Formalin has long been used for traditional treatment of fish ectoparasites, even though it is a highly toxic compound. Besides this, formalin is a one of the major constituent of plywood mill effluent. Perumbavoor, Ernakulam (district) of Kerala is one of the major plywood industrial belt and hundreds of plywood factories have been working in a limited area. All these plywood factories are discharging effluents directly into the nearby water bodies without any proper treatments. Hence a detail study is necessary to evaluate the impact of formalin on aquatic organisms especially fishes. In this ground a study was undertaken to evaluate haematological and biochemical changes resulting from the exposure of *Oreochromis niloticus* to sub lethal concentrations of formalin ($1/80^{th}$ (0.175 ml), $1/70^{th}$ (0.2 ml) and $1/50^{th}$ (0.28 ml) dilution of LC50 of formaldehyde) for a period of 20hrs, 100hrs and 300 hrs. It is noted that with an increase in the concentrations and exposure period, the total count of RBC, haemoglobin, PCV, MCH, MCHC and MCV decreased as compared to that of the control. The WBCs count increased with increase in concentration and exposure period. Blood Glucose level showed an increasing trend with dosage and exposure time. Total Protein, Globulin and Albumin were lower in exposed fish as compared to control. The changes observed in this study indicated that haematological and biochemical parameters can be used as an indicator of formalin related stress in fish. The current work emphasized the necessity to regulate the discharge of formaldehyde from domestic and industrial

**Corresponding author: Email: drarunkurup@gmail.com;*

Text Matters: A Journal of Literature, Theory and Culture

No. 11 (2021): Literature and Security / Bodies, Traumas, Transgressions / Pop Cultural Encounters

Guest Editor: Liam Gearon

Published: 2021-11-22

Full Issue

PDF

Articles

PDF HTML

Northern Ireland's Interregnum. Anna Burns's Depiction of a (Post)-Troubles State of (In)security

Ryszard Bartnik

64-83

PDF HTML

"...delivered from the lie of being truth": The Affective Force of Disinformation, Stickiness and Dissensus in Randy Ribay's Patron Saints of Nothing

Vincent Pacheco, Jeremy De Chavez

84-96

PDF HTML

Transforming the Ich-Du to the Ich-Es: The Migrant as "Terrorist" in Kabir Khan's New York and Kamila Shamsie's Home Fire

Minu Susan Koshy

97-105

PDF HTML

Victim-Warriors and Restorers—Heroines in the Post-Apocalyptic World of Mad Max: Fury Road

Anna Reglińska-Jemioł

106-118

PDF HTML

Aligning with Sociopaths: Character Engagement Strategies in Highsmith's and Minghella's Talented Mr. Ripleys

Lech Zdunkiewicz

119-136

PDF HTML

Mer-Hagography: The Erasure, Return and Resonance of Splash's Older Mermaid

Philip Hayward

139-156

PDF HTML

From Romero to Romeo—Shakespeare's Star-Crossed Lovers Meeting Zombedy in Jonathan Levine's Warm Bodies

Magdalena Cieślak

157-177

Text Matters, Number 11, 2021
https://doi.org/10.18778/2083-2931.11.07

Minu Susan Koshy
Mar Thoma College for Women, Kerala

Transforming the *Ich-Du* to the *Ich-Es*: The Migrant as "Terrorist" in Kabir Khan's *New York* and Kamila Shamsie's *Home Fire*

ABSTRACT

Terror narratives have been characterized by a dialogism where the "normative" I—i.e. the "non-threatening mainstream"—defines and delineates subjects whose identity is centred on their (actual or presumed) location in the terror network. This is especially so in the case of Asian migrants who settle down in Western countries, as their very identity as Asian locates them at a precarious point in the real or imagined "terror network." The migrant is no longer the *Du* (Thou), but the *Es* (It), imparting an identity to the *Ich* (I), where the *Ich* denotes the "original" citizens of the country. The transactions of the "I" with the "Thou" and the "It" become significant in the context of Asian immigrants in that, for the dominant mainstream (the "I"), the "terrorist" is an *Es*/"It" that has gradually marked its transition from the *Du*/"Thou." The person of the "terrorist" finds its ontological properties from the gradual movement away from a "Thou" to an "It." The hitherto unbounded "Thou" is transformed into a definable "It," by ascribing to her/him a religion, race, colour, nationality and ethnicity. He/she is not confronted, as every "Thou" is, but is rather "experienced" as a source of terror, as an "It." The paper attempts to explore the transformation of the figure of the "migrant terrorist" from a confronted "Thou" to an "imagined/experienced" "It" through an analysis of *New York* (2009) by Kabir Khan and *Home Fire* (2017) by Kamila Shamsie.

Keywords: Ich-Du, Ich-Es, Asian migrant, terror narratives, objectification, pathologizing gaze.

Electro, Physical & Theoretical Chemistry

Optoelectronic Properties of Polycyclic Benzenoid Hydrocarbons of Various Sizes and Shapes for Donor-π-Acceptor Systems: A DFT Study

Ramachandran Rakhi[a, b] and Cherumuttathu H. Suresh*[a, b]

The zigzag and armchair-edged benzenoid polycyclic aromatic hydrocarbons (PAHs) possessing circular, parallelogram, rectangular and triangular shapes have been studied for a systematic evaluation of their optoelectronic properties for the design of donor-π-acceptor (D-π-A) systems using M06L/6-31 + G(d) level of density functional theory (DFT). Molecular electrostatic potential (MESP) analysis of the PAHs is done to characterize their electron distribution while the time-dependent DFT (TD-DFT) analysis was used for the absorption spectral analysis. MESP analysis showed Clar's sextet like electronic arrangement in armchair-edged systems whereas zigzag-edged ones showed significant electron localization towards the edges. The absorption spectra revealed a linear trend in absorption maximum (λ_{max}) for most of the armchair-edged systems with respect to the number of π-electrons. MESP based assessment of the electron rich/deficient features of PAH systems led to the design of PAH-π-PAH type D-π-A systems wherein a conjugated diene moiety functions as the π-spacer. The D-π-A behaviour of these systems significantly enhanced with the introduction of electron donating functional group NMe_2 on donor PAH and electron withdrawing group COOH on the acceptor PAH. The MESP features, frontier molecular orbital (FMO) distribution, and absorption spectral features supported the strong D-π-A character of functionalized PAH-π-PAH. Among the different shapes studied, the rectangular PAH moiety showed the most efficient tuning of HOMO-LUMO gap. The optical and electronic properties of PAH, PAH-π-PAH and functionalized PAH-π-PAH systems suggest the high tunable character of these properties with respect to the size and shape of the PAH.

Introduction

The field of molecular materials flourished in the 21st century after the isolation of graphene by Nobel Prize winners Geim and Novoselov,[1] while the pioneering theoretical work on such a system was done by P. Wallace in the year 1947.[2] Graphene is a benzenoid type polycyclic aromatic hydrocarbon (PAH), characterized with a flat monolayer of sp^2 carbon atoms wherein the CC bond connections favor a two-dimensional extended π-conjugation[3–5] and yields exceptional electronic, thermal and mechanical properties.[1,6] Despite being one atom thick, graphene can be optically visualized.[7–8] Together with this visibility, other remarkable optical properties like hot luminescence, saturable absorption, and broadband applicability renders graphene an ideal photonic and optoelectronic material.[9–17]

Large flakes of graphene or an extended PAH system can be termed as nanographene,[3,18–23] the properties of them are largely influenced by the size and edge shape.[24–28] As the size of the PAH increases, the number of isomers possible also increases.[29] Graphene nanoflakes are stable than carbon nanotubes of similar size, but less stable than the corresponding fullerenes. In addition, large flakes have almost zero bandgap whereas small ones are semiconductors or insulators. Graphene nanoflakes tend to show new and unexpected electronic, optical, vibrational and magnetic properties based on the size and geometry.[24–25,30–35] For example, triphenylene has an absorption maximum 265 nm while its isomer tetracene shows a much higher absorption maximum, 471 nm. In addition, triphenylene is quite stable against oxidation whereas tetracene is easily oxidized. On the basis of resonance structures of PAH, Clar proposed the sextet rule which predicts the largest number of disjoint benzene-like π-conjugated moieties one can draw for a PAH. According to Clar's rule, triphenylene having three sextet rings is more aromatic and more stable than the isomer tetracene having only one sextet.[36–39]

Two types of periphery (zigzag and armchair) and three types of edges (the bay, the cove and the fjord) are observed for PAHs, (Figure 1).[24] PAHs with armchair periphery are more resonance stabilized compared to those with a zigzag periphery, making zigzag ones more reactive. In fact, larger PAHs with zigzag periphery is instantaneously converted to quinine in the air.[24,31] It is already proven that the HOMO-LUMO band gap engineering can be done by changing the size and shape of graphene nanoflakes.[40–41] Large PAHs are present naturally, but graphene nanoflakes are very difficult to synthesize and are not found naturally.[42] Both top-down[43–47] and bottom-up[48–49]

[a] Dr. R. Rakhi, Dr. C. H. Suresh
Chemical Sciences and Technology Division, CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram 695019, India
E-mail: sureshch@niist.res.in
[b] Dr. R. Rakhi, Dr. C. H. Suresh
Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India

Supporting information for this article is available on the WWW under https://doi.org/10.1002/slct.202004320

UTTAR PRADESH JOURNAL OF ZOOLOGY

42(14): 84-95, 2021
ISSN: 0256-971X (P)

AN EXPLORATORY SEQUEL OF THE REGULATORY ROLE OF SALINITY IN FRESHWATER FISH

REEMY SARA MATHAI[1,2*] AND A. U. ARUN[3]

[1]Department of Zoology, Mar Thoma College for Women, Perumbavoor, Kerala, India.
[2]PG and Research Department, Nirmala College, Muvattupuzha, Kerala, India.
[3]Department of Zoology, St. Peter's College, Kolenchery, Kerala, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author RSM performed the literature searches, compiled the data and drafted the manuscript while author AUA is the guide who helped in corrections and forming the rough draft into a well framed one. Both authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Telat Yanik, Professor, Atatürk University, Turkey.
Reviewers:
(1) Rigoberto Fimia Duarte, University of Medical Sciences of Villa Clara (UCM-VC), Cuba.
(2) Murat Yigit, Canakkale Onsekiz Mart University, Turkey.

Received: 01 May 2021
Accepted: 05 July 2021
Published: 09 July 2021

Review Article

ABSTRACT

Salinity has a stronger individual effect on organismal performance traits than other stressors, hence it is considered as a potent environmental stressor. Salinity acclimation process forces fish to undergo endocrinological, morphological and biochemical changes This paper would serve to provide a better understanding about the role of salinity in regulating the survival, growth, development, fitness and well-being of freshwater fish. Certain physiological mechanisms of salinity effects which are yet to be understood fully are also mentioned in the paper. The paper reveals that the 'salinity effect' could not be subject to generalizations as several factors like genetic make-up, species, strain, life history, nutritional status, size, acclimation time and environmental factors affect the salinity tolerance of fish. The paper gives an insight into the research gaps in the area.

Keywords: Factor; gill; growth; protein; salinity; salt; stress; survival.

1. INTRODUCTION

Stress is an inevitable part of life, adaptation to which churns the clock of evolution; exposing greater challenges on the survival and fitness of poikilothermic organisms. In comparison with terrestrial forms, fish face additional challenges from diverse osmotic and ionic gradients and pH levels [1].

Several internal (nervous, endocrinological, neuro-endocrinological) and external (ecological) factors come into play in controlling or synchronizing many activities and functions in fish. These could be grouped into two, namely (1) *determining factors* (temperature, salinity, photoperiod) which act directly through receptors to increase or decrease growth; and (2) *limiting factors*, which operate above (ammonia)

**Corresponding author: Email: reemysara@gmail.com;*

UTTAR PRADESH JOURNAL OF ZOOLOGY

42(17): 117-122, 2021
ISSN: 0256-971X (P)

RESPIRATORY STRESS OF SALINITY ON *Oreochromis niloticus*

REEMY SARA MATHAI[1], A. U. ARUN[2*], G. HRISHITHA[2], SHALU SOMAN[3], R. REVATHY[3] AND BLESSY RAJAN[4]

[1]Mar Thoma College for Women, Perumbavoor, India.
[2]St. Peter's College, Kolenchery, India.
[3]Nirmala College, Muvattupuzha, India.
[4]St. Xavier's College, Vaikom, India.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author RSM managed the analyses of the study and drafted the manuscript. Author AUA designed the study and wrote protocol. Author GH carried out the experiments. Authors SS, RR and BR managed the literature searches. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Telat Yanik, Professor, Atatürk University, Turkey.
Reviewers:
(1) Ravindragouda Patil, India.
(2) Abdul Hamid, Halu Oleo University, Indonesia.

Received: 20 June 2021
Accepted: 26 August 2021
Published: 01 September 2021

Original Research Article

ABSTRACT

Oreochromis niloticus (Nile tilapia) commonly found in the freshwater bodies of Kerala was used in this study as the experimental fish so as to determine the effect of salinity on the respiration rate of the fish. The fishes were exposed to different salinities (5ppt, 10ppt, 15ppt, 20ppt) for a period of one hour. The sample with 0ppt salinity was taken as the control. Using Winkler's method, the dissolved oxygen level in the water taken at different intervals (5^{th} minutes, 15^{th} minutes, 30^{th} minutes and 1 hour) from the sample solutions were estimated. In control (0ppt) average oxygen consumption during different time interval was found to be stable at 0.12 mg/ml/g body weight. The dissolved oxygen consumption by fish increased with increasing salinities from 0ppt to 10ppt, then decreased in 15ppt and 20ppt, besides this consumption of Oxygen decreased from 5^{th} minutes to 60^{th} minutes of exposure. The opercular beats of the fish was noted and it was found that in the control (with 0 ppt salinity), the rate of opercular beats was quite steady without a huge rise or fall and the average value noted was 122/minutes. In all other salinities (5, 10, 15 and 20 ppt), the opercular beats was decreased from 1^{st} minute to 60^{th} minute. The rate of opercular beats was lower in the control when compared with 5ppt,10ppt, 15ppt and 20ppt.Even though *Oreochromis niloticus* (Nile tilapia) is very sturdy fish, and tides over stressful environment conditions, salinity changes in this experimental setup caused changes in the respiration rate of the fish. So this study discloses how other less sturdy aquatic fauna could easily succumb to salinity change in their environment.

**Corresponding author: Email: drarunkurup@gmail.com;*

Applied Ecology and Environmental Sciences, 2021, Vol. 9, No. 11, 983-987
Available online at http://pubs.sciepub.com/aees/9/11/10
Published by Science and Education Publishing
DOI:10.12691/aees-9-11-10

Shampoos as a Mosquito Controller - A Preliminary Toxicity Study on Its Larvicidal Potential

Reemy Sara Mathai[1,2], A.U. Arun[3,*], Blessy V Rajan[2,4], Shalu Soman[2], Revathy R[2]

[1]Mar Thoma College for Women, Perumbavoor
[2]Nirmala College, Muvattupuzha
[3]St.Peter's College, Kolenchery
[4]St.Xavier's College, Vaikom
*Corresponding author: drarunkurup@gmail.com

Received October 11, 2021; Revised November 13, 2021; Accepted November 26, 2021

Abstract Mosquito Control is important to the community because of the vector potential that exists from mosquitoes in transmitting diseases and the annoyance factor in disrupting outdoor activities. The vector potential of mosquitoes stems from the female's bloodsucking habits. Various mosquito species are capable of transmitting malaria, dengue, yellow fever, filariasis, encephalitis, chikungunya, and Zika viruses and other diseases. Apart from being a nuisance to the public by affecting labor efficiency, depreciation of real estate values, and interference with outdoor activities, they also affect the health of livestock, pets, and wild animal population. Several techniques are used for mosquito control like chemical control, biological control, source reduction, environmental control, genetic control, traps and personal protection. Shampoos being regularly used, the effluent containing the same is being discharged into the open environment. The present study attempts to investigate the larvicidal effects of different shampoos (a means of chemical control) on mosquito larvae. Toxicity studies were carried out using the serial dilution method and LC_{50} was estimated for each of the shampoo type (Superia, Clinic Plus, Dove, Sunsilk) at 24h interval for five days. A comparison of the lethal effect of these shampoos at specific concentrations (0.1, 0.15, 0.2, 0.25, 0.3 and 0.4) was also done. The study reveals that Superia shampoo has the best larvicidal properties ($0.1mlL^{1}$) compared to Dove ($0.15ml\ L^{-1}$), Sunsilk ($0.15ml\ L^{-1}$) and Clinic Plus ($0.2ml\ L^{-1}$). The low LC_{50} value for a particular shampoo could be attributed to the special combination of ingredients used in its preparation which could be employed for mosquito control. An extensively used cosmetic product could be turned into an effective vector control product with further research in the area.

Keywords: *mosquito, larvicidal effect, shampoo, toxicity, vector control*

Cite This Article: Reemy Sara Mathai, A.U. Arun, Blessy V Rajan, Shalu Soman, and Revathy R, "Shampoos as a Mosquito Controller - A Preliminary Toxicity Study on Its Larvicidal Potential." *Applied Ecology and Environmental Sciences*, vol. 9, no. 11 (2021): 983-987. doi: 10.12691/aees-9-11-10.

1. Introduction

Mosquitoes constitute the most important single family of insects from the standpoint of human health. Due to their high potential to exploit even adverse environmental conditions, mosquitoes can rapidly increase their population [1]. Mosquitoes transmit more diseases than any other group of arthropods and affect millions throughout the world.

Approximately, half of the world's population is at risk of mosquito-borne diseases, with the highest-burden for socioeconomically disadvantaged populations. Urbanization, globalization, climate change, and land-use shifts have each contributed to the re-emergence and expansion of mosquito-borne diseases [2,3].

Mosquito borne diseases are prevalent in more than 100 countries across the world, infecting over 700,000,000 people every year globally and 40,000,000 of the Indian population. WHO has declared the mosquitoes as "public enemy number one" [4] as they act as a vector for most of the life-threatening diseases like malaria, yellow fever, dengue fever, chikungunya fever, filariasis, encephalitis, West Nile virus infection, Zika virus fever, etc., around the globe [5,6,7,8]. They not only can carry diseases that afflict humans, but also transmit several diseases and parasites to birds, dogs, horses, etc. [9] and contribute significantly to poverty and social debility in tropical countries [10]. Therefore, the control of mosquitoes is an important public health concern around the world.

To prevent proliferation of mosquito borne diseases and to improve quality of environment and public health, mosquito control is essential. Chemical, biological, physical, organic and genetic control measures have been employed to control the vector population [11]. Environmental management (through reduction or removal of mosquito breeding sites) is being used along with chemical or microbiological ovicides, larvicides, and pupicides. But these are only moderately effective, due to resistance arising from physiological (e.g., insecticide resistance) [12]

NJC

ROYAL SOCIETY OF CHEMISTRY

PAPER

View Article Online
View Journal

Cite this: DOI: 10.1039/d1nj02960f

Fabrication of ternary composites with polymeric carbon nitride/MoS_2/reduced graphene oxide ternary hybrid aerogel as high-performance electrode materials for supercapacitors†

Marilyn Mary Xavier,[ab] S. Mohanapriya,[c] Reshma Mathew,[a] Nayarassery N. Adarsh,[d] P. Radhakrishnan Nair[a] and Suresh Mathew *[ab]

Received 16th June 2021,
Accepted 10th October 2021

DOI: 10.1039/d1nj02960f

rsc.li/njc

Electrode materials for supercapacitors have been one of the crucial factors for the successful design of a renewable energy storage device. In this work, we present a bottom-up approach for the large-scale synthesis of three ternary hybrid aerogel nanocomposites, namely CMGA-1, CMGA-2 and CMGA-3, *via* the facile self-assembly of reduced graphene oxide (rGO), molybdenum disulfide (MoS_2) and polymeric carbon nitride nanosheets derived from urea (TE_UCN). The three composites differ from each other only in the content of TE_UCN, with TE_UCN wt% of 33%, 60% and 71.4%, respectively, for CMGA-1, CMGA-2 and CMGA-3. All three composites possess a large surface area with a hierarchical porous structure. The influence of the wt% of TE_UCN in these composites on the electrochemical performance of the electrode was investigated using charge–discharge curves. When used as the electrode for supercapacitors, the nanocomposites exhibit pseudocapacitive behavior in NaCl solution. Comparing the three nanocomposites investigated here, CMGA-3 showed the best electrochemical performance, with a specific capacitance of 467 F g^{-1} and the ability to retain up to 80.4% of this capacitance even after 2000 cycles, demonstrating good stability and improved cyclic performance. The excellent supercapacitance of CMGA-3 is due to its high surface area (Brunauer–Emmett–Teller surface area = 432.3 m^2 g^{-1}) and low equivalent series resistance of 3.24 Ω.

Introduction

We are facing serious environmental challenges such as global warming, climate change and air pollution due to the frenzied usage of fossil fuels.[1] Moreover, fossil fuel is facing a crisis, as it is non-renewable, and will be exhausted in due course. Thus, we need to explore green and alternative energy sources for our day-to-day life. Since energy storage plays such an important role in renewable energy generation, the development of high-performance energy storage devices is one of the top research priorities of material scientists.[2,3] On the other hand, we are witnessing unprecedented transformations in our lifestyle due to the invention and evolution of various mechanical, electronic and electrical gadgets, tools and products. These technological advancements have been followed by an increase in energy demand. Thus, in a nutshell, we need an alternative energy storage system that can not only meet our energy demands but also address the environmental challenges associated with non-renewable fossil fuels. In this context, supercapacitors (SCs) are promising and fascinating electrochemical energy storage devices owing to their high power density, rapid charge/discharge time, long cycle life, and minimal safety issues, accompanied by a simple configuration.[4–11] Low energy density and poor cycling stability are the major roadblocks to the implementation of SCs for practical applications. Among the various nanomaterials, two-dimensional (2D) nanosheets such as graphene,[12] reduced graphene oxide (rGO),[13] polymeric carbon nitride[14] and molybdenum disulphide (MoS_2)[15] have attracted the attention of material science researchers due to their high surface area, shortened ion transport and charge storage capability. Due to their large surface area, which enables complete access to surface active sites, high mechanical power, and mobility in the atomic scale dimension, 2D layered materials have recently become popular as electrodes for electrochemical capacitors.[16]

Graphene is an excellent 2D nanomaterial having unprecedented structural and functional features such as high surface

[a] *Advanced Molecular Materials Research Centre (AMMRC), Mahatma Gandhi University, Kottayam, 686560, Kerala, India. E-mail: sureshmathewmgu@gmail.com*
[b] *School of Chemical Sciences, Mahatma Gandhi University, Kottayam, 686560, Kerala, India*
[c] *CSIR-Central Electro Chemical Research Institute, College Road, Karaikudi, Tamil Nadu, 630003, India*
[d] *Chemistry and Biomolecular Science, Clarkson University, 8 Clarkson Ave., Potsdam, New York, 13699, USA*

† Electronic supplementary information (ESI) available. See DOI: 10.1039/d1nj02960f

ACS OMEGA

http://pubs.acs.org/journal/acsodf

Article

Organic Compound with Potential for X-ray Imaging Applications

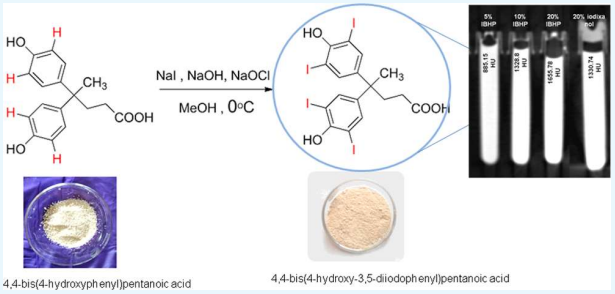
Gopika V. Gopan, K. Kezia Susan, Enakshy Rajan Jayadevan, and Roy Joseph*

Cite This: *ACS Omega* 2021, 6, 24826−24833

Read Online

ACCESS | Metrics & More | Article Recommendations

ABSTRACT: A radiopaque compound, namely, 4,4-bis(4-hydroxy-3,5-diiodophenyl)pentanoic acid, was synthesized by the electrophilic aromatic iodination of 4,4-bis(4-hydroxyphenyl)-pentanoic acid using sodium iodide and sodium hypochlorite. The active iodines created by hypochlorite were selectively bound to the ortho positions of the diphenolic acid and obtained a tetraiodo compound. Characterization of this iodinated compound was accomplished by routine methods such as Fourier transform infrared (FTIR) spectroscopy, ^{1}H nuclear magnetic resonance (NMR) spectroscopy, energy-dispersive X-ray spectroscopy, mass spectroscopy, UV−Vis spectroscopy, and thermogravimetry. The iodine content in the compound was as high as 64% by weight and therefore expected to possess substantial radiopacity. A 5% solution of the compound in dimethyl sulfoxide exhibited radiopacity of 885 ± 7 Hounsfield Units when tested with computed tomography (CT) scanner. In vitro cytotoxicity test performed using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay demonstrated that the compound was noncytotoxic to L929 fibroblast cells up to the level of 0.8 mg/mL concentration. Overall results indicate that this highly radiopaque compound has the potential to be used for X-ray imaging in the clinical scenario.



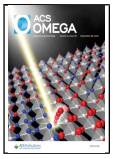
1. INTRODUCTION

Medical imaging plays a crucial role in the diagnosis and treatment of diseases. A myriad of reports in the literature indicates the importance of developing radiopaque compounds for imaging applications.[1−17] Radiopaque compounds along with some polymers find applications in imaging body organs,[2−9] detection or diagnosis of various diseases, monitoring embolization processes,[1,10,11] construction of implants used in surgery,[1,12,13] and dental compositions.[1,14] Lei et al. reported the development of a radiopaque thermoreversible hydrogel for preventing postoperative adhesions.[5] Recently, Wu et al. designed a macromolecular contrast agent with "ultrahigh radiopacity" through the polymerization of iodinated trimethylene carbonate monomer and poly(ethylene glycol).[8] Contrast agents used in diagnosis are radiopaque compounds, and they generally fall into two categories: ionic and nonionic.[18] The ionic compounds used for intravascular use have a high osmolarity.[19] This is responsible for several adverse effects such as pain, endothelial damage, thrombosis, etc. But nonionic compounds are less hyperosmolar solutions. However, they are expensive and exhibit a high rate of adverse events.

Compounds containing multiple iodine atoms, usually three per compound, have been used as radiopaque agents.[20−22] A high iodine concentration is used to achieve opacification around 250−300 Hounsfield units (HU) in the thoracic aorta and 300−350 HU in the coronary arteries.[23] The radiodensity of iodinated contrast is 25−30 (HU) per milligram of iodine per milliliter at a tube voltage of 100−200 kVp. This substituent is pharmacologically acceptable, which enables the compound to be administered to man or animal. These compounds were found to have sufficient tolerance to the human organ system also. For this purpose, nonionic structures have been suggested, i.e., iodobenzene derivatives possessing nonionic substituent. Iodination involves an electrophilic aromatic substitution in which aromatic constituents that have an electron-donating group can sufficiently activate the carbons on the ring. Therefore phenols, aniline derivatives, or alkyl aniline that contain OH, NH_2, or NHR constituents easily undergo iodination. There are different reported techniques for iodination. Edgar and Steinmetz reported an iodination technique for hydroxyl aromatic and amino aromatic compounds using metal iodide and metal hypochlorite.[24] Another technique using iodine monochloride was reported by Filimonov et al.[25]

Reporting new nontoxic compounds with a high level of radiopacity to the scientific literature would pave the way for

Received: July 12, 2021
Published: September 16, 2021



RNI No. APTEL/2003/12253

భావవీణ

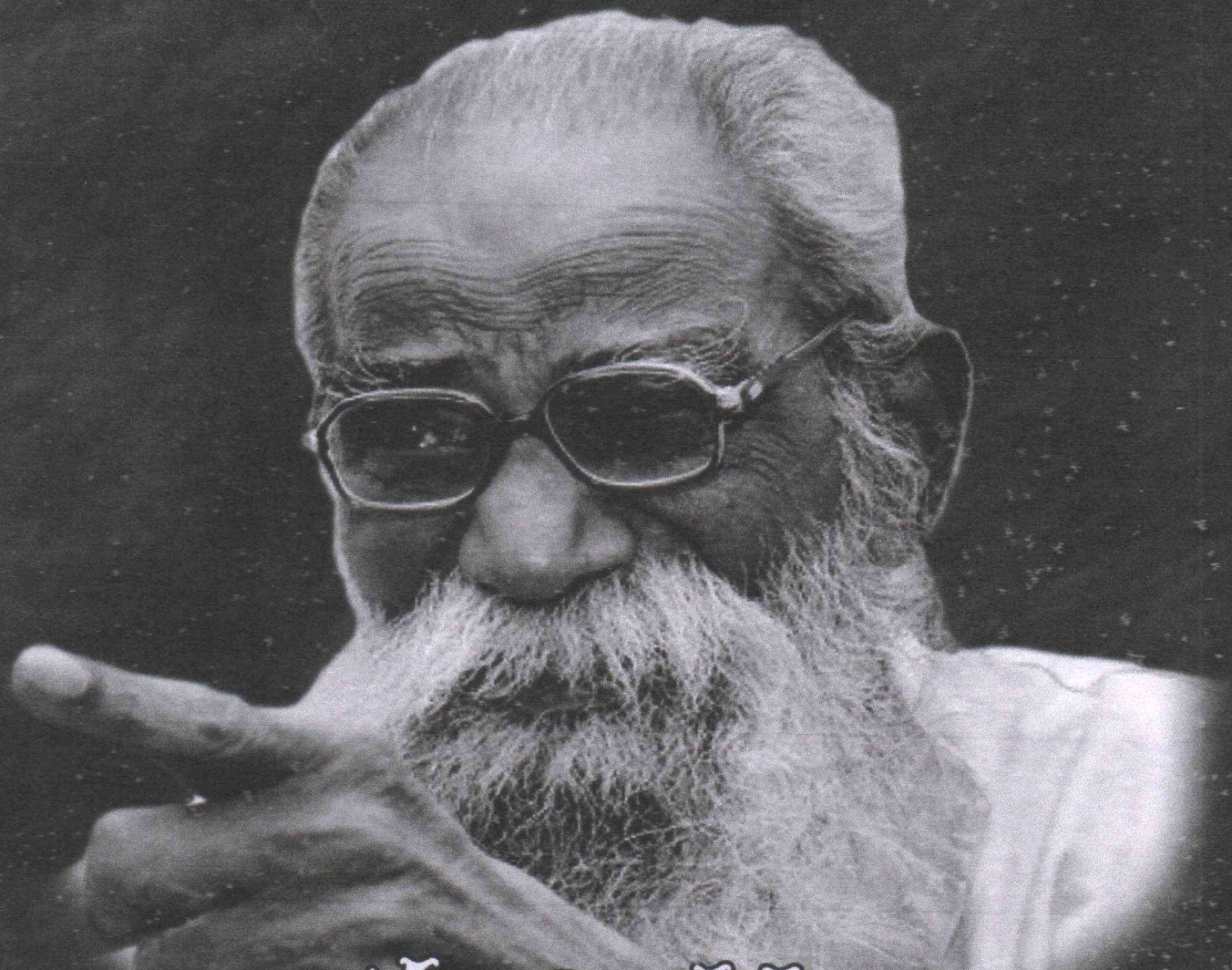
కళలు, సాహిత్య సాంస్కృతిక బహుభాషా త్రైమాసిక పత్రిక

ज्ञान-विज्ञान विमुक्तये
UGC
University Grants Commission
UGC Care List Group - 1
Journal Sl. No 34 under
Arts and Humanities
Category

BHAVA VEENA

Journal of Arts, Literary, Culture & Language Study

Vol : 18 Issue No. 7 Monthly July 2021 ISSN No. : 2456-4702 Rs. : 15/-



రావూరి భరద్వాజ

BHAVAVEENA
Vol. 18, Issue. 7, July 2021
ISSN No. : 2456-4702 - RNI No. APTEL/2003/12253
భావవీణ
UGC CARE List Group - 1 Journal
under Arts and Humanities Category

Contents (విషయ సూచిక)

BHAVAVEENA
Vol. 18, Issue. 7, July 2021
ISSN No. : 2456-4702 - RNI No. APTEL/2003/12253

భావవీణ

UGC CARE List Group - 1 Journal
under Arts and Humanities Category

Empire Drink and Beverage Culture : TEA

- Dr. Sebastian Joseph
Associate Professor and Research Guide, PG Dept. of History, UC College, Aluva, Eranakulam, Kerala.

- Jijo Jayaraj
Assistant Professor on Contract, PG Department of History, Pavanatma College, Murickassery, Idukki, Kerala.

Summary :

The tea History is one of the most memorable in the history of the world. The production and marketing of tea led to the imperialism. Many regions in Asia and Africa were colonized after the tea trade. Here is a look at the history of how tea was traded, marketed and how the plant tea became a tool of the empire around the world is inquired by the article.

Keywords : Tea, Medicine, Beverage, Tea culture, Tea Imperialism, Empire, Great Britain

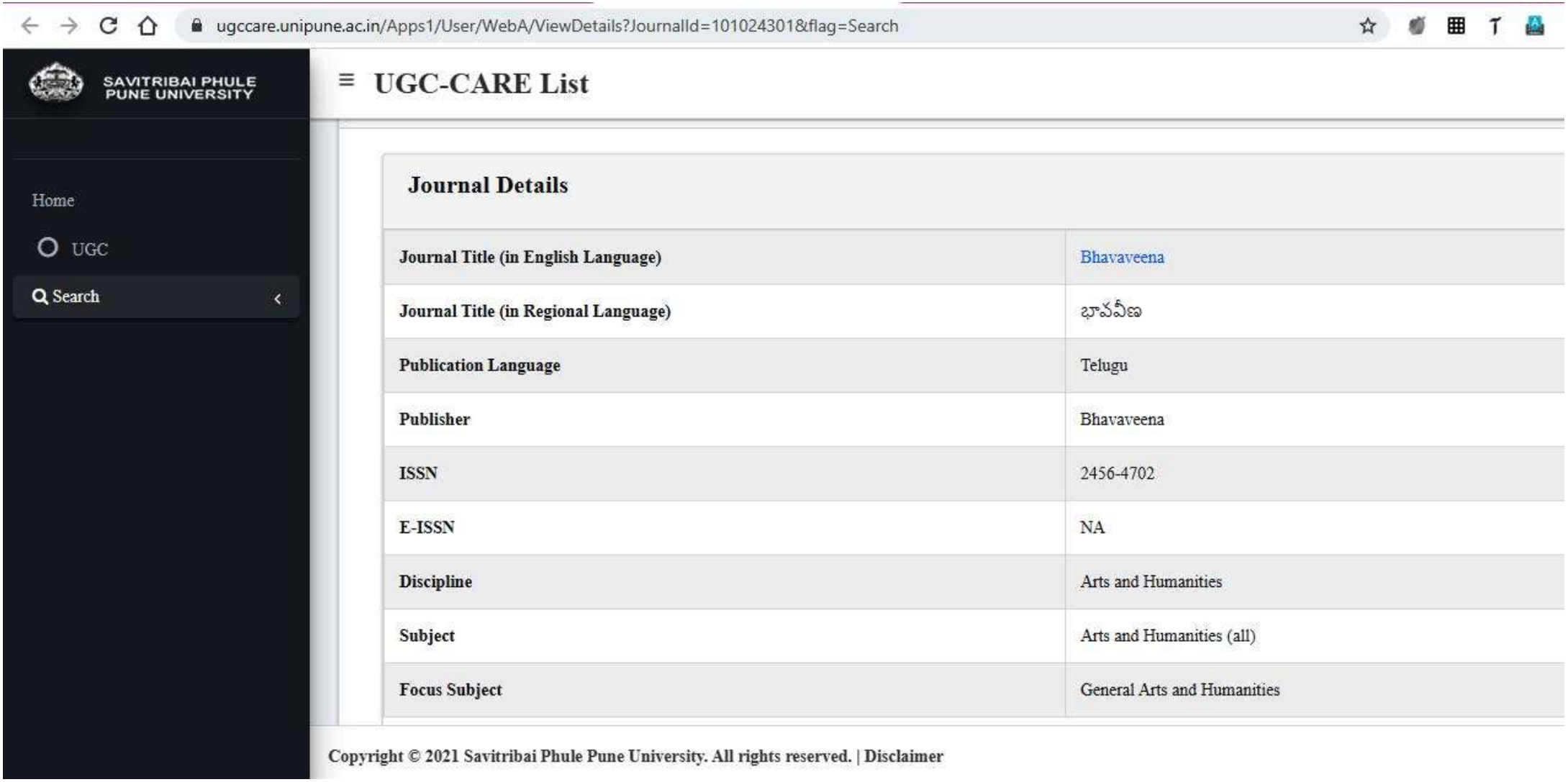
Introduction :

Tea as everyone knows is a global beverage now. Tea has got a unique history which has causated deep historical changes all around the world. There is no other drink that has changed the history of the world. The origin of the plant Tea is in China and the Chinese were the first to show the world the use of the tea. Thus the drink called tea came before the world and it was used as a medicine. But the tea trade was not first started by the Chinese but by the Portuguese. The tea business was then run by the East India Company. The drink quickly became popular throughout Europe as tea became popular. Tea shops have sprung up all over the Europe and tea has become part of a culture. As the famous Post Modern historian Habermas said, tea culture and the tea shops become a public space in Europe. The educated middleclass of Europe used to come to the tea shops and discussed and decided on things in general and political matters so that the tea shops in Europe as a public space.

But the turning point in history with regard to tea came with the passing of the Charter Act of 1833. With the Charter Act China stopped the monopoly trade with East India Company. This later became a milestone in the history of the world. The tea plant became a cause for imperialistic trade. After the industrial revolution there were many wealthy families in Europe. It was an opportunity for them to invest in many colonies and make profit. The charter Act gave every citizen the right to invest in any British colony. In this way tea production began around the world and thus colonized the world. This imperialism spread in India as well as in other parts of the world. Alfred Crosby calls this imperialization through a plant as 'plant imperialism'.

Origin of Tea - The History :

The tea, camellia has been known to man for a long time. It has been cultivated by the Chinese people for more than two thousand years. It has been cultivated by the Chinese people not on large plantations, but in thousands of small plots. Thus the Chinese were well familiar with the tea plant and its value. The origin of the word 'tea' goes to China. The Chinese call it as 'kia'. As far as it is known, it was during the course of the 6th Century AD that the name evolved to 'cha'. When it arrived


ugccare.unipune.ac.in/Apps1/User/WebA/ViewDetails?JournalId=101024301&flag=Search
SAVITRIBAI PHULE PUNE UNIVERSITY
UGC-CARE List
Home
UGC
Search
Journal Details
Journal Title (in English Language) Bhavaveena
Journal Title (in Regional Language) భావవీణ
Publication Language Telugu
Publisher Bhavaveena
ISSN 2456-4702
E-ISSN NA
Discipline Arts and Humanities
Subject Arts and Humanities (all)
Focus Subject General Arts and Humanities
Copyright © 2021 Savitribai Phule Pune University. All rights reserved. | Disclaimer

ISSN - 2348-2397
APPROVED UGC CARE

SHODH SARITA

SHODH SARITA
Vol. 7, Issue 25 (II), January-March, 2020
Page Nos. 166-170

AN INTERNATIONAL BILINGUAL PEER REVIEWED REFEREED RESEARCH JOURNAL

THE ARCHIVED EMPIRE

Records Mirroring Planter Capitalism in Travancore

Dr. Sebastian Joseph*
Jijo Jayaraj**

ABSTRACT

The archival records on the high ranges of Munnar give not only the history of that region but also the nature and intend of the colonizer. The plantation industry became a land mark in the history of this remote region of the then princely state called Travancore. The region got transformed with the coming of the planters from Europe. It was through this process that a new record making and history making started in the area. The plantation records created by the plantation company and the British government reveals how they seen the landscape and natural resources of the region. Thus we can see that the records speak not only the government rationality but also points to a hidden meaning of imperializing a region for the sake of the European capitalists. The expectations of the European market was fulfilled by the returns from this tiny area. Department reports especially of the revenue and forest departments that figuratively project the exact utility of the land, the forested lands on the native hills. Thus the records itself become the manifestations of imperialism.

Keywords : Munnar, Plantation, Hill station, High ranges, Sources, Records, Archives, Colony, Concession, Resource, Tea, Crop

Introduction

Reconfiguration and conversion of lands under the control of the native government was an important priority of the British for making profit through the expansion of plantation system. Imperative was the demands of the colonial government and industrial capitalists, that led to the creation of a welter of records that attest the will of the Empire. A variety of documents like land surveys, travel accounts, departmental files especially revenue and forest, plantation files and files on infrastructural developments collectively implicate the urges of an industrially developed country on the native landscape. Tea, Cinchona and Coffee plantations opened and managed by the European planters produced records that on a parallel plane expose the exploitative nature of the colonial government and their hunger for land resources and its control.

Documents on the Forest Department and its Working

Right from the times of the creation of the Travancore Forest Department in 1860 a new genre of records were in the making that points to the control of the native state over its forest resources and the concomitant control exercised by the reformer regime under the Colonial tutelage. Following the creation of the department a series of forest regulations were enacted for regulating the use of the pasturage and the natural resources within the reserved forest. There is a plethora of records coming under this rubric of Regulations and Forest Rules. According to one such forest rules "the lands at the disposal of the Government may for the purpose of these rules be classed as follows; (a). lands of which the government has acquired the ownership or possession by purchase, lease or otherwise., (b). asessed unoccupied lands, unoccupied and un assessed lands, that is waste lands which are un assessed and un surveyed for

*Assistant Professor and Research Guide in History, P. G Department and Research Centre in History, UC College, Aluva, Eranakulam, Kerala, 683102
**PhD Scholar - P. G Department and Research Centre in History, UC College, Aluva, Eranakulam, Kerala, 683102

purpose of revenue, d. occupied but un asessed lands."

Topographical Survey of Travancore

Travels and explorations in colonial India conducted by the botanists and the forest officials during the early periods of the company rule and colonial governance found its expression in Travancore also. The colonial gaze through the surveys and reports later reflected in the control and utilization of the forest resources of the region. It was through these processes that the colonial government brought forest management plans and later reservation acts and curtailed the rights of the local population especially of the adivasis living in the forest areas. This urge was reflected in letters of correspondence and in one instance it was advocated by a government revenue official in these words, "in order to prepare a proper record of the settlement arrived at, it will be necessary to carry out a topographical survey of the country on either side of the line and prepare proper maps showing the distinctive features in the neighbourhood. In accordance with the general orders under which this department is working, the opportunity will be taken of extending the topographical survey on the British side to Madurai, Coimbatore and Tinnevely, thus including a large extent of zamindars and forest tracts and completing the data for the preparation of maps of the whole of the British territory in that part of the Indian peninsula."

Records on the Colonial Hunt

The planters who came to the hill ranges suffered from loneliness as they were living in miles away and aloof from their family and friends in an unknown remote corner of a jungle. Hunting was regarded as an activity in taming the hostile wild and showing the valour of the European planter/hunter. The politics behind this sport was assertion of superiority of the White hunter before the native and thereby establishing a hegemonic clout. The records including the shooting permit, game laws, auction sale of the skins, horns of the animals, elephant tusk kudivila etc., are available. The game laws have been amended and shooting permits were issued infavour of the planters. For instance there was a request from HD Deane seeking permission to shoot in the Periyar valley, "in an extract of Mr. Dean's letter received from the S. R section, he seeks permission to shoot an elephant with his son John Drummond Deane in February and March next in the reserve round the Periyar dam."Rights were given to the foreign to import fire arms to resist the attack of the wild animals. Especially there was a large scale attack from the wild dogs and the government issued orders to resist the attack by announcing reward for the killing of the wild dogs. "I beg to inform you that His Highness the Maharajah is pleased to sanction the reward for the wild dogs killed in the high range and the reward for the wild dog skin of which is produced before the Tahsildar being increased from Rs. Five to Rs. Seven per head."

Colonial Forest Reports as Seeds of Environmental Governance

The *High Ranges of Travancore* written by J. D Munro one of the earliest European planters makes it explicit the industrial urge of the colonizer. This report opens the official vista of the imperial planter world and considered as the Bible of the White planters. This is an official report submitted to the Travancore state on 8th March 1877 after detailed survey undertaken by Munro in the hills for demarcating the boundary dispute between the Travancore state and the Madras Presidency.. It discusses geographical features to anthropological and biological features of the hills. It was J. D Munro one among the few British officials who foregone the commercial viabilities of the hills. In the beginning of the report itself he argues that, "there is a great deal of swamp land in this valley which might be brought in to cultivation". Munro in his report describes the peaks, its features and height. He finds the view of Anaimudi and Currincolam as grand. Though small in size, the report is a crucial reference point for understanding land reconfiguration in Travancore.

Files on Application for the Acquisition of Land by the Foreigners

Plenty of records are available on the acquisition of land in the Kannan Devan Hills by the Europeans for the plantations. After Kannan Devan Concession of 1877 and 1879 there was tremendous increase in the extent of plantations. The demand for the land further increased during the 1890s to 1920s and plenty of land suitable for agriculture had been leased out to the European planters. Planters hunger for land was visible in their applications

APPROVED UGC CARE ISSN - 2348 - 2397

SHODH SARITA

JOURNAL OF ARTS, HUMANITIES AND SOCIAL SCIENCES

AN INTERNATIONAL MULTIDISCIPILANARY QUARTERLY BILINGUAL
PEER REVIEWED REFEREED RESEARCH JOURNAL

Certificate of Publication

Dr. Sebastian Joseph
Assistant Professor and Research Guide in History
P. G Department and Research Centre in History
UC College, Aluva, Eranakulam, Kerala, 683102
Jijo Jayaraj
PhD Scholar
P. G Department and Research Centre in History
UC College, Aluva, Eranakulam, Kerala, 683102

TITLE OF RESEARCH PAPER

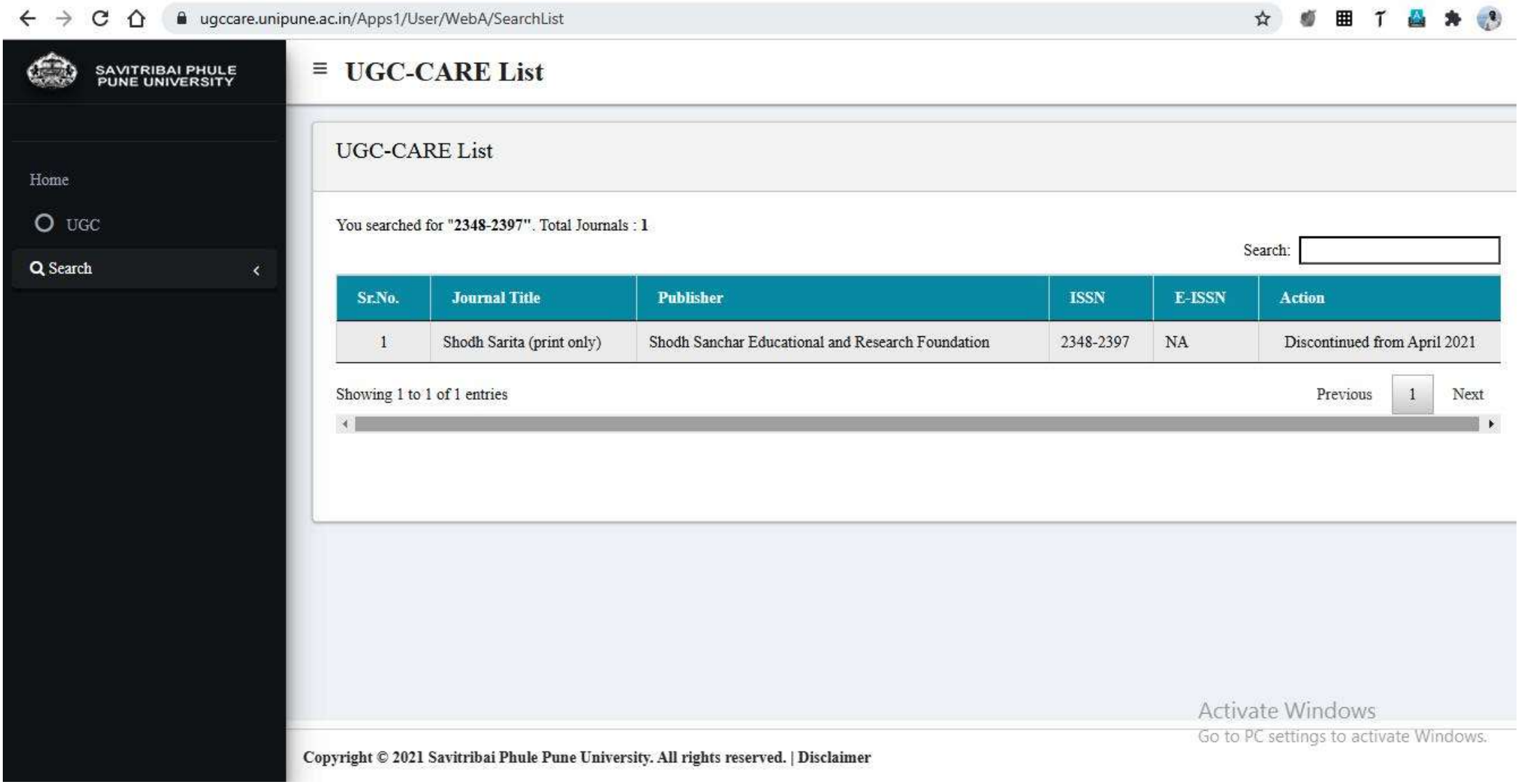
THE ARCHIVED EMPIRE
Records Mirroring Planter Capitalism in Travancore

This is certified that your research paper has been published in
Shodh Sarita, Volume 7 Issue 25 (II) January to March 2020

Date : 25-04-2020

SHODH SARITA
Editor in Chief

CHIEF EDITORIAL OFFICE
448 /119/76, KALYANPURI THAKURGANJ, CHOWK, LUCKNOW -226003 U.P.,
Cell.: 09415578129, 09415141368, 09161456922 | E-mail : dr.vinaysharma123@gmail.com
Website : http://www.seresearchfoundation.in | http://www.seresearchfoundation.in/shodhsarita


ugccare.unipune.ac.in/Apps1/User/WebA/SearchList
SAVITRIBAI PHULE PUNE UNIVERSITY
UGC-CARE List
Home
UGC
Search
UGC-CARE List
You searched for "2348-2397". Total Journals : 1
Search:
Sr.No. | Journal Title | Publisher | ISSN | E-ISSN | Action
1 | Shodh Sarita (print only) | Shodh Sanchar Educational and Research Foundation | 2348-2397 | NA | Discontinued from April 2021
Showing 1 to 1 of 1 entries
Previous 1 Next
Activate Windows
Go to PC settings to activate Windows.
Copyright © 2021 Savitribai Phule Pune University. All rights reserved. | Disclaimer

Materials Chemistry and Physics 242 (2020) 122506

Contents lists available at ScienceDirect

Materials Chemistry and Physics

journal homepage: www.elsevier.com/locate/matchemphys

Electrical conductivity tuning in p-type transparent conducting $AgGaO_2$ and in quaternary $AgInGaO_2$ thin films

Keerthi K [a], Hilal Rahman [a], Rajani Jacob [b], Benoy M. D [c], Rachel Reena Philip [a,*]

[a] Thin Film Research Lab, U.C. College, Aluva, Kerala, India
[b] Department of Physics, Mar Thoma College, Perumbavoor, Kerala, India
[c] Department of Physics, Mar Athanasius College, Kothamangalam, Kerala, India

HIGHLIGHTS

- This is the first report seen in literature on $AgInGaO_2$.
- Band gap and electrical conductivity tuning by compositional variations.
- Three orders magnitude increase in electrical conductivity by quaternary formation.

ARTICLE INFO

Keywords:
Transparent conducting oxides
Optical properties
Electrical properties
Amorphous films
Crystalline films

ABSTRACT

We report tuning of electrical conductivity in a wide range from 10^{-2} to 10^{+3} S/m in p-type transparent conducting thin films of silver gallium oxide and in the quaternary films of silver indium gallium oxide. The conductivity tailoring is correlated with changes in carrier concentration and mobility induced by compositional variations and indium incorporation. The achievement of crystallization of the films at a temperature ~623 ± 5 K, the lowest temperature of crystallization for AGO so far reported, enhances the technological importance of the study. Tuning of optical band gap from 3.62 eV to 3.77 eV for AIGO and 3.98 eV–4.01 eV for AGO is realized by adjusting the composition.

1. Introduction

Transparent conducting oxides (TCOs) have broad applications in transparent electronic devices such as light emitting diodes, liquid crystals, touch screen displays, solar cells, glass window coatings etc [1–3]. Till 1997, only n-type TCOs were known and scientists have been in search of a p-type transparent conducting material for transparent electronic applications. The delafossite $CuAlO_2$ is the first p-type TCO that has been prepared and ever since, research on delafossites have been intensified [4]. Delafossites are a group of I-III-VI TCOs having ABO_2 structure that have been attracting wide research interest in the recent years because of their exceptional properties of good optical transmittance, tunable electrical conductivity and bipolarity. The bipolarity is due to their particular layered structure which offers two different conduction paths for electrons and holes. O–A–O dumbbell layer is considered as an easy path for holes and the edge sharing octahedral BO_6 layer for electrons [5–9]. Various Ag based delafossites reported in literature are $AgInO_2$, $AgGaO_2$, $AgScO_2$, $AgFeO_2$, $AgCrO_2$, $AgAlO_2$ and $AgYO_2$ [10–12]. Of these, $AgGaO_2$ exhibit properties like visible light transparency, moderate conductivity, wide optical band gap and photocatalytic activity that could find applications in Transparent Electronics, Gas sensing, Photocatalysis, DSSCs etc [5,12]. However some major drawbacks that have been limiting its applications are the poor electrical conductivity and the high energy budget due to requirement of substrate temperatures above 773 K for their preparation [13].

Here, we report preparation of thin films of amorphous and delafossite crystalline $AgGaO_2$ and $AgInGaO_2$ of p-type polarity by two different methods: plasma assisted reactive evaporation and vacuum evaporation followed by post air annealing. Apart from the fact that this is the first report on p-type amorphous $AgGaO_2$ as well as on amorphous and crystalline $AgInGaO_2$, one interesting observation is that here crystalline delafossite formation is achieved at a temperature ~623 ± 5 K which is much lower than so far reported by other authors. The latter offers the possibility of avoiding expensive substrates like quartz for the film deposition and hence makes the method more cost effective.

* Corresponding author.
E-mail address: reenatara@gmail.com (R.R. Philip).

https://doi.org/10.1016/j.matchemphys.2019.122506
Received 30 November 2018; Received in revised form 29 July 2019; Accepted 29 November 2019
Available online 29 November 2019

Journal of Cosmology and Astroparticle Physics
An IOP and SISSA journal

A new class of non-canonical conformal attractors for multi-field inflation

Tony Pinhero and Supratik Pal

Physics and Applied Mathematics Unit, Indian Statistical Institute,
203 B.T. Road, Kolkata 700 108, India

E-mail: tonypinheiro2222@gmail.com, supratik@isical.ac.in

Received January 11, 2020
Accepted February 13, 2020
Published March 9, 2020

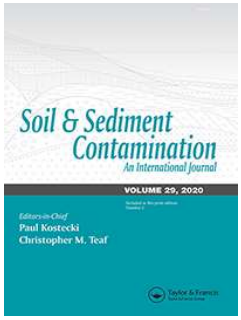
Abstract. We propose a new broad class of multi-field non-canonical inflationary models as an extension of multi-field conformal cosmological attractors. This also generalizes the recently discovered class of non-canonical conformal attractors for single field inflation. Kinetic terms of this class of models are phenomenologically arising from $\mathcal{N} = 1$ supergravity and from $\mathcal{N} = 1$ superconformal theory, with two conformal scalar compensator fields in the latter. We show that the inflationary dynamics and predictions of this class of models are stable with respect to the significant modification of both radial and angular part of the potential, but it is very sensitive to its minuscule modification in the geometry of the field space metric. We also show that our framework can pass the latest observational constraints set by Planck 2018.

Keywords: inflation, cosmology of theories beyond the SM, physics of the early universe, supersymmetry and cosmology

ArXiv ePrint: 1810.12712

https://doi.org/10.1088/1475-7516/2020/03/022

JCAP03(2020)022



Soil and Sediment Contamination: An International Journal

ISSN: 1532-0383 (Print) 1549-7887 (Online) Journal homepage: https://www.tandfonline.com/loi/bssc20

Spatial Distribution and Contamination Assessment of Trace Metals in the Coral Reef Sediments of Kavaratti Island in Lakshadweep Archipelago, Indian Ocean

Anu Joy, P P Anoop, R Rajesh, Angel Mathew & Anu Gopinath

To cite this article: Anu Joy, P P Anoop, R Rajesh, Angel Mathew & Anu Gopinath (2020) Spatial Distribution and Contamination Assessment of Trace Metals in the Coral Reef Sediments of Kavaratti Island in Lakshadweep Archipelago, Indian Ocean, Soil and Sediment Contamination: An International Journal, 29:2, 209-231, DOI: 10.1080/15320383.2019.1699899

To link to this article: https://doi.org/10.1080/15320383.2019.1699899

Published online: 09 Dec 2019.

SOIL AND SEDIMENT CONTAMINATION
2020, VOL. 29, NO. 2, 209–231
https://doi.org/10.1080/15320383.2019.1699899

Taylor & Francis
Taylor & Francis Group

Spatial Distribution and Contamination Assessment of Trace Metals in the Coral Reef Sediments of Kavaratti Island in Lakshadweep Archipelago, Indian Ocean

Anu Joy[a], P P Anoop[a], R Rajesh[a], Angel Mathew[b], and Anu Gopinath[c]

[a]Department of Chemistry and Research Centre, St Albert's College, Ernakulam, India; [b]Department of Statistics, Maharaja's College, Ernakulam, India; [c]Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

ABSTRACT

Surficial coral reef sediments collected from 17 sampling stations (shore, lagoons, and outer lagoons) of Kavaratti, Island belonging to Lakshadweep Archipelago were analyzed for trace metal concentration, total organic carbon and sediment grain size composition. The predominant grain size constituent of sediments from the sampling stations was medium sand with low organic carbon content. Except Cd and Pb, all the other trace metals selected for the study were below their global average shale concentration. The sediment contamination was assessed on the basis of geochemical and ecological risk indices. Considerable contamination and significantly high ecological risk were reported from all stations and the serious threat was from Cadmium. Diesel-based power generation, untreated sewage, activities related to shipping, fishing, agriculture, and tourism are the main anthropogenic sources contributing to trace metal pollution in Kavaratti. Statistical analysis of the data also supported the anthropogenic sources of origin of trace metals.

KEYWORDS

Coral reef sediments; spatial analysis; trace metal; contamination assessment; anthropogenic sources

Introduction

Trace metals are one of the most abundant classes of contaminants generated and are continuing to be introduced to the aquatic system, thereby create a real hazardous situation for marine ecosystems and organisms health. These are deemed serious pollutants because of toxicity, persistence, and non-biodegradability in the environment (Pekey 2006). Although metals are natural constituents of the earth's crust and are present in all ecosystems, their concentrations have been dramatically increased by human activities (Alkan et al. 2015). The main sources of trace elements are natural activities such as volcanic eruptions and soil erosion, and human activities such as industrial production, waste disposal, the discharge of contaminated wastewater, the inappropriate management of electronic waste (e-waste), and the application of fertilizers in agriculture (Joy et al. 2019a; Sardar et al. 2013; Wang and Björn 2014; Worakhunpiset 2018).

Marine sediments can act as potential sinks and provenance of pollutants and contaminants in the aquatic environment because of their set up of variable lithogenic, mineralogical and chemical properties. In aquatic environments, many metals are

CONTACT Anu Gopinath dranugopinath@gmail.com Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/bssc.

Marine Pollution Bulletin 158 (2020) 111409

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Baseline

Geochemical fractionation of trace elements in the coral reef sediments of the Lakshadweep Archipelago, Indian Ocean

Anu Joy[a], P.P. Anoop[a], R. Rajesh[a], Jose Mathew[a], Angel Mathew[b], Anu Gopinath[c,*]

[a] Department of Chemistry and Research Centre, St Albert's College, Ernakulam, India
[b] Department of Statistics, Maharaja's College, Ernakulam, India
[c] Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

ARTICLE INFO

Keywords:
Coral reef sediments
Fractionation
Trace elements
Risk assessment code
Contamination factor

ABSTRACT

Geochemical fractionation of seven trace elements (Cr, Mn, Fe, Cu, Zn, Cd, and Pb) was investigated in the surficial coral reef sediments of three inhabited islands (Kavaratti, Kadmat, and Agatti) belonging to the Lakshadweep Archipelago. The observations indicated that the metals showed their highest contents in the residual fraction of geological origin. The extent of risk, bioavailability, and contamination of trace elements was assessed by risk assessment codes and contamination factors. Based on the results, medium potential adverse effects were observed in the sediments of Kavaratti and Agatti. The concentration of Cd in the exchangeable and carbonate-bound fractions was above its global average shale value in the sediments of Kavaratti and Agatti, suggesting its high mobility and bioavailability and thus an environmental threat to the coral reef ecosystem.

Sediments constitute reservoirs of bioavailable trace elements which act as micronutrients but can also have toxic effects and cause perturbations to the ecosystem (Gleyzes et al., 2002). In sediments, metals can be present in various chemical forms and generally exhibit different physical and chemical behaviours such as migration behaviour, chemical interactions, biological availability, and potential toxicity (Youcef et al., 2004). All the species of a particular metal do not have the same impacts on the ecosystem (Tessier et al., 1979). The potential toxicity of trace metals in sediment is a function of their mobility and bioavailability, which depends on the phase of the metals and the chemical and physical processes that govern transformations between phases (Wali et al., 2014). However, the sole criterion of total metal concentration does not provide enough information to understand their various forms, mobility, bioavailability, or potential risks to the environment (Davutluoglu et al., 2011; Nemati et al., 2011) and may not be able to reflect the physical and chemical behaviours of metals in the environment (Equeenuddin and Pattnaik, 2017; Jafarabadi et al., 2018). The sequential extraction procedure allowed the determination of the distribution of trace elements between the different geochemical fractions, reflecting the relative proportions of each metal transported by different chemical mechanisms (Passos et al., 2011; Sundaray et al., 2011) and assessing how intensely these elements are bound to the sediment (Lee et al., 2017). Hence, this is a valuable tool for assessing the long-term negative impacts of metals from sediment (Lee et al., 2017; Zhang et al., 2017; Jafarabadi et al., 2018).

Lakshadweep is a tropical archipelago of coral islands, scattered in the Arabian Sea (8°–12°N latitude and 71°–74°E longitude) off the south-western coast of India. It consists of 36 tiny coral islands with a total surface area of 32 km^2. It has a lagoon area of 4200 km^2, with 20,000 km^2 territorial water and 4,00,000 km^2 of Exclusive Economic Zone. According to a 2011 census, Lakshadweep has a total population of 64,429 in ten inhabited islands with a population density of 2013 persons per km^2, being one of the highest in India (LAPCC, 2012). The coral reefs enclose the islands in extensive lagoons and protect them from storm damage and other ravages of the sea (Joy et al., 2019). Because coral reefs provide food, income, employment, shelter, and protection, the livelihood of the islanders of the Lakshadweep Archipelago is greatly dependent on them. Human developmental activities have increased in Lakshadweep in recent decades due to an increase in living standards and technology. The present study focuses on the different chemical fractions of seven trace elements (Cr, Mn, Fe, Cu, Zn, Cd, and Pb) in the surficial coral reef sediments of three inhabited islands – Kavaratti, Kadmat, and Agatti belonging to the Lakshadweep Archipelago. The study also assesses the mobility of the metals in order to identify the extent of risk and contamination level of the sediment and to delineate the contributing sources of the trace elements in reef sediments. Because metal fractionation studies in Lakshadweep are limited, the present study will differentiate between the residual metals (natural background) and non-residual ones (man-made sources of pollution).

* Corresponding author.
E-mail address: dranugopinath@gmail.com (A. Gopinath).

https://doi.org/10.1016/j.marpolbul.2020.111409
Received 9 January 2020; Received in revised form 16 June 2020; Accepted 24 June 2020

PUBLICATION CERTIFICATE

This publication certificate has been issued to

JIJO JAYARAJ

For publication of research paper titled

COLONIAL MAKING OF MUNNAR: LOCAL HISTORY

Published in

Studies in Indian Place Names (SIPN) [ISSN 2394-3114]

Vol:*40* **issue:** *81* **Month:** *March* **Year:** *2020*

Impact factor:*6.1*

The journal is indexed, peer reviewed and listed in UGC care in March 2020

Editor

SM Murthy

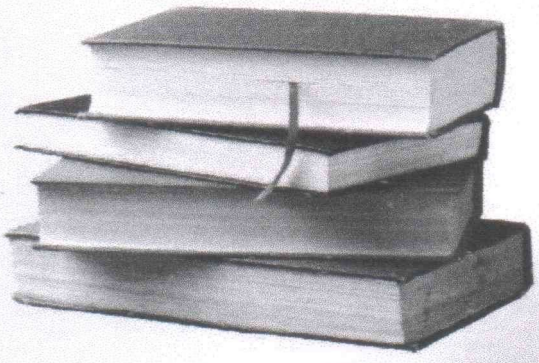
Studies in Indian Place Names (SIPN) [ISSN 2394-3114]

Published by: The Place Names Society

Note: This eCertificate is valid with published papers and the paper must be available online at https://archives.tpnsindia.org//

$html = '';

Studies in Indian Place Names (SIPN) with ISSN 2394-3114



Studies in Indian Place Names (SIPN) with ISSN 2394-3114 is UGC Care listed journal for research publication. SIPN considers review and research articles related to Social Science and Humanities: Arts and Humanities, Physical Education, Library Science, History, Anthropology, Management, Commerce, Home Science, Sociology, Hotel Management, Tourism, Mass Communication, Accounting, Education, Economics, Law, Philosophy, Finance, Political Science, Visual Arts, Performing Arts, English, Science: Engineering (All Branches), Psychology, and Architecture, Geography and Geology, Agricultural, Biological Sciences, Environmental Science, Ecology, Archaeology, Biodiversity and Conservation, Entomology, Health Science: Medicine and Dentistry, Nursing and Allied Health Science, Ayurveda. On behalf of Studies in Indian Place Names, I would like to extend my regard to all fellow researchers and scholars and wish prosperity in their field. Published by: The Place Names Society of India, NPS India

Send papers for publication to editor@tpnsindia.org

ISSN 2394-3114

An International Registered & Refereed Monthly Research Journal

Studies in Indian Place Names

UGC Approved Journal

UGC Care Journal

The Place Names Society of India

TPNS India

ISSN NO : 2394-3114
Vol No : 40 Issue No : 81

Colonial Making of Munnar: Local History

Jijo Jayaraj
PhD Scholar, UC College
Aluva, Eranakulam, Kerala - 683102

INTRODUCTION

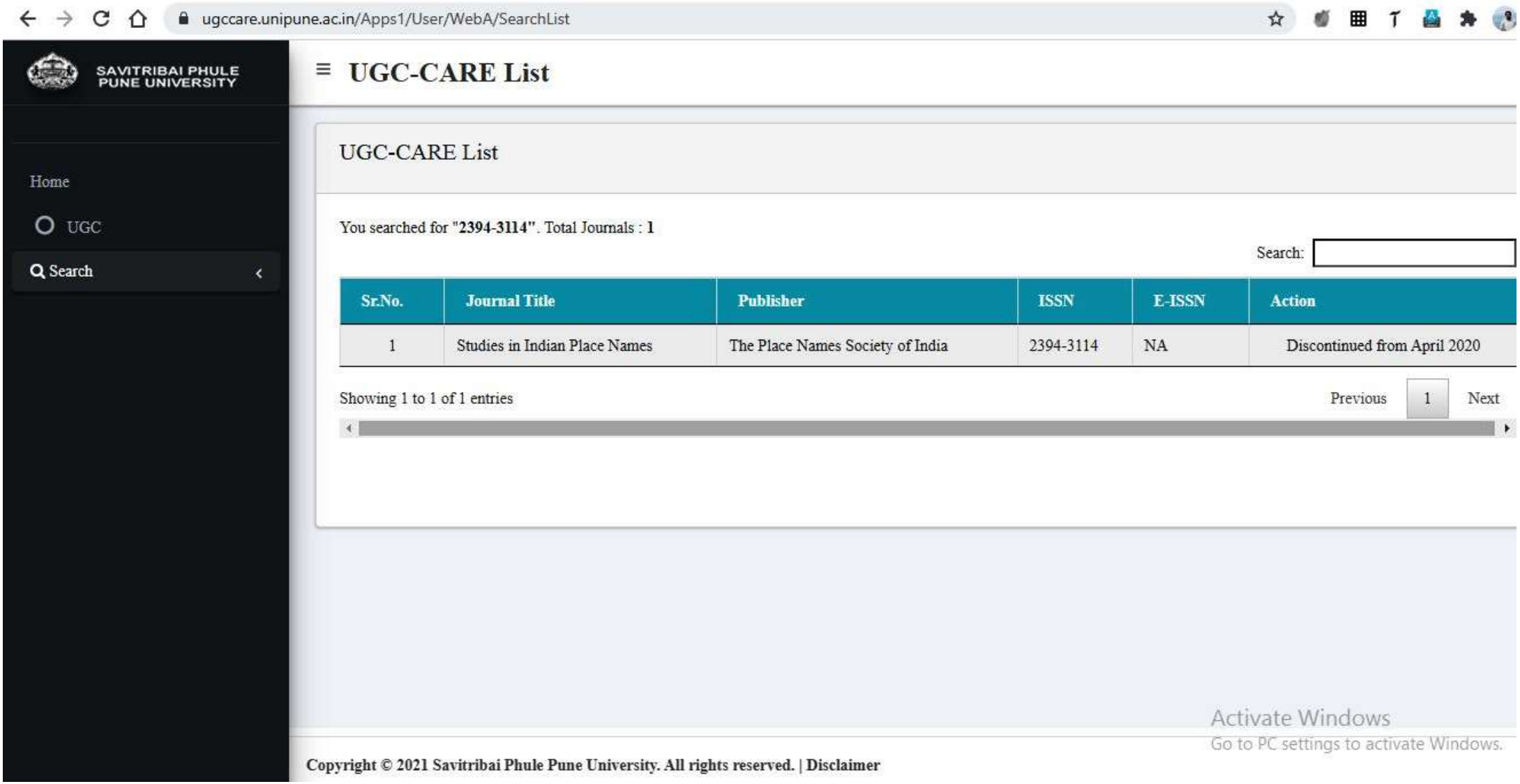
Munnar the confluence of three rivers, Kannimala, Kundale and Nallathanni was once the abode of rogue wild animals. These hills earlier known as Kannan Devan Hills had a different story to reveal. These wild spaces with its variety of flora, fauna, and all above the primitive men 'Muduvars' and their unique customs remained undisturbed and un destroyed for many centuries.Munnar is located at the north-eastern side of Idukki District of Kerala bordering Tamil Nadu. These high ranges are situated on the southern slopes of the Western ghats. The area under study 'Munnar' derived its name as it is situated at a place where the three rivers Nallathanni, Kannimalai, and Kundala join as a confluence. The Nallathanniriver begins from Nallathanni and flows towards north-east direction and joins Muthirapuzha river at Munnar and flows down to join periyar river at Panamkutty. The second river Kannimalariver originates from Aneimudi reserve forest and flows eastward to join Muthirapuzha at Munnar. The third river Kundala originates from the Top Station and flows westward to Kundala dam reservoir and finally to Munnar and join with Nallathanni and Kannimala. Thus the three rivers Kannimala, Nallathanni and Kundalariver originates in the Kannan Devan Hills have their confluence at Munnar town and flow down towards Periyar as Muthirapuzha river. The course of the river is westward.

Floristic and Faunistic Features of Munnar

Munnar is unique for the ecological and biological features and diversities. The high elevation helped the area to receive heavy rain from south-west and north-east monsoons. The estates in the high ranges are clustered around the town of Munnar. It is situated between 76° 52'30'' and 77° 15' east longitude and between 9° 52' and 10° 10' latitude. The whole area is hilly in character. The hill slopes from north-east to south-west direction. There are numerous ridges in various directions. These ridges with an extensive high elevation up to the Palani hills or the Kodaikanal hills.Aneimudi (Elephants fore head) (2695 M) in Munnar is the highest peak in South India, which is located in the boundary between Eravikulam National Park and Munnar division. The second highest peak in the hill is the 'Meesapulimala' with an altitude of 2637 M.

Geologically the area is part of the archane system. The rocks represented by charnockite, granite, silimanite and magnalities. There are four types of soil in this tract; it includes laterite soil, with yellowish brown colour. The soil is rich in hydroxides or iron and aluminium. But the soil has low fertility and contains fair amount of organic matter. Only a few species live in this kind of soil. The alluvial soil is the other type found on the banks of the rivers and streams. It is rich and is supplemented with organic matters including deposits of aluminium. This fertile soil on the river and stream banks supports a good tree growth.

Floristically it was one of the richest areas in the country. There is not less than three thousand and five hundred species of trees with different age and girths are seen. These forests were once dense and evergreen. The evergreen species diversity was the peculiarity of


ugccare.unipune.ac.in/Apps1/User/WebA/SearchList
SAVITRIBAI PHULE PUNE UNIVERSITY
UGC-CARE List
Home
UGC
Search
UGC-CARE List
You searched for "2394-3114". Total Journals : 1
Search:
Sr.No. | Journal Title | Publisher | ISSN | E-ISSN | Action
1 | Studies in Indian Place Names | The Place Names Society of India | 2394-3114 | NA | Discontinued from April 2020
Showing 1 to 1 of 1 entries
Previous 1 Next
Activate Windows
Go to PC settings to activate Windows.
Copyright © 2021 Savitribai Phule Pune University. All rights reserved. | Disclaimer

PUBLICATION CERTIFICATE

This publication certificate has been issued to

Jijo Jayaraj and Dr. Sebastian Joseph

For publication of research paper titled

Native Labour and the Making of European plantations in Colonial India: Perspectives from Travancore

Published in

Studies in Indian Place Names with ISSN no. 2394-3114

Vol:*40* **issue:** *60* **Month:** *March* **Year:** *2020*

Impact factor:*6.3*

The journal is indexed, peer reviewed and listed in UGC Care

Editor

Eduindex Journals

www.eduindex.org
editor@eduindex.org

Note: This eCertificate is valid with published papers and the paper must be available online at the website under the network of EDUindex. For cross check you can contact at editor@eduindex.org

ISSN: 2394-3114
Vol-40-Issue-60-March -2020

Native Labour and the Making of European Plantations in Colonial India: Perspectives from Travancore

Jijo Jayaraj [1], Dr. Sebastian Joseph [2]

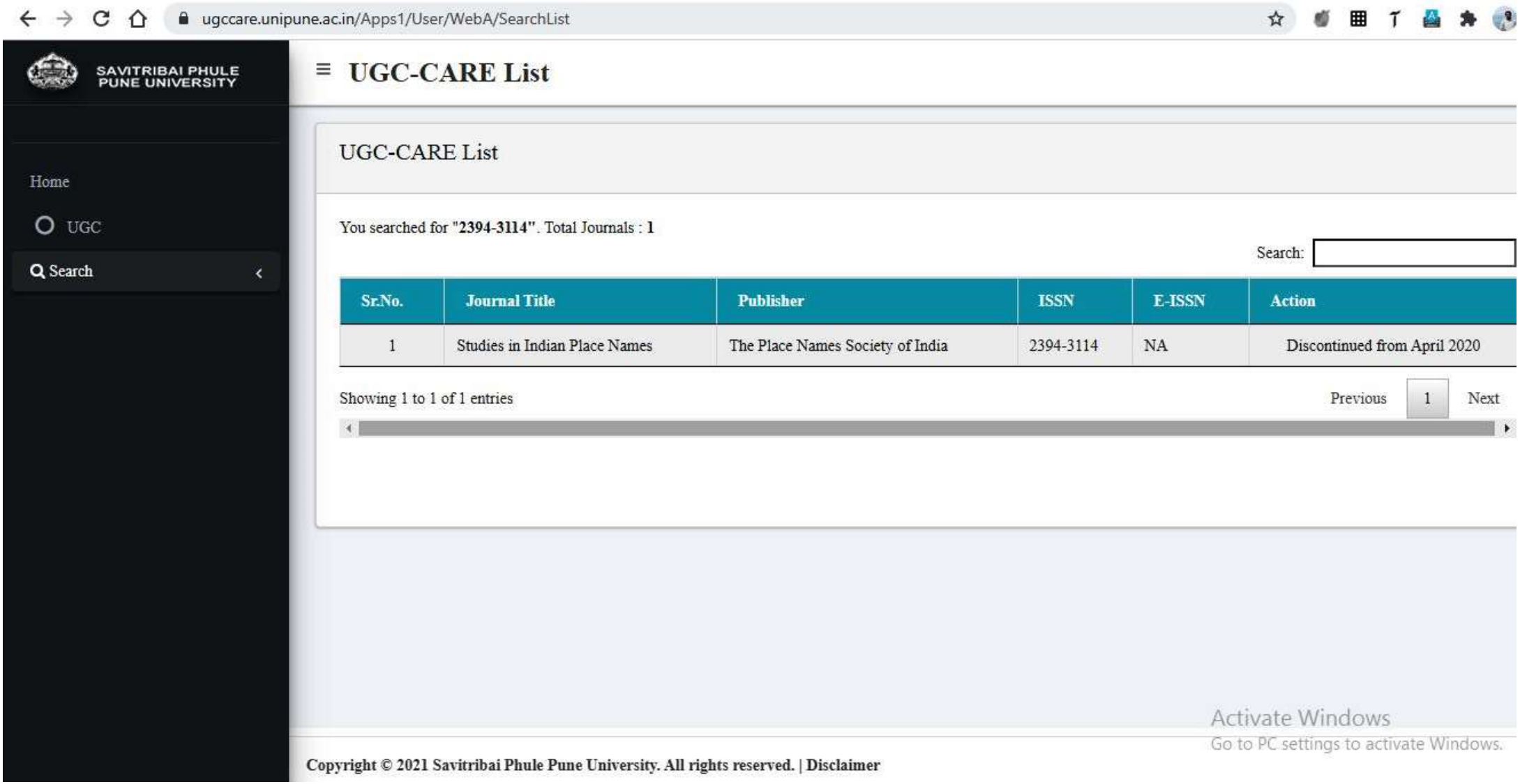
[1] PhD Scholar, P.G Department and Research Centre in History,
UC College, Aluva

[2] Assistant professor and Research Guide, P.G Department and Research Centre in History,
UC College, Aluva

Abstract

This paper tries to locate the role of the Tamil labour in the plantation history of a region called Munnar Hills in the erstwhile Travancore State in Kerala. The labour migration has been a common aspect since the establishment of the plantation industry in the colonial times and the case of Munnar is no exception to this phenomenon. The coffee, tea plantations began in the early half of the 19th century required large number of labour force to work in the estates as coolies. After heavy clearing happened in the area it became imperative for the empire builder to make positive investment of labour and capital. As they faced acute shortage of labourers the planters searched for the availability of labour supply from the low country villages of Madras Presidency who were willing to work in the plantations. The planters relied upon the Kangani system by appointing the labour contractors, who later became gang bosses, to regulate the migrant labour recruitment. An advance system was also successfully employed in which the peasants of the villages under the Presidency who were in hard plight under their *Zamindars* found extremely helpful for running their life through shifting to the estates of the European planter. *Layams,* the cottages in line, for the laborers depicted the architecture of power of the colonizer planter which was a disciplining and surveillance mechanism enforced in typical conditions. It is argued in the paper that since the opening of plantations in the native state a new set of people emerged as plantation workers who were effectively utilized by the capitalist planter for the cause of industrial production of a new beverage, tea and the story of the tragedies of the labourers destined to work under contractual obligations for a living.

Keywords: Capital, Labour, Plantation, Industry, Labour Contractor (Kangani)


ugccare.unipune.ac.in/Apps1/User/WebA/SearchList
SAVITRIBAI PHULE PUNE UNIVERSITY
UGC-CARE List
Home
UGC
Search
UGC-CARE List
You searched for "2394-3114". Total Journals : 1
Search:
Sr.No.
Journal Title
Publisher
ISSN
E-ISSN
Action
1
Studies in Indian Place Names
The Place Names Society of India
2394-3114
NA
Discontinued from April 2020
Showing 1 to 1 of 1 entries
Previous
1
Next
Activate Windows
Go to PC settings to activate Windows.
Copyright © 2021 Savitribai Phule Pune University. All rights reserved. | Disclaimer

ScienceDirect

Solid State Sciences
Volume 89, March 2019, Pages 37-49

Photocatalytic colour enhancement of Methylene Blue and Rhodamine B dyes by coupled Titania Tenorite nanocomposites

Neena Anna Kurien, K.V. Divya, Paulose Thomas [1], K.E. Abraham

Department of Physics, S.B. College, Changanacherry, Kottayam, Kerala, 686101, India

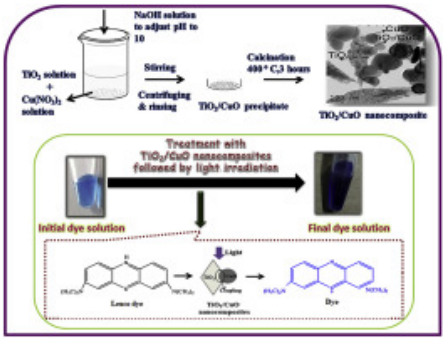
Received 6 November 2018, Revised 17 December 2018, Accepted 18 December 2018, Available online 22 December 2018, Version of Record 31 December 2018.

https://doi.org/10.1016/j.solidstatesciences.2018.12.012

Abstract

Photocatalytic colour enhancement of Methylene Blue (MB) and Rhodamine B (RhB) dye is achieved by dual band gap Titania Tenorite (TiO_2/CuO) nanocomposite system prepared by a cost effective co-precipitation method. The UV–Visible and XPS analyses reveal that the existence of dual band gap is due to the coupling of the constituent metal oxides in the nanocomposite. The band gap of TiO_2 in the nanocomposite is tuned to the visible region, by changing the CuO content. Owing to the band gap tuning capability, the nanocomposite can be used from the UV to Visible region for the colour enhancement. The crystalline structure, morphology, molecular structure and chemical bonding of the samples are analyzed by XRD, FTIR and TEM. The PL spectrum shows a reduction in intensity with increase in CuO content. Methylene Blue and Rhodamine B dyes used to check the photocatalytic activity of TiO_2/CuO nanocomposite reveals that the dye-metal oxide nanocomposite forms an amazing combination providing a colour enhancement of dye in the presence of light due to the conversion of the dye from its colourless Leuco form to MB or RhB. The mechanism of colour enhancement is well justified by UV–Vis absorption spectra.

Graphical abstract



Download : Download high-res image (250KB)

Download : Download full-size image

Introduction

Nanotechnology plays a vital role in scientific research and it makes influence to almost all sectors of life. This emerging science leads to the development of the society by improving the living standard. A nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometres (nm). It can also be structures having nano-scale repeat distances between the different phases that make up the material [1]. The combination of two materials in a nanocomposite helps to rectify the shortcomings of the individual materials. As a result, the comprehensive properties of the nanocomposite differ markedly from that of the component material.

These special features of nanocomposites make them useful in photocatalytic applications which include the degradation studies of dyes, antibiotics etc. [[2], [3], [4], [5]].

Titanium Dioxide (Titania-TiO_2) is an eco-friendly material which has many applications ranging from photocatalysis to cosmetics. The three highly crystalline forms anatase, rutile and brookite-TiO_2 are widely used among the different polymorphic forms of TiO_2 [6]. But its main drawback is that it responds to light in the UV region. Ultraviolet radiation is only 5% of the solar spectrum at ground level [7]. So it will be of great importance if we could tune the response of TiO_2 to the visible region which occupies 44% of the solar spectrum by making use of other environment friendly metal oxides. This can be achieved by coupling TiO_2 with other metal oxides like oxides of Zinc, Copper, Iron, Tungsten etc [[8], [9], [10], [11]].

Earlier, TiO_2 has been coupled with Cupric Oxide (CuO-Tenorite) by different methods such as hydrothermal method, electro spinning etc. to produce film, powder and fibre. Zhang and Tang reported the synthesis of graded band gap films by varying the composition of CuO/TiO_2 [9]. Manjunath et al. synthesized heterojunction CuO-TiO_2 nanocomposite by hydrothermal method for photocatalytic hydrogen generation [12]. J.Chen et al. prepared CuO/TiO_2 hierarchical nanostructure for glucose detection [13]. Li et al. varied CuO concentration and produced CuO/TiO_2 hybrid nanofibres [14]. The synthesis of the nanocomposites in powder form by simple cost effective co-precipitation method is rarely reported. Lee and co-authors used co-precipitation method to synthesize TiO_2/CuO by varying CuO loadings for the photocatalytic removal of dichlorophenoxyacetic acid herbicide. But they reported that the low loading amount causes no change in the structure and optical property of TiO_2 [15].

TiO_2 and its composites have been used for the photocatalytic degradation of many textile dyes. Dyes used in textile industries are the major cause of water pollution as the dye wastes from the industries dissolve in water. Photocatalytic degradation results in the degradation of toxic dyes into non-toxic compounds thereby reducing water pollution. Houas et al. reported photocatalytic degradation pathway of Methylene Blue (MB) in water [16]. Sandoval and co-workers used Titanate nanotubes for removal of MB [17]. Ajmal et al. has

done the Photocatalytic degradation of textile dyes on Cu_2O-CuO/TiO_2 anatase powders [18]. Synthesis of ZnO/CuO and TiO_2/CuO nanocomposites for the degradation of textile dyes was studied by Muzakki et al. [19]. In addition to the photocatalytic degradation, TiO_2 was also used for photocatalytic colour switching. Wang et al. reports the photocatalytic reversible colour switching of MB and RhB using TiO_2 nanocrystals [20]. Photocatalytic colour switching of redox dyes with TiO_2 has been achieved by Wang and his co-workers [21].

Although the photocatalytic degradation and colour switching of dyes using TiO_2 have been reported earlier, there are no reports on the photocatalytic colour enhancement of dyes. This work presents the photocatalytic colour enhancement of MB and RhB by TiO_2/CuO nanocomposites. Here, using a simple cost effective co-precipitation method anatase TiO_2 is coupled with Cupric Oxide (Tenorite-CuO). TiO_2/CuO nanocomposites are synthesized by varying the concentration of Copper nitrate solution. The combination of wide band gap TiO_2 and narrow band gap CuO has resulted in tuneable dual band gaps with significantly improved optical properties. The photocatalytic colour enhancement of MB and RhB by the TiO_2/CuO nanocomposites makes them suitable as a colour additive with these dyes.

Section snippets

Synthesis and characterization of TiO_2/CuO nanocomposites

Titanium (IV) oxide and Copper (II) nitrate tri-hydrate purchased from Sigma Aldrich, Sodium hydroxide pellets (Merck India Ltd) and double distilled water are used as the starting materials for the synthesis of TiO_2/CuO nanocomposites. Methylene Blue and Rhodamine B dyes purchased from Merck India Ltd. is used for the photocatalytic enhancement study. All reagents are of AR grade. TiO_2/CuO nanocomposites are prepared by a slightly modified co-precipitation method reported by T.H. Nguyen et al. …

Structural analysis: X-Ray Diffraction analysis

Fig. 1 shows the X-ray Diffraction pattern of the prepared TiO_2/CuO nanocomposites. The peaks corresponding to both TiO_2 and CuO are present in the spectra which is an obvious indication of the formation of nanocomposites. In Fig. 1 the planes oriented at (1 0 1), (1 0 3), (0 0 4), (2 0 0), (1 0 5), (2 1 1), (2 0 4), (1 1 6), (2 2 0), (2 1 5) and (2 2 4) are found to be matching with JCPDS card #841286 for TiO_2 anatase tetragonal structure with lattice constants a = 3.782 and b = 9.502 which is …

Conclusion

The Titania Tenorite (TiO_2/CuO) nanocomposites have been successfully synthesized through cost effective co-precipitation method. The formation of the nanocomposite is confirmed by XRD, FTIR and TEM analyses. The shift in binding energy obtained from the XPS analysis manifests the formation of Ti—O—Cu bond in the nanocomposite due to the coupling of TiO_2 and CuO. The nanocomposites exhibit dual band gap which correspond to CuO and TiO_2 respectively. The band gap energy of TiO_2 is tuned from the…

Acknowledgements

Neena Anna Kurien acknowledges Mahatma Gandhi University, Kottayam, Kerala, India for providing University JRF 2016. The authors also acknowledge SAIF, CUSAT, Cochin; Amrita Centre for Nanosciences and Molecular Medicine-AIMS, Cochin; ACMS,IIT Kanpur; Common Instrumentation Facility, ARMS Lab and Chemistry Research Laboratory, S.B College, Changanacherry for analysis support.…

Research data for this article

Data not available / Data will be made available on request

Further information on research data ↗

References (53)

H. Huang *et al.*
Rational design on 3D hierarchical bismuth oxyiodides via in situ self-template phase transformation and phase-junction construction for optimizing photocatalysis against diverse contaminants
Appl. Catal. B Environ. (2017)

H. Huang *et al.*
Environmental in situ assembly of BiOI @ $Bi_{12}O_{17}Cl_2$ p-n junction : charge induced unique front-lateral surfaces coupling heterostructure with high exposure of BiOI {001} active facets for robust and nonselective photocatalysis
Appl. Catal. B Environ. (2016)

H. Yang *et al.*
Synthesis of WO_3/TiO_2 nanocomposites via sol-gel method
J. Alloy. Comp. (2005)

J. Chen *et al.*
Electrospun three-dimensional porous CuO/TiO_2 hierarchical nanocomposites electrode for nonenzymatic glucose biosensing
Electrochem. Commun. (2012)

B. Li *et al.*
A multifunctional noble-metal-free catalyst of CuO/TiO_2 hybrid nanofibers
Appl. Catal., A (2017)

A. Houas *et al.*
Photocatalytic degradation pathway of methylene blue in water
Appl. Catal., B (2001)

A. Sandoval *et al.*
Titanate nanotubes for removal of methylene blue dye by combined adsorption and photocatalysis
Fuel (2017)

A. Ajmal *et al.*
Photocatalytic degradation of textile dyes on Cu_2O-CuO/TiO_2 anatase powders
J Environ Chem Eng (2016)

Z. He *et al.*

Surface chemical analysis on the carbon-doped mesoporous TiO2 photocatalysts after post-thermal treatment: XPS and FTIR characterization
J. Phys. Chem. Solid. (2013)

T. Mahalingam *et al.*
Structural, optical, morphological and thermal properties of TiO_2–Al and TiO_2–Al_2O_3 composite powders by ball milling
Phys. Lett. (2017)

View more references

Cited by (4)

An effective wastewater treatment based on sunlight photodegradation by SnS<inf>2</inf>–ZnS/clinoptilolite composite
2020, Solid State Sciences

Citation Excerpt :

…It has also reported that the phase crystallinity of ZnO during the photodegradation process in aqueous media can be changed [51]. In recent decades, for increasing the photocatalytic activity of ZnO and TiO2 and shifting their band gaps towards longer wavelengths some strategies such as doping, supporting and coupling of them with other semiconductors have been used [52–66]. In general, a comparison of the work with the above-mentioned semiconductors shows the following advantages for our catalyst.…

Show abstract

Structurally modified electrospun poly(methyl methacrylate) nanofibers as advanced host matrices for PbS quantum dots
2021, Journal of Applied Polymer Science

Exploring the dielectric behavior of Titania Tenorite nanocomposites
2019, AIP Conference Proceedings

A novel way to use metal nitrates for environmental remediation with the help of photocatalytic action of titania tenorite nanocomposite
2021, Journal of Water and Environmental Nanotechnology

Recommended articles (6)

Research article

Five chiral Cd(II) complexes with dual chiral components: Effect of positional isomerism, luminescence and SHG response
Journal of Solid State Chemistry, Volume 221, 2015, pp. 85-94

Show abstract

Research article

UV/visible-light photodegradation of organic dyes over mesoporous titania prepared by using 2,4,5-triphenylimidazole as template

Materials Science in Semiconductor Processing, Volume 27, 2014, pp. 452-460

Show abstract

Research article

Risk Factors for Hypertension After Living Donor Kidney Transplantation in Korea: A Multivariate Analysis

Transplantation Proceedings, Volume 48, Issue 1, 2016, pp. 88-91

Show abstract

Research article

Thiacalix[4]arene 1,2,3-triazole-polyethylene glycol polymers: Synthesis and dye adsorption properties

Chinese Chemical Letters, Volume 26, Issue 9, 2015, pp. 1091-1095

Show abstract

Research article

CdSe@ZnS nanocomposites prepared by a mechanochemical route: No release of Cd^{2+} ions and negligible in vitro cytotoxicity

Materials Research Bulletin, Volume 49, 2014, pp. 302-309

Show abstract

Research article

Phase transition in polar 2-nitroanilinium nitrate. Graph-set approach of hydrogen bonding patterns and analysis of vibrational spectra

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Volume 207, 2019, pp. 313-320

Show abstract

1 Present address: Department of Physics, Mar Thoma College for Women, Perumbavoor, Kerala- 683542, India.

View full text

Urban Financial inclusion–A descriptive study

Dr Anilkumar V V
Associate Professor and Head of the Department
Department of Commerce
NSS Hindu College
Changanassery

Sujo Mary Varghese
Assistant Professor
Department of Commerce
Mar Thoma College for Women
Perumbavoor

Abstract
Financial inclusion is a necessity both in the urban and rural areas of a country. Urban financial inclusion becomes important because of the bulging urbanisation of the economy. This paper is a study on the concept of urban financial inclusion.

Key words: Urban Financial inclusion

Financial inclusion refers to the rendering of financial services to those who do not form part of the formal financial sector mainly the disadvantaged and low income groups. The key players in financial inclusion are Banks, NBFC's, Insurance companies, Market players, Pension funds and postal systems. Of these banks have a primary and major role to play on account of its regulatory system and the multiple and vast services they render. The regulators in the process are the Reserve Bank of India(RBI), Insurance Regulatory and Development Authority(IRDA), Telecom Regulatory Authority of India(TRAI) and the Securities Exchange Board of India(SEBI),institutions and think tanks and certainly the Government.

Economic and inclusive growth is the most effective way to reduce poverty. However economic growth can still leave many people in persistent poverty if they do not have the capacity to participate in and benefit from the growth process. Financial inclusion offers incremental and complementary solutions to tackle poverty to promote inclusive growth and to address the Millenium Development Goals(2000). Access to financial inclusion allows the poor to save money outside the house safely. This brings prosperity over a period of time.

Objective of Financial inclusion

The objective of financial inclusion(FI) is to extend financial services to the large and unserved population of the country to unlock its growth potential. In addition it strives to achieve inclusive growth by making finance available to the poor in particular. FI enables Banks to channelise the savings of the unserved population of the country and offers new business avenues for lending to this group. Banks were identified as the key drivers in bringing the excluded sections to the formal financial sector whether it be savings, credit, insurance, pension, social security schemes and remittance platform.

Review of literature

Financial exclusion in general

Lammermann, Stefanie(2010) stressed on the role of European Union in tackling the issue of financial exclusion. A list of basic financial services is considered essential to daily life viz. a bank account to receive income, a transaction

Journal of Emerging Technologies and Innovative Research
(An International Scholarly Open Access Journal, Peer-reviewed, Refereed Journal)
Impact factor 7.95 Calculate by Google Scholar and Semantic Scholar | AI-Powered Research Tool, Multidisciplinary, Monthly, Multilanguage Journal

UGC Approved Journal no 63975
ISSN: 2349-5162 | ESTD Year : 2014
Call for Paper
Volume 10 | Issue 3 | March-2023

Published In:
Volume 6 Issue 2
February-2019
eISSN: 2349-5162

UGC and ISSN approved 7.95 Impact factor UGC Approved Journal no 63975

7.95 Impact factor calculated by Google scholar

Unique Identifier
Published Paper ID: JETIR1902420
Registration ID: 196027

Page Number
170-176

Post-Publication
Download eCertificate, Confirmation Letter
editor board member
JETIR front page
Journal Back Page
UGC Approval 14 June Wef of CARE List UGC Approved Journal no 63975

Title

Urban Financial Inclusion–A descriptive study

Authors

Dr Anilkumar V V
Suja Mary Varghese

Abstract

Financial inclusion is a necessity both in the urban and rural areas of a country. Urban financial inclusion becomes important because of the bulging urbanisation of the economy. This paper is a study on the concept of urban financial inclusion.

Key Words

Urban Financial Inclusion

Cite This Article

"Urban Financial Inclusion–A descriptive study", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.6, Issue 2, page no.170-176, February-2019, Available :http://www.jetir.org/papers/JETIR1902420.pdf

ISSN

2349-5162 | Impact Factor 7.95 Calculate by Google Scholar

An International Scholarly Open Access Journal, Peer-Reviewed, Refereed Journal Impact Factor 7.95 Calculate by Google Scholar and Semantic Scholar | AI-Powered Research Tool, Multidisciplinary, Monthly, Multilanguage Journal Indexing in All Major Database & Metadata, Citation Generator

Cite This Article

"Urban Financial Inclusion–A descriptive study", International Journal of Emerging Technologies and Innovative Research (www.jetir.org | UGC and issn Approved), ISSN:2349-5162, Vol.6, Issue 2, page no. pp170-176, February-2019, Available at : http://www.jetir.org/papers/JETIR1902420.pdf

Publication Details

Published Paper ID: JETIR1902420

Registration ID: 196027

Published In: Volume 6 | Issue 2 | Year February-2019

DOI (Digital Object Identifier):

Page No: 170-176

Country: -, -, -.

Area: Engineering


WWW.JETIR.ORG
7.95 Impact Factor by google scholar
JETIR
editor@jetir.org
An International Scholarly Open Access, Peer-Reviewed, Refereed, Multidisciplinary Journal UGC and ISSN Approved Norms | ISSN: 2349-5162
INTERNATIONAL JOURNAL
OF EMERGING TECHNOLOGIES
AND INNOVATIVE RESEARCH
An International Scholarly Open Access Journal, Peer-reviewed, Refereed Journals, Impact factor 7.95 (Calculate by google scholar and Semantic Scholar | AI-Powered Research Tool), Multidisciplinary, Monthly, Indexing in all major database & Metadata, Citation Generator, Digital Object Identifier(DOI), Monthly, Multidisciplinary and Multilanguage (Regional language supported)
Publisher and Managed by: IJPUBLICATION
UGC Approved Journal no 63975(19)
Journal of Emerging Technologies and Innovative Research
International Peer Reviewed & Refereed Journals, Scholarly Open Access Journal
ISSN: 2349-5162 | ESTD Year: 2014 | Impact factor 7.95 | UGC, ISSN Approved Journal no 63975
Website: www.jetir.org | Email: editor@jetir.org
JETIR
Website: www.jetir.org
JETIR

INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (ISSN: 2349-5162)

International Peer Reviewed & Refereed, Scholarly Open Access Journal, Impact Factor: 7.95

ISSN: 2349-5162 | ESTD Year: 2014 | UGC, ISSN Approved Journal no 63975

International Journal of Emerging Technologies and Innovative Research is published under the name of JETIR publication and URL: www.jetir.org

©JETIR Research Journal

Published in Gujarat, Ahmedabad India

Typesetting: Camera-ready by author, data conversation by JETIR Publishing Services.

JETIR Journal, WWW. JETIR.ORG, editor@jetir.org

ISSN (Online): 2349-5162

International Journal of Emerging Technologies and Innovative Research (JETIR) is published in online form over Internet. This journal is published at the Website http://www.jetir.org maintained by JETIR Gujarat, India.

ISSN : 2349-5162

9 772349 516207


INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (ISSN: 2349-5162 JETIR.JETIR.ORG)
International Peer Reviewed & Refereed Journal, Scholarly Open Access Journal
ISSN: 2349-5162 | ESTD Year: 2014 | Impact factor 7.95 | UGC, ISSN Approved Journal no 63975
An International Scholarly Open Access Journal, Peer Reviewed, Refereed Journals, Impact factor 7.95 (Calculate by google scholar and Semantic Scholar | AI-Powered Research Tool), Multidisciplinary, Monthly, Indexing in all major database & Metadata, Citation Generator, Digital Object Identifier(DOI), Monthly, Multidisciplinary and Multilanguage (Regional language supported)
Impact Factor : 7.97 (calculated by google scholar | AI-Powered Research Tool)
Monthly, Multidisciplinary and Multilanguage (Regional language supported)
International, Scholarly Open Access
Peer Review & Refereed Journal
Journal Soft copy, Research Paper, Certificate, DOi and Hard copy of Journal Provided. Refereed Journal, Peer Journal and Indexed Journal and Quick, qualitative and Speedy Review and Publication Process. COPE Guidelines, SEO and Automated Metadata Citation Generator, Referred by Universities
Indexing In Google Scholar, SSRN, ResearcherID-Publons, Semantic Scholar | AI-Powered Research Tool, Microsoft Academic, Academia.edu, arXiv.org, Research Gate, CiteSeerX, ResearcherID Thomson Reuters, Mendeley : reference manager, DocStoc, ISSUU, Scribd, SSRN, Open and many more indexing
Automated Metadata Citation Generator
Fast Process and Low Publication Charge
Provide the Mail and SMS notification
Approved, Open Access Journal
Highly Secure SSL Website
Managed By IJPUBLICATION
Submit Your Manuscript/Papers To editor@jetir.org
Or www.jetir.org ©JETIR, All Rights Reserved | www.jetir.org | editor@jetir.org
ISSN : 2349-5162
9 772349 516207
JETIR - ECO FRIENDLY JOURNAL | ISSN:2349-5162
ePaper Submission
eDocument Generations
eReview Report
JETIR
ePayment
eConfirmation Letters
eCertificates
SAVE PAPER | SAVE TREES | GO FREEN

Bull. Mater. Sci. (2019) 42:218
https://doi.org/10.1007/s12034-019-1893-2

Structural and optical properties of synthesized poly(methyl methacrylate) (PMMA) and lanthanide β-diketonate complexes incorporated electrospun PMMA nanofibres for optical devices

PRINCY PHILIP[1], PAULOSE THOMAS[2], E TOMLAL JOSE[1,*], K C PHILIP[1] and P C THOMAS[1]
[1]Research and postgraduate, Department of Chemistry, St. Berchmans College, Changanacherry, Kottayam 686 101, India
[2]Department of Physics, Marthoma College for Women, Perumbavoor 683542, India
*Author for correspondence (tomlalj27@gmail.com)

MS received 30 June 2018; accepted 3 March 2019

Abstract. Fabrication of electrospun nanofibres is the glittering area of research because of their flexible characteristics and numerous applications in almost all walks of life and technology. Poly(methyl methacrylate) (PMMA) is one of the significant and interested synthetic polymers in the recent research because of their characteristic properties like higher environmental stability, resistance to attack by moulds and enzymes, commercial availability, easiness to handle, etc. In the present study, pristine PMMA nanofibres with diameters of 60–150 nm with 109 nm as the most distributed one are prepared by an electrospinning method using a binary solvent mixture. An enhancement in the intensity of visible photoluminescence emission is observed in PMMA nanofibres embedded with samarium and neodymium β-diketonate complexes. The morphological incorporation of samarium and neodymium β-diketonate complexes in PMMA nanofibres and material composition of the samples are examined by high resolution electron microscopy analyses. The amorphous nature and molecular bonding of pure PMMA nanofibres and incorporated fibre complexes are elucidated through structural and molecular analyses. The supreme optical absorptions and reemissions of samarium and neodymium β-diketonate complexes embedded in the pure PMMA fibre sample in the visible region indicate not only their application in lighting or display devices, but also as active materials in organic light emitting diodes for new era curved/rolled display devices.

Keywords. Electrospinning; lanthanide β-diketonate PMMA nanofibre complexes; photoluminescence; PMMA nanofibre.

1. Introduction

Today, nanomaterials form a major part of research and analysis. Nanostructures like nanoparticles, nanowires, nanotubes, nanofibres, etc. are the topics of interest to the modern researchers since their applications are numerous. Among the various nanostructures, nanofibres have several characteristic properties like high surface area to volume ratio, flexibility in surface functionalities and superior mechanical properties like stiffness and tensile strength compared to other forms of the materials [1]. Polymer nanofibres act as good host matrices for nanoparticles, drugs, metals, etc. They have a wide variety of applications such as tissue engineering scaffolds, filtration membranes, dressings for wound healings, etc. [2] which enhanced the preparation of nanofibres through various methods like drawing, template synthesis, phase separation, self-assembly, electrospinning, etc. [1]. Among these methods, electrospinning is the most important and favourable one. It is the technique capable of producing polymer fibres in the nanometre diameter range from an electrostatically driven jet of polymer solution (or polymer melt). The different dimensions, shapes and porosity of polymer nanofibres can be obtained by varying the spinning parameters and polymer characteristics [3].

Herein, the present study progresses through three different stages. First is the preparation of electrospun poly(methyl methacrylate) (PMMA) nanofibres. PMMA is preferred since it is a commercially available synthetic polymer with exceptional characteristics like transparency, good tensile strength and processability as compared with other commercially available polymers. It is an economical alternative to other polymers such as polyacrylonitrile (PAN), polyvinylidene difluoride (PVDF), etc. [4]. The production of PMMA nanofibres with diameter <100 nm is very much rare in the electrospinning field. The second stage of the study is the preparation of lanthanide β-diketonate complexes. Lanthanides like samarium and neodymium show excellent luminescence properties. β-Diketone ligands are preferred to prepare complexes because of their chemical stability, highly molar extinction coefficiency and high energy transfer efficiency from the ligand to the Ln(III) ions [5]. Lanthanide β-diketonate complexes are well-known molecular luminescent materials and they have characteristic emission bands [6]. Therefore, the incorporation of the luminescent material into

Published online: 28 June 2019

Turkish Journal of Physics

Volume 43 | Number 4 Article 3

1-1-2019

The novel synthesis and luminescence studies of CuO and Fe2 O3 embedded(8-hydroxyquinoline)zinc nanocomposites

ABRAHAM KUTTICHERIL EAPEN

PAULOSE THOMAS

TÜBİTAK

Turkish Journal of Physics

http://journals.tubitak.gov.tr/physics/

Research Article

Turk J Phys
(2019) 43: 324 – 336
© TÜBİTAK
doi:10.3906/fiz-1807-39

The novel synthesis and luminescence studies of CuO and Fe_2O_3 embedded (8-hydroxyquinoline)zinc nanocomposites

Abraham Kutticheril EAPEN[1,*], **Paulose THOMAS**[2]
[1]Department of Physics, St. Berchmans College, Changanacherry, Kerala, India
[2]Department of Physics, Mar Thoma College for Women, Perumbavoor, Kerala, India

Received: 17.07.2018 • **Accepted/Published Online:** 11.03.2019 • **Final Version:** 02.08.2019

Abstract: The present study investigates the synthesis of novel luminescent polymer nanocomposite through the incorporation of CuO and Fe_2O_3 into a $C_{18}H_{12}N_2O_2Zn$ host polymer matrix. The observed green electroluminescence behavior originates mainly from the shift in the HOMO-LUMO energy gap of the polymer matrix caused by the inclusion of oxidized metal/oxygen ions from the incorporated metal oxides into the pyridyl and phenyl groups of the host polymer. The existence of oxidized metal/oxygen ionic states in the polymer matrix is successfully confirmed through X-ray photoelectron spectroscopic analysis. The FTIR analysis is utilized to verify the presence of pyridyl and phenyl groups in the host polymer matrix. The successful incorporation of CuO and Fe_2O_3 into the host polymer matrix is examined through FESEM and HRTEM analyses. XRD, EDS, and XPS analyses are employed in order to confirm the exact crystalline phase and material compositions of the samples prepared.

Key words: Metal oxide-(8-hydroxyquinoline)zinc polymer nanocomposites, organic photoelectroluminescence, morphology, XPS analysis

1. Introduction

For the past few years, researchers have focused their attention on the synthesis and characterization of light-emitting organic compounds for promising applications in various types of electroluminescent (EL) devices. Organic EL devices are supreme candidates for use in portable display device applications because of their lower power consumption and potential for the production of all ranges of color emissions [1–5]. Numerous EL studies have been conducted on metal-based quinoline derivatives such as tris-(8-hydroxyquinoline) aluminum (Alq_3), bis-(8-hydroxyquinoline), and zinc (Znq_2) due to their excellent flexibility, high photoconductivity, and the high lifespan of devices. As compared to Alq_3, Znq_2 has been used more extensively due to its efficient electron transport property, lower biasing voltages, and higher quantum yields in device performance [4–6]. For example, the comparative studies conducted by Huo et al. on organic light-emitting diode (OLED) performances of chloro and fluoro substituted Zn(II)8-hydroxyquinolinates found that the material is suitable for yellow OLEDs [7]. Sapochak et al. studied the EL and structural effects of zinc(II) bis(8-hydroxyquinoline) on electronic states and device performance. The study observed that the strategic substitution of 8-hydroxyquinoline ligands into the metal component and control of the structural symmetry of the corresponding metal chelates may offer a route to high efficiency and lower operating voltage for small-molecule OLEDs [8]. Wang et al. fabricated EL and phosphorescent OLEDs using novel Zn(II) complexes of 2-(2-hydroxyphenyl)benzothiazole ligands. The

*Correspondence: abrahamke@gmail.com

THE IMPACT OF MOBILE - COMMERCE: A SWOT ANALYSIS

ANANDHI.R
M.PHIL SCHOLAR,
PG & RESEARCH DEPARTMENT OF COMMERCE,
SREE NARAYANA GURU COLLEGE, K.G.CHAVADY, COIMBATORE
Mobile.: 9497406335, Email: anandhiganga25@gmail.com

ABSTRACT

In the last few years, there had been immense growth of wireless technology in India. This growth has changed people to do business in mobile commerce (M-Commerce). Day by day many people are choosing M-Commerce instead of E-Commerce to attain good and fast transaction in the market. M-Commerce gains more importanceamong Indians, over the last few years. Due to large number of mobile application, growth rate in mobile penetration in India is increasing day by day. The users has intensely increased on mobile phone and consuming bandwidth of internet providers. Although many people have started E-Commerce but still they hesitate to use M-Commerce because of security problems, payment issues and complexity of mobile applications. This paper identifies facts about the feasibility of M-Commerce and its growth and the Strength and opportunity, weakness and threats lying ahead.

INTRODUCTION: -

M-commerce is defined as "the ability to purchase goods anywhere through a wireless Internet-enabled device. Primary mobile communication exists through web-enabled wireless phones. Mobile Commerce refers to wireless electronic commerce used for conducting commerce or business through a handy device like cellular phone or Personal Digital Assistant (PDA). It is also said that it is the next generation wireless E-commerce that needs no wire and plug-in devices. Mobile commerce is usually called as 'M-commerce' in which user can do any sort of transaction including buying and selling of goods, asking any services, transferring ownership or rights, transacting and transferring money by accessing wireless internet service on the mobile handset itself. The next generation of commerce would most probably be mobile commerce or M-commerce. The difference between E-commerce and M-commerce is that E-commerce is limited to PC users with an Internet Connection. With M-commerce moving to an SMS platform among other things, M-commerce is open to almost the entire mobile population.

DEFINITION OF M-COMMERCE:-

A simple definition of Mobile Commerce describes it as "any transaction with a monetary value that is conducted via a mobile telecommunications network"

submitcikitusi@gmail.com

ISSN NO: 0975-6876

IMPACT FACTOR - 6.1

CIKITUSI

CIKITUSI JOURNAL FOR MULTIDISCIPLINARY RESEARCH

HEC recognized journal

No. 40784 (https://www.ugc.ac.in/eid=NDA3ODQ=)

A Peer Reviewed/ Referred Journal

An ISO 7021 : 2008 Certified Journal

Thomson Reuters' Research ID : M-94236-2018 Indexed Journals

SCOPUS SUGGESTED JOURNAL ID: 45M2HG58E5374L58

VOLUME 6 - ISSUE 4 - April 2019

Download cover page

Indian Journal of Geo Marine Sciences
Vol. 48 (03), March 2019, pp. 369-378

Spatial variability of biochemical composition in coral reef sediments of Kavaratti and Pitti islands, Lakshadweep archipelago

Anu Joy[1], P.P. Anoop[1], R Rajesh[1], Angel Mathew[2], & Anu Gopinath[3]*

[1]Department of Chemistry and Research Centre, St Albert's College, Ernakulam, India
[2]Department of Statistics, Maharaja's College, Ernakulam, India
[3]Department of Fishery Hydrograph, Kerala University of Fisheries and Ocean Studies, Kochi, India
*[E-mail: dranugopinath@gmail.com]

Received 07 August 2017; revised 08 January 2018

In this study, variability of biochemical composition in the surficial coral reef sediments of Kavaratti and Pitti islands in Lakshadweeep archipelago was investigated. Biochemical composition of sedimentary organic matter from the study area was characterized by the dominance of proteins in Pitti and carbohydrates in Kavaratti over lipids. The percentage ratio of the labile to total organic matter indicated that most of the deposited organic matter was refractory in both environments. The higher PRT:CHO ratios in Pitti sediments compared to that of Kavaratti indicated that in the former there was low dead organic matter accumulation. The lower LPD:CHO ratios estimated for sediments in both islands indicated low quality of labile organic matter to support benthic fauna.

[Keywords: Coral reef sediments, Kavaratti, Pitti, Organic matter, Biochemical composition, Labile organic matter]

Introduction

Marine sediment overlay two-thirds of the earth's surface representing one of the largest microbial habitats on the earth. It is complex in nature and acts as the major sites for mineralization and nutrient regeneration of organic matter derived from pelagic primary production and terrestrial input[1]. The surficial sediments can play an important regulatory function through the storage and transformation capacity of organic matter and nutrients and through the reactivity of biogeochemical buffers[2]. A fraction of 25–50% of the organic matter derived from coastal primary production is deposited to the sediments[3,4,5]. The oxic surface layer of marine sediments can account for more than half of the total organic carbon mineralization[6,7].

Coral reef ecosystems are widely recognized as among the most biologically diverse and complex ecosystems; they have been called the marine equivalent of tropical rain forests[8]. These are characterized by exceedingly high rates of productivity, yet are typically situated in nutrient poor waters[9]. Coral reef sediments are generally loose and unconsolidated in nature. Sediments are fundamental for the function of oligotrophic coral reef ecosystems because they are major places for organic matter recycling. This releases the nutrients to the surrounding environment and the dynamics of nutrients are linked to the ecological processes. The study of nutrients would help in understanding the potential availability of life supporting elements in the aquatic system[10]. Therefore, both qualitative and quantitative studies are important for understanding the basic processes governing the distribution and biogeochemical cycling of nutrients[11]. The best coral development is always found on the nutrient-depleted oligotrophic waters, as they are the least tolerant of nutrient enrichment. The biogeochemical processes in the oxic sediment layer play an important role for highly permeable, carbonate sediments in coral reefs[12,13,14,15].

Reef sediments are typically derived from the calcareous skeletons of corals processed by bio-eroding organisms, but also by other biological, chemical and physical processes[16,17]. Generally, permeable reef sediments function as biocatalytical filters that lead to a very effective processing and regeneration of organic matter[18,19,20,21]. Consequently, these sediments contribute to the release of the limiting nutrients N and P after remineralization of organic material[22]. Through their contribution to an efficient element cycling[18,22], reef sediments are crucial for the functioning of coral ecosystems and help to maintain typically high biomass and primary productivity in coral reefs[23,24], despite of the surrounding oligotrophic waters[25,26,27].

ISSN-2321-7065

IJELLH

International Journal of English Language, Literature in Humanities

SMART MOVES JOURNAL IJELLH

Volume 7, Issue 6, June 2019

Published: 29-06-2019

Article

Ms. Sangeetha Rachel Koruth

Assistant Professor and Research Scholar

Mar Thoma College for Women

Affiliated to Mahatma Gandhi University

Ernakulam, Kerala, India

srk42282@gmail.com

The Other Side of India-Partition: The Decanonisation of the Patriarchs

Abstract

Despite all the squabble and commotion around the most controversial documentary of the year "India's Daughter"(2015) which is based on the real story of the rape victim in Delhi, we are yet to brood on how many such daughters have been ignored in past decades of India's history. Many men and women historiographers have done extensive study on India's Partition and contributed to the archives of Indian History. But none of them has ever attempted to focus on the heroic deeds of women activists or experiences of women victims during Partition. It is at this context we understand the relevance of the memoirs of those social activists who worked incessantly for the rehabilitation and revival of rape victims of Partition. The rescuing enterprise of Rameshwari Nehru, Mridula Sarabhai, Kamlaben Patel , Anis Kidwai and Susheela Nayyar is an instance of faith that women's potency cannot be shrouded in furtiveness and they are not unequal to men. The survival propensity of ordinary women and the service rendered by women activists during the violence ridden partition days of India make them stalwarts of women's history of India. History should open to discuss the valour and indomitable spirit of these women so that it remains a record of equality and tolerance. Our history is incomplete without including her heroines and martyrs. A

Physics Letters B 796 (2019) 220–224

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Realising mutated hilltop inflation in supergravity

Tony Pinhero*, Supratik Pal

Physics and Applied Mathematics Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700108, India

ARTICLE INFO

Article history:
Received 18 May 2019
Received in revised form 18 July 2019
Accepted 18 July 2019
Available online 23 July 2019
Editor: M. Trodden

ABSTRACT

We present $\mathcal{N}=1$ supergravity models of mutated hilltop inflation (MHI) for both large and small field sectors. Models with canonical kinetic terms are developed based on a shift symmetric Kähler potential in inflaton superfield, and with a superpotential linear in Goldstino superfield. We also construct models with non-canonical kinetic terms for MHI by generalising the shift symmetry. We found that a good fraction of the models can address the entire branch of MHI in a single framework.

1. Introduction

Among a plethora of models for cosmological inflation [1], one of the very interesting models that is well-appreciated after the latest Planck 2015 and 2018 data [2,3], is the Mutated Hilltop Inflation (MHI) [4] model. First proposed around a decade back, the salient features of these models have been explored at length at different stages (see, e.g., [1,5,6]). MHI models generically have a potential of the form

$$V = V_0\,(1 - \operatorname{sech}\mu\phi) \tag{1}$$

for the inflaton field ϕ with Minkowski minimum at $\phi = 0$. This model belongs to the class of chaotic inflation with super-Planckian inflaton field value $\phi \geq 1$. Depending on the value of model parameter μ, MHI can occur in two branches: one belongs to large field excursion sector $\Delta\phi \geq 1$ for $\mu \lesssim 2.8$ and the other one belongs to small field sector $\Delta\phi \leq 1$ for $\mu \gtrsim 2.8$ [5]. Moreover, the model has a subset in the large field sector which belongs to the class of α-attractors [7–15] for the limiting case $\mu\phi \gg 1$ [5]. Spectral index n_s is almost independent of the parameter μ, but with a slight negative running, and the tensor to scalar ratio r can address the value from 10^{-4} to 10^{-1} depending upon the value of μ. Subsequently, some more interesting features of these models have been studied in [1,6]. These predictions are in good agreement with the latest Planck 2015 and 2018 data [2,3].

However, despite all its successes, a complete description of MHI in the context of supergravity is still unavailable. The aim of the present article is to construct a supergravity model that would lead to the mutated hilltop inflation. The form of the potential mentioned in Eq. (1) can be considered as the functional form of $\tanh\phi$ and hence it belongs to the class of α-attractors and these α-attractors are well formulated and studied in the context of supergravity and string theory [7–18]. In fact, the T-model variant of α-attractor gives rise to a potential of the form Eq. (1) and, for suitable choice of the parameter μ (and hence α), one can realise the MHI model for small-field and large-field within the framework of α-attractor.

The goal of this *letter* is to construct a supergravity framework that can account for MHI, with all non-inflaton moduli fields stabilised, and to demonstrate that it can address each and every branch of the model therefrom. One can accomplish this in the context of general inflaton potentials in supergravity for the chaotic inflation [19], since MHI falls under the category of chaotic inflation. In such a scenario one has to choose a Kähler potential which is invariant under the shift of inflaton superfield T and a superpotential which is linear in Goldstino superfield S [20]. More specifically, Kähler potential should be a function of $T \pm T^*$ and the component (i.e., real or imaginary part of inflaton superfield), which is not appearing in the Kähler potential should be treated as the real inflaton field: $T \mp T^*$. This is to avoid the usual η-problem in supergravity.

Explicit functional form for these super- and Kähler potentials in such a construction reads

$$W = Sf(T) \qquad K^{\pm} = K^{\pm}\left(\left(T \pm T^*\right)^2, SS^*\right). \tag{2}$$

This Kähler potential is invariant under the following shift transformation:

* Corresponding author.
E-mail addresses: tonypinheiro2222@gmail.com (T. Pinhero), supratik@isical.ac.in (S. Pal).

https://doi.org/10.1016/j.physletb.2019.07.042

Indian Journal of Geo Marine Sciences
Vol. 48 (09), September 2019, pp. 1419-1426

Role of hydrographical parameters and total organic carbon on mercury allocation along the riverine transect of Beypore, south-west coast of India

Jose Mathew[1], Anoop P.P[1], Anu Joy[1], & Anu Gopinath[2*]

[1]Department of Chemistry, St Albert's College, Ernakulam, India,
[2]Kerala University of Fisheries and Ocean Studies, Kochi, India
*[E-mail: anugopinath@gmail.com]

Received 23 November 2017; revised 22 May 2018

Distribution of total mercury (THg) was carried out in the sediments of Beypore estuary. The THg concentration in surface sediments varied from 0.03 ppm to 0.17 ppm. The pollution index approach using contamination factor (CF) revealed that the sampling stations are moderately contaminated with respect to mercury. Further, the effects of hydrographical parameters (pH, salinity, dissolved oxygen) and total organic carbon (TOC) of the sediment were studied over the spatial distribution of mercury (Hg). Correlation analysis unveiled THg exhibited significant positive correlations with TOC (R=0.91) and salinity (R=0.744). However significant inverse correlation was observed between pH and Hg (R =-0.93). The C: N ratios suggest that the organic matter is labile in nature. Total organic carbon was found to control the distribution of Hg. It is the first base line study in this estuary.

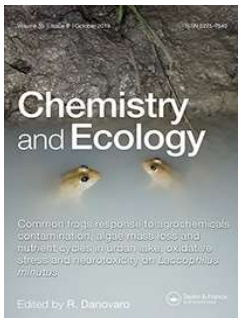
[Keywords: pH; Salinity; Dissolved oxygen; Total organic carbon; Mercury; Beypore estuary]

Introduction

Mercury (Hg) is regarded as a global pollutant and an extremely toxic metal occurring naturally in air, water and soil[1, 2]. The element Hg occurs naturally from countless sources[4,5,6] and its toxicity is well established[3]. Numerous studies pertaining to Hg in coastal and estuarine sediments have unveiled the fact that organic matter is a key variable which influences distribution of Hg in aquatic environments[7,8,9,10,11,12,13]. Total organic carbon (TOC) is found to exhibit excellent correlations with Hg circulation in sediments[8,9,10] . It is cited that primary driver of sediment diagenesis in freshwater and marine sediments is organic carbon (OC) flux[14]. The stability of Hg-OC complexes depends on several factors: 1) nature and composition of organic matter; 2) Hg concentrations; and 3) pH, ionic strength and redox condition of the medium[15,16,17].

Organic carbon transported to the sediment can be of two types namely, autochthonous and allochthonous carbon[18]. Autochthonous carbon, which is typically considered the more labile of the two types of carbon, is produced at or near the site of consumption. Organic carbon produced outside the system of interest is considered allocthonous organic carbon[18]. Since organic carbon in fluvial systems can be degraded during transport by microbial and macrobiotic processes, allocthonous carbon (produced elsewhere) tends to be more refractory[19]. Both the magnitude and type of organic carbon play major roles in controlling the rates of sediment diagenesis. Carbon and nitrogen in aquatic ecosystems are governed by the amalgamation of terrestrial and autochthonous organic matter[20,21,22,23,24,25.]. It is found that freshly formed organic matter from mainly planktonic organisms has a C/N ratio of 6 to 9[26,27,28]. Salinity is regarded as a key factor in understanding speciation of Hg in estuarine sediments[16,29,30]. Earlier studies have observed that salinity intrusion brings high turbidity, which can also alter the Hg distribution[31]. Further increasing association of Hg with sediments has also been reported via "salt out" effects in estuary[16, 32, 33]. pH is also considered as an important factor in unveiling the mobility of Hg in sediments[34,35].

The present study encompasses the effect of physico-chemical parameters and total organic carbon on the spatial distribution of Hg concentration in Beypore estuary. The literature shows that very few data banks are available in this estuary. Studies regarding physico chemical parameters, tidal influence, nitrogen fluxes and trace metal chemistry have been undertaken in this estuary[36,37,38,39] . The potent pollution source identified was Gwalior rayon factory, a popular paper and pulp industry that changed the face of river Chaliyar. Paper pulp factory



Chemistry and Ecology

ISSN: 0275-7540 (Print) 1029-0370 (Online) Journal homepage: https://www.tandfonline.com/loi/gche20

Biochemical composition of sedimentary organic matter in the coral reefs of Lakshadweep Archipelago, Indian Ocean

Anu Joy, P. Anoop, R. Rajesh, Jose Mathew, Angel Mathew & Anu Gopinath

To cite this article: Anu Joy, P. Anoop, R. Rajesh, Jose Mathew, Angel Mathew & Anu Gopinath (2019) Biochemical composition of sedimentary organic matter in the coral reefs of Lakshadweep Archipelago, Indian Ocean, Chemistry and Ecology, 35:9, 805-824, DOI: 10.1080/02757540.2019.1665031

To link to this article: https://doi.org/10.1080/02757540.2019.1665031

CHEMISTRY AND ECOLOGY
2019, VOL. 35, NO. 9, 805–824
https://doi.org/10.1080/02757540.2019.1665031

Taylor & Francis
Taylor & Francis Group

Biochemical composition of sedimentary organic matter in the coral reefs of Lakshadweep Archipelago, Indian Ocean

Anu Joy[a], P. Anoop[a], R. Rajesh[a], Jose Mathew[a], Angel Mathew[b] and Anu Gopinath[c]

[a]Department of Chemistry and Research Centre, St Albert's College, Ernakulam, India; [b]Department of Statistics, Maharaja's College, Ernakulam, India; [c]Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

ABSTRACT

Surface sediments were collected from the shore and lagoons of Kavaratti, Kadamat Agatti and Pitti islands of Lakshadweep Archipelago during May 2015 and analysed for biochemical composition and quality of organic matter. The biochemical composition of sedimentary organic matter from the entire study area was characterised by the dominance of carbohydrates (CHO) followed by proteins (PRT) and finally lipids (LPD). PRT:CHO ratios were less than 1 and indicated the presence of aged organic matter in the islands. The poor nutritional quality of sediments to support benthic fauna was evident from the values of LPD:CHO ratios. The refractory nature of sediments and less availability of food to benthic source was supported by BPC:TOC ratios. Based on estimated ratios and biopolymeric carbon values, the trophic status of the study area was categorised as oligotrophic.

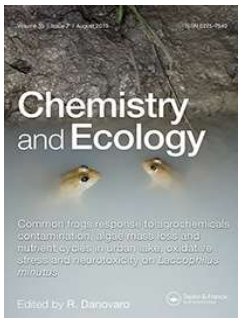
ARTICLE HISTORY
Received 3 March 2019
Final Version Received 4 September 2019

KEYWORDS
Coral reef sediments; organic matter; biochemical composition; Lakshadweep

Introduction

Marine shelf sediments are the major sites for mineralisation and nutrient regeneration of organic matter derived from pelagic primary production and terrestrial input [1]. A fraction of 25–50% of the organic matter derived from coastal primary production is deposited to the sediments [2]. It plays a pivotal role in the chemistry of oceans and provides a significant reservoir in the global carbon cycle [3]. Quantity and the composition of organic matter in sediments are strongly influenced by heterotrophic microorganisms [4,5]. Organic matter in sediments is derived from a variety of sources such as autochthonuos, allochthonuos and anthropogenic sources [6]. Biogeochemical processes associated with organic matter remineralization in sediments depend greatly on its quality. Hence quantity and quality of organic matter in surface sediments are recognised as major factors affecting benthic fauna dynamics and metabolism [7–9]. Organic matter in marine sediments is composed of labile and refractory compounds, whose relative importance changes as a function of a complex array of processes, including degradation, heterotrophic utilisation, transformation, accumulation and export [10]. The assessment of the quantity and quality of organic matter, whether labile or refractory, is a prerequisite for explaining diagenetic processes [7]. The biochemical composition has been commonly utilised to achieve vital

CONTACT Anu Gopinath dranugopinath@gmail.com



Chemistry and Ecology

ISSN: 0275-7540 (Print) 1029-0370 (Online) Journal homepage: https://www.tandfonline.com/loi/gche20

Spatial variation of phosphorus fractionation in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean

Anu Joy, P. Anoop, R. Rajesh, Jose Mathew, Angel Mathew & Anu Gopinath

To cite this article: Anu Joy, P. Anoop, R. Rajesh, Jose Mathew, Angel Mathew & Anu Gopinath (2019) Spatial variation of phosphorus fractionation in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean, Chemistry and Ecology, 35:7, 592-612, DOI: 10.1080/02757540.2019.1618281

To link to this article: https://doi.org/10.1080/02757540.2019.1618281

Published online: 05 Jun 2019.

CHEMISTRY AND ECOLOGY
2019, VOL. 35, NO. 7, 592–612
https://doi.org/10.1080/02757540.2019.1618281

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Spatial variation of phosphorus fractionation in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean

Anu Joy[a], P. Anoop[a], R. Rajesh[a], Jose Mathew[a], Angel Mathew[b] and Anu Gopinath[c]

[a]Department of Chemistry and Research Centre, St Albert's College, Ernakulam, India; [b]Department of Statistics, Maharaja's College, Ernakulam, India; [c]Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

ABSTRACT

Surface sediments were collected from the shore and lagoons of Kavaratti, Kadamat and Agatti islands of Lakshadweep Archipelago during May 2015 and analysed for the spatial distribution of the micronutrient element, phosphorus. Phosphorus was separated by sequential extraction procedure into five fractions – exchangeable (Ex-P), iron bound, (Fe-P), calcium bound (Ca-P), organic and residual fractions (OP) and total phosphorus (TP). The average relative contribution of each P species to TP was: $OP > Ca - P > Ex - P > Fe - P$. The high concentration of organic and residual phosphorus (87–96%) compared to inorganic phosphorus is particularly evident at stations characterised by higher total phosphorus concentrations. Among the three forms of IP in the sediments, Ca-P was dominant at all stations. The OC/OP ratio ranged from 3 to 163 in the sediments, suggesting that the organic matter in sediments had been subjected to degradation. Hence, the major contribution towards organic and residual phosphorus form is from the residual fraction comprising biologically resistant or non-available phosphorus form composed of refractory materials. The concentration of phosphorus reported in the present study is higher than that of the earlier studies in Lakshadweep, indicating a terrestrial and anthropogenic influence on the sediment.

ARTICLE HISTORY
Received 6 July 2018
Final Version Received 12 April 2019

KEYWORDS
Phosphorus; fractionation; coral reefs; sediments; Lakshadweep

Introduction

Coral reefs occupy a unique niche in marine ecosystems [1]. They are one of the most productive ecosystems [2] and are used as environmental indicators because of their apparent sensitivity to physical and chemical changes in the marine environment [3]. Although coral reefs are oligotrophic in nature, production of organic matter and nutrient turnover attribute is high. In order to unravel the high biological productivity of the reef ecosystem, the role of phosphate as a growth-limiting nutrient is of great concern [4]. P is also critical to the global climate and environmental changes because of the relationship between atmospheric carbon dioxide and marine photosynthetic productivity [5–7]. Numerous studies have indicated that estuaries and adjacent seas are important sinks for P, which can be captured in large quantities in these ecosystems

CONTACT Anu Gopinath dranugopinath@gmail.com

Marine Pollution Bulletin 146 (2019) 106–116

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Baseline

Spatial variation of trace element concentration and contamination assessment in the coral reef sediments of Lakshadweep Archipelago, Indian Ocean

Anu Joy[a], Anoop P P[a], Rajesh R[a], Jose Mathew[a], Angel Mathew[b], Anu Gopinath[c,*]

[a] Department of Chemistry, Research Centre, St Albert's College, Ernakulam, India
[b] Department of Statistics, Maharaja's College, Ernakulam, India
[c] Department of Aquatic Environment Management, Kerala University of Fisheries and Ocean Studies, Kochi, India

ARTICLE INFO

Keywords:
Coral reef sediments
Trace elements
Geochemical indices
Potential ecological risk index

ABSTRACT

Surface sediments were collected from the shore and lagoons of Kavaratti, Kadmat and Agatti islands of Lakshadweep Archipelago and analysed for trace element concentration. The sediment contamination was assessed on the basis of geochemical, biological hazard and ecological risk indices. Except Cd and Pb, all the other trace elements selected for the study were below the contamination level. Compared to Kadmat, Kavaratti and Agatti were more polluted and the pollution was pronounced in lagoons than shore. Population pressure, untreated sewage, diesel based power generation, shipping and tourism activities contribute to sediment contamination. Statistical analysis revealed the association of trace elements with sedimentary characteristics due to anthropogenic sources.

Trace elements are the most toxic, abundant and persistent pollutants that can accumulate in marine habitats and increases the concentration through biomagnification (Chakraborty et al., 2010). These are transported to the marine environment through natural and anthropogenic processes as dissolved species in water or in association with suspended sediments. Trace elements have the potential to affect sediment nutrient cycling, cell growth and regeneration as well as reproductive cycles and photosynthetic potential of marine organisms (Bricker, 1993). The geochemical investigation of sediment provides information about trace elements in the aquatic systems (Boamponsem et al., 2010).

Lakshadweep is an archipelago of coral islands scattered in the Arabian Sea off the West Coast of India. It consists of 36 tiny islands, 12 atolls, 3 reefs and 5 submerged banks, covering an area of 32 km^2 with lagoons occupying about 4200 km^2. Lakshadweep has a total population of 64,429 with a population density of 2013 persons/km^2, which is one of the highest in India (LAPCC, 2012). The islands are flat and scarcely rise more than two meters and are vulnerable to storms and sea erosion. They are made up of coral sand and boulders which have been compacted into sandstone. The lagoons have sandy bottoms with scattered coral boulders and pinnacles followed by extensive sea grass beds at the landward side (James et al., 1986). According to Pillai (1986) 105 species of corals under 37 genera were recorded from Lakshadweep.

The livelihood of the islanders of Lakshadweep Archipelago is greatly dependent on coral reefs, as they provide food, income, employment, shelter and protection. The geochemical aspect of trace elements within the reef environment requires an attention as it can assess the pollution status of the ecosystem. Hence a baseline data regarding the trace element pollution is essential to assess the health of these coastal ecosystems. The present study is an attempt to assess the contamination and spatial distribution pattern of seven trace elements (Cr, Mn, Fe, Cu, Zn, Cd and Pb) in the shore and lagoon sediments of three inhabited islands, namely, Kavaratti, Kadmat and Agatti belonging to Lakshadweep Archipelago.

Kavaratti is the capital of Lakshadweep Archipelago. It is a popular tourist destination due to the presence of pristine white sand beaches and calm lagoons. Kavaratti having an area of 3.93 km^2 lies 360 km away from the Kerala coast at 10° 32′ and 10° 35′ N latitude and 72° 35′ and 72° 40′ E longitude. The maximum length and width of the island is 5.8 and 1.6 km respectively. It is the most populated island in Lakshadweep. It has a lagoon area of 8.96 km^2. This island ranked first among the islands with 86 species of corals and live coral coverage was recorded as 39% (Pillai and Jasmine, 1989). Kadmat is located at 11° 10′ and 11° 16′ N latitude and 72° 45′ and 72° 48′ E longitude, with an area of 3.20 km^2. The lagoon has a width of 1.5 km. It is the central

* Corresponding author.
E-mail address: dranugopinath@gmail.com (A. Gopinath).

https://doi.org/10.1016/j.marpolbul.2019.06.003
Received 6 March 2019; Received in revised form 22 May 2019; Accepted 1 June 2019

Journal of Emerging Technologies and Innovative Research
An International Open Access Journal Peer-reviewed, Refereed Journal
www.jetir.org | editor@jetir.org An International Scholarly Indexed Journal

Certificate of Publication

The Board of

Journal of Emerging Technologies and Innovative Research (ISSN : 2349-5162)

Is hereby awarding this certificate to

Dr. Jijo Jayaraj

In recognition of the publication of the paper entitled

Female Planters and European Socialization: An Example From Kannan Devan Hills, South India

Published In JETIR (www.jetir.org) ISSN UGC Approved (Journal No: 63975) & 7.95 Impact Factor

Published in Volume 6 Issue 3 , March-2019 | Date of Publication: 2019-03-15

EDITOR

EDITOR IN CHIEF

JETIR1903N36 Research Paper Weblink http://www.jetir.org/view?paper=JETIR1903N36 Registration ID : 403589

WWW.JETIR.ORG
7.95 Impact Factor by google scholar

JETIR
editor@jetir.org

An International Scholarly Open Access, Peer-Reviewed, Refereed, Multidisciplinary Journal UGC and ISSN Approved Norms | ISSN: 2349-5162

INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH

An International Scholarly Open Access Journal, Peer-reviewed, Refereed Journals, Impact factor 7.95 (Calculate by google scholar and Semantic Scholar | AI-Powered Research Tool), Multidisciplinary, Monthly, Indexing in all major database & Metadata, Citation Generator, Digital Object Identifier(DOI), Monthly, Multidisciplinary and Multilanguage (Regional language supported)

- Publisher and Managed by: IJPUBLICATION
- UGC Approved Journal no 63975(19)

Journal of Emerging Technologies and Innovative Research

International Peer Reviewed & Refereed Journals, Scholarly Open Access Journal

ISSN: 2349-5162 | ESTD Year: 2014 | Impact factor 7.95 | UGC, ISSN Approved Journal no 63975

Website: www.jetir.org | Email: editor@jetir.org

INTERNATIONAL JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (ISSN: 2349-5162 JETIR JETIR.ORG)

International Peer Reviewed & Refereed Journal, Scholarly Open Access Journal

ISSN: 2349-5162 | ESTD Year: 2014 | Impact factor 7.95 | UGC, ISSN Approved Journal no 63975

An International Scholarly Open Access Journal, Peer-reviewed, Refereed Journals, Impact factor 7.95 (Calculate by google scholar and Semantic Scholar | AI-Powered Research Tool), Multidisciplinary, Monthly, Indexing in all major database & Metadata, Citation Generator, Digital Object Identifier(DOI), Monthly, Multidisciplinary and Multilanguage (Regional language supported)

Impact Factor : 7.97 (calculated by google scholar | AI-Powered Research Tool)	Monthly, Multidisciplinary and Multilanguage (Regional language supported)
International, Scholarly Open Access	Peer Review & Refereed Journal
Journal Soft copy, Research Paper, Certificate, DOi and Hard copy of Journal Provided. Refereed Journal, Peer Journal and Indexed Journal and Quick, qualitative and Speedy Review and Publication Process. COPE Guidelines, SEO and Automated Metadata Citation Generator, Referred by Universities	Indexing In Google Scholar, SSRN, ResearcherID-Publons, Semantic Scholar | AI-Powered Research Tool, Microsoft Academic, Academia.edu, arXiv.org, Research Gate, CiteSeerX, ResearcherID Thomson Reuters, Mendeley : reference manager, DocStoc, ISSUU, Scribd, SSRN, Open and many more indexing
Automated Metadata Citation Generator	Fast Process and Low Publication Charge
Provide the Mail and SMS notification	Approved, Open Access Journal
Highly Secure SSL Website	Managed By IJPUBLICATION

ISSN : 2349-5162

9 772349 516207

Female Planters and European Socialization: An Example From Kannan Devan Hills, South India

Dr. Sebastian Joseph, Dept. of History, UC College, Aluva, Eranakulam, monichenjo@gmail.com, 9447355190

and

Dr. Jijo Jayaraj, Assistant Professor on Contract, Dept. of History, Pavanatma College, Murickassery, Idukki, jijojayarajan@gmail.com, 9562234721

Abstract: The planters opened the wild of Kannan Devan Hills for the new plantation industry. like the plantation labourers the planters also settled with their family in the Bungalows. All the planters were busy with the plantation and the lady planters were very active in the public sphere of Munnar. Clubs, Church, Dramatic Societies, Theaters, Exhibition programmes were conducted under the leadership of the female planters.

Keywords: Club life, Female planters, Lodge and Church, Empire, Exhibition, Associations, Gatherings, Stress

Introduction

Plantation industry did a vital transformation in the landscape as well as the socio cultural milieu of the high ranges of Munnar which was largely known as the Kannan Devan Hills situated in the Northern part of the erstwhile Travancore state. When the planters arrived here they had to face extreme adversities like the wild forest, wild animals, entirely different population with different custom etc. In order to keep the planter and their family mentally fit they need to engage in social and cultural activities. This process was visible throughout the plantation estates of South India. Some of the programmes were conducted exclusively for the planter women like the exhibition Programme, Dramatic programmes etc. they were also very active in the club life and amusements all the programmes were organized by the respective estate clubs and competitions organized between different Planter Associations of South India. The empire and the state gave necessary support because the best mental health could produce better outcome. These cultural and social activities attracted more planters from Europe who came up here to invest. A European model of social life was constructed here.

Women in the Exhibition Programmes

With the progress of time the plantation spread all over the High Ranges. Planters who came from Scotland and from other parts of Europe brought their family also. The social life slowly developed in Munnar. The planter males were busy in the tedious toil in the hill station, and found hunting fishing as the means of leisure. Ladies in the High Range have since the earliest days organized their own entertainment. There were frequent tea meetings, and an annual bazaar at which local talents were

displayed, tennis mornings and fund raising organizations for everything, from war to draughts or floods.(Amita Baig, Handerson, 1972)[1] The Munnar exhibition programme was the most popular event among the madam planters of the district. The exhibition Programme was started in 1900. The Exhibition was organized in the Indian club.(Travancore Gazette 1923)[2] Button sewing competition, book title competition, Tennis, hat trimming competition, sketching completion, etc., were conducted as part of the event.

The competition for the best show of fruits and vegetables was the main attraction. In the first event Miss. Eherdt of Gudarle estate and Mrs. Martin of Chittavurrai competed for the prize. Photographs of all printed, developed and send up by the competitors were produced. The short story competition was won by the Baroness von Rosenburg. (Violet Martin, 1930)[3] Dress making for ladies and children was keenly contested. An auction of the perishable articles was held. On the same evening an important concert was given and the night ended with dancing.

In 1901 the second exhibition was conducted and remarkable was the native participation in it. Wood carving competition was conducted and the native community made excellent contribution. The third exhibition was conducted in 1911. Mr. and Mrs. Swayne organized the third exhibition. The outbreak of the Second World War put a stop to the exhibition.

Church and Faith

Henry Gribble, father of Baroness von Rosenberg, paid a visit to the High Range in April 1901. He was a keen mason and under his persuasion those who were free masons got together. Six of these were members of Scottish Lodges. While, A. F. F Martin was a member of the English Lodge. On 24th May 1902, Lodge Heather was opened. The installation took place by a quorum of seven members. Gribble officiated the occasion. A. F. F Martin was selected as the first Master. A beautiful hymn was sung by Gribble. Lodge meetings took place each full moon and proved a great success. New masters were installed each year and more than once have the rights of the masonic funeral been given to Masons who have passed beyond. Baroness von Rosenberg, Mrs. Martin and Miss. Anna Martin, sister of A. F. F Martin were the ladies interested in the furnishing of the Lodge. The first Bishop to visit the High Range was Bishop Hodges. He came from Kodaikanal in April 1898.(Violet Martin, 1930)[4] A. F. F Martin the senior planter accompanied him from Bombardie shola. The Bishop stayed for four weeks and held two services one at Chittuvurrai Bungalow and other one at Mrs. Thorps Bungalow. He visited several other estates. He went to Bodimettu through Periakanal. In 1905 Buchanan urged the then Manager of the K. D. H. P to build a Church at Munnar. The Church was built below the Cemetery at old Munnar. It took about a year to complete.

The first recorded service took place on 1st may 1898 at W. D Martins bungalow at Shollamali. The service was taken by the Rev. C. A Neve, a CMS Missionary. Eight adults participated and a baby was baptised. Like the planters the Chaplains moved all along the estates on the horseback. The first

© 2018 IJRAR January 2019, Volume 06, Issue 1 www.ijrar.org (E-ISSN 2348-1269, P- ISSN 2349-5138)

FINANCIAL EXCLUSION AND ITS VARIOUS CAUSES

1.Sujo Mary Varghese, Assistant Professor, Department of Commerce, Mar Thoma College for Women, Perumbavoor,Ernakulam,Kerala, India

2. Dr Anilkumar V. V.(Research Guide), Associate Professor and Head of the Department of Commerce, NSS Hindu College, Changanassery, Kerala, India

Abstract: Financial Exclusion is the lack of access to formal financial services and is universal. The more number of people without a basic bank account as the first requirement is concentrated in the developing economies. This paper deals with the concept of financial exclusion and the reasons behind people not accessing the mainstream financial services.

Index Terms: Exclusion

INTRODUCTION

Man is a social being. He needs to be a part of all the activities of the society in order to lead a social life. It also includes being a part of Government regulations, being included in the financial sector, being a part of and enjoying the social security measures and the like. There are sections of people who are excluded from the society or socially excluded.

Exclusion consists of dynamic, multi-dimensional processes driven by unequal power relationships interacting across four major dimensions - economic, political, social and cultural - and at different levels including individual, household, group, community, country and global levels. It results in a continuum of inclusion/exclusion characterised by unequal access to resources, capabilities and rights which results in health inequalities[1].

Social exclusion is a great form of discrimination. It occurs when people are wholly or partially excluded from being participating in the economic, social and political life of their community, based on their belonging to a certain social class, category or group. In India, social exclusion happens on the basis of identities including caste, ethnicity, religion, gender and disability.

Social exclusion is recognised by three main features:

1. It involves culturally-defined social categories, with associated cultural perceptions, values and norms that help in forming social interaction.
2. It is embedded in social relations.
3. It has very far reaching consequences since the people are denied their rights and basic entitlements denying them basic standard of living[2]

Financial exclusion and social exclusion are somewhat complementary to each other. Financial exclusion reinforces the risk of social exclusion while social exclusion automatically leads to financially exclusion. Hence financial exclusion has deep rooted consequences on individuals and the society.

Financial exclusion can be explained as the inefficiency of individuals, households and groups to access necessary financial services in the appropriate form. It may arise due to issues with access, prices, marketing and financial literacy or from self exclusion due to bitter experiences or perceptions. Very simple tools such as a bank account or a credit card has become a part and parcel of everyday life. If this is the case, then the consequences of not having any of these is beyond imagination. Lack of access to any of these facilities is a serious hindrance to social and economic integration.

A person is said to be financially excluded when he has lack of access to any or all of the services offered by the formal financial institutions in their country or do not avail or make use of these services.

The report by the European Commission (2008) defines financial exclusion as follows:

Financial exclusion refers to a process whereby people encounter difficulties accessing and/or using financial services and products in the mainstream market that are appropriate to their needs and enable them to lead a normal social life in the society in which they belong.

There is also a widespread recognition that financial exclusion forms part of a much wider social exclusion, faced by some groups who lack access to quality essential services such as jobs, housing, education or health care.

The report also establishes a list of basic financial services considered essential to daily life: a bank account to receive money; a transaction account to make payments from; a savings account to safeguard money; and access to flexible and unsecured credit to manage temporary cash shortages and unexpected expenses.

Financial exclusion is of 4 types:

1. Banking Exclusion
2. Savings exclusion
3. Credit exclusion

Peer Reviewed ISSN Approved | Impact Factor: 7.17

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS

International Peer Reviewed & Refereed Journals, Open Access Journal
E-ISSN 2348-1269, P- ISSN 2349-5138

Scholarly open access journals, Peer-reviewed, and Refereed Journals, Impact factor 7.17 (Calculate by google scholar and Semantic Scholar | AI-Powered Research Tool), Multidisciplinary, Monthly, Indexing in all major database & Metadata, Citation Generator, Digital Object Identifier (DOI), UGC Approved Journal NO: 43602(19)

Publisher and managed by: IJ Publication

Website: www.ijrar.org | E-mail: editor@ijrar.org

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR)

(E-ISSN 2348-1269, P- ISSN 2349-5138)

International Peer Reviewed, Open Access Journal

E-ISSN 2348-1269, P- ISSN 2349-5138 | Impact factor: 7.17 | ESTD Year: 2014

UGC and ISSN Approved UGC Approved Journal NO: 43602(19).

Published in India

E-ISSN 2348-1269, P- ISSN 2349-5138

Typesetting: Camera-ready by author, data conversation by IJRAR Publishing Services – IJRAR Journal.

IJRAR Journal, WWW.IJRAR.ORG

E-ISSN 2348-1269, P- ISSN 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) (IJRAR) is published in online form over Internet. This journal is published at the Website http://www.ijrar.org, maintained by IJRAR Gujarat, India.

TRAUMATIC TRANSNATIONALISM: THE REFUGEE AS TRANSNATIONAL SUBALTERN IN MOHSIN HAMID'S EXIT WEST

Minu Susan Koshy

New Academia

New Academia: An International Journal of English Language, Literature and Literary Theory

(E-ISSN 2347-2073) (U.G.C. Journal. No. 44629) Vol. VII Issue II, April. 2016

TRAUMATIC TRANSNATIONALISM: THE REFUGEE AS TRANSNATIONAL SUBALTERN IN MOHSIN HAMID'S *EXIT WEST*

Dr.Minu Susan Koshy
Assistant Professor
Dept. of English
Mar Thoma College for Women
Perumbavoor, Ernakulam
Kerala
minususankoshy@gmail.com

Abstract

Transnationalism as an academic discourse has significantly altered the way immigration and cross-border movements have been interpreted by mainstream academia. With its emphasis on how national borders concede to the demands of inter-national movements propelled by globalization, ease of access to transport and communication, religious/political persecution and other socio-cultural factors, transnationalism has established itself as a major agent in policy formulation and decision making by states across the world. The figure of the refugee is a problematic one in discourses of transnationalism in as much as the 'refugee situation', as different from the 'diasporic/immigrant situation', is one that entails a completely different envisaging of transnationalism. As opposed to the diaspora, the community of refugees cannot, at least at the superficial level, be termed a 'productive' one, serving to extend the transnational base of the place of settlement. Refugees are perceived of as parasitical entities draining the resources of the countries in which they settle with no potential contribution to its economy or capital base. The post 9/11 "paranoid nationalism" (Hage 221) and the increased fear of 'non-natives' as threats to national security, has led to many nations closing off their borders to refugees. And in locales where they are allowed entry, they are treated as subhuman entities who are to be confined in camps segregated from the rest of the population. This makes 'disciplining', documentation and surveillance possible. The refugee becomes the transnational subaltern figure, caught between two nations, yet unacceptable and traumatized in both. The positive connections between nations, as underscored by transnationalism become problematic here since the refugee's relationship with her/his state is precarious and traumatic. Mohsin Hamid's Exit West (2017) exemplifies the refugee as a transnational subaltern figure, silenced and traumatized by the multiple states in which she seeks refuge. The paper attempts to explore the refugee crisis and traumatic transnationalism with the aim of unearthing potential ways of subverting existing hierarchies that silence refugees, as depicted in the novel and explores the ways in which the

Interactions Forum (/)

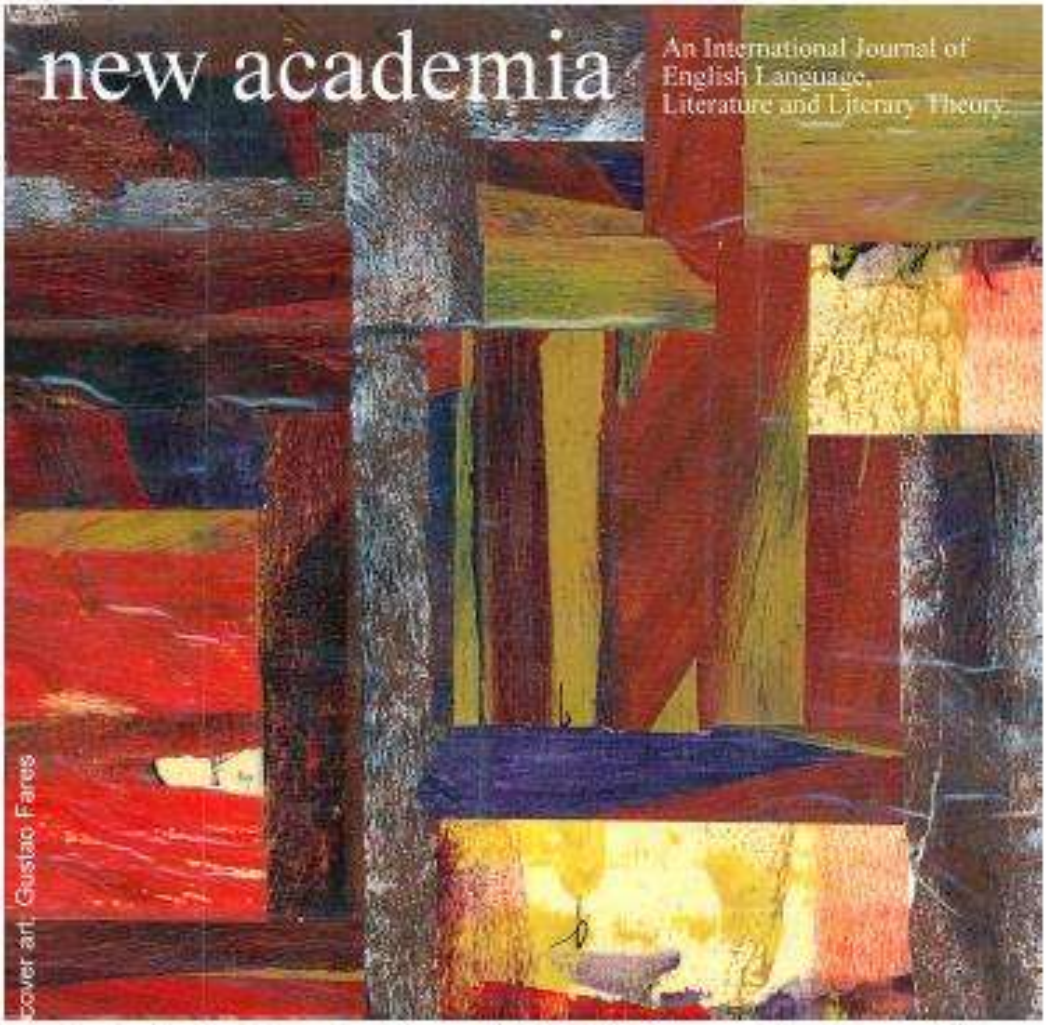
New Academia (/new-academia)

NEW ACADEMIA: An International Journal of English Language, Literature and Literary Theory

(Peer Reviewed and Refereed Journal)

(Online ISSN 2347-2073)

Click: UGC Journal No. 44829 (up to 14 June 2019- Page No. 127)
(/images/pdfs/newacademia/logo/UGC_Cancelled_List.pdf)



New Academia: An International Journal of English Language, Literature and Literary Theory is a **Peer Reviewed (https://www.angelo.edu/services/library/handouts/peerrev.php) and Refereed** journal published quarterly by Interactions Forum, Pune.

VOL. VII ISSUE II APRIL 2018

New Academia: An International Journal of English Language and Literary Theory (E-ISSN 2347-2073) (UGC Journal. No. 44829)

Volume VII Issue II April 2018

Editor: Dr. Sachin Londhe

Contents

Materials Science in Semiconductor Processing 82 (2018) 82–91

Contents lists available at ScienceDirect

Materials Science in Semiconductor Processing

journal homepage: www.elsevier.com/locate/mssp

Exploring the photoluminescence emission behaviour of vacuum deposited Sb_2O_3 thin film having randomly oriented thorn like structures

K.V. Divya, Paulose Thomas[1], K.E. Abraham*

Department of Physics, SB College, Changanacherry, Kottayam, Kerala 686101, India

ARTICLE INFO

Keywords:
Antimony trioxide
Vacuum thermal evaporation
Photoluminescence emission
Thin film
Thorn morphology

ABSTRACT

An intense UV–visible photoluminescence of vacuum deposited Sb_2O_3 thin film surface crowded with randomly oriented thorn like structures have been studied using photoluminescence (PL) spectroscopy. The resulting UV emissions are near band edge (NBE) emissions. All the visible deep level emissions (DLE) are due to oxygen defect states. The thorn like structures is achieved by the inclined arrangement of substrates with respect to the source in the vacuum chamber. Some distorted polygonal shapes also emerge among the randomly oriented thorns giving an impression of a hybrid formation upon annealing. This formation of various structures leads to decreased UV NBE and defect level PL emission. The excitation wavelength dependence of PL emission has also been studied. The optical band gap energy of the film is found to be varying from 3.64 to 3.42 eV on annealing. The prepared films are of Sb_2O_3 cubic structure with polycrystalline nature as confirmed from XRD results. The emergence of thorn like morphology is clearly demonstrated with the aid of FE-SEM and TEM analyses. EDS verifies the elemental composition of Sb_2O_3. This paper provides an insight into the influence of confinement directions or film surface morphology on the PL emission intensities and PL emission ranges of Sb_2O_3.

1. Introduction

The quality of modern world devices is highly reliable on thin films prepared through vacuum based synthesis techniques. Vacuum pressure plays an important role in modifying thin film parameters like adhesion, purity, homogeneity, film thickness etc. [1]. High vacuum of nearly $\sim 10^{-5}$ Torr and more is used in various vacuum deposition techniques such as Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD), Molecular Beam Epitaxy (MBE), Sputtering etc. A major significance of PVD method is that a large variety of substrates can be coated with unlimited number of materials including metals, alloys, semiconductors, organic and inorganic compounds etc. The thin films produced are of various microstructures with excellent adhesion. Such thin films are widely used in optical, opto-electronic and microelectronic systems [2,3]. The greatest advantages of vacuum thermal evaporation are faster evaporation rate, better step coverage and substrate damage prevention in comparison with other PVD techniques like sputtering, CVD etc. In addition, film purity and thickness can be controlled using suitable vacuum condition and by varying the deposition rates [4].

Antimony Trioxide (Sb_2O_3) is a semi-metal oxide semiconductor with wide and direct band gap of 3.3 eV [5,6]. This V – VI group compound has got many applications in optoelectronics and industrial chemistry. Antimony Trioxide is an excellent flame retardant synergist in plastic and polymer industry [7,8] and can even act as a good catalyst in organic synthesis and photochemistry [9–13]. Like any other metal oxide semiconductors, Antimony Trioxide also got applications in optoelectronic devices such as solar cell and UV LED. It is also used as a part in heat mirrors and spectrally selective coatings [14]. Sb_2O_3 exist in two polymorphic phases: the low-temperature senarmontite phase with cubic shape and the high-temperature valentinite phase with orthorhombic shape [15–17].

Recently, synthesis and characterization of micro and nanostructures of Sb_2O_3 have been intensively studied by many authors. For examples, Jamal et al. studied the photocatalytic degradation of acridine orange and chloroform sensing using as grown Sb_2O_3 microstructures [13]. Cebriano and coworkers studied the photoluminescence and optical resonances in Sb_2O_3 micro and nanotriangles [18]. Besides, they studied the self-assembly phenomena, luminescence and phase transitions in Sb_2O_3 micro-rods [19]. Zhengtao and coworkers synthesized Sb_2O_3 single-crystalline nanobelts with elliptical cross section and studied its emission properties [20]. They as well investigated the emission properties of single crystalline Sb_2O_3 nanowires with rectangular cross section [21]. Several studies have been

* Corresponding author.
E-mail address: abrahamke@gmail.com (K.E. Abraham).
[1] Present address: Department of Physics, Mar Thoma College for Women, Perumbavoor, Kerala 683542, India.

https://doi.org/10.1016/j.mssp.2018.03.031
Received 6 December 2017; Received in revised form 21 March 2018; Accepted 23 March 2018

PAPER

Enhanced room temperature gas sensing of aligned Mn_3O_4 nanorod assemblies functionalized by aluminum anodic membranes

Neetha John[1], Paulose Thomas[2,1], K V Divya[1] and K E Abraham[1]

Published 11 June 2018 • © 2018 IOP Publishing Ltd

Nanotechnology, Volume 29, Number 33

Citation Neetha John *et al* 2018 *Nanotechnology* **29** 335503

DOI 10.1088/1361-6528/aac655

abrahamke@gmail.com

[1] Department of Physics, S.B. College, Changanassery, Kerala, India-686101

[2] Marthoma College for Women, Perumbavoor, Kerala, India- 683542.

K E Abraham https://orcid.org/0000-0002-6427-3468

1. Received 26 February 2018
2. Revised 26 April 2018
3. Accepted 21 May 2018
4. Published 11 June 2018

Abstract

Enhanced room temperature gas sensing of aligned Mn3O4 nanorods assemblies functionalized by Aluminum Anodic membranes.

To cite this article before publication: Neetha Rachel John *et al* 2018 *Nanotechnology* in press https://doi.org/10.1088/1361-6528/aac655

Enhanced room temperature gas sensing of aligned Mn_3O_4 nanorods assemblies functionalized by Aluminum Anodic membranes.

*Neetha John, Paulose Thomas[1], Divya K. V., Abraham. K. E**

Department of Physics, S.B. College, Changanassery, Kerala, India-686101

ABSTRACT

The study signifies a conductometric chemical sensor design using aligned Mn_3O_4 nanorods. Nanostructuring is an emerging field of prominence due to its capacity to introduce unprecedented properties in materials with potential applications. Hydrothermally prepared in situ Mn_3O_4 sample appears in urchin rod like morphology which changes to spherical shape on annealing. An aluminum anodic membrane/template (AAO) is used for the growth of the nanorods and also as a medium to support the sensor. Aligned Mn_3O_4nanorods are formed in the pores of AAO by vacuum infiltration approach which is later on annealed. Gold electrical contacts are deposited on the top or bottom ends of the Mn_3O_4-embedded AAO to ensure conductometric sensing along the length of the Mn_3O_4 nanorods. In comparison to Mn_3O_4 film based sensor, Mn_3O_4 nanorods in AAO template has enhanced sensitivity for detecting ethanol and acetone vapour at room temperature. The novel property observed is a result of the large surface area and number of oxygen vacancies of the uniformly aligned and parallel assemblies of nanorods. The sensor exhibits lowest response time of 4 seconds for ethanol and 2 seconds for acetone at room temperature with a concentration of 50 ppm. The response time is 7 and 5 seconds respectively for 25 ppm. The maximum sensitivities of the sensor at room temperature for ethanol and acetone gases are 67 % and 68 % respectively for 50 ppm concentration. The growth mechanism of aligned nanorods formed in the AAO template is well established through FESEM analysis. The XPS and HRTEM study give additional evidence for the presence of oxidation states and structure of prepared nanostructures respectively.

KEYWORDS: *Mn_3O_4 nanorod; Aluminum Anodic Membrane; Gas sensor.*

1. INTRODUCTION

Metal oxide nanocrystals are proficient to exhibit exemplary electrical applications which has triggered the quest to design their improved versions with functional applications like sensing, energy storage, catalysis and magnetic data storage [1]. Among them, manganese oxides are widely used in many fields because of their potential applications such as supercapacitors [2], ion exchange [3], molecular absorption [4], magnetic applications [5] and secondary batteries

[1]Marthoma College for Women, Perumbavoor, Kerala, India- 683542.

*Corresponding author email address: abrahamke@gmail.com

Dielectric relaxation and AC conductivity mechanism of eco-friendly Fe_2O_3 hexagonal nanomorphotype

T. PAULOSE, K. E. ABRAHAM*
St. Berchmans College, Changanacherry, Kerala, 686 101, India

We report dielectric and electron transport properties of hydrothermally synthesized ecofriendly Fe_2O_3 hexagonal nanomorphotype. The space charge polarization and orientational polarizations are the main mechanisms behind the dielectric property of Fe_2O_3 nanostructure. The frequency and temperature dependent impedance analysis was carried out in the frequency range 100Hz-1MHz. By theoretical fitting methods, the dielectric relaxation formalism has been identified as the Cole-Cole like relaxation. The AC conductivity in the nanomorphotype obeys the universal power law and also the frequency exponent parameter "s" decreases with increase in temperature. Correlating the nature of "s" with various theoretical models and observing that the conduction mechanism is mostly due to the thermally activated charge carriers, both overlapped polaron hopping transport (OLPT) and correlated barrier hopping (CBH) theoretical models are found to be valid in the present case. The dielectric study of Fe_2O_3 hexagonal nanomorphotype opens up the way for developing charge storage devices with least environmental hazard.

(Received March 21, 2016; accepted June 7, 2017)

Keywords: Fe_2O_3 hexagonal nanomorphotype, Dielectric properties, Impedance spectroscopy, AC conductivity

1. Introduction

The researchers in nanoregime have great interest to extract the dielectric behavior of semiconductor metal oxide nanomaterials. The semiconductor metal oxide nanomaterials show huge dielectric constant in nano range compared to its bulk microstructure [1-3]. The high dielectric constant materials are used in various technological applications like wireless communication systems, high energy storage devices, space missions, etc [4]. But still, the efficient dielectric as well as materials used in electronic industry has made huge negative environmental impact on earth surface/atmosphere. After the usage, scientific world are least concerned about the disposals of these materials. Meanwhile more research is being carried out to find better ecofriendly materials for electronic/industrial applications. Many more recent studies show Fe_2O_3 nanostructures are an ecofriendly material [5-7]. The present study is to put forward the ideas of dielectric and electron transport property of more ecofriendly Fe_2O_3 hexagonal nanomorphotype for electronic applications.

Recently, nanostructured Fe_2O_3 has received great attention due to its variety of applications in the field of energy, environmental studies, pigment for paint industry, and contrasting agent for medical diagnostics, magnetic resonance imaging and many other biomedical applications [8, 9]. In recent years, researchers have fabricated different morphotypes of iron oxide nanomaterials. For instance, Aaron M et al. reveal three iron oxide polymorphs, hematite, maghemite and magnetite grown on KBr substrates and its vibrational spectroscopic analysis [10]. Albert G. Nasibulin et al.and Huey-Wen Liou et al reported the Raman spectroscopic and hyperthermia therapy study of Fe_2O_3 nanowires respectively [11, 12]. Nitin Kaduba Chaudhari et al. and De Mont ferrand C et al. fabricated environment friendly hexagonal shaped Fe_2O_3 nanocrystals [13, 14]. However, there is lack of detailed reports from the dielectric properties of nanomaterials with hexagonal shapes especially in Fe_2O_3 nanostructures. N. N. Mallikarjuna and team reported the novel high dielectric constant nano composites of polyaniline dispersed with α-Fe_2O_3 nanoparticles and they suggested that conductivity and dielectric constant values are increased by increasing the amount of α-Fe_2O_3 in the matrix [15]. S. I. Srikrishna Ramya and C. K. Mahadevan conducted a work on the effect of calcination on the electrical properties and quantum confinement of Fe_2O_3 nanoparticles and reported that dielectric property is strongly dependent to quantum confinement effect [16]. S.K. Sahoo et.al studied the characterization of γ and α -Fe_2O_3 nano powders synthesized by emulsion precipitation-calcination route and also examined the rheological behavior of α -Fe_2O_3 [17]. S. M. Reda tested the electric and dielectric properties of Fe_2O_3/Silica nanocomposites and suggested that AC conductivity and dielectric loss of these composites increased gradually with increasing both annealing temperature and particle size [18]. S. S. Shinde and coworkers fabricated the hematite α -Fe_2O_3 thin films and examined its application to photoelectron chemical solar cells [19]. M. V. N. Ambika Prasad et.al studied the electrical and sensing properties of Polyaniline / Iron Oxide nanocomposites and reported that prepared nanocomposite has potential application in sensor devices [20].