Closure Report

File Number : EEQ/2016/000119

Project Title : Electrochemical synthesis of nano-wires and their physio-chemical parametric evaluations for sensor applications

Principal Investigator : Dr. Sandeep Arya
Jammu University
Jammu, jk, Jammu, Jammu and kashmir-180006

Total Sanctioned Amount : 49,12,000 (INR)

Total Released Amount : 41,30,000 (INR)

Start Date of the Project: 04 May, 2017

Date of completion: 03 May, 2021 (48 months)

Approved Objectives :

The proposed objectives are as follows-
• To synthesize single, binary and ternary nanowires using template based electrodeposition method for semiconductor device and sensor applications.
• To characterize the as-synthesized nanowires for their morphology and material used.
• To study the physical and chemical properties of as-synthesized nanowires.
• To investigate the as-synthesized nanowires further for their electrical and sensing applications.
• The development of new nanostructures will remain the significance of work along with device formation.
• The outcome of the experiment will be reported in good quality research journal.

Deviation made from original objectives (If Any) :

No

Ph.D. Produced/ Likely to be : 2

Technical Personnel Trained : 3

Total Expenditure : 39,00,000 (INR)

Concise Research Accomplishment :

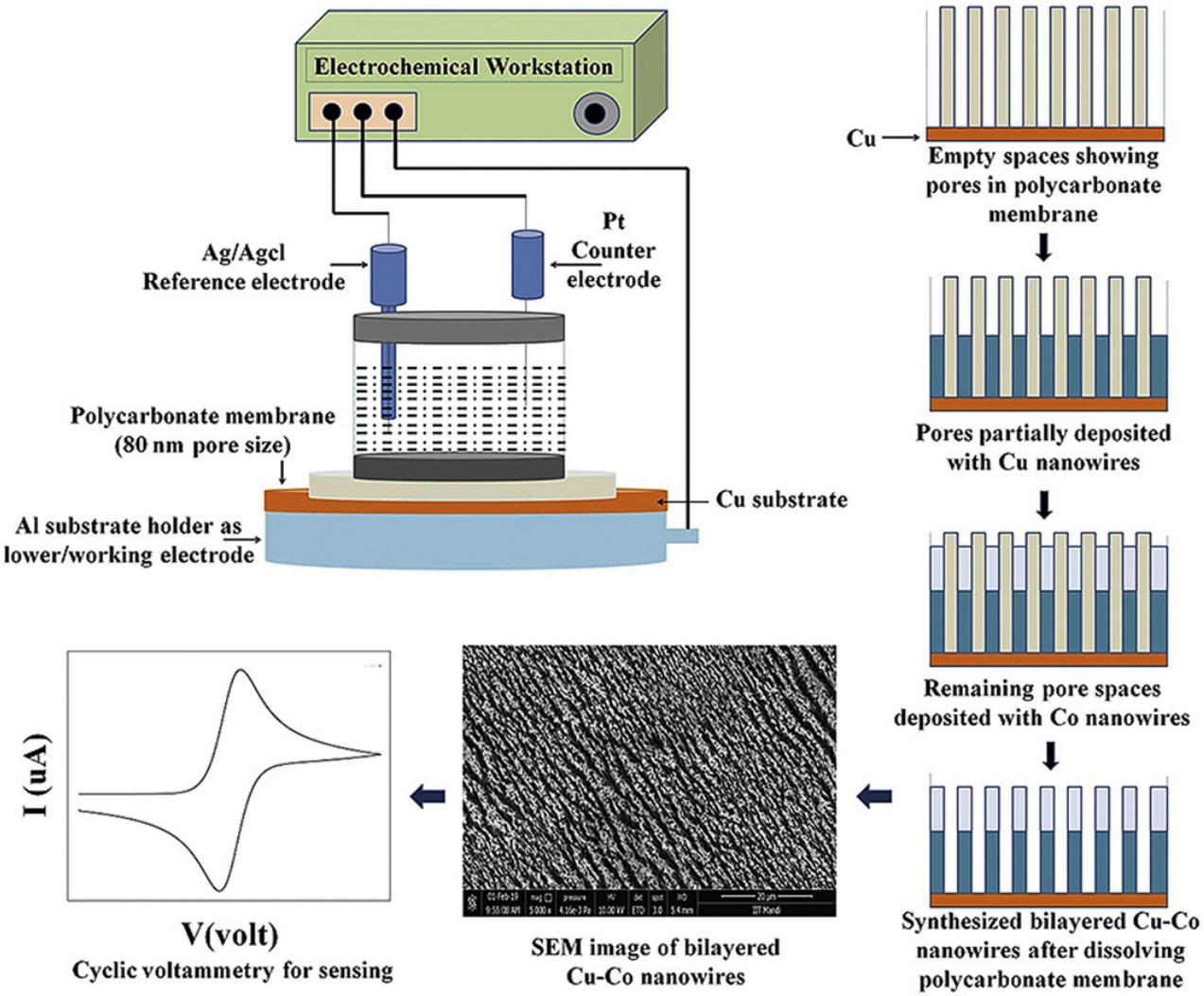
My research in the past four years has focused on electrochemical sensing and energy storage applications. The primary focus during this period of research was to synthesized nanowires using a chemical method via template assisted electrodeposition technique. In this regard, several nanowires were synthesized and their physio-chemical properties were studied for sensing and energy applications. Single, binary and some composite nanowires such as, Ni, Co, Cu-Fe, NiFe, etc. were synthesized via chemical electrodeposition method. These nanowires were further investigated for their morphology and elemental compositions. After satisfactory results, the synthesized nanowires were further investigated for sensing different fluids. Moreover, some Ni based nanowires along with their composites were investigated for energy storage applications such as supercapacitors. Few nanowires, such as Bi2O3, were also investigated for degradation of specific pollutants present in water. Inspite of all this, few nanoparticles were also synthesized by using the equipment purchased under this project and these synthesized nanoparticles were investigated for different applications, such as, photodiodes, photocatalysts, and anti-counterfieting applications. From all these investigations, several research papers were published in various SCI indexed journals.

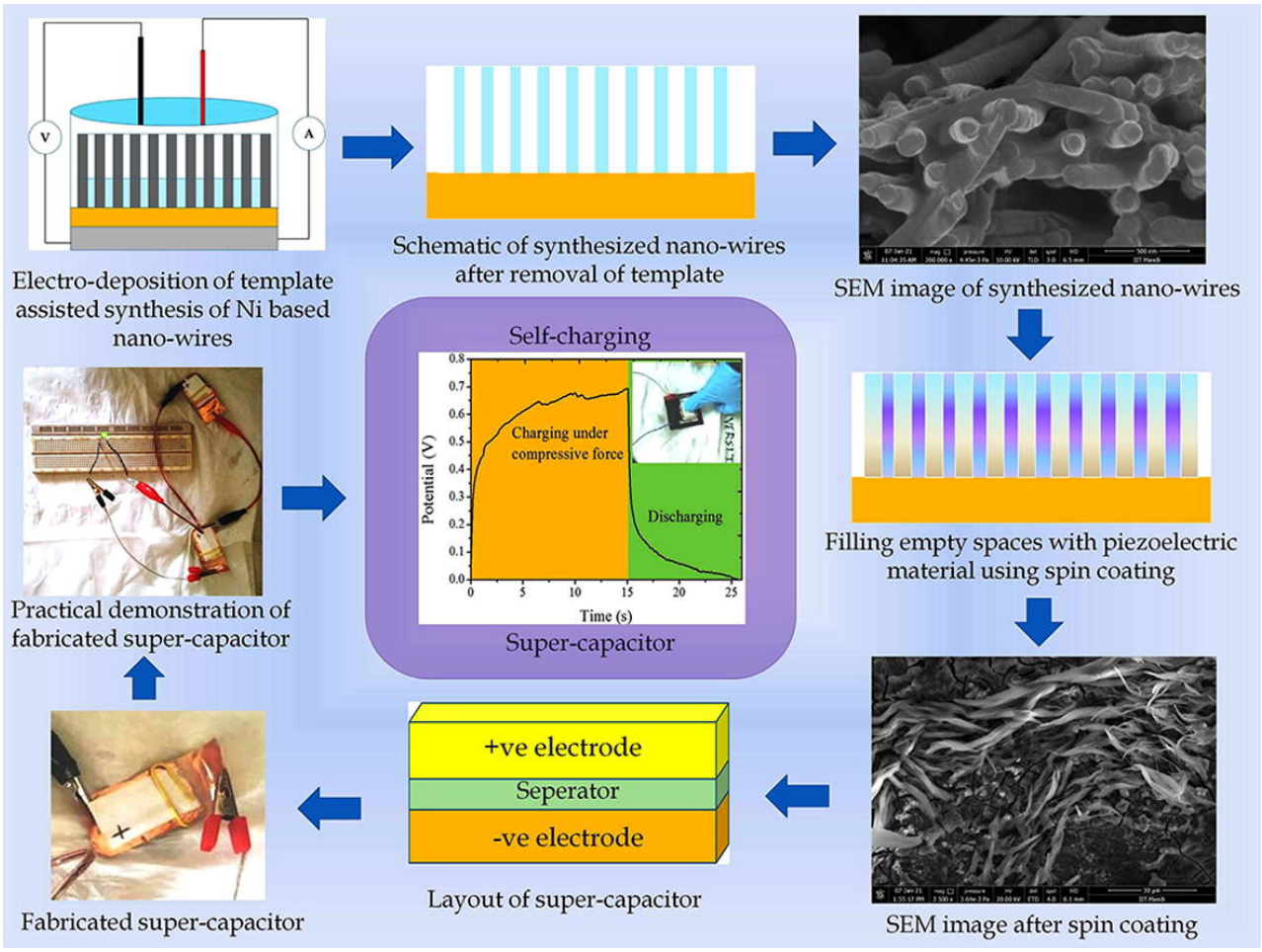
Closure Details

Experimental/ Theoretical Investigation carried out

List of experiments conducted during this project 1. Electrochemical detection of ammonia solution using tin oxide nanoparticles synthesized via sol–gel route: In this experiment, electrochemical detection of ammonia solution (NH4OH) using sol–gel-synthesized tin oxide (SnO2) nanoparticles is investigated. Structural characteristics were studied using X-ray diffraction, scanning electron microscope and energy-dispersive X-ray spectroscopy that confirmed the formation of tin oxide nanoparticles. Optical characterizations were also studied via UV–Vis–IR spectroscopy and photoluminescence spectroscopy. After successful confirmation of sol–gel synthesis, these tin oxide nanoparticles were deposited on patterned copper substrate via thermal evaporator. Analysis for sensing ammonia solution was carried out using a three electrode system via electrochemical workstation. Electrochemical technique incorporates the results of cyclic voltammetry. The results confirmed that the SnO2-deposited copper (Cu) platform successfully detect the presence of ammonia solution in double-distilled water. These results were further analyzed and compared with each indium tin oxide (ITO)-coated glass and pure copper substrate. Moreover, the tin oxide-deposited copper platform showed better performance than ITO substrate. 2. Performance of template-assisted electrodeposited Copper/Cobalt bilayered nanowires as an efficient glucose and Uric acid senor: In this work, Copper/Cobalt bilayered nanowires (Cu/Co-bilayered NWs) were successfully synthesized on Copper substrate via template-assisted electrodeposition method. The synthesis was done at room temperature (27°C) and the length of the nanowires was controlled by adjusting the deposition time, deposition potential and many other factors. Polycarbonate track-etch membrane of 150nm hexagonal pore size was used as a template. Structural characteristics were examined using field emission scanning electron microscopy, energy-dispersive X-ray spectroscopy, X-ray diffraction and transmission electron microscope that confirmed the successful formation of Cu/Co-bilayered NWs. Investigation for sensing of Glucose and Uric Acid was carried out using electrochemical sensing. Cyclic voltammetry (CV) and differential pulse voltammetry (DPV) methods confirmed the successful detection of Glucose and Uric acid in a phosphate buffer solution. The real sample (sugarcane juice) was also tested to sense the presence of glucose using synthesized nanowires. The results proved that synthesized nanowires can be an economical sensor with great performance and sensitivity. 3. Template Based Electrochemical Synthesis of Copper (Cu) Nanowires as CH2Cl2 Sensor: In this work, Copper (Cu) nanowires were synthesized electrochemically from aqueous acidic solution of 1M copper (II) sulfate (CuSO4•5H2O) on a copper substrate by template-assisted electrodeposition method. The electrodeposition was conducted at room temperature and the length of nanowires was controlled by adjusting the deposition time. Different Structural and morphological characteristics were examined using X-ray diffraction (XRD), field emission scanning electron microscope (FESEM) and energy dispersive X-ray spectroscopy (EDX) that confirmed the successful synthesis of Cu nanowires. Moreover, the synthesized Cu nanowires were investigated for CH2Cl2 chemical sensing using different electrochemical techniques. The results showed that Cu nanowires can sense CH2Cl2 very effectively. 4. Performance of electrochemically synthesized Nickel-Zinc and Nickel-Iron (Ni-Zn//Ni-Fe) nanowires as battery type supercapacitor: In this experiment, a high performance Ni–Fe composite nanowires array based supercapacitor anode was fabricated via electrochemical deposition using polycarbonate membrane. The synthesized nanowires demonstrate outstanding electrochemical performance with good specific capacitance of 1255.17 Fg1 at 3 Ag1 and 80% capacitive retention at the end of 5000 charge-discharge cycles. In addition, an asymmetrical supercapacitor (Ni–Zn//Ni–Fe) was also fabricated that demonstrates 95.23% of capacitive retention after 2000 cycles. The fabricated supercapacitor device showed energy density of 63.62 Wh kg1 at a power density of 0.64 KW kg1. Further, the practical performance of a single asymmetrical supercapacitor device was demonstrated by lighting up a 2.2 V green LED. These results reveal the potential of the synthesized nanowires in potable energy storage gadgets. 5. High performance asymmetric supercapacitor based on vertical nanowire arrays of a novel Ni@Co-Fe LDH core@shell as negative and Ni(OH)2 as positive electrode: In this work, a novel flexible Ni@Co–Fe LDH core–shell nanowires supercapacitor negative electrode is synthesized using polycarbonate membrane on a copper substrate via an electrochemical deposition technique. The synthesized battery-type negative electrode exhibits remarkable specific capacitance of 1289 F g1 at 1 A g1 and excellent cycling stability with 76.66% capacitive retention after 5000 cycles. Furthermore, the Ni(OH)2//Ni@Co–Fe LDH nanowires based asymmetric supercapacitor exhibits excellent cycling stability of 90.49% after 1000 cycles with a highest energy density of 68 Wh kg1 at 0.38 KW kg1, and a good energy density of 31.8 Wh kg1 is still attained at a high power density of 6 KW kg1. For practical demonstration, a white LED of 3.3 V is lit by using two asymmetrical supercapacitor devices connected in series. The device offers a favorable and effective pathway for advanced energy storage. 6. Synthesis of SnO2 nanowires as a reusable and flexible electrode for electrochemical detection of riboflavin: In this work, The fabrication and testing of a riboflavin (RF) sensor based on the use of tin oxide (SnO2) nanowires was successfully attained. Template directed electrodeposition was used to produce one-dimensional nanostructures of SnO2. SnO2 nanowires were achieved by the electrodeposition of tin(ii) chloride into the nanochannels of the porous polycarbonate membrane by applying potential of 0.75 V. Various techniques such as XRD, FESEM, EDS and FTIR were used to characterize the synthesized nanowires. All electrochemical studies were carried out in phosphate buffer pH 7.0 and 0.1 Vs1 scan rate. The fabricated sensor showed excellent anti-interference ability against electroactive species and metal ions. It also proved its long-term stability and good reproducibility with RSD values 1.90% and 1.30% respectively. The voltammetric signal increases linearly in the 0–13 M concentrations range with a lower detection limit of 0.6 μM. Rs and Rct values decreased significantly with increasing concentration. The synthesized electrode is proved to be useful for the estimation of the RF content in pharmaceutical samples with 98% recovery. 7. Highly stable self-charging piezoelectric (Rochelle salt) driven supercapacitor based on Ni nanowires: In this work, an asymmetric piezo-supercapacitor device is fabricated using Nickel/Rochelle Salt (Ni/RS) nanowires array as cathode,

Polypyrrole/Nickel/Rochelle (PPy/Ni/RS) nanowires array as anode and rochelle salt based filter paper as a separator and energy harvester. The fabricated device demonstrates self-charging phenomenon due to piezoelectric effect upto 700 mV under a compressive force of 30 N in just 15 s. Moreover, the electrochemical results reveal tremendous cyclic stability with capacitive retention of 99% and 96% for PPy/Ni/RS and Ni/RS nanowires array based electrodes even after 10,000 repeated GCD cycles. In addition, the fabricated Ni/RS//PPy/Ni/RS based asymmetric device shows a high energy density of 166.23 Wh/kg at 0.24 KW/kg. The practical demonstration of the asymmetric supercapacitor is also given by lighting up a green LED. The proposed facile as well as cost-effective approach for smart self-chargeable power package supercapacitor provides new insights for developing next generation all-in-one energy harvesting and storage devices. 8. Electrochemical sensing and photocatalytic degradation of 2,4-Dinitrophenol via Bismuth(III) oxide nanowires: In this study, we have performed the electrochemical sensing of 2,4-Dinitrophenol (2,4-DNP) and for this purpose, one dimensional Bismuth (III) oxide (Bi2O3) nanostructures have been investigated as selective materials. The Bi2O3 nanowires were fabricated at a 90°C of temperature through a straightforward technique of heating. The standard characterization techniques such as XRD, SEM, EDS, and XPS were used to study the morphological, structural and optical properties of the synthesized Bi2O3 nanowires while CV and DPV electrochemical methods were employed for observing the electrochemical reaction of the original and modified electrode for 2,4-DNP determination. Additionally, the degradation of 2,4-DNP was studied with the addition of Bi2O3 nanowires. The results showed that the Bi2O3 nanowires successfully degrades 2,4-DNP in 600 minutes under visible light. This study provides an economical, facile and low-temperature method for the application of Bi2O3 nanowires in integration devices.



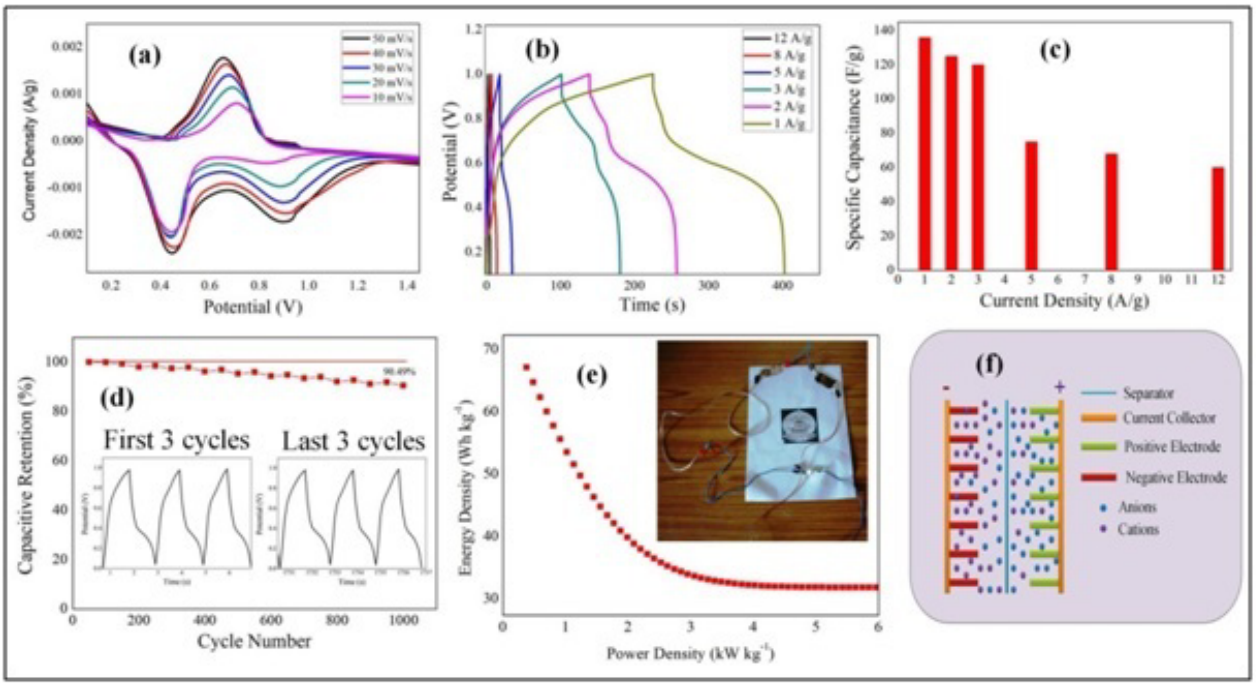


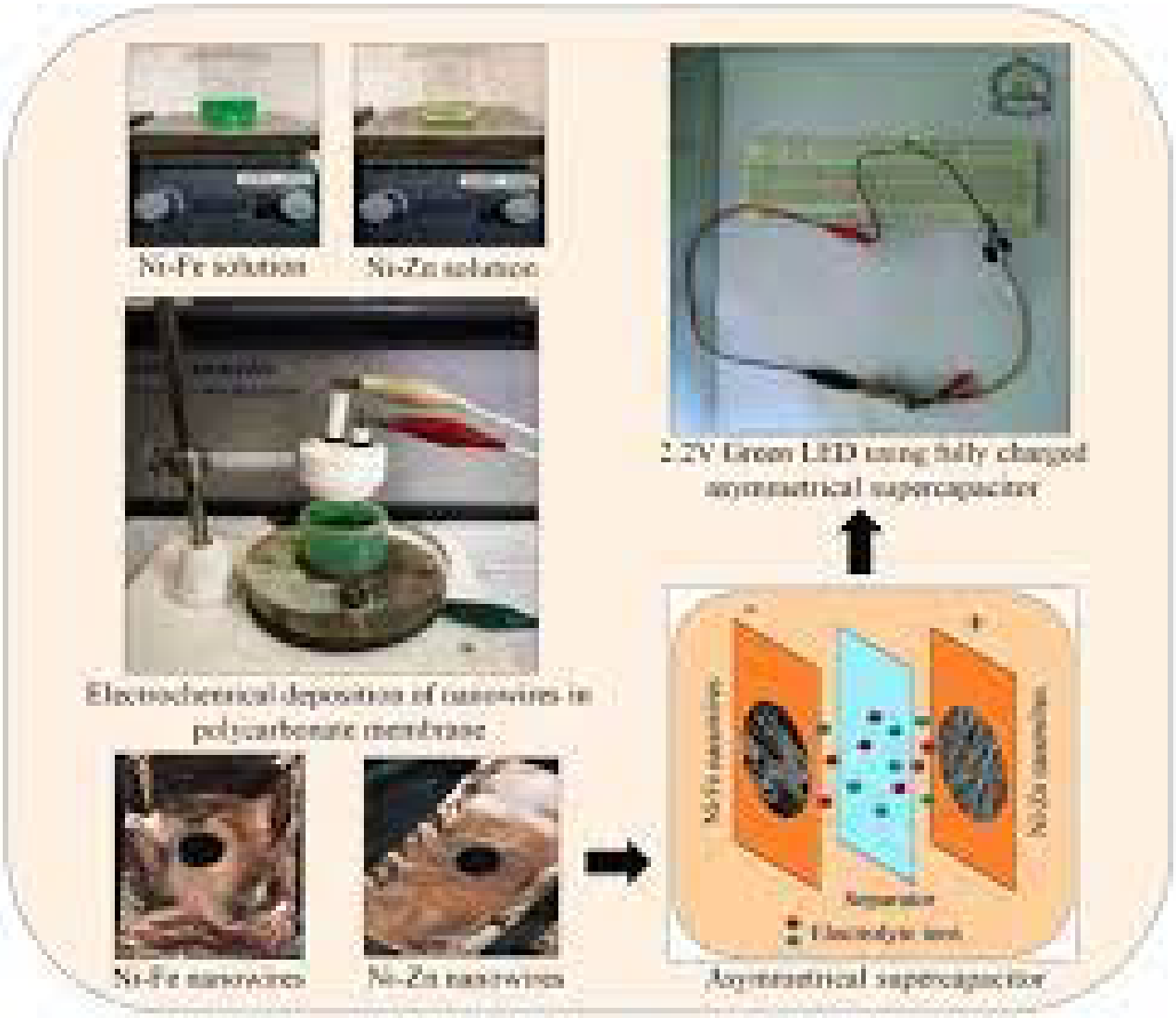
Detailed Analysis of result

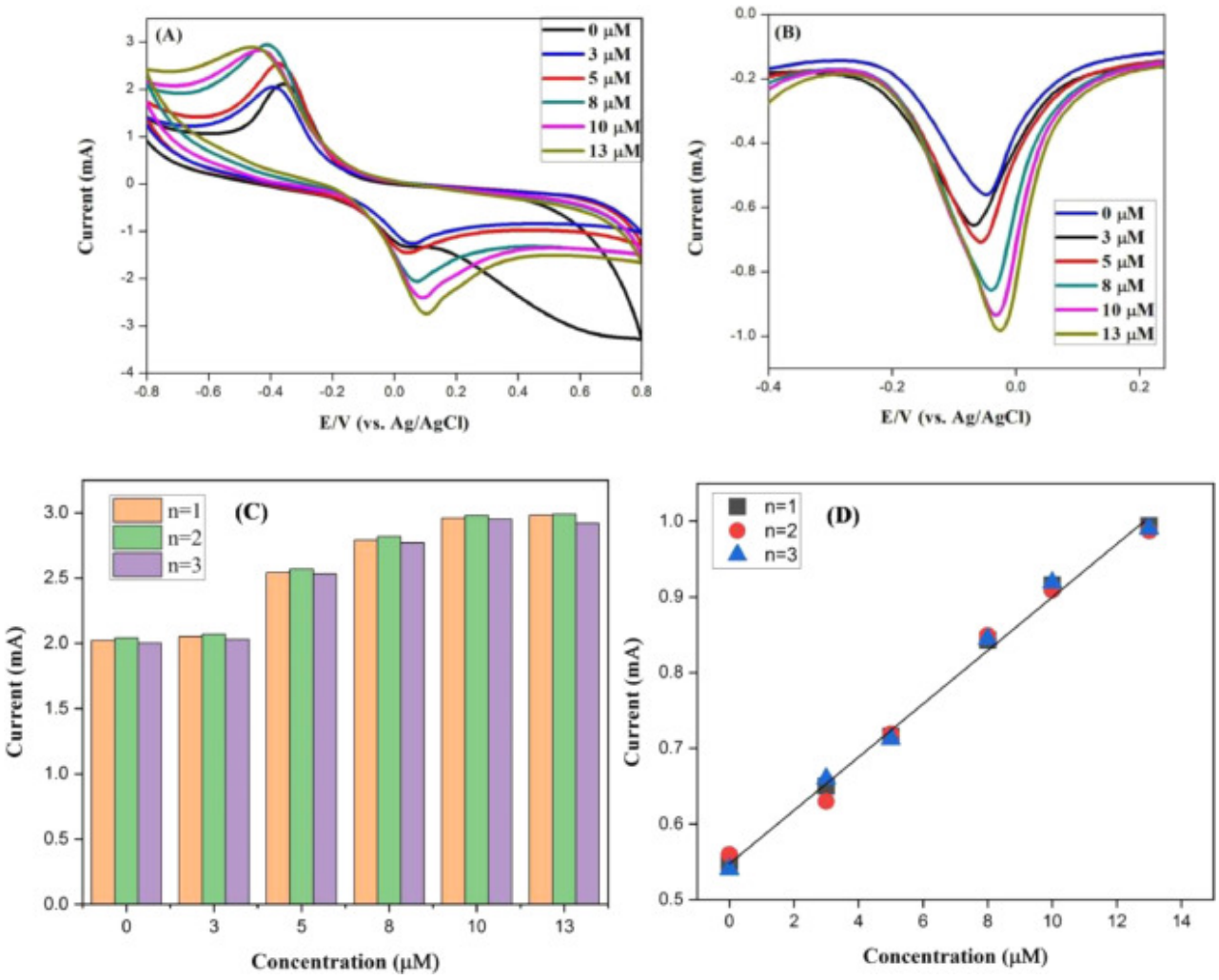
Result Analysis 1. Electrochemical detection of ammonia solution using tin oxide nanoparticles synthesized via sol–gel route: In this work, SnO2 nanoparticles were successfully synthesized via sol–gel technique. The structural and morphological properties of the synthesized nanoparticles were characterized through XRD, EDS, SEM, UV–Vis and PL spectrometry. Further, the fabricated device by involving as-synthesized nanoparticles was studied for sensing NH4OH solution. The obtained results suggested that the fabricated SnO2-layered device offers a simple, fast, good selectivity, high sensitivity and is a convenient method to detect NH4OH. Thus, the preliminary characterization showed that detection of NH4OH using SnO2 nanomaterial is possible. Detection of NH4OH solution is necessary to monitor the quality of liquid fertilizer solutions which consist of ammonia, ammonium nitrate, urea and aqua ammonia. 2. Performance of template-assisted electrodeposited Copper/Cobalt bilayered nanowires as an efficient glucose and Uric acid senor: A highly ordered single crystalline Cu/Co metallic bilayered nanowires of 150 nm diameter has been successfully synthesized using template based electrodeposition method at room temperature. FESEM, XRD, EDX and TEM studies confirm the successful formation of Cu/Co hexagonal structure of uniform growth with high aspect ratio. Experiment shows that the synthesized nanowires are capable of sensing glucose and uric acid effectively. Important features such as oxidation peak currents for glucose (1.25 mA) and uric acid (0.5 mA and 1.7 mA), distinct oxidation potentials for glucose (-0.4 V) and uric acid (-0.25 and -0.65 V), linear increase in oxidation currents with increase in concentration and distinct reduction potential for glucose (-0.5 V) and uric acid (-0.35V) were some significant observations. Further, the analysis of the results using copper substrate along with the synthesized bilayered Cu/Co nanowires as other plate of a parallel plate capacitor showed that the change in capacitance varies in accordance to the change in density of dielectric medium. These results may be very useful for sensing glucose and uric acid in an economical way with improved sensitivity and selectivity. 3. Template Based Electrochemical Synthesis of Copper (Cu) Nanowires as CH2Cl2 Sensor: In this work, a Cu nanowire array of 200 nm diameter has been successfully synthesized using electro-deposition method at room temperature. XRD, FESEM and EDX studies confirmed the formation of highly ordered Cu nanowire structure of consistent growth with large aspect ratio. Experimental results confirmed that the electrodeposited Cu nanowires are able to sense the CH2Cl2. The sensing of CH2Cl2 is determined electrochemically by three different methods and all these methods had shown the same trend of sensing. Thus, it can be concluded that Cu

nanowires based electrode can be easily fabricated and can be used for sensing CH2Cl2 with greater sensitivity. 4. Performance of electrochemically synthesized Nickel-Zinc and Nickel-Iron (Ni-Zn//Ni-Fe) nanowires as battery type supercapacitor: High performance Ni–Fe composite nanowires array based supercapacitor electrode was successfully synthesized via facile and costefficient electrochemical deposition technique. The synthesized nanowires array electrode have the potential to efficiently work in negative voltage window with high specific capacitance of 1255.17 Fg1 at 3 Ag1 and shows 80% capacitive retention even at the end of 5000 charge-discharge cycles in three-electrode mode. Taking advantage of negative potential window, the synthesized Ni–Fe composite nanowires array electrode is used as anode whereas Ni–Zn composite nanowires array electrode, synthesized by same technique, is used as cathode to fabricate an asymmetrical supercapacitor that demonstrates high specific capacitance of 75.3 Fg1 at 1 Ag1 with 95.23% capacitive retention after 2000 cycles. Moreover the assembled supercapacitor device exhibits high energy density of 63.62Wh kg1 at a power density of 0.64 KW kg1. Moreover, the feasibility of the device was demonstrated by glowing a 2.2 V green LED by using single supercapacitor. Further, since stability and durability of an electrode are the two imperative factors so in future we will work on these parameters in order to achieve better results. 5. High performance asymmetric supercapacitor based on vertical nanowire arrays of a novel Ni@Co-Fe LDH core@shell as negative and Ni(OH)2 as positive electrode: A high performance asymmetrical supercapacitor was developed by using Ni(OH)2 nanowires and Ni@Co-Fe LDH core-shell nanowires as the positive and negative electrode in 6M KOH electrolyte. Initially, the Ni@Co-Fe LDH core-shell nanowires array electrode was synthesized by electrochemical deposition method. The Ni@Co-Fe LDH core-shell nanowires array negative electrode exhibited a high capacitance of 1289 F/g with a high cycling stability of 91.6% over 1000 charge-discharge cycles. Furthermore, the asymmetrical supercapacitor operated at a high voltage of 1.6 V with energy density 68 Wh/kg and specific capacitance of 136 F/g at 1 A/g was fabricated. The asymmetrical supercapacitor delivered cyclic stability over 1000 charge-discharge cycles by maintaining 90.49% of the initial specific capacitance. Such easy on pocketbook and high-performance core-shell nanowires array negative electrode presents a bright future for advance energy storage. 6. Synthesis of SnO2 nanowires as a reusable and flexible electrode for electrochemical detection of riboflavin: SnO2 nanowires were synthesized on copper substrate by template directed elelctrodeposition method. The synthesized nanowires act as an economical flexible working electrode. It also represents good linearity for RF determination in a selected range from 0 to 13 M. However, when tested for RF content in pharmaceutical samples in the range from 52 to 150 M, the developed sensor still remains its linearity which indicates that the fabricated sensor not only works well in 0–13 M range but beyond that range also. Electrochemical studies were carried out by CV and DPV studies. EIS technique also verified about the successful determination of RF. The developed sensor exhibits good stability, reproducibility and efficiency. Moreover, its practical application was also checked in pharmaceutical tablet by the recovery test. Compared with all other existing electrodes employed for RF detection, the work reported by us, not only showed remarkably lower detection limit but it the cheapest electrode ever synthesized. The reported paper included the usage of copper tape as substrate and SnCl2.2H2O, precursor for synthesis of SnO2 nanowires, and both of them are very economical. The use of this working electrode in the complete set up of the devices built for RF detection can replace the costly electrodes. Apart from all, owing to the flexible nature of the synthesized working electrode, it showed high bend ability when subjected to an external force. The flexibility of synthesized SnO2 nanowires on a copper tape has the ability to replace the existing rigid substrates and their robustness indeed provides them a high tolerance for strain. The major advantage of our sensor is that the synthesized nanowires were directly used for sensing riboflavin while the previously reported mentioned reference was able to sense riboflavin only after the successful modification of costly available electrode with their synthesized materials. So, the extra step of modification and comprising of the analyte with the layered film is also eliminated in our case. In case of nanowires, there is a free diffusion of the analyte and the product molecules in the solution and more adsorption on the surface leading to the direct transfer of electrochemical signal and hence the better performance of the synthesized electrode 7. Highly stable self-charging piezoelectric (Rochelle salt) driven supercapacitor based on Ni nanowires: An asymmetrical supercapacitor was successfully fabricated using PPy/Ni/RS nanowires as anode and Ni/RS nanowires as the cathode. Further, an asymmetrical piezo-supercapacitor was also fabricated by using rochelle salt as piezoelectric energy harvester. The nanowires array based electrodes were synthesized via electrochemical deposition technique followed by spin coating. The PPy/Ni/RS nanowires based electrode exhibits specific capacitance of 1578.12 Fg-1 at 1.8 Ag-1 whereas the Ni/RS nanowires based electrode shows specific capacitance of 86.6 Fg-1 at 0.6 Ag-1 along with tremendous cyclic stability. The fabricated asymmetrical supercapacitor shows specific capacitance of 129.8 Fg-1 at 0.001 A. Furthermore, the fabricated asymmetrical piezo-supercapacitor exhibits self-charging property and can be charged up to 700 mV under a compressive force of 30 N in just 15 s. Such an easy on pocketbook and high-performance dvice provides a new promising direction for next generation self-powered sustainable power systems for portable electronics applications. 8. Electrochemical sensing and photocatalytic degradation of 2,4-Dinitrophenol via Bismuth(III) oxide nanowires: To preserve a sustainable ecosystem, a user-friendly toxic detection system is essential. Here, we have studied Bi2O3 nanostructures as selective materials for electrochemical sensing of 2,4-Dinitrophenol (2,4-DNP). Due to their unique optical, mechanical, and catalytic properties, Bi2O3 nanowires are preferred for the sensing and degradation of 2,4 DNP. A simple heating procedure was used to prepare Bi2O3 nanowires at a temperature of 90 °C using a polycarbonate membrane of 80 nm pore size. The electrochemical deposition takes place at a potential of -1.0 V applied for 140 s at room temperature. The morphological, structural, and optical properties of the synthesized Bi2O3 nanowires were studied using standard characterization techniques such as XRD, SEM, EDS, Raman, and XPS, while the electrochemical characteristics of the

original and Bi2O3-modified electrodes were studied using CV, DPV, and EIS. Additional investigation revealed that Bi2O3-modified electrode provided a surface suitable for the analyte 2,4 DNP, demonstrating it to be a valuable electrocatalyst. The synthetic electrode's LOD and LOQ are both found to be 201.29 fM. Both good electrochemical activity and stable electrodes were found in the fabricated bismuth oxide electrode-based sensor. After one month, the modified electrode had not been significantly affected. Photocatalytic activity was investigated to degrade 2,4-DNP by adding bismuth oxide nanowires and bismuth oxychloride, a photocatalyst, in the presence of visible light. Bi2O3nanowires synthesized successfully managed to completely degrade 2,4-DNP with more than 90% efficiency in six hours. Based on this research, it can be concluded that a low-temperature, inexpensive, and simple method for using Bi2O3nanowires in future ultra-large-scale integration devices is being developed.




Ni-Fe solution
Ni-Zn solution
2.2V Green LED using fully charged asymmetrical supercapacitor
Electrochemical deposition of nanowires in polycarbonate membrane
Ni-Fe nanowires
Ni-Zn nanowires
Asymmetrical supercapacitor



Conclusions

The conclusions drawn while completing this project is as under: 1. Several nanowires were successfully synthesized by template directed elelctrodeposition method. 2. Elemental and morphological characterizations such as XRD, FESEM and EDX studies confirmed the formation of highly ordered nanowire structures of consistent growth with large aspect ratio. 3. Experiment showed that the synthesized nanowires are capable of sensing several analytes present in the liquid solution. 4. It is also concluded that the synthesized nanowires based electrode can be easily fabricated and can be used for sensing different analytes with greater sensitivity. 5. A high performance supercapacitors were also developed by using Ni based nanowires. 6. Nanowires based electrode exhibits specific capacitance upto 1578.12 Fg-1 at 1.8 Ag-1 along with tremendous cyclic stability. The fabricated supercapacitors showed high specific capacitance. 7. All these techniques are environmental friendly, efficient and economical.

Scope of future work

In future, more nanowires are proposed to be synthesized for energy and sensing applications. The focus in future will be on attaining high capacitance for supercapacitors while for nanowires based sensors, high sensitivity along with better selectivity and reusability. Moreover, integration of such devices in wearable and flexible form will also be studied in future.

List of Publications (only from SCI indexed journals) :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impact Factor
Electrochemical detection of ammonia solution using tin oxide nanoparticles synthesized via sol–gel route	Sandeep Arya, Mohammad Riyas, Asha Sharma, Bikram Singh, Prerna, Pankaj Bandhoria, Saleem Khan, Vishal Bharti	APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING (International)	Aug-2018	124 (538)	Published		1.604
Highly stable self-charging piezoelectric (Rochelle salt) driven supercapacitor based on Ni nanowires	Sonali Verma, Sandeep Arya, Vinay Gupta, Ajit Khosla	CHEMICAL ENGINEERING JOURNAL (International)	Nov-2021	424 (130567)	Published	10.1016/j.cej.2021.130567	13.273
High performance asymmetric supercapacitor based on vertical nanowire arrays of a novel Ni@Co-Fe LDH core@shell as negative and Ni(OH)2 as positive electrode	S. Verma, V. Gupta, A. Khosla, S. Kumar, S. Arya	IOP Nanotechnology (International)	Mar-2020	31 (245401)	Published	10.1088/1361-6528/ab7b07	3.399
Green Synthesis of Silver Nanoparticles Using Aqueous Extract of Rosa brunonii Lindl and Their Morphological, Biological and Photocatalytic Characterizations	Madhulika Bhagat, Rythem Anand, Ram Datt, Vinay Gupta, Sandeep Arya	Journal of Inorganic and Organometallic Polymers and Materials (International)	May-2019	29 (1039–1047)	Published		1.754
Synthesis of Au-SnO2 nanoparticles for electrochemical determination of vitamin B12	A Sharma, S Arya, D Chauhan, PR Solanki, S Khajuria, A Khosla	Journal of Materials Research and Technology-JMR&T (International)	Oct-2020	9 (14321)	Published	10.1016/j.jmrt.2020.10.024	5.289
Effect of Pd concentration on the structural, morphological and photodiode properties of TiO2 nanoparticles	Bikram Singh, Sandeep AryaE, Asha Sharma, Prerna Mahajan, Jyoti Gupta, Anoop Singh, Sonali Verma, Pankaj Bandhoria, Vishal Bharti	JOURNAL OF MATERIALS SCIENCE-MATERIALS IN ELECTRONICS (International)	Apr-2019		Accepted	doi.org/10.1007/s10854-019-01095-5	2.324
Electrochemical sensing and photocatalytic degradation of 2,4-dinitrophenol via bismuth (III) oxide nanowires	B Singh, A Singh, A Sharma, P Mahajan, S Verma, B Padha, A Ahmed, S Arya	JOURNAL OF MOLECULAR STRUCTURE (International)	Jan-2022	1255 (132379)	Published	10.1016/j.molstruc.2022.132379	3.196
Performance of template-assisted electrodeposited Copper/Cobalt bilayered nanowires as an efficient glucose and Uric acid senor	J Gupta, S Arya, S Verma, A Singh, A Sharma, B Singh, Prerna, R Sharma	MATERIALS CHEMISTRY AND PHYSICS (International)	Aug-2019	238 (121969)	Published	10.1016/j.matchemphys.2019.121969	2.781
Sol-gel synthesis of Cu-doped p-CdS nanoparticles and their analysis as pCdS/n-ZnO thin film photodiode	Sandeep Arya, Asha Sharma, Bikram Singh, Mohammad Riyas, Pankaj Bandhoria, Mohammad Aatif, Vinay Gupta	Optical Materials (Others)	Mar-2018	79 (115-119)	Published		2.238

List of Papers Published in Conference Proceedings, Popular Journals :

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impact Factor

Title of the Paper	List of Authors	Journal Details	Month & Year	Volume	Status	DOI No	Impact Factor
Template based Electrochemical Synthesis of Copper (Cu) Nanowires as CH2Cl2 Senso	Jyoti Gupta, Sandeep Arya, Anoop Singh, Sonali Verma, Asha Sharma, Bikram Singh and Amit Tomar	Integrated Ferroelectrics (International)	May-2019		Accepted	DOI	0.367

List of Patents filed/ to be filed :

Patent Title	Authors	Patent Type	Country/Agency Name	Patent Status	Application/Grant No.
Not Available					

Equipment Details :

Equipment Name	Cost (INR)	Procured	Make & Model	Utilization %	Amount Spent (INR)	Date of Procurement
Autoclave	2,00,000	Yes	Runyes Feng	40	1,95,500	05 Mar, 2020
Centrifugal Machine	50,000	Yes	BGSTC 4100D	50	1,05,374	06 Dec, 2017
Ultrasonic Cleaner	50,000	Yes	IIc-SONIC-171B	60	45,902	10 Oct, 2017
Potentiostat/Electro chemical Workstation	12,50,000	Yes	CHI 660E	40	14,44,239	22 Jan, 2018
Analytical balance	1,00,000	Yes	SHIMADZU	50	38,272	04 Dec, 2017
LCR Meter	2,00,000	Yes	Agmatel	60	24,945	16 Mar, 2020
One high end computational machine, one Multifunction Printer, a hard disk, and related accessories	1,50,000	Yes	HP, canon, WD	40	1,33,779	09 Oct, 2017

Plans for utilizing the equipment facilities in future:

With this developed facility, the principal investigator is committed in developing novel nanowires and exploring them for frontier areas of research in the field of energy storage and electrochemical sensing. The ultimate goal is to produce efficient sensing and energy devices that are eco-friendly and can replace the costly techniques. The future research will continue to focus in developing such devices that would in the long run modulate the technology. All the equipment's procured in this research project would continue to aid and support the PhD students for enhancing their technical skills and substantiate the research methodologies.

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SERB-Notification

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To: info@serbonline.in

Thu, May 30, 2024 at 4:18 PM

SERB India |

Science and Engineering Research Board

(Statutory Body Established Through an Act of Parliament : SERB Act 2008)
Department of Science and Technology, Government of India

Closure acknowledgement to the Convener / PI

Anusandhan National Research Foundation (ANRF)

(A statutory body created by an Act of Parliament - ANRF Act, 2023)

ANRF

3rd & 4th Floor, Block II

Technology Bhavan, New Mehrauli Road

New Delhi - 110016

File Number: EEQ/2016/000119

Dated: 30-May-2024

Subject: Project titled " **Electrochemical synthesis of nano-wires and their physio-chemical parametric evaluations for sensor applications** "

Dear Dr. Sandeep Arya

The ANRF has received the required financial documents and the same have been accepted. Hence, this file is closed officially. This is for your kind information.

Yours sincerely,

(Dr. Thangaradjou T)

Scientist F

Email: ms_eeq@serbonline.in

Dr. Sandeep Arya

Jammu University , Jammu, Jk, Jammu, Jammu And Kashmir-180006