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[Web Page](#) | [Google Scholar](#) | [ORCID](#) | [Vidwan](#) | [Researcher ID](#) | [Scopus](#)

Professional Overview


A dynamic researcher with experience and focusing on

- Anode and Cathode Catalysts for Fuel cell Applications
- Green Hydrogen Production-Photocatalytic CO₂ Reduction
- M13 bacteriophage, Biomaterials, Biosensors, and Electrochemical Sensors
- Smart Conductive Hollow Carbon Networks – Lithium-Sulfur Battery Applications
- Exfoliation of Metal Nanosheets from Hexacyanometalates – Energy Storage Applications

Professional Experience (As of January 2025)

- **Assistant Professor (Stage-11)** (Dec 22, 2020 – Ongoing): **4 Years and 1 Month**
 Dept of Chemistry, Institute of Science, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India
- **Visiting Professor** (October 2024 – September 2025): **On-going**
 Dept of Chemistry, Incheon National University, Songdo-22012, Incheon, South Korea
 Mentor: Prof. Kyuwon Kim
- **Research Professor** (March 2020 – Dec 2020): **10 Months**
 Dept of Chemistry, Incheon National University, Songdo-22012, Incheon, South Korea
 Mentor: Prof. Kyuwon Kim
- **Post-Doctor Researcher** (October 2014 – Feb 2020): **5 Years & 5 Months**
 Dept of Chemistry, Incheon National University, Songdo-22012, Incheon, South Korea
 Mentor(s): Prof. Kyuwon Kim & Prof. Taeun Yim

Publications & Patents Index

Total No. of Publications	42	Google Scholar QR Code 
Peer-reviewed Journals	42	
As a Corresponding Author*	9	
As a First Author	26	
Above 10 Impact Factor Papers	4	
Citations	743*	
h-index	17	
i10-index	21	
i20-index	15	
International Patents Registered	6	
Indian Patents Filed	5	In Filing Process: 1
Books/Book Chapters	2	

*[Google Scholar](#)

Best Five Publications so far

5. **Biosensors and Bioelectronics**, 2020, 161, 112237 (1-8). (IF 10.7)
Aggregation-Free Optical and Colorimetric Detection of Hg(II) with M13 Bacteriophage-Templated Au Nanowires
Manivannan, S. Park, S. Jeong, J and Kim, K
DOI: 10.1016/j.bios.2020.112237
[Weblink:](#)
4. **ACS Applied Materials & Interfaces**, 2020, 12, 17557–17570. (IF 8.3)
Hematite/M (M = Au, Pd) Catalysts Derived from a Double-Hollow Prussian Blue Microstructure: Simultaneous Catalytic Reduction of *o*- and *p*-Nitrophenols
Manivannan, S. An, S. Jeong, J. Viji, M and Kim, K
DOI: 10.1021/acsami.0c01704
[Weblink:](#)
3. **Biosensors and Bioelectronics**, 2017, 94, 87–93. (IF 10.7)
Gold Dendrites Co-deposited with M13 Virus as a Biosensor Platform for Nitrite Ions
Seo, Y[†]. **Manivannan, S[†]**. Kang, I. S-w, Lee and Kim, K. (†Both authors contributed equally)
DOI: 10.1016/j.bios.2017.02.036
[Weblink:](#)
2. **Chemical Engineering Journal**, 2012, 204-206, 16–22. (IF 13.3)
Synthesis of silicate sol-gel matrix embedded silver nanostructures: Efficient nanocatalyst for the reduction of 4-nitrophenol
Manivannan, S. Krishnakumari, B and Ramaraj, R
DOI: 10.1016/j.cej.2012.07.092
[Weblink:](#)
1. **Chemical Engineering Journal**, 2012, 210, 195–202. (IF 13.3)
Synthesis of Cyclodextrin–Silicate Sol-Gel Composite Embedded Gold Nanoparticles and its Electrocatalytic Application
Manivannan, S and Ramaraj, R
DOI: 10.1016/j.cej.2012.08.085
[Weblink:](#)

Externally Sponsored Research Projects: National/International

S. No	Title	Funding Agency	Duration & Grant No	Budget	Role / Status
4	“Metal-, Metal Oxide- and Carbon Nanomaterials based Smart Agrochemicals and their Applications in Sustainable Agriculture”	Institute of Eminence (IoE), Banaras Hindu University, Varanasi, U.P, India.	2 Years & Trans-Disciplinary Research Grant under IoE Scheme	Rs. 10,00,000/-	Principal Investigator / Ongoing
3	“Infused and Interconnected Hollow Carbon Network and Its Electrochemical Applications”	SERB-SRG/2022/000138 BHU/SRICC/M-14-0598	2 Years & Sep-2022 to Sep-2024 Start Date: 26 Sep 2022	Rs. 32,50,000/-	Principal Investigator / Completed
2	“A Universal Method for Free-standing Exfoliation	Institute of Eminence (IoE), Banaras Hindu	3 Years & Seed Grant-II to new Faculties	Rs. 15,00,000/-	Principal Investigator / Completed

	of Chiral Two-dimensional Metal Nanosheets”	University, Varanasi, U.P, India.	under IoE for the year 2021-22 (IoE Scheme) PFMS Scheme No: 3254		
1	“Synthesis of Hollow Carbon Network and Its Electrochemical Applications”	NRF, South Korea (under creative challenge scheme)	3 Years & 2019R111A1A01 058767	Rs. ~1,00,00,00 0/- (150,000,00 0 KRW)	Principal Investigator / June 2019-Dec 2020 Completed
A	No. of Projects Ongoing:				1
	No. of Projects Completed:				3

International/National Patents Registered

S. No	Title of Invention	Inventors	Patent Registration No	Issue Date	Publication No
12	“Electrochemically Grown Spiral Mixture of Seashell-like Platinum Nanostructures and Structure Dependent Catalytic Methanol Oxidation”	Raman Kumar and Manivannan, S.	Under Progress for submission with the Indian Patent Office.		
11	“Adsorption-based silicate sol-gel assisted <i>in-situ</i> synthesis of bi-functional Prussian blue (PB)/gold nanoparticle composite for electrochromic and catalytic applications”	Ritesh Tolani, Reena Kumari and Manivannan, S.	Under Progress for submission with the Indian Patent Office.		
10	“Fabrication of a Catalyst by Confining Metal Nanostructures on Inner and Outer Walls of a Hollow Carbon Sphere for Methanol Fuel Cell Applications”	Raman Kumar, Reena Kumari and Manivannan, S.	Under Progress for submission with the Indian Patent Office.	-	-
9	“Switching Gold and Platinum Nanostructured Layers of the Modified Electrode for Increasing the Methanol Fuel Cell Efficiency”	Raman Kumar and Manivannan, S.	Under Progress for submission with the Indian Patent Office.	-	-
8	“Vertical growth of metal hexacyanoferrate flakes and its exfoliation into free-standing 2D metal nanosheets”	Sachin Kumar and Manivannan, S.	Filed. Application No: 202411035465 Date of Filing: 04/05/2024 with the Indian Patent Office.	-	-
7	“Infiltration of Metal Ions in Partially Porous Prussian blue-Fe ₂ O ₃ mixed Microstructure to Obtain 3-D Nano-catalytic Networks via Electroless Deposition for Environmental Remediation Applications”	Sachin Kumar and Manivannan, S.	Filed. Application No: 202411017371 Date of Filing: 11/03/2024 with Indian Patent Office.	-	-
6	“Electrochemical Sensor Detecting Dopamine Using Nitrogen-Doped Carbon Sphere Having Au-Ag Alloy Nanodots and Platinum and Method of The Same”	Manivannan, S. Jeong, J and Kim, K	10-2160358-0000	28.09.2020	Awaited

5	“Biosensor Detecting Mercury Ion Using Conjugates of Virus and Silver Nanoparticle”	Manivannan, S. and Kim, K	10-2088563-0000	12.03.2020	1020190110247
4	“Preparation Method of Gold Nano Electrode Using Electrochemical Co-Deposition of Gold and Virus for Detecting Nitrite Ion”	Manivannan, S. and Kim, K	10-2060238-0000	11.02.2020	1020190094682
3	“Electrochemical Sensor Detecting Nitrobenzene Using Au-Ag Alloy Nanodots and Method of the Same”	Manivannan, S. and Kim, K	10-2067888-0000	17.01.2020	1020190107921
2	“Preparation Method of Platinum Nano Electrode Using Electrochemical Co-Deposition of Platinum and Virus”	Manivannan, S. and Kim, K	10-1742912-0000	01.06.2017	Awaited
1	“Preparation Method of Nano Electrode Using Virus-Infused Bio-Template”	Manivannan, S. Kang, I. Seo, Y. and Kim, K	10-1719100-0000	23.03.2017	Awaited
A	No. of Patents Granted:				6
	No. of Patents Applied/Under Progress:				6
B	Total				12

Education

Entry	Title	Duration	Institute	Mentor	Remarks
5	Ph.D., Chemistry	October-2007 – June-2014	Madurai Kamaraj University, Madurai	Dr. R. Ramaraj, FASc., FNASc., FNA., DAE – Raja Ramana Fellow (RRF) and CSIR Emeritus Scientist	Awarded on 10 th June 2014
	Title	“ <i>Synthesis and Studies of Silicate Sol-Gel Matrix Embedded Mono- and Bi-Metal Nanomaterials and Their Applications</i> ”			
	External	Prof. Ashok K Ganguli , FASc., FNASc., Institute of Nanoscience and Technology (INST), Mohali, Punjab			
	Specialization	Physical Chemistry/Electrochemistry/Nanomaterials/Sensors/Energy			
	Publications Output	9; Peer-reviewed Journals out of Ph.D. work			
4	M.Sc., Chemistry	June-2004 – July-2006	Madurai Kamaraj University, Madurai.	Dr. R. Ramaraj, FASc., FNASc., FNA.,	64.95%
3	B.Sc., Chemistry	June-2000 – April-2003	University of Madras, Periyar Arts & Science College, Cuddalore	Specialization: Industrial Chemistry	62.85% (Excluding Language Papers) 59.55% (Including Language Papers)
2	HSC	March. 2000	Tamil Nadu State Board		61.00%
	Subjects	Tamil, English, Physics, Chemistry, Maths, and Biology			
1	SSLC	Apr. 1998	Tamil Nadu State Board		80.00%
	Subjects	Tamil, English, Maths, Science and Social Science			

Editorial/Reviewer Activities

1. The Journal of Physical Chemistry A, ACS Publications
2. Journal of Nanoscience and Nanotechnology, American Scientific Publishers
3. Chemical Engineering Journal, Elsevier Publications
4. Optik, Elsevier Publications

5. Journal of Hazardous Materials, **Elsevier** Publications
6. Electroanalysis, **Wiley-VCH** Publishers
7. Scientific Reports, **Nature** Publications
8. Frontiers in Chemistry, **Frontiers** Publications

Books/Book Chapters

S. No.	Title	Author's Name	Publisher	Year of Publication
2	“Two-dimensional Nanomaterials for Seawater Splitting” Book Title: Hydrogen from Seawater Splitting: Technology & Outlook	R. Tolani and S. Manivannan*	CRC Press, Taylor and Francis Group, U.S.A.	2024. Published.
1	“Introduction: Nanomaterials for Sustainable Energy Applications” Sonkar, P.K., & Ganesan, V. (Eds.). (2023). Nanomaterials for Sustainable Energy Applications (1st ed.). CRC Press. https://doi.org/10.1201/9781003208709	S. Manivannan* , R. Praveen, K. Kim, and R. Ramaraj	CRC Press, Taylor and Francis Group, U.S.A.	2024 eBook ISBN9781003208709

Invited Talks & Guest Lectures

5. **Topic:** “M13 Virus-based Biosensor-probes for Aggregation-free Detection of Mercury (II) Ions” held on Feb 21-23, 2024, Chemical Research Society of India (CRSI) Local Chapter-2024, Three-Day National Conference on Current Trends in Chemical Sciences, February 21-23, 2024, Invited talk organized by School of Chemistry and CRSI Local Chapter, Madurai Kamaraj University, Madurai, Tamil Nadu.
4. **Topic:** “Infiltration of Metal Nanoparticles in Partially Porous Prussian blue-Fe₂O₃ mixed Microstructures to Enable 3-D Catalytic Sites/Network for Environment Remediation Applications” held on 23 December 2023, Invited talk organized by Central Instrumentation Facility (CIF), School of Physical, Chemical and Applied Sciences, Pondicherry University (A Central University under MoE, Govt. of India), Puducherry - 605 014, Puducherry State, India.
3. **Topic:** “M13 Virus-based Biosensor-probes for Aggregation-free Detection of Heavy Metal Ions” held on 01 September 2023, Invited talk organized by Department of Chemistry and NIT Puducherry, Karaikal, Tamil Nadu.
2. **Topic:** “M13 Virus-based Biosensor-probes for Aggregation-free Detection of Heavy Metal Ions” held on 18 November 2020, National Webinar organized by Department of Chemistry and IChE, Saintgits College of Engineering, Kottayam, Kerala.
1. **Topic:** “M13 Virus-based Biosensor-probes for Aggregation-free Detection of Heavy Metal Ions” held on 23-24 June 2020, Virtual International Conference on Innovations in Interdisciplinary Research (VICIIDR – 2020), Track 7 of 10: Materials and Mathematical Sciences at Kalasalingam Academy of Research and Education, Srivilliputtur, India.

National/International Conferences Presented/Participated

18. **“Resource Person”**_Chemical Research Society of India (CRSI) Local Chapter-2024, Three-Day National Conference on Current Trends in Chemical Sciences, February 21-23, 2024, Invited talk organized by School of Chemistry and CRSI Local Chapter, Madurai Kamaraj University, Madurai, Tamil Nadu.
17. **“Treasurer”** *National Symposium on EMERGING TRENDS IN CHEMICAL SCIENCES (ETCS 2023)* December 15-16, 2023, Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi 221 005, U.P.
16. 2nd International Meeting on Energy Storage Devices (IMESD2023) & Industry-Academia Conclave (IAC) December 7-10, 2023 Department of Physics, Indian Institute of Technology Roorkee, Roorkee, India (**Paper Presented**)
Title: Exploring the Synergistic Impact of Switching Nanostructured Gold and Platinum Layers towards the Methanol Oxidation Reaction
15. **“Resource Person”** in the “National Symposium on Recent Advances in Nanoscience and Nanotechnology” held on 26th October 2023 at the Department of Chemistry, Gandhigram Rural Institute (Deemed to be University) Gandhigram – 624 302, Tamil Nadu.
14. Spring 2020 General Meeting and Conference, Korean Electrochemical Society, July 16-18, 2020, ICC, Jeju, South Korea.
13. 11th International Symposium on Natural Sciences, Incheon National University, Songdo, South Korea, Oct 9-11, 2019 (**Paper Presented-Best Poster**)
Title: M13 bacteriophage-templated Au Nanowires and It’s Aggregation-free Colorimetric and Optical Biosensor Studies towards Environment Pollutant Hg(II) ions
12. ACS Fall 2019 National Meeting & Expo on Chemistry & Water, San Diego, USA, Aug 24-30, 2019
11. 2019 Korean Chemical Society Analytical/Electrochemical Branch Summer Joint Symposium, June 27-28, 2019, Hotel Beach Palace, Chungnam, Boyreong, South Korea. (**Paper Presented**)
Title: Spectroelectrochemical Studies on Silicate Sol-Gel Matrix Supported Prussian blue Nanostructures Based Electrochromic Devices
10. The 123rd General Meeting of the Korean Chemical Society, April 17-19, 2019, Suwon Convention Center, Suwon, South Korea.
9. Spring 2019 General Meeting and Conference, Korean Electrochemical Society, April 4-6, 2019, ICC, Jeju, South Korea. (**Paper Presented**).
Title: Vertically Grown Pt Nanoplates on Gold Substrates as an Electrochemical Sensor Platform for Nitrite Ions
8. 2019 KNOS Winter Workshop on Nano-Optics & Related Techniques, February 20-22, 2019, Venue: Hotel Tirol, Muju, South Korea.
7. The 121st General Meeting of the Korean Chemical Society, April 18-20, 2018, ICC, Jeju, South Korea. (**Paper Presented**).
Title: Electrochemically Co-deposited Virus-Platinum Nanohybrids as an Electrocatalyst
6. The 117th General Meeting of the Korean Chemical Society, April 20-22, 2016, KINTEX, South Korea. (**Paper Presented-Best Poster**).

- Title:** Virus-Assisted Growth of Metal Alloy Nanostructures at reduced Graphene oxide sheets as an Electrocatalyst for Methanol Oxidation
5. 2015 Fall Meeting of the Korean Electrochemical Society, October 29-31, 2015, CECO, South Korea.
 4. The 116th General Meeting of the Korean Chemical Society, October 14-16, 2015, EXCO, South Korea. **(Papers Presented)**.
Title: Surface attached β -cyclodextrins controlled growth of 3D gold dendrites on reduced graphene oxide sheets and its electrocatalytic studies
 3. The 115th General Meeting of the Korean Chemical Society, April 14-16, 2015, KINTEX, South Korea. **(Paper Presented)**.
Title: Supramolecular Association of Enzyme on Sol–Gel Matrix Embedded Gold Nanoparticles Supported Reduced Graphene Oxide–Cyclodextrin Nanocomposite: Synergistic Electrochemical Biosensor
 2. Tenth International Symposium on Advances in Electrochemical Science and Technology (ISAEST-10), January 28-30, 2013, Hotel Green Park, Chennai, INDIA. **(Paper Presented)**.
Title: Concurrent Electrochemical Oxidation and Sensing of Hydrazine, Sulphite and Nitrite by Raspberry-Like Gold Nanostructures Modified Electrodes
 1. ICMS-Cambridge University Winter School on Chemistry and Physics of Materials, December 6-10, 2010, Venue: JNCASR, Bangalore, INDIA. **(Paper Presented)**.
Title: Assemblies of core/shell Au/Ag nanoparticles embedded in a silicate sol-gel matrix

Merit/Honor/Award/Service Activities

- 2019 – **Best Poster** - 11th International Symposium on Natural Sciences, Incheon National University, Oct 9-11, 2019, Songdo, South Korea.
- 2016 – **Best Poster** – The 117th General Meeting of the Korean Chemical Society, April 20-22, 2016, KINTEX, South Korea.
- 2013 – Awarded as a **CSIR–Senior Research Fellow-Ext.** by the Council of Scientific and Industrial Research, New Delhi, India.
- 2011 – Awarded as a **CSIR–Senior Research Fellow** by the Council of Scientific and Industrial Research, New Delhi, India.
- 2009 – Awarded as a **UGC–Junior Research Meritorious Fellow** by University Grants Commission, New Delhi, India under Basic Scientific Research (UGC-BSR) Scheme.

Membership

- American Chemical Society; Membership No. 31352807
- Korean Chemical Society; Membership No. 26311
- Korean Electrochemical Society; Membership No. 1500371

Countries Visited

- South Korea – Post-Doctoral Programme (Oct-2014 – Dec-2020)
- United States of America – Conference, ACS Fall Meeting, San Diego, Aug 24-30, 2019

Personal Proforma

Birth Date & Place : 22 Oct 1982 & Tamil Nadu

Sex : Male
Marital Status : Married
Father's Name : N. Shanmugam
Spouse's Name : S. Saranya
Children's : Two
Nationality : INDIA
Passport No : Y5136785
Languages Known : Tamil (native), English (fluent), Hindi (Moderate) & Korean (moderate)

Address: No.2/203, Brahminar St., New Tirupachur, Tiruvallur-631203, Tamil Nadu.

Doctoral Work-Overview

- Green and biocompatible synthetic routes for the mono- and bi-metallic gold and silver nanoparticles were developed.
- Their optical and electrochemical properties were studied in detail.
- Gold and silver nanoparticles-based electrochemical sensors and electrocatalysts were developed to study the toxic molecules (nitroaromatics, Hg(II) ions, nitric oxide, hydrazine, sulfite ions, and nitrite ions) and fuels (CH₃OH, H₂O₂, and O₂).
- The electroless deposition method was developed for the fabrication of metal hexacyanoferrates-derived thin films.
- Interparticle surface plasmon coupling modes were studied for the bi-metallic Gold-Silver nanoparticles for the first time.

Post-Doctoral Work-Overview

- Protocols to obtain the chiral metal nanostructures were developed for the first time.
- M13 bacteriophage amplification and engineering at its major coat protein.
- Bio-mineralization and bio-templating methods to obtain biomaterials.
- Applying biomaterials as electrode materials for biosensors and energy applications.
- Prussian blue analogue-Spectroelectrochemistry-Electrochromic device fabrication.
- Smart carbon materials for Li-S battery applications.
- 1-D arrays of metal NPs over M13 bacteriophage fibrillar surface as SERS nanoprobos.
- Exfoliation of 3D transition hexacyanometalates into 2D metal nanosheets-SERS nanoprobos.

References

- (1) **Dr. R. Ramaraj**, M.Sc., Ph.D., D.Sc., (Japan), D.Sc., (India), FASc., FNASc., FNA., **DAE – Raja Ramana Fellow (RRF) and CSIR Emeritus Scientist**
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e-mail: ramarajr@yahoo.com, ramaraj.ram@gmail.com
- (2) **Dr. Kyuwon Kim**, M.Sc., Ph.D.,
Director, Electrochemistry Laboratory for Sensors & Energy (ELSE)
Professor, Department of Chemistry, Incheon National University

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- (3) **Dr. Taeun Yim**, M.Sc., Ph.D.,
Professor, Department of Chemistry, Incheon National University
119, Academy-ro, Yeonsu-gu, Incheon, 22012, South Korea
Mobile: +82-32-835-8093, e-mail: yte0102@inu.ac.kr
- (4) **Dr. V. Ganesan**, M.Sc., Ph.D.,
Professor, Department of Chemistry
Institute of Science, Banaras Hindu University, Varanasi- 221005, Uttar Pradesh, India.
Tel: +91 9452072138 (O), e-mail: velganes@yahoo.com
- (5) **Dr. S. Krishnamoorthi**, M.Sc., Ph.D.,
Professor, Department of Chemistry
Institute of Science, Banaras Hindu University, Varanasi- 221005, Uttar Pradesh, India.
Tel: +91 9450200221 (O), e-mail: skmoorthi@bhu.ac.in

International Patents Registered

6. **Title of Invention:** “Electrochemical Sensor Detecting Dopamine Using Nitrogen-Doped Carbon Sphere Having Au-Ag Alloy Nanodots and Platinum and Method of The Same”

Inventors: Manivannan, S. Jeong, J and Kim, K

Abstract: The present invention relates to an electrochemical sensor for detecting dopamine, using a nitrogen-doped carbon sphere containing gold-silver alloy nanodots and platinum (Pt) nanoparticles; and a method of preparing the same. More specifically, the electrochemical sensor comprises an electrode and a nitrogen-doped carbon sphere on the electrode, wherein the nitrogen-doped carbon sphere comprises: an inner wall impregnated with gold-silver alloy nanodots; and an outer wall comprising Pt nanoparticles. The nitrogen-doped carbon sphere (AuAg/ND_C/Pt) of the present invention including the gold-silver alloy nanodots and the Pt nanoparticles, due to a small size of a pore structure and a large active surface area, exhibits a synergistic electrocatalytic action with respect to dopamine oxidation compared to SiO₂/AuAg/ND_C/Pt. An electrode catalyst modified with the nitrogen-doped carbon sphere of the present invention may be used to selectively determine dopamine regardless of 100x concentration of ascorbic acid and lauric acid.

Patent Registration No.: 10-2160358-0000

Application Date: 2019. 04. 15

Application Number: 10-2019-0043936

Issue Date: 2020. 09. 28

Date of Decision to Grant Registration (Trial Decision): 2020. 09. 17

Classification: G01N 33/543

(Expected) Date of Expiration: 2039. 04. 15

Publication Number: NA

Name of the Agency: Korean Intellectual Property Office

5. **Title of Invention:** “Biosensor Detecting Mercury Ion Using Conjugates of Virus and Silver Nanoparticle”

Inventors: Manivannan, S. and Kim, K

Abstract: The present invention relates to a biosensor for detecting mercury ion using conjugates of virus and silver nanoparticles, and more specifically, to a biosensor for detecting mercury ion which uses conjugates comprising M13 virus (designed in M13-4E form) and silver (Ag) nanoparticles stabilized by a silicate sol-gel matrix (SSG). According to the present invention, the biosensor has demonstrated a structural transformation to Ag-Hg amalgam due to interactions between Ag NPs and Hg(II) ions and has observed that such CGs exhibits unique light extinction characteristics of the Ag NP SPR band while maintaining the biological properties of M13. Therefore, SSG-Ag_(4E) CGs shows high selectivity to Hg(II) ions and may be directly used to detect Hg(II) ions in an aqueous solution containing complex interferences.

Patent Registration No.: 10-2088563-0000

Application Date: 2018. 03. 20

Application Number: 10-2018-0031948

Issue Date: 2020. 03. 12

Date of Decision to Grant Registration (Trial Decision): 2020. 03. 06

Classification: G01N 33/554

(Expected) Date of Expiration: 2038. 03. 20

Publication Number: 1020190110247

Name of the Agency: Korean Intellectual Property Office

4. **Title of Invention:** “Preparation Method of Gold Nano Electrode Using Electrochemical Co-Deposition of Gold and Virus for Detecting Nitrite Ion”

Inventors: Manivannan, S. and Kim, K

Abstract: The present invention relates a preparation method of a gold nano electrode using electrochemical co-deposition of gold and virus for detecting a nitride ion and, more specifically, relates to a preparation method of a gold nano electrode for detecting a nitride ion, wherein through M13 virus (wild type and designed in the form of M13-Y3E or M13-4E) and gold (Au) deposition for co-deposition in an electrode (ITO), a gold nanostructure with excellent electrochemical reaction concerning nitrite ion detection and measurement can be manufactured with a simple method. According to the present invention, a manufactured nano electrode can selectively react to only a nitride ion under the existence of a lot of interfering substances, and a nitride ion of which an electrode has a low concentration of 100 μ M is selectively detected.

Patent Registration No.: 10-2060238-0000

Application Date: 2018. 02. 05

Application Number: 10-2018-0014127

Issue Date: 2020. 02. 11

Date of Decision to Grant Registration (Trial Decision): 2019. 12. 20

Classification: G01N 27/333

(Expected) Date of Expiration: 2038. 02. 05

Publication Number: 1020190094682

Name of the Agency: Korean Intellectual Property Office

3. **Title of Invention:** “Electrochemical Sensor Detecting Nitrobenzene Using Au-Ag Alloy Nanodots and Method of the Same”

Inventors: Manivannan, S. and Kim, K

Abstract: The present invention relates to an electrochemical sensor for detecting nitrobenzene using Au-Ag alloy nanodots and a manufacturing method thereof. Herein carbon electrode surface is modified to a silicate sol-gel matrix embedded with Au-Ag alloy nanodots (SSG-AuAg NDs) to provide excellent electrocatalyst effects concerning nitrobenzene reduction, thereby providing excellent sensor characteristics when detecting the nitrobenzene. Moreover, the silicate sol-gel matrix embedded with Au-Ag alloy nanodots of 3 nm or less can be synthesized by a single-step synthesis without using harmful reduction agents such as hydrazine, sodium borohydride, and alkyl trimethyl ammonium halide.

Patent Registration No.: 10-2067888-0000

Application Date: 2018. 03. 13

Application Number: 10-2018-0029261

Issue Date: 2020. 01. 17

Date of Decision to Grant Registration (Trial Decision): 2020. 01. 10

Classification: G01N 27/30

(Expected) Date of Expiration: 2038. 03. 13

Publication Number: 1020190107921

Name of the Agency: Korean Intellectual Property Office

2. **Title of Invention:** “Preparation Method of Platinum Nano Electrode Using Electrochemical Co-Deposition of Platinum and Virus”

Inventors: Manivannan, S. and Kim, K

Abstract: The present invention relates to a method for preparing a platinum nanoelectrode by coprecipitation with a virus, and more particularly, to a method for preparing a platinum nanoelectrode by coprecipitation with an M13 virus capable of synthesizing a platinum nanostructure having excellent electrochemical catalytic activity by a simple method, by coprecipitation to an electrode (ITO) through electrodeposition of platinum (Pt) and the M13 virus (designed in a wild type and M13-Y3E or M13-4E form). The platinum nanostructure prepared according to the present invention can achieve excellent catalytic properties when applied as an electrocatalyst for methanol oxidation reaction (MOR) of a direct methanol fuel cell (DMFC).

Patent Registration No.: 10-1742912-0000

Application Date: 2016.06.08

Application Number: 10-2016-0070923

Issue Date: 2017. 06. 01

Date of Decision to Grant Registration (Trial Decision): 2017. 05. 25

Classification : C25D 3/52

(Expected) Date of Expiration: 2036. 06. 08

Publication Number : NA

Name of the Agency: Korean Intellectual Property Office

1. **Title of Invention:** “Preparation Method of Nano Electrode Using Virus-Infused Bio-Template”

Inventors: Manivannan, S. Kang, I. Seo, Y. and Kim, K

Abstract: The invention relates to the M13 virus (M13-Y3E) which is designed so that the peptide of the predetermined sequence is more specifically expressed as the manufacturing method of the nano electrode using the template in which the virus is included to the surface, the silicate sol-gel

matrix (T) which is functional to the amine, the M13 virus which mixes the restored oxide graphene (rGO) and it designs the bio - template composite and here it makes the metal after doing the coating with the electrodeposition (Electrodeposition) and it forms the Au-Pt alloy nanostructure on the electrode (ITO) surface and in that way is injected. Is the nucleation for the metal nanostructure, and the manufacturing method of the Pt- base bi-metal nano electrode that effectively induces growth and it makes the low-density packing possible and it stabilizes the rGO and it increases the electrochemical activity surface area (ECSA) and uses the template which can implement very excellent catalyst activation about the methanol oxidation (MOR) of the fuel cell, etc. and in which the virus is included. As to the manufacturing method according to the present invention, the method itself is convenient. Besides it is very the composition (the artificiality) peptide producing a similar effect efficient in case the use in the comparison cost side.

Patent Registration No.: 10-1719100-0000

Application Date: 2016. 06. 08

Application Number: 10-2016-0070915

Issue Date: 2017. 03. 23

Date of Decision to Grant Registration (Trial Decision): 2017. 03. 16

Classification: G01N 27/327

(Expected) Date of Expiration: 2036. 06. 08

Publication Number : NA

Name of the Agency: Korean Intellectual Property Office

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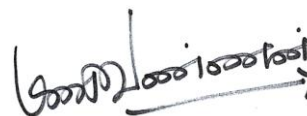
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Manivannan, S. Jeong, C. Jeong, J and Kim, K
5. Prussian blue Nanostructured Network embedded Silver Nanoparticles and Highly Accessible Hotspots for SERS Analysis
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Declaration

The above information is true to the best of my knowledge.

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