# Curriculum vitae


***Palla Gopal***

***pgopal@iittp.ac.in***
***pgopal1802@gmail.com***
***Mob:-+91-9393055020***

**ADDRESS**
D. No – 23/378,
Nagulakatta street,
Jammalamadugu,
Kadapa, Andhra Pradesh,
India, Pin: 516434.


## RESEARCH INTERESTS

Electrochemical sensors and biosensors
wearable sensors and biosensors
Lab-on-chip biosensing devices
Nanomaterials for biosensor applications
Surface plasmon resonance based biosensors

## CAREER

| | |
|---|---|
| **Jan-2019 to April-2020** | **Postdoctoral Research Fellow -** Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, Olsztyn, Poland.<br>**Project Title:** *Development of new generation biosensors suitable for the early diagnosis of neurodegenerative diseases*.<br>**Advisor: Prof. Hanna Radecka.** |
| **2017** | **Ph. D. – Electroanalytical chemistry *(December 2017)*,**<br>**Sri Venkateswara University, Tirupati, INDIA**.<br>**Thesis Title:** *Development of electrochemical sensors and biosensors for the monitoring of natural antioxidants, drugs and environmental pollutants.*<br>**Advisor: Dr. T. Madhusudana Reddy.** |
| **2010** | **M. Sc. – Physical Chemistry**<br>**Sri Venkateswara University, Tirupati, INDIA**. |
| **2008** | **B. Sc.** – **Mathematics, Physics, Chemistry**<br>S. C. N. R. Govt. Degree College, Proddatur, India<br>**Sri Venkateswara University, Tirupati, INDIA.** |

## AWARDS AND DISTINCTIONS

| | |
|---|---|
| 2011 | Qualified **CSIR-UGC National Eligibility Test for Lectureship** |
| 2012 | Qualified **Graduate Aptitude test for Engineering (GATE-2012)** |
| 2013 | **Meritorious Research Fellowship (JRF)** by UGC-BSR, Govt. of India, New Delhi**,** India |
| 2017 | **Best Oral Presentation Award** in the Two Day National 2017 Seminar on Modern Trends in Chemistry Research (MTCR2017) January, 27-28, 2017. |

**RESEARCH EXPERTISE:**

- ✓ Development of various and antibody-based immunosensing platforms for the biosensors.
- ✓ Self-assembled monolayer redox center-based platforms for electrochemical sensors and biosensors applications.
- ✓ Metal complexes for the development of self-assembled monolayer based redox centers
- ✓ Antibody based immunosensor platforms for neurodegenerative diseases.
- ✓ Immobilization of nanostructured materials and Enzymes on the electrode surface.
- ✓ Surface plasmon resonance (SPR) based analysis of biomolecule interaction with surface.
- ✓ Surface characterization with Atomic Force Microscopy (AFM)
- ✓ Development of simple electrochemical sensors and biosensors for the monitoring of various natural antioxidants, drugs and environmental pollutants.
- ✓ Development of acetylcholinesterase-based biosensors for the monitoring of pesticide residues.
- ✓ Development of novel nanocomposite materials for both energy storage and sensor applications.
- ✓ Characterization of the developed sensors with cyclic voltammetry, differential pulse voltammetry, square wave voltammetry, electrochemical impedance spectroscopy, chronoamperometry, Surface plasmon resonance (SPR), Atomic force microscopy (AFM) and scanning electron microscopy (SEM).
- ✓ Detailed investigation of electrochemical reduction and oxidation mechanisms of various phenolic compounds and nitro aromatic compounds.
- ✓ Evaluation of kinetic parameters such as diffusion coefficient, heterogeneous rate constants and analytical parameters.
- ✓ Enzyme kinetics and mechanism pathway of enzyme towards specific analyst.
- ✓ Practical applications of the developed sensors for the quantitative estimation of antioxidants in food beverages, drugs in pharmaceutical formulations and environmental pollutants in water samples.

**PROFESSIONAL EXPERIENCE:**

- ✓ 2017 to 2018, Project Associate, **Indian Institute of Technology Tirupati, Tirupati**. (Duties include lab course for undergraduates).
- ✓ 2012–October to 2016–December, involved in conducting the physical chemistry lab course for the post graduates in **Sri Venkateswara University, Tirupati, India**.
- ✓ 2015–January to 2017–May, involved in teaching the Electroanalytical techniques, Electrochemistry, Nuclear chemistry, Advances in polarography for post graduates in **Sri Venkateswara University, Tirupati, India**.
- ✓ 2012-June to 2012-December, worked as a project assistant for the "**Development of acetylcholinesterase-based biosensors for pesticide monitoring**".

**PROFESSIONAL MEMBERSHIP:**

- ✓ Life member of ***Indian society of electroanalytical chemistry (ISEAC)*** from 2017.
- ✓ Life member of ***Association of Environmental Analytical Chemistry of India (AEACI)*** from 2014.

## LIST OF PUBLICATIONS PUBLISHED AND IN PRESS

1. **P. Gopal**, K. Malecka, Wim Dehaen, Jerzy Radecki, Hanna Radecka, Immunosensor incorporating half-antibody fragment for electrochemical monitoring of Amyloid-β fibrils in artificial blood plasma. ***Bioelectrochemistry,*** 137, **2021,** 107643.
2. **P. Gopal**, G. Narasimha, T. Madhusudana Reddy, Electrochemical kinetic evolution of epinephrine at the developed tyrosinase based biosensor and its sensitive determination in human serum samples. ***Process Biochemistry,*** 92, **2020**, 476-485.
3. K. Malecka, S. Menon, **P. Gopal,** K. Girish Kumar, M. Daniels, W. Dehaen, J. Radecki, H. Radecka, Redox-active monolayers self-assembled on gold electrodes-effect of their structures on electrochemical parameters and DNA sensing ability, ***Molecules***, 25, **2020,** 607.
4. P. Raghu, T. Madhusudana Reddy, **P. Gopal**, K. Reddaiah, N. Y. Sreedhar, A novel horseradish peroxidase biosensor towards the detection of dopamine: A voltammetric study, ***Enzyme Microb. Technol.,*** 57, **2014,** 8–15.
5. T. V. Gopal, T. Madhusudana Reddy, P. Shaikshavali, G. Venkataprasad, **P. Gopal,** A Facile In-Situ Development of L-Valine Film onto the Surface of Carbon Paste Electrode Towards the Detection of Environmentally Hazardous 4-Amino Phenol, Zeitschrift für Physikalische Chemie, (https://doi.org/10.1515/zpch-2019-0007)

6. G. Venkataprasad, T. Madhusudana Reddy, A. Lakshmi Narayana, O. M. Hussain, P. Shaikshavali, T. Venu Gopal, **P. Gopal,** A facile synthesis of Fe3O4-Gr nanocomposite and its effective use as electrochemical sensor for the determination of dopamine and as anode material in lithium ion batteries, ***Sens. Actuator A-Phys,*** 293, **2019**, 87–100.
7. P. Shaikshavali, T. Madhusudana Reddy, V. N. Palakollu, R. Karpoormath, Y. Subba Rao, G. Venkataprasad, T. Venu Gopal, **P. Gopal**, A simple method of developing CuOAu/MWCNTs nanocomposite modified glassy carbon electrode for the sensitive and selective simultaneous monitoring of Acetaminophen and 4-Aminophenol, ***Synthetic Metals***, 252, **2019,** 29–39.
8. G. Venkataprasad, T. Madhusudana Reddy, T. Venu Gopal, P. Shaikshavali, **P. Gopal,** Fabrication of a Novel Shaped Graphene/poly (Evan's blue) Composite Chemical Sensor for the Electrocatalytic Boost up of Neurotransmitter (Dopamine): A Voltammetric Investigation, ***Anal. Bioanal. Electrochem.,*** 11, **2019,** 1100-1116.
9. **P. Gopal,** T. Madhusudana Reddy, Development of electrochemical sensor for the monitoring of terbutaline in pharmaceutical formulations. ***Colloids Surf. A,*** 538, **2018,** 600–609.
10. P. Shaikshavali, T. Madhusudana Reddy, G. Venkataprasad, **P. Gopal**, A highly selective electrochemical sensor based on multi walled carbon nano tubes/poly (Evans blue) composite for the determination of L-Dopa in presence of 5-HT and folic acid: A voltammetric investigation, ***J. Iran. Chem. Soc.,*** 15, **2018**, 1831–1841.
11. T. Venu Gopal, T. Madhusudana Reddy, G. Venkataprasad, P. Shaikshavalli, **P. Gopal**, Rapid and sensitive electrochemical monitoring of paracetamol and its simultaneous resolution in presence of epinephrine and tyrosine at graphene oxide and L-Valine composite film modified carbon paste electrode, ***Colloids Surf. A***, 545, **2018**, 117-126.
12. G. Venkataprasad, T. Madhusudana Reddy, T. Venugopal, P. Shaikshavali, **P. Gopal**, A novel electrochemical sensor based on multi-walled carbon nanotubes/poly (LMethionine) for the investigation of 5-nitroindazole: A voltammetric study. ***Anal. Chem. Lett.,*** 8, **2018**, 457–474.
13. **P. Gopal**, T. Madhusudana Reddy, P. V. Narayana, Development, Characterization and Application of a Carbon-Based Nanomaterial Composite as an Electrochemical Sensor for Monitoring Natural Antioxidant (Gallic Acid) in Beverages, ***ChemistrySelect***, 2, **2017**, 1–9.
14. G. Venkataprasad, T. Madhusudana Reddy, P. Shaikshavali, **P. Gopal**, P. V. Narayana, Electrochemical Determination of 3,5-dinitrobenzoic Acid in the Presence and Absence of CTAB at Multi-Walled Carbon Nanotubes Modified Glassy Carbon Electrode: A Voltammetric Study, ***Anal. Bioanal. Electrochem.,*** 9, **2017,** 400-411.

15. P. Shaikshavali, T. Madhusudana Reddy, G. Venkataprasad, **P. Gopal**, Fabrication, Characterization and Application of Poly (L-Cystine)/multi Walled Carbon Nanotubes Modified Glassy Carbon Electrode towards the Simultaneous Determination of Dopamine in presence of Uric Acid and Folic Acid, ***Anal. Bioanal. Electrochem.,*** 9, **2017,** 940-955.
16. G. V. Raghunadha Reddy, T. Madhusudana Reddy, P. V. Narayana, **P. Gopal**, K. Reddaiah, Electrochemical Determination of Dopamine and its Simultaneous Resolution in the Presence of Uric Acid at Poly (Pyrocatechol Violet) Modified Glassy Carbon Electrode: A Voltammetric Study, ***Indian Journal of Advances in Chemical Science,*** 4, **2016,** 250-256.
17. G. V. Raghunatha Reddy, T. Madhusudana Reddy, **P. Gopal,** P. V. Narayana, The Electrochemical Redox Behavior of Pyrocatechol Violet and its Quantitative Measurement at Graphene Modified Glassy Carbon Electrode: A Voltammetric Study, ***Indian Journal of Advances in Chemical Science,*** 4, **2016,** 490-495.
18. P. V. Narayana, T. Madhusudana Reddy, **P. Gopal**, M. Mohan Reddy, G. Ramakrishna Naidu, Electrocatalytic boost up of epinephrine and its simultaneous resolution in the presence of serotonin and folic acid at poly (serine)/multi-walled carbon nanotubes composite modified electrode: A voltammetric study, ***Mater. Sci. and Eng. C***, 56, **2015,** 57–65.
19. **P. Gopal**, T. Madhusudana Reddy, P. Raghu, K. Reddaiah, P. V. Narayana, Electrocatalytic Activity of L-Cystine towards the Sensitive and Simultaneous Measurement of Nitrobenzene and 4-Nitrophenol: A Voltammetric Study, ***Anal. Bioanal. Electrochem***., 7, **2015,** 739-751.
20. **P. Gopal**, T. Madhusudana Reddy, C. Nagaraju, G. Narasimha, Preparation, characterization and analytical application of an electrochemical laccase biosensor towards low level determination of isoprenaline in human serum samples, ***RSC Adv.,*** 4, **2014,** 57591-57599.
21. **P. Gopal,** T. Madhusudana Reddy, P. Raghu, K. Reddaiah, P. V. Narayana, The Electrochemical Redox Behaviour of Acid Blue 25 and its Quantitative Measurement at Carbon Paste Electrode: A Voltammetric Study, ***Anal. Bioanal. Electrochem.,*** 6, **2014,** 183 – 194.
22. P. V. Narayana, T. Madhusudana Reddy, P. **Gopal,** G. Ramakrishna Naidu, Electrochemical sensing of paracetamol and its simultaneous resolution in the presence of dopamine and folic acid at a multi-walled carbon nanotubes/poly(glycine) composite modified electrode, ***Anal. Methods***, 6, **2014,** 9459-9468.
23. K. Reddaiah, T. Madhusudana Reddy, Y. Subba Rao, P. Raghu, **P. Gopal**, Development of electrochemical sensor based on β-cyclodextrin/$K_{10}$ montmorillonite towards the enhanced

electro-catalytic oxidation of isoorientin: A voltammetric study, ***Mater. Sci. and Eng. B***, 183, **2014,** 69–77.

24. P. V. Narayana, T. Madhusudana Reddy, **P. Gopal**, P. Raghu, K. Reddaiah and M. Srinivasulu, Development of Trypan Blue Polymer Film Based Electrochemical Sensor for the Determination of Dopamine and its Simultaneous Detection in Presence of Ascorbic Acid and Uric acid: A Voltammetric Method, ***Anal. Bioanal. Electrochem.,*** 6, **2014,** 485-500.
25. P. V. Narayana, T. Madhusudana Reddy, **P. Gopal**, K. Reddaiah, P. Raghu, Development of Electrochemical sensor based on Poly (xylenol orange) film towards the determination of L-Dopa and its simultaneous resolution in the presence of Uric acid: A cyclic Voltammetric study, ***Research Journal of Chemical Sciences,*** 4, **2014,** 37-43.
26. **P. Gopal**, T. Madhusudana Reddy, K. Reddaiah, P. Raghu, P. V. Narayana. "An electrochemical investigation and reduction mechanism of 3, 5- Dinitrobenzoic acid at a glassy carbon electrode: A voltammetric study" ***J. Mol. Liq.***, 178, **2013,** 168-174.
27. K. Reddaiah, T. Madhusudana Reddy, P. Raghu, **P. Gopal**, "Sol-gel Immobilized Horseradish Peroxidase Modified Carbon Paste Electrode towards the Determination of Hydroquinone in Non-Aqueous Solvents: A Voltammetric Study" ***Anal. Bioanal. Electrochem.,*** 4, **2012,** 372-385.

## IN-PREPARATION AND SUBMITTED

1. **P. Gopal**, G. Narasimha, T. Madhusudana Reddy, *The voltammetric kinetic evolution and sensitive monitoring of rutin at tyrosinase based electrochemical biosensor.* (Manuscript ***Under communication***)
2. **P. Gopal**, G. Narasimha, T. Madhusudana Reddy**,** *Novel application of a biosurfactant for the development of electrochemical biosensor towards the sensitive and simultaneous monitoring of dopamine in the presence of uric acid and ascorbic acid* (Manuscript ***Under communication***)
3. G. V. Raghunatha Reddy, T. Madhusudana Reddy, **P. Gopal**, *Development of an electrochemical sensor based on modification of glassy carbon electrode with multi walled carbon nano tubes for the sensitive determination of Metaraminol* (Manuscript ***Under communication***)

4. G. V. Raghunatha Reddy, T. Madhusudana Reddy, **P. Gopal**, *Electrochemical sensor for the sensitive detection of riboflavin at glassy carbon electrode modified with multi walled carbon nano tubes* (Manuscript ***under preparation***)

## Conferences/Workshops (selected):

- **Poster presented in** 9th International Workshop on Surface Modification for Chemical and Biochemical Sensing held in 8 - 12 November 2019,

  **Poster title:** Label Free Electrochemical Immunosensing Platforms Based on Self-Assembled Monolayers for Monitoring of $A\beta_{1-42}$ Fibrils
- **Poster presented in** International Conference on Electrochemical Science and Technology 2014 held on 7-9 August 2014 in IISc, Bangalore**.**
- **Poster presented in** Discussion meet on Electrochemistry and Applications ($12^{th}$ ISEAC – DM – 2016) held on 7 – 8 December, 2016 in Mumbai.
- **Attended** BRNS – AEACI Tenth School on Analytical Chemistry – 2015 during 18 – 25 May 2015.

**Google Scholar Profile**:

https://scholar.google.com.au/citations?user=mGjhjVIAAAAJ&hl=en

**Researchgate Profile**:

https://www.researchgate.net/profile/Palla_Gopal

## REFEREES:

**Dr. T. Madhusudana Reddy**,
Assistant Professor,
Department of Chemistry,
SVU College of sciences,
Sri Venkateswara University, Tirupati – 517502.
tmsreddysvu@gmail.com
Mobile: +91-9441088587

**Prof. Hanna Radecka,**
Institute of Animal Reproduction and
Food Research
Polish Academy of Sciences
Tuwima-st 10
10-748 Olsztyn, Poland. Tel. (+4889) 523 46 36
hanna.radecka@pan.olsztyn.pl

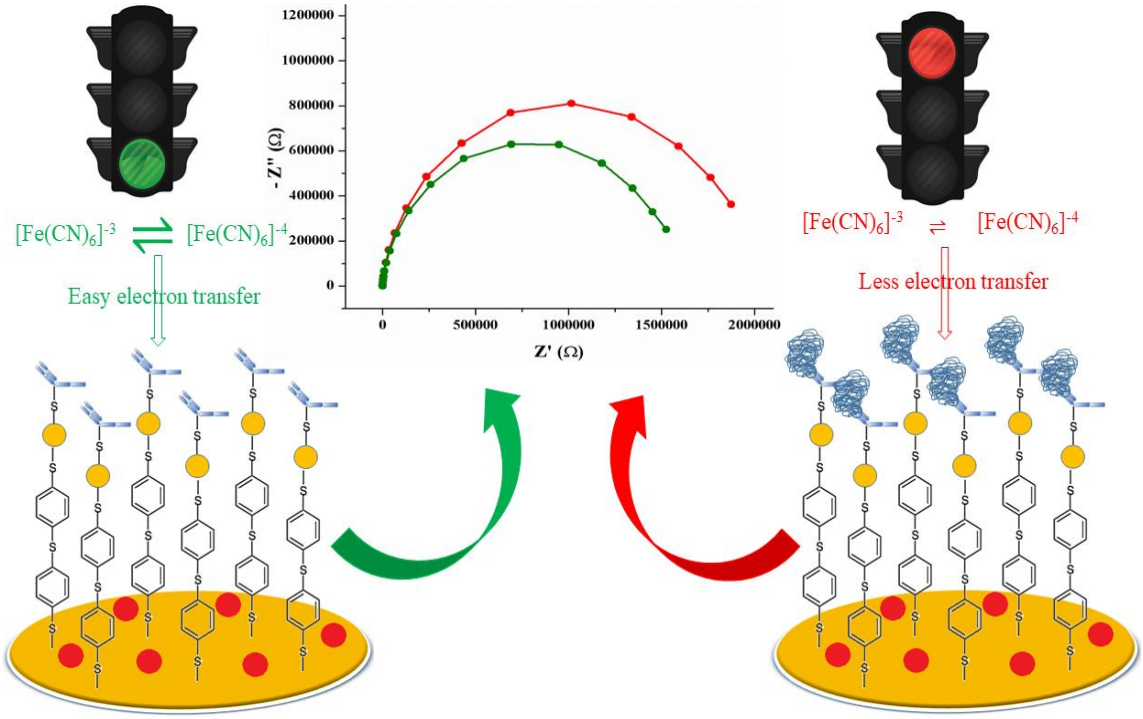
**Dr. Debasish Mondal,**
Assistant Professor,
Department of Chemistry,
Indian Institute of Technology Tirupati,
Tirupati, India – 517506
debasish@iittp.ac.in
Mobile: +91-9515275435

# ***Summary***


**Summery of Postdoctoral research:**

**Immunosensor incorporated Fab part of Anti-Amyloid Fibrils OC Antibody for electrochemical monitoring of Amyloid-β fibrils in artificial blood plasma**

Here in, an electrochemical immunosensor for the selective and sensitive monitoring of $A\beta_{1-42}$ fibrils is presented. The sensing platform was prepared via the formation of 4,4′-thiobisbenzenethiol (TBBT) self-assembled monolayer on the clean gold surface followed the covalent entrapment of gold nanoparticles (AuNPs). The Fab parts of OC antibody were immobilized on AuNPs via S-Au covalent Au-S bonds. The fabricated immunosensor was successfully characterized with the aid of cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and atomic force microscopy (AFM) studies. The developed biosensor was efficaciously used for the sensing of $A\beta_{1-42}$ fibrils in both phosphate saline buffer (PBS) and artificial blood plasma (ABP) displaying good sensitivity level of 67.97 kΩ/pM and 127.18 kΩ/pM for PBS and ABP respectively. The moderate response towards $A\beta_{1-42}$ oligomers proved the immunosensor selectivity.

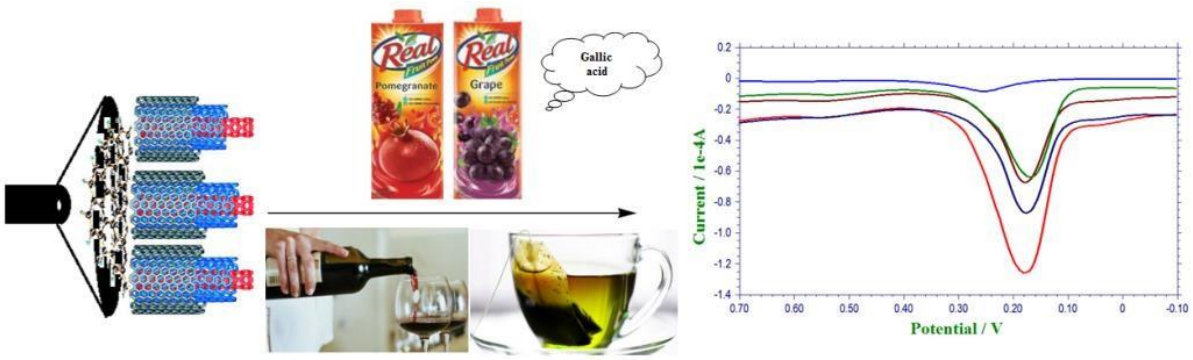




Graphical representation for sensing mechanism of biosensor towards sensing of $A\beta_{1-42}$ fibrils

**Summery of Doctoral research:**

## Electrochemical monitoring of Gallic acid in Food samples at graphene and Multi walled carbon nano tubes modified Glassy carbon electrode

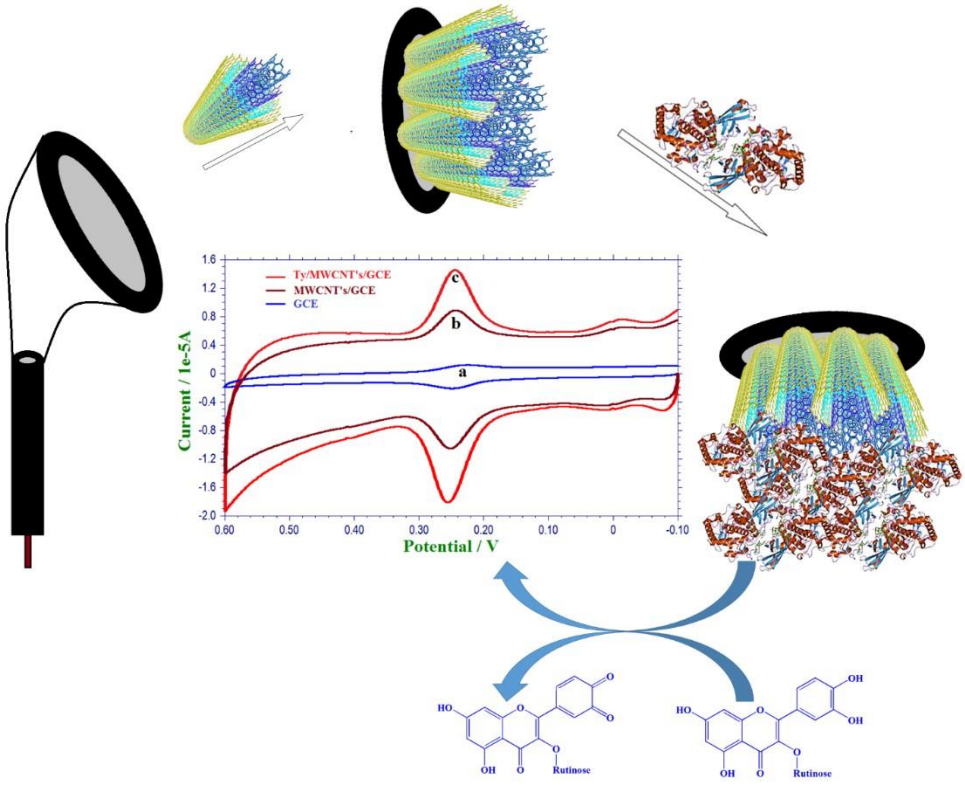
Gallic acid (GA) is one of the organic acids, which is found in many natural plants and in food beverages. Here in, we have developed a chemical sensor for the monitoring of GA in various food beverages like wine, green tea and fruit juices. The electrochemical oxidation behavior of GA was found to be as an irreversible oxidation process and the electrochemical oxidation mechanism was proposed. The effect of supporting electrolyte pH on the electrochemical oxidation behavior was studied and pH-6.0 was selected as an optimum pH. Based on the scan rate results a linear relation was observed between the square root of scan rate and peak currents of GA confirming the oxidation process of GA as diffusion controlled process. Kinetic parameters such as number of electrons involved in the oxidation process of GA, heterogeneous rate constant and charge transfer coefficient values were determined. From the effect of concentration results, limit of detection (LOD) and limit of quantification (LOQ) values were calculated as $4.39 \times 10^{-7}$ M and $1.46 \times 10^{-6}$ M. The repeatability, reproducibility and stability of the developed electrode were examined and the results were confirmed that the developed sensor was in superior in condition. Finally, the practical application of the developed sensor was examined for the quantitative estimation of GA in wine, green tea and fruit juices.




Electrochemical behavior of GA at Graphene/MWCNTs/GCE.

**The voltammetric kinetic evolution and sensitive monitoring of rutin at tyrosinase based electrochemical biosensor**

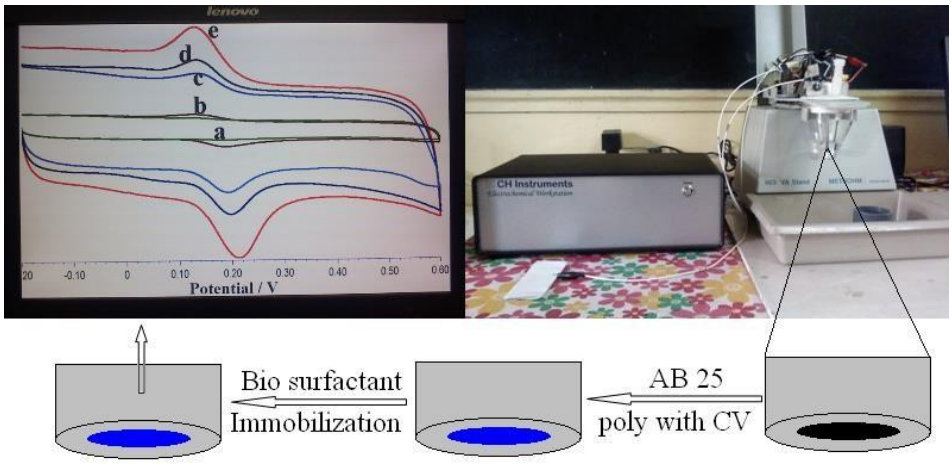
Rutin (RU) is an important antioxidant found in many plants and natural sources. Herein our present investigation was focused on the development of electrochemical biosensor based on the modification of glassy carbon electrode (GCE) for the sensitive monitoring of RU. The modification was achieved by the drop casting of multi walled carbon nano tubes (MWCNTs) followed by immobilization of Tyrosinase enzyme (Ty) on to the GCE surface. The developed biosensor was characterized by cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and Tafel plot studies. The electrochemical redox behavior of RU at developed biosensor was studied and the possible electrochemical redox mechanism was proposed. In order to achieve sensitive results, the effect of supporting electrolyte pH on the redox behavior of RU was observed and pH – 6.0 was selected as optimum pH. Further the kinetic behavior of RU at developed biosensor was evaluated and it was found to be an adsorption controlled process. From the effect of scan rate results the surface coverage concentration (Γ), heterogeneous rate constant ($k_s$) and charge transfer coefficient values (α) were estimated. The analytical parameters such as limit of detection and limit of quantification values were calculated from the linear regression equation as $4.673 \times 10^{-8}$ M and $1.55 \times 10^{-7}$ M. Finally, the practical utility of the developed biosensor was tested for the repeatability, reproducibility and stability.




Electrode mechanism for redox behavior of Rutin.

**A novel application of biosurfactant as a biosensor for sensitive monitoring of Dopamine in the presence of Uric acid and Ascorbic acid.**

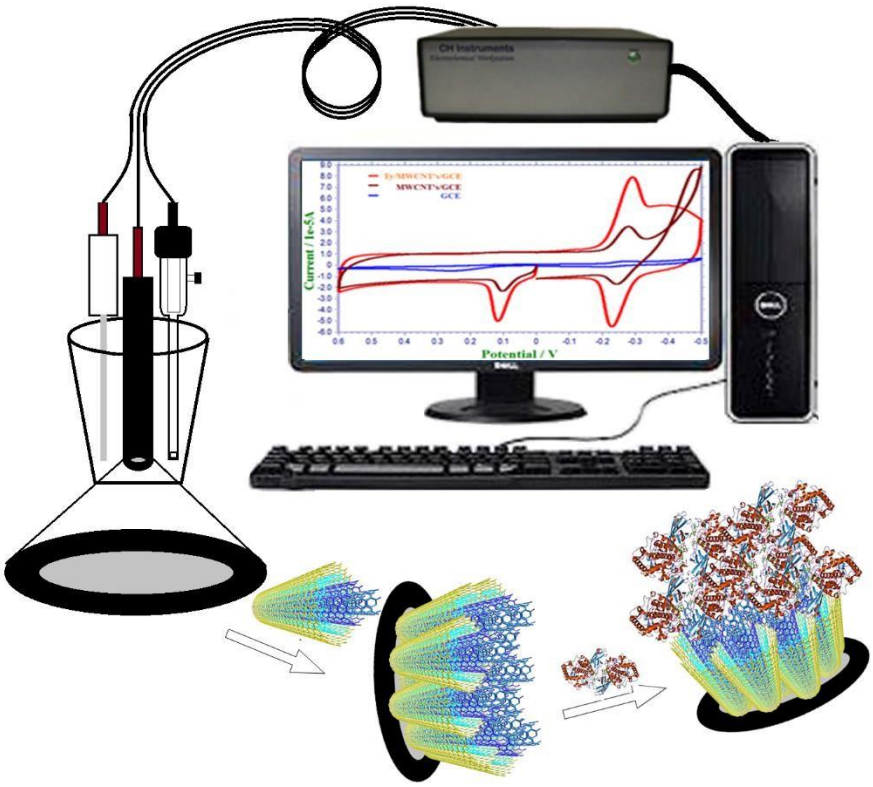
Herein, for the first time we have reported biosurfactants for the sensor application. Biosurfactants are surface active and produced from fungi, bacteria and yeast. Biosurfactants will have amphiphilic nature and contains a hydrophobic and hydrophilic moiety that enhances the sensitivity of the analyte molecules. Dopamine is an important neurotransmitter plays vital role in functioning of human brain and Dopamine was determined on the basis of immobilization of biosurfactants on polyAB25/GCE. Dopamine has showed reversible oxidation and reduction peaks at potentials nearly about 0.3 V. Based on the effect of pH results, the electrochemical reaction involves equal number of protons and equal number of electrons. The scan rate results reveal that the redox reaction of dopamine was controlled by diffusion process. Through the calibration plot, limit of detection (LOD) and limit of quantification (LOQ) values were evaluated. Simultaneous determination of dopamine in the presence of Uric acid and Ascorbic acid was successfully carried out. Repeatability, reproducibility and stability of the developed biosensor were examined and the results were in satisfactory condition.




Graphical abstract for the redox behavior of Dopamine.

**Electrochemical kinetic evolution of epinephrine at the developed tyrosinase based biosensor and its sensitive determination in human serum samples**

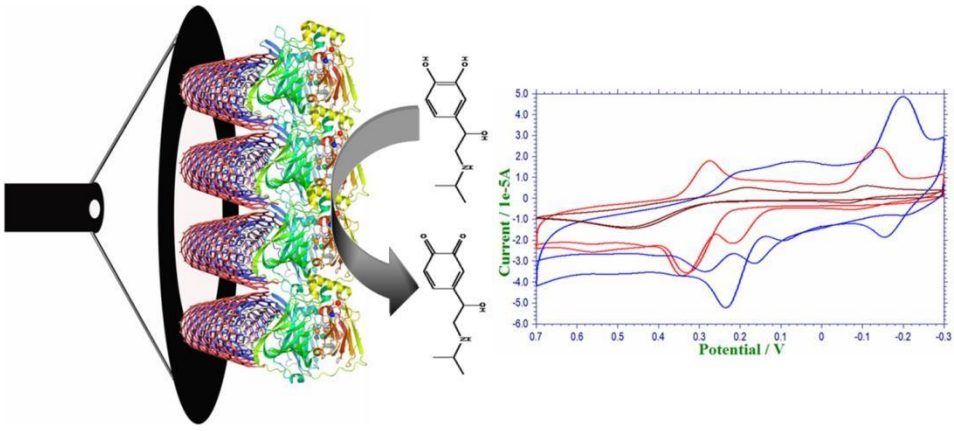
Epinephrine (EP) is one of the important neurotransmitters, which plays a vital role in the central nervous system. Here in, the present work reports the development of biosensor based on the modification of glassy carbon electrode with multi walled carbon nano tubes followed by the drop casting of Tyrosinase enzyme (Ty/MWCNTs/GCE) towards the sensitive determination of EP. The comprehensive electrochemical redox behavior of EP at the developed biosensor was examined and the redox mechanism was anticipated. The biosensor was characterized by using cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and tafel plot studies. The effect of pH on the redox behavior of EP was studied and pH-7.0 was selected as optimum pH. From the effect of scan rate results, kinetic parameters such as diffusion coefficients, charge transfer coefficients and heterogeneous rate constant values were evaluated. Through calibration plot, the limit of detection and limit of quantification values were evaluated. The low apparent Michaelis – Menten constant ($K_m^{app}$) was determined as 0.159 mM, demonstrating the immense catalytic activity of the Ty enzyme. The repeatability, reproducibility and stability of the developed biosensor were studied. Finally, the developed biosensor was seasoned for the practical application in quantification of EP in human serum samples.




Fabrication of biosensor and redox behavior of Epinephrine.

**Preparation, characterization and analytical application of an electrochemical laccase biosensor towards low level determination of isoprenaline in human serum samples**

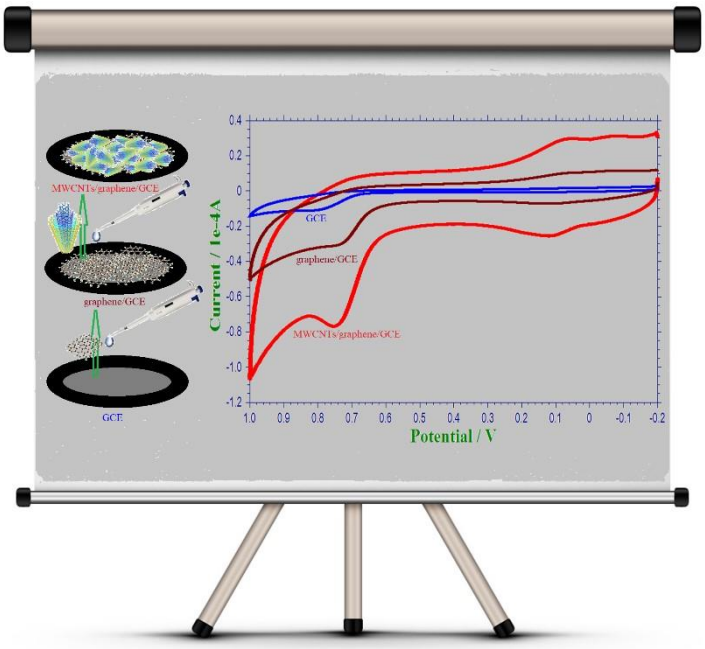
A novel electrochemical biosensor was developed based on the immobilization of multi walled carbon nanotubes (MWCNT) on to the glassy carbon electrode (GCE) and subsequent casting of silca sol-gel (SiSG) entrapment of Laccase (Lac) enzyme on to the MWCNT/GCE. The catalytic activity of laccase biosensor was found to be good enough in sensitive determination of Isoprenaline (ISP) with the aid of voltammetric techniques and we have also demonstrated the detailed electrochemical redox mechanism of ISP. From the effect of the pH, we have optimized the optimum pH as 5.5 and from effect of scan rate; we have evaluated the kinetic parameters, heterogeneous rate constant, charge transfer coefficient and diffusion coefficient values. Furthermore, limit of detection (LOD) and limit of quantification (LOQ) values were achieved as $1.8 \times 10^{-7}$ M and $6.0 \times 10^{-7}$ M. The simultaneous determination of ISP in the presence of uric acid (UA) and ascorbic acid (AA) was successfully carried out. The surface nature of the biosensor was characterized by using the electrochemical impedance spectroscopy. Finally, the validation of the proposed method was verified by the recovery of injection (ISP) in serum sample and their recoveries were found to be in satisfactory range. The proposed method was found to have good repeatability, reproducibility and stability with lower relative standard deviation (RSD) values.




Fabrication of SiSG-Lac/MWCNT/GCE and redox behavior of Isoprenaline.

**Development of electrochemical sensor for the monitoring of terbutaline in pharmaceutical formulations**

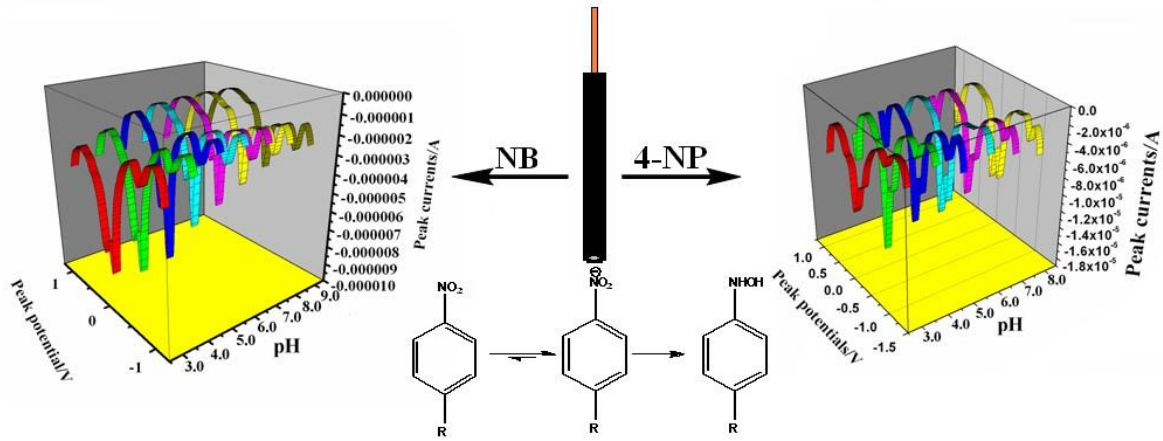
The present investigation is focused on the quantitative monitoring of Terbutaline (TB) based on the development of a chemical sensor made by the modification of glassy carbon electrode (GCE) with graphene followed by multi walled carbon nanotubes (MWCNTs). The developed sensor was characterized with cyclic voltammetry, Tafel and electrochemical impedance spectroscopy (EIS) studies. The detailed electrochemical redox behavior of TB was examined and possible redox mechanism was proposed. We have studied the effect of pH on the redox behavior of TB and the results suggest that the pH-4.5 was an optimum pH. From the effect of scan rate results, we have made a conclusion that the redox process was controlled by diffusion process and the kinetic parameters were calculated. In order to obtain the limit of detection and limit of quantification, we have examined the effect of concentration and from the calibration plot it was found as $6.527 \times 10^{-7}$ M and $2.175 \times 10^{-6}$ M. The repeatability, reproducibility and stability of MWCNTs/graphene/GCE, suggest that the developed sensor was superior in condition. The developed sensor was used for the estimation of TB in pharmaceutical formulations and the results were found to be in satisfactory range.




The electrochemical behavior of Terbutaline at fabricated sensor.

**Electrocatalytic activity of L-cystine towards sensitive and simultaneous measurement of nitrobenze and 4-nitrophenol: A voltammetric study**

A new simple, sensitive and selective electrochemical method for the determination of Nitrobenzene (NB) and 4-Nitrophenol (4-NP) at L-Cystine modified glassy carbon electrode was developed with the help of cyclic voltammetry (CV) and differential pulse voltammetry (DPV) techniques. Based on the effect of pH, a detailed electrochemical redox mechanism was proposed and the number of electrons involved in the $R\text{-}NO_2 \rightarrow R\text{-}NO_2^{-\bullet}$ step was determined. The kinetic parameters such as heterogeneous rate constants ($k_s$) and charge transfer coefficient ($\alpha$) values were calculated and were found to be as $0.711 \times 10^{-6}$ $s^{-1}$, $1.486 \times 10^{-6}$ $s^{-1}$ and 0.521, 0.501 for both NB and 4-NP respectively. The NB and 4-NP systems were controlled by diffusion process and the diffusion coefficients values were determined as $3.24 \times 10^{-7}$ $cm^2/s$ and $7.04 \times 10^{-7}$ $cm^2/s$ for NB and 4-NP respectively. The limit of detection (LOD) and limit of quantification (LOQ) values were evaluated as 0.746 µM/L, 2.49 µM/L for NB and 1.049 µM/L, 3.49 µM/L for 4-NP respectively. The developed method was effectively applied for the simultaneous determination of NB and 4NP. Moreover, the surface nature of the electrode was investigated by electrochemical impedance spectroscopy. Finally, the developed method was successfully applied for the real sample analysis with satisfactory recovery values having low RSD values.




Graphical representation of electrochemical behavior of 4-NP and NB.

*********