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Agreement for Undertaking Collaborative R&D project

Title of the Project: **Printed Electrocatalyst Layers for PEMFC/DMFC**

This AGREEMENT is made and entered into on this 18th day of July ...Two thousand and Nineteen by and between the **ONGC Energy Centre Trust** registered as a Trust and having one

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of its offices located at 8th Floor, Core-4, SCOPE Minar, Laxmi Nagar, New Delhi-110092 (hereinafter called '**OECT**', which expression shall unless repugnant to the context or meaning thereof include all its successors, administrators, executors and assignees) of the **Party-1**

AND

Indian Institute of Science- Bangalore having its office at Indian Institute of Science, Bangalore- 560012, INDIA (herein after referred to as **IISc-Bangalore** which expression shall unless repugnant to the context or meaning thereof include all its successors, administrators, executors and assignees) of the **Party-2**

The Parties (1), and (2) hereafter being collectively referred to as the "Parties" and individually as the "Party";

PREAMBLE:

Whereas IISc-Bangalore has represented to OECT that it has capability in undertaking the **'Printed Electrocatalyst Layers for PEMFC/DMFC'** and has submitted a Project Proposal dated 26.02.2019 appended to this AGREEMENT as Annexure I. The submitted project proposal has been approved by DG-OEC on 12June 2019.

AND,

Whereas, IISc-Bangalore represents that it has the necessary experience and expertise for carrying out and agrees to undertake R&D Project in collaboration with OECT as defined in this AGREEMENT.

AND,

Whereas, OECT desires that, IISc-Bangalore should undertake the assigned Collaborative R&D Project more explicitly defined in the sections below in this AGREEMENT.

AND,

Whereas, IISc-Bangalore agree to provide all the necessary facilities to the Principal Investigator (PI) of the project to perform the Collaborative R&D Project as defined in this AGREEMENT.

Now therefore it is agreed between the parties as under:-

1.0 DEFINITIONS

Unless inconsistent with or otherwise indicated by the context, the following terms stipulated in this AGREEMENT shall have the meaning as defined hereunder.

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1.1 **AGREEMENT:** This AGREEMENT together with the Schedules, Parts, Annexures and Appendices attached hereto and will include any modifications, amendments or alterations thereof as agreed between the parties from time to time.

1.2 **CONSULTANT:** The person or persons with technical knowhow/expertise appointed by IISc-Bangalore, if deemed necessary, to guide/assist the Principal Investigator and facilitate in overall execution of the Project Work, as defined in this AGREEMENT.

1.3 **CO-PRINCIPAL INVESTIGATOR(S) (Co-PI):** The person or persons who may be appointed / nominated by IISc-Bangalore, if deemed necessary, to assist PI in the overall execution of Project Work, as defined in this AGREEMENT.

1.4 **DESIGN:** "Design" shall include an industrial design, drawings and layouts.

1.5 **INTELLECTUAL PROPERTY:** Includes patent, copyright, design, trade secret and property in discoveries, inventions, improvements, designs, data or information and materials/microbes isolated or created in pursuance of the research/technology development activities under the project whether or not such intellectual property will be capable of patent, copyright or similar infringement protection or recognition and includes knowledge and information described as Confidential under this AGREEMENT.

1.6 **INVENTION:** "Invention" shall bear the meaning assigned thereto in the Indian Patents Act, 1970 (including any re-enactment thereof) as amended from time to time.

1.7 **ONGC GROUP OF COMPANIES**: All subsidiary and joint venture companies of the Oil and Natural Gas Corporation Limited and ONGC group of companies.

1.8 **PARENT ORGANIZATION:** The Oil and Natural Gas Corporation Limited, ("ONGC"), a company incorporated and registered under "Companies Act – 1956" and having its Registered office at Pandit Deendayal Upadhyaya Urja Bhavan, 5 Nelson Mandela Marg, Vasant Kunj, New Delhi-110070.

1.9 **PATENT:** "Patent" shall bear the meaning assigned under the Patents Act, 1970 (including any re-enactment thereof) as amended from time to time.

1.10 **PRINCIPAL INVESTGATOR (PI):** The person appointed/nominated by IISc-Bangalore in consultation with OECT, who shall be responsible for the overall execution of Project Work as defined in this AGREEMENT.

1.11 **PROJECT CO-ORDINATOR (PC):** The person designated by OECT to interact, monitor / review the Project Work carried out by Principal Investigator and his/her Project Team.

1.12 **PROJECT PERSONNEL:** Persons with requisite qualifications appointed by IISc-Bangalore, as per IISc-Bangalore norms for any appointment in this research project, for technical help in execution of the Project Work.

1.13 **PROJECT WORK:** Shall mean overall mutually agreed scope of work which is given at Clause 3 of this AGREEMENT and also defined in the Project proposal at Annexure I relating to the Collaborative R&D work to be performed by IISc-Bangalore with OECT.

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1.14 RESEARCH FELLOW: Persons with requisite qualifications as per IISc-Bangalore norms appointed by IISc-Bangalore specifically for this project work to carry out research. The Research Fellows will get stipend in accordance with the OECT guidelines.

1.15 SUB-CONTRACT: Shall mean any work order placed by IISc-Bangalore on a third party for executing any portion of the Project Work under the scope of the AGREEMENT with necessary written consent of OECT. Such sub-letting shall not relieve the IISc-Bangalore from any obligation, duty or responsibility under this AGREEMENT.

1.16 SUB-CONTRACTOR: Shall mean any person or persons or firm or their legal representatives, successors, assignees to whom part of this AGREEMENT has been sublet by the IISc-Bangalore after necessary written consent of OECT.

2.0 OBJECTIVE OF THE PROJECT

BROAD OBJECTIVE

Fabrication of conductive, electrocatalytically active, nanostructured films with Ultra low Platinum loading on Nafion membranes for PEMFC/DMFC applications

SPECIFIC OBJECTIVES

1. Use of pulsed electrodeposition technique to form 1-10 atomic layer thick platinum shells onto metallic nanostructured films.
2. Electrochemical characterization of pulse-deposited Platinum films for benchmarking activity parameters for PEMFC/DMFC applications, such as ECSA values, Mass activity, CO tolerance, durability

3.0 SCOPE OF WORK

The project scope envisions the use of an inkjet printer to generate conductive and porous silver nanostructures on Nafion membranes. The study of deposition techniques to form a electrocatalytic coating layer with ultra-low platinum loading along with the use of electrochemical techniques for performance characterization also falls within the scope of the project.

The methodology followed will be as follows:

i. The print-expose-develop process developed in our group will be used to fabricate porous and conductive silver nanostructure films with particle or nanowire morphology on Nafion membrane.
ii. Use of a self-terminating electrochemical deposition technique to fabricate platinum overlayers, in steps of monoatomic shells, on printed silver nanowire networks.
iii. Electrochemical characterization of MOR/ORR activity will be carried out.

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Time Schedule for Activities through Bar Chart:

Sl. No.	Major Activities	Time Period		
		(6 months)	(12 months)	(18 months)
1	**Proof of Concept** - Optimization of protocol for pulsed electrodeposition of platinum atomic layers			
2	**Procurement** of Rotating Ring Disk Electrode setup			
3	**Lab-Scale Demonstration** - Electrochemical characterization of MOR/ORR activity			

4.0 DELIVERABLES

The major deliverables in this project will include:

- ✓ Additive fabrication process for carbon-support free nanostructured, electrocatalytically active and electrically-conductive thin film with ultralow platinum loading (< 50 μg/cm^2)
- ✓ Electrochemical characterization results for ORR/MOR activity and demonstration of optimal configuration(s) with ECSA > 80 m^2/g_{pt} and specific activity @0.9V >0.44 A/mg_{pt}

5.0 FINANCIAL COMMITMENTS & MODE OF PAYMENT

5.1. OECT will pay a total sum of Rs. 24,13,353/- (Rupees Twenty four lakhs thirteen thousand three hundred and fifty three only) plus applicable GST to IISc-Bangalore for the Project Work, as per the following details:

Budget Head	1st Year (Rs.)	2nd Year (Rs.)	Total (Rs.)
Capital Equipment	6,00,000	0	6,00,000
Manpower	5,15,712	2,57,856	7,73,568
Consumables	4,00,000	2,00,000	6,00,000
Travel	25,000	25,000	50,000
Contingency	50,000	25,000	75,000
Any Other (Scientific fee)	----	----	----
Overheads @ 15%	2,38,607	76,178	3,14,785
Total Estimated Budget excluding GST	**18,29,319**	**5,84,034**	**24,13,353**

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A. **Equipment:**

Sl. No.	Generic Name of the Equipment	Estimated Cost(Rs.)	Purpose
1.	RDE (Rotating Disk Setup)	6,00,000	For characterizing the ORR/MOR specific activity of fabricated samples without diffusion limitations
	Total (Rs.)	**6,00,000**	

B. **Manpower:**

Sl. No.	Designation	Yearly Rate (Rs.)	Duration in Months	Estimated Amount (Rs.)	Purpose
1.	PMRF fellow	5,15,712	18	7,73,568	OECT contribution towards PMRF fellowship for JRF

C. **Consumables:**

Sl. No.	Item	Estimated Amount (Rs.)	Purpose
1	Nafion membranes, Metal salt precursors etc	3,00,000	For preparing samples
2	CeNSE usage fees	3,00,000	Facility charges for materials characterization
	Total (Rs.)	**6,00,000**	

5.2. I the payments shall be made to IISc-Bangalore. IISc-Bangalore will be responsible for proper custody of equipments/materials and expenditure on the Project Work as defined in this AGREEMENT.

5.3. OECT shall make payment towards total cost of the AGREEMENT in installments on milestone achievement basis. The payment shall be released against completion of milestones mentioned in the table below. However, in case it is absolutely essential to make any deviation, specific written request may be sent by PI to OECT for approval. The payment shall be made based on actual subject to the upper limit mentioned in the budget.

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5.3.1 Details of Milestones/Targets based Payments

Installament	Milestones/Targets	Month from Start Date	Installment to be released from total amount sanctioned (Rs.)	Justification
1st	Initial release: Signing the agreement	0	12,00,000	Purchase of RDE setup, PMRF fellowship and consumables
2nd	Half-yearly Report, Procurement of RDE setup, **Proof of concept** Fabrication of Platinum coated conductive, electrocatalytically active nanostructures on Nafion membranes with **loading < 50 µg/cm^2**	6	5,00,000	PMRF fellowship and consumables, travel contingency
3rd	Annual progress report, preliminary electrochemical characterization	12	5,00,000	PMRF fellowship, contingency and consumables Overheads for 1st year
4th	**Lab-scale Demonstration** Optimization of number of platinum overlayers for enhanced electrocatalytic performance with **ECSA values > 80 m^2/gpt** and **Specific activity @0.9V of 0.44 A/mgpt** Submission of Final Technical Report and Audited statements	18	2,13,353	Final settlement
	Total		**24,13,353**	

Note: Milestone based completion report will be submitted after each milestone.

5.4. Approval of the Project Work and the financial support by OECT is for this project and the amount received by IISc-Bangalore should be exclusively spent for the project work/activities within the approved time duration. IISc-Bangalore is not permitted to seek or utilize funds from any other organisation (government, semi-government, autonomous and private bodies) for this project approved by OECT, except in cases, where a project is approved for joint funding with/by OECT.

5.5. IISc-Bangalore will be responsible for expenditure incurred on the project and shall maintain separate account and records for the project to be implemented under this AGREEMENT. All payments, made by OECT to IISc-Bangalore by Electronic clearing system (ECS)/ RTGS/NEFT, shall be credited to this account. If it is found expedient by TIBS to keep a part or whole of the amount released by OECT in a bank account earning

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interest, the interest thus earned shall be reported to OECT and reflected as receipt from OECT in the 'Statement of Accounts'.

5.6. IISc-Bangalore is required to inform OECT if they are recognized as a R&D institute, which is eligible for exemption from deduction of Tax Deduction at Source (TDS) and is also required to produce a certificate from the competent Tax Authority in this regard. Normally, TDS rules shall be applicable in respect of all payments made by OECT, unless IISc-Bangalore is able to produce in advance applicable Tax Exemption Certificate towards such receipts, issued by competent Tax Authorities. It will be the sole responsibility of IISc-Bangalore to inform OECT in advance about availing of Tax Exemption and also to ensure timely submission of Tax Exemption Certificate to receive full payment of amount of the instalments. In case of delay in submission of certificate and consequent delay in release of payments, OECT will not be responsible for any delay in implementation schedule of the project on account of such delays. If no prior request is received, OECT will deduct TDS as per applicable rates. In case IISc-Bangalore is desirous of receiving the amount of instalment from OECT without any TDS deduction and it expects delay in receiving the Tax Exemption certificate from concerned Tax authority, it should provide funds for the project work from its own resources in the interim period and ensure that project work is not hampered.

5.7. IISc-Bangalore will submit the request for release of milestone based payment, in the prescribed format (Annexure-IV of this AGREEMENT) along with the progress report and the latest statement of expenditure in the prescribed format including Committed Expenditure, duly audited by internal/external auditor, as the case may be.

5.8. All milestone based payments will be released by OECT only after the satisfactory completion of each milestone-wise tasks/goals by IISc-Bangalore and their acceptance by OECT. The next milestone based payment will be released only after receipt of documents on utilization of funds released under previous payment and other related documents as per prescribed format. In case of procurement of equipment for the project, instalment will be paid by OECT only after IISc-Bangalore completes all pre-procurement actions, as per laid down procedures of IISc-Bangalore for such procurement and submits a copy of invoice/purchase order/letter of intent/letter of credit as the case may be, as supporting document for release of instalment. The PI/institute will submit details of the item, quantity, price, delivery schedule, payment terms etc. and a copy of the purchase order and invoice to be submitted as soon as issued on the supplier. Whenever, the delivery period is over, the PI should confirm receipt of equipment, its commissioning and the extent of payment (full or part payment) made. In case, the equipment delivery period, for which instalment has been released, is not over before the next milestone based instalment becomes due, the PI must confirm giving requisite details and justifications.

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Any delay in delivery or commissioning of the equipment or release of payments for equipment must be explained with full justification while making request for next instalment. In all cases, the required financial documents must be audited as per clause 5.7 of the AGREEMENT.

5.9. No payment will be made for purchase of any new equipment before six months of project completion or if equipment delivery is within last six months of the project, unless specific written approval of OECT is obtained. The budget for purchase of capital equipment is not allowed to be diverted or utilized for any other purpose, without prior written approval from OECT.

5.10. On completion of all steps relating to the purchase of capital equipment, the equipment must be entered into asset register to be maintained by IISc-Bangalore for this project.

5.11. If a request for release of milestone based instalment is made in second quarter of the financial year, the PI should enclose the audited statement of the accounts along with the Utilization Certificate for the previous financial year duly audited by external auditor in the prescribed format (Annexure-V and VI of this AGREEMENT), if not submitted earlier.

5.12. On completion of the Project and submission of the final report and other related documents etc., IISc-Bangalore shall render the final audited accounts/ statement of expenditure in the prescribed format, duly certified by authorised representative of the University/Head of Institute/Organisation for release of the final instalment by OECT.

5.13. Any unspent amount left with IISc-Bangalore will be immediately returned through ECS/ RTGS/NEFT in favour of "ONGC Energy Centre Trust" payable at New Delhi, but not later than 30 days of approved project completion date IISc-Bangalore shall be liable for penal interest @18% per annum on unspent amount retained beyond the specified period).

5.14. On completion of the project, IISc-Bangalore shall submit full details of Assets acquired by under the project utilising OECT funds in the prescribed format (Annexure-VII of this AGREEMENT) and copies of purchase orders and invoices of all Assets, along with Final audited Statement of Accounts (Annexure-V of this AGREEMENT).

5.15. In case IISc-Bangalore is not in a position to implement or complete the project due to valid reasons accepted by OECT, it should, forthwith, refund to OECT the total funds received by it or balance, thereof.

5.16. OECT and its authorised representatives shall have the right of access to the books and accounts of IISc-Bangalore maintained in respect of this project and funds received from OECT will provide all assistance to the OECT team to inspect the books of accounts and give suitable reply to their observations/findings in a time bound manner. All corrective actions required, if any, in this regard will be implemented by the PI and IISc-Bangalore.

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6.0 DURATION OF THE AGREEMENT

This AGREEMENT shall be valid for a period of 18 months from .....2019 to ..... 2020 unless otherwise terminated or extended in terms of the AGREEMENT.

7.0 RESPONSIBILITIES AND ACTIVITIES

7.1 IISc-Bangalore shall undertake to perform the Project Work under this AGREEMENT with all reasonable skill, diligence and care in accordance with sound industry practice to the satisfaction of OECT and accept full responsibility for the satisfactory quality of such services as performed by them.

7.2 As per the project proposal, Dr. Venugopal Santhanam, Chemical engineering Department, IISc-Bangalore, shall be the Principal Investigator who shall be leading and guiding the project team for achieving the objectives and deliverables, as per agreed scope of work. A Co-Principal Investigator, Prof. Ganapathy Ayappa shall also be identified to prevent loss to the project and OECT, and in such an event, both shall be responsible for carrying out the assigned Project Work. The Co-PI shall function as PI in the absence of PI and should be totally in knowledge of the activities of the Project Work.

7.3 If the PI's to whom the project has been sanctioned by OECT wishes to leave IISc-Bangalore, the IISc-Bangalore will inform the same to OECT in advance and in consultation with OECT:

i) Evolve steps to ensure successful completion of the project by appointing a new PI, or

(ii) Designate the Co-PI as the PI before relieving the PI in consultation with OECT.

7.4 OECT on its part has designated Project Manager-Hydrogen Project of OECT as the Project Coordinator (PC).

7.5 All required administrative support and infrastructure facilities by way of provision of desired quality of work space, water, electricity, communication and other required infrastructure facilities etc. for smooth implementation of the Project Work shall be provided by IISc-Bangalore to the PI and the project team.

7.6 IISc-Bangalore shall undertake to carry out the Project Work and related studies, as per the scope of work and deliverables etc. defined in this AGREEMENT within the agreed time frame and budget by employing competent personnel.

7.7 IISc-Bangalore shall deploy qualified research personnel for achieving all the goals set out under the project, in accordance with laid down procedure for recruitment followed by IISc-Bangalore.

7.8 All the Personnel including Research Personnel, appointed by the IISc-Bangalore under the project, for full/part duration of the project, are to be treated as project personnel on contract to the IISc-Bangalore and will be governed by the Administrative rules (for leave,

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TA/DA etc.) of IISc-Bangalore, as applicable for contract project personnel. They are not to be treated as employees of the OECT under any circumstances and OECT will have no liability, whatsoever, for the Project Personnel, during and after completion of the project duration.

7.9 For the expeditious implementation of the Project Work, IISc-Bangalore will provide full support to the PI in the process of selection and appointment of project personnel/staff and shall make payment to them in accordance with the guidelines given in this AGEEMENT.

7.10 The consolidated emoluments paid to Research Fellows engaged for the project work will be as per the prevailing OECT norms during the period of implementation of the Project Work. Other than consolidated emoluments, applicable as per OECT norms, TA/DA will be paid, in case of official travel, as per the prevailing rules of the IISc-Bangalore and the same shall be adjusted against the travel budget of the project, as approved by OECT.

7.11 OECT will deploy its own manpower to be a part of the project team for effective implementation of the Project Work. This manpower will be in addition to the manpower agreed as a part of the project budget. During the implementation of the Project Work, the OECT personnel will report to the PI. However, their terms of engagement will remain as per their contract with OECT or applicable service rules. OECT will inform the PI about their placement in advance. IISc-Bangalore will provide them all work related facilities and infrastructure support within the budget approved.

7.12 IISc-Bangalore shall not engage any consultant, sub-contract or assign the technical work or studies concerning the project, either wholly or in part to any other institute/organization or any third party without prior permission in writing from OECT. In case, it is considered necessary in the interest of the Project Work, the PI will request to OECT in writing giving full justification including its financial and IPR implications. However, mere applying for permission to sub-contract the said project work/studies will not amount to grant of permission and OECT reserves the right to disagree to such request for any sub-contracting or consultancy.

8.0 REVIEW OF PROGRESS & SUBMISSION OF REPORTS

8.1 The Principal Investigator (PI) or in his absence the Co-PIs will regularly submit to OECT monthly progress reports on or before 27th day of each month, through e-mail in the prescribed format (Annexure-II of this AGREEMENT). The report among other things will include (a) Project Work accomplished against the set targets (b) reasons for the short fall, if any, and proposed remedial measures (c) other scientific achievements made during the period, (d) publications, (e) placement of manpower, (f) procurement of equipment etc. and (g) planned targets for the next month.

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8.2 In addition to the above the PI shall furnish 2 hard copies and one copy in electronic form of the Progress Report on the project related work/studies, on quarterly basis in the prescribed format (Annexure-II of this AGREEMENT).

8.3 OECT will regularly review the progress of the work through visits to IISc-Bangalore or by inviting the PI to OECT facilities/office. OECT may, if considered necessary by OECT, depute a team of experts to review the progress of the project. IISc-Bangalore shall extend all required facilities and full support for such visits to facilitate effective monitoring and implementation of the project. The travel budget of the project will include cost towards visits of the PI and others for attending such review meetings.

8.4 OECT will provide a copy of the report on the review of the project to the PI, for implementation. The PI's and IISc-Bangalore will take into account the suggestions made by the reviewing team on mid-term corrections/modifications in the project work, while formulating necessary corrective/remedial actions for implementation, subject to feasibility of implementation of such suggestions/actions within the approved project budget. PI will provide action taken report to OECT on the report of review of the project.

8.5 On completion of the project, the PI will submit a draft 'Project Completion Report' on the work done under the project for review by OECT. Comments/suggestions, if any, will be incorporated by the PI as appropriate and thereafter, 5 copies of the final consolidated 'Project Completion Report' will be submitted to OECT in the prescribed format (Annexure-III of the AGREEMENT). One copy in electronic form will also be submitted to OECT.

8.6 The 'Project Completion Report' must include full details of objectives and work plan for the project, work/studies undertaken by PI/IISc-Bangalore, as per the approved objectives/work plan, discussions & inferences of the results of the research, outcome of project and achievements, all relevant technical details/specifications/process flow diagrams, working drawings for designing of the systems/equipment for further work on demonstration/scale up, as the case may be, along with inventory of required materials, specifications etc. All items covered under the head "deliverables" of the project must be covered in this report.

9.0 TECHNOLOGY TRANSFER

9.1 At the completion of the Project Work, the developed technology shall be transferred to OECT/ONGC or ONGC group of companies or any agency to be specified by OECT for Demonstration and/ or commercialization.

9.2 IISc-Bangalore shall also provide samples of all the used chemicals optimised for the process and other detailed information on the process to OECT for safe deposition and preservation for protection of IPR and subsequent use.

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10.0 REMUNERATION FOR PROJECT PERSONNELS

10.1 Qualified manpower for Project work will be deployed by IISc-Bangalore as per IISc-Bangalore norms following the procedure laid down in the Institute.

10.2 Emoluments:

I. The consolidated emoluments paid to a deployed manpower will be as per this AGREEMENT but will not be less than the emoluments payable as per IISc-Bangalore norms prevailing on the date of signing this AGREEMENT and will not be changed during the currency of the AGREEMENT, unless norms followed at the Institute/University/ UGC/DST/CSIR level, that may be applicable to IISc-Bangalore, are revised.

II. The emoluments of the deployed manpower shall be the part of total project budget as given in this AGREEMENT.

11.0 OWNERSHIP OF IMMOVABLE & MOVABLE ASSETS

11.1 For permanent, semi-permanent assets acquired solely or mainly out of the project budget, an audited record in the form of a register in the prescribed format (Annexure-VII of this AGREEMENT) shall be maintained by IISc-Bangalore. The term "Assets" include (a) the immovable property acquired out of the funds; and (b) movable property of capital nature where the value exceeds Rs. 50,000/- or a lower amount as per the policy of IISc-Bangalore. This amount will be intimated by IISc-Bangalore to OEC within 15 days of signing of the AGREEMENT. IISc-Bangalore is required to send to the OECT a list of assets acquired under the project on annual basis. A consolidated list of asserts will be submitted on completion of the project, as a part of the Project Completion Report.

11.2 OECT shall have Sole Ownership of all Assets acquired under the project for which OECT has made the payments to IISc-Bangalore. These assets should not be disposed off or encumbered or utilized by IISc-Bangalore for any purpose other than those for which the budget had been sanctioned, without the prior written permission from OECT.

11.3 IISc-Bangalore shall undertake to properly maintain and upkeep the capital assets/equipment purchased using OECT funds and also to provide all suitable infra-structure, like working space, environment, air conditioning and other required facilities, for smooth operation of equipments, as per procedures recommended by OEM.

11.4 On conclusion/ termination of a project, OECT will be free to take back, sell or otherwise dispose off the assets, which are the property of OECT. IISc-Bangalore shall render to OECT necessary facilities for arranging the return, sale or disposal of these assets. OECT has the discretion to gift its share of assets to IISc-Bangalore or transfer them to any other institute/organisation, if it is considered appropriate.

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11.5 If the Capital equipment/other assets are allowed to be retained by the IISc-Bangalore after completion of the project, IISc-Bangalore will give an undertaking to maintain the assets from its own resources. Further, if required, IISc-Bangalore will continue to provide the equipment/assets for use by OECT, if need so arises or in any other projects, which may be awarded to IISc-Bangalore by OECT in future.

12.0 PUBLICATIONS, INTELLECTAL PROPERTY RIGHTS & OWNERSHIP

12.1 IISc-Bangalore are required to seek protection of Intellectual Property Rights (IPR) for the results/output of the research/technology development project sanctioned by OECT. If the results of research are to be legally protected under IPR, the results shall not be published or relied upon or referred to, prior to its registration.

12.2 Publication of the research results in journals/ conferences shall be jointly authored by IISc-Bangalore and OECT. The PI shall seek prior approval of OECT for publishing technical/ scientific papers based on the research work done under the project, which do not merit protection under IPR. The PI shall submit copy of the manuscript of paper at the time of seeking approval from OECT. The investigator(s) should acknowledge the assistance received from OECT. The PI shall submit 5 copies of the paper to OECT after it is published.

12.3 If the result is in the form of a survey report / product performance evaluation or other such activities which have commercial implications, IISc-Bangalore shall not publish the results without specific written approval of OECT. Such reports/product performance evaluation etc. will be the sole property of OECT.

12.4 The intellectual property including inventions, designs, improvements, design and property in discoveries, data, knowledge, information and materials isolated or created in pursuance of the research/technology development activities under the project shall be patented or protected against patent, copy right or similar infringements, jointly, in the name of OECT, and IISc-Bangalore.

12.5 The expenditure incurred on filing the INDIAN IPR application including patent, maintenance of patent and any other related expenditure shall be equally shared by OECT and IISc-Bangalore.

12.6 IISc-Bangalore /PI shall send copy/copies in advance of all application forms, containing summary, detailed specifications, drawings etc, as required by appropriate Patent Office, along with all other relevant details to OECT in the prescribed format (Annexure-VIII of this AGREEMENT) for seeking written approval from OECT, prior to submission of any application for filing of joint patent.

12.7 IISc-Bangalore/PI shall send one copy of the 'Full Text Document' of the joint Patent to OECT within one month of its publication.

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12.8 The right to first use of IPR/Patent/Technology developed thorough this collaborative Project Work for its commercial exploitation shall rest with OECT for direct use by ONGC including the Group of Companies of ONGC, without any encumbrances. No royalty shall be paid to IISc-Bangalore for such usage of IPR.

12.9 OECT shall have the full right of transferring/assigning/licensing product/process/ technology developed through the project work to third party, under intimation to IISc-Bangalore. OECT shall share proceeds of IPR sale with IISc-Bangalore.

12.10 Any benefit accruing from assignment of right to third parties shall be equally shared between IISc-Bangalore and OECT.

12.11 The expenditure incurred on filing the INTERNATIONAL (PCT and National Phase Entry) IPR application including patent, maintenance of patent and any other related expenditure is fully borne by OECT. Any earnings accruing from transfer and commercialization shall be shared by OECT and IISc-Bangalore (including the PI) in the ratio of 50:50 or OECT shall recover the additional cost paid by OECT (which may be over the OECT share of 50%) from the revenue share of IISc-Bangalore as mutually agreed.

12.12 All rights and obligations relating to joint IPR, if any, shall survive the termination of the project for any reason.

13.0 RETURN OF DATA, LITERATURE AND DOCUMENTS

The data, literature and documents supplied by OECT to the Institute/Organization including such items purchased out of funds provided by OECT during the course of the Project will always remain the property of OECT and the same shall be handed over to OECT immediatly after the submission of final report. OECT may, at any time during the execution of the AGREEMENT demand return of the data,literature and documents, notwithstanding whether Project Work has been completed or not IISc-Bangalore shall be obliged to return the same immediately on demand of OECT, without retaining a copy.

14.0 CONFIDENTIALITY

14.1 The Parties shall during the Term of this AGREEMENT and at any time after its expiration or earlier termination treat as absolutely confidential all knowledge and information including knowledge and information related to discoveries, inventions, designs, improvements, experiments and trials conducted in effecting such inventions or improvements and the geographical location of such experiments and trials, designs or improvements, processes or plans utilized, machinery, apparatus or equipment used and all documents related to the foregoing and shall not disclose the same to any third person by any means including publication through electronic or print media without prior written consent of the other party.

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Provided however that if the Parties for the purposes of implementing its objects, collaborates or contracts with other research institutions or entities (in public or private sector), in all such cases, the said Party shall enter into separate contracts with such institutions or entities and such contracts will include covenants of the nature expressed herein binding such institutions or entities to treat such knowledge and information as confidential.

14.2 The Parties shall exercise reasonable control over all its employees, representatives, servants, agents, sub-contractors or any other person to which it has provided access to such knowledge or information in pursuance of obligations under this AGREEMENT to prevent misuse of such knowledge or information in breach of terms herein contained herein and shall also ensure that such employee, representative, servants, agents, sub-contractors or any other persons do not permit unauthorized access to such knowledge or information to anyone whosoever.

15.0 TAXES AND DUTIES

15.1 IISc-Bangalore, unless specified otherwise in the AGREEMENT, shall bear and pay all tax liabilities, duties and Govt. levies, including Service tax, customs duty, Corporate and personnel taxes levied or imposed on the IISc-Bangalore and/or OECT on account of payments received by it from the OECT for the Project Work done under this AGREEMENT. It shall be the responsibility of IISc-Bangalore to submit to the concerned Indian authorities, the returns and all other concerned documents required for this purpose and to comply in all respects with the requirements of the laws in this regard, in time.

15.2 The agreed sum payable to IISc-Bangalore under clause 5.1 of this AGREEMENT shall be exclusive of all taxes including service tax, duties, corporate and personal tax, as applicable. If any taxes & duties are required to be paid by OECT which is related to the work being done by IISc-Bangalore, it will be recovered from IISc-Bangalore. Any refund of duties, taxes, on any expenditure incurred, for the project work, received by IISc-Bangalore even after the expiry of the approved date of completion of Project Work will be refunded by IISc-Bangalore to OECT.

16.0 TERMINATION, EFFECTIVE DATE & EXTENSION OF AGREEMENT

16.1 The AGREEMENT shall be effective from the date of its execution and shall remain in force till the submission of the Project completion report or expiry of the AGREEMENT by efflux of time as per Clause 6, whichever happens earlier unless terminated or extended by the parties mutually on the agreed terms and conditions.

16.2 **EXTENSION**: The duration of the AGREEMENT may be extended at the sole discretion

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of OECT on written request of IISc-Bangalore, subject to the condition that no additional financial implication is involved. Request for extension in the prescribed format (Annexure IX of this AGREEMENT) should be sent two months in advance before the expiry of the AGREEMENT.

16.3 The AGREEMENT may be terminated by OECT by giving a notice of one month in writing. In case of termination, herein set forth, the obligation of the OECT to pay shall be limited to the period up to the date of termination. Also, the clauses mentioned in Clause 16.5 of this AGREEMENT shall survive the termination of this AGREEMENT.

16.4 **TERMINATION ON ACCOUNT OF FORCE MAJEURE**: Either party shall have the right to terminate this AGREEMENT on account of Force Majeure, as set forth in Clause 17 of this AGREEMENT.

16.5 **SURVIVAL OF TERMS:** Clause 9, 11, 12,13,14,18, 22 and 23 of this AGREEMENT shall survive the termination of this AGREEMENT.

17.0 FORCE MAJEURE

17.1 In the event of either party being rendered unable by Force Majeure to perform any obligation required to be performed by them under the AGREEMENT, the relative obligation of the party affected by such Force Majeure shall be suspended for the period during which such cause lasts.

17.2 The term "Force Majeure" as employed herein shall mean acts of God, including but limited to War, Civil Riots, Fire directly affecting the performance of the AGREEMENT, Flood and Acts and Regulations of government.

17.3 Upon the occurrence of such cause and upon its termination, the party alleging that it has been rendered unable as aforesaid thereby, shall notify the other party in writing, the beginning of the cause amounting to Force Majeure as also the ending of the said clause by giving notice to the other party within 72 hours of the ending of the cause respectively. If deliveries are suspended by Force Majeure conditions lasting for more than 2 (two) months, OECT shall have the option of cancelling this AGREEMENT in whole or part at its discretion without any liability on its part.

17.4 Time for performance of the relative obligation suspended by Force Majeure shall then stand extended by the period for which such cause lasts.

18.0 APPLICABLE LAW AND JURISDICTION

The AGREEMENT, including all matters connected with this AGREEMENT shall be governed by the Indian law both substantive and procedural, for the time being in force and shall be subject to the exclusive jurisdiction of Indian Courts at Delhi.

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19.0 COMPLIANCE WITH LAWS

IISc-Bangalore shall perform the duties under this AGREEMENT and undertake the Project Work and its related activities in due compliance with all applicable laws in India, along with rules and regulations, if any, of duly constituted Governmental Authorities in India and shall obtain, if applicable, any such licenses, consents, registrations and other governmental approvals, etc., if any, required by laws in India in connection with this AGREEMENT and for the conduct of the Project Work. The parties shall indemnify and hold harmless the other party from and against any claim/loss/damages suffered on account of the failure of the party to comply with the applicable laws.

20.0 MODIFICATION IN AGREEMENT

20.1 All modifications leading to changes in the AGREEMENT with respect to technical and/or commercial aspects, including terms of deliverables, shall be considered valid only when accepted in writing by OECT and if considered necessary, by issuing amendment to the AGREEMENT.

20.2 Any other changes in the AGREEMENT shall only be binding on the Parties when duly executed in writing by way of an amendment to the AGREEMENT.

21.0 INDEMNITY

IISc-Bangalore agrees to indemnify and hold OECT harmless from any claim or damages arising from IISc-Bangalore's willful and gross negligent performance and/or criminal act in Project Work under this AGREEMENT. Notwithstanding anything to the contrary contained herein the AGREEMENT, IISc-Bangalore will not be liable for OECT's acts and OECT agrees to hold IISc-Bangalore harmless from any claim or damages arising from OECT's willful and gross negligent performance of Project Work under this AGREEMENT.

22.0 RESOLUTION OF DISPUTES THROUGH CONCILIATION BY OECT (Not applicable in cases valuing less than Rs 5 Lakhs)

In any dispute, difference, question or disagreement arises between the parties hereto or their respective representatives or assignees, in connection with construction, meaning, operation, effect, interpretation of the AGREEMENT or breach thereof which parties are unable to settle mutually, the same may first be referred to conciliation through Outside Expert Committee ("OEC") to be constituted by DG, OECT as provided hereunder:

22.1. The party desirous of resorting to conciliation shall send a notice of 30(thirty) days to the other party of its intention of referring the dispute for resolution through OEC. The notice

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invoking conciliation shall specify all the points of disputes with details of the amount claimed to be referred to OEC and the party concerned shall not raise any new issue thereafter.

22.2. DG, OECT shall nominate three outside experts, one each from financial /commercial, Technical and Legal fields from the Panel of outside Experts maintained by ONGC who shall together be referred to as OEC (Outside Expert Committee).

22.3. Parties shall not claim any interest on claims/counterclaims from the date of notice invoking conciliation till execution of settlement agreement, if so arrived at. In case, parties are unable to reach a settlement, no interest shall be claimed by either party for the period from the date of notice invoking conciliation till the date of OEC recommendations in any further proceedings.

22.4. The Proceedings of the OEC shall be broadly governed by Part III of the Arbitration and Conciliation ACT, 1996 including any modifications thereof.

22.5. OEC shall hear both the Parties and recommend possible terms of settlement between the Parties. The recommendations of the OEC shall be non-binding and the Parties may decide to accept or not to accept the same. Parties shall be at liberty to accept the OEC recommendation with any modification they may deem fit.

22.6. Where recommendations are acceptable to both the parties, a settlement agreement will be drawn up in terms of the OEC recommendations or with such modifications as may be agreed upon by the Parties. The settlement agreement shall be signed by both the Parties and authenticated by all the OEC members either in person or through circulation. This settlement agreement shall have the same legal status and effect as that of an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal under Section 30 of the Arbitration and Conciliation Act, 1996.

22.7. The Parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement, except where its disclosure is necessary for purposes of implementation and enforcement.

22.8. The Parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the dispute that is the subject of the conciliation proceedings,

i. Views expressed or suggestion made by the other party in respect of a possible settlement of the dispute;
ii. Admissions made by the other party in the course of the OEC proceedings;
iii. Proposal made by the OEC;
iv. The fact that the other party had indicated his willingness to accept a proposal for the settlement made by the OEC.

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22.9. The parties shall present their case before OEC only through their in-house executives. Neither party shall be represented by a lawyer unless OEC specifically desires that some issue of legal nature is in dispute that needs to be clarified /interpreted by a lawyer.

22.10. OEC members shall be entitled for the following fees and facilities (As amended from time to time):

Sr. No.	Fees/Facility	Entitlement	To be paid by
1	Fees	Rs. 10,000 per meeting subject to maximum of Rs. 1,00,000 for the whole case. In addition, one OEC number chosen by OEC shall be paid an additional amount of Rs. 10,000 towards secretarial expenses in writing minutes/OEC recommendations.	Claimant
2	Additional Fee for attending meeting to authenticate the settlement agreement	Rs 10,000/-.	Claimant
3	Transportation in the city of meeting	Luxury car or Rs. 1,500 per day.	Claimant
4	Venue for meeting	OECT conference rooms/Hotels.	OECT
Facilities to be Provided to the Out-stationed member			
5	Travel From the city of residence to the city of meeting	Business class air ticket/ first class train tickets/ Luxury car/ reimbursement of actual fare. However, entitlement of air travel by Business class shall be subject to austerity measures, if any, ordered by Govt of India.	Claimant
6	Transport to and fro airport/railway station in the city of residence	Luxury car or Rs 2,000/-	Claimant
7	Stay for out stationed member	5 star Hotel	OECT
8	Transport in the city of meeting	Luxury car or Rs. 1,500 per day	Claimant

22.11. All the expenditure incurred in the OEC proceedings shall be shared by the parties in equal proportion. The Parties shall maintain account of expenditure and present to the other for the purpose of sharing on conclusion of the OEC proceedings.

22.12. If the parties are not able to resolve the dispute through OEC or do not opt for conciliation through OEC, the party may invoke arbitration clause as provided in the AGREEMENT.

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23.0 ARBITRATION

Except as otherwise provided elsewhere in the AGREEMENT, if any dispute, difference, question or disagreement arises between the parties hereto or their respective representatives or assignees, in connection with construction, meaning, operation, effect, interpretation of the AGREEMENT or breach thereof which parties are unable to settle mutually, the same shall be referred to Arbitration as provided hereunder:

23.1. A party wishing to commence arbitration proceeding shall invoke Arbitration Clause by giving 60 days notice to the other parties. The notice invoking arbitration shall specify all the points of disputes with details of the amount claimed to be referred to arbitration at the time of invocation of arbitration and not thereafter. If the claim is in foreign currency, the claimant shall indicate its value in Indian Rupee for the purpose of constitution of the arbitral tribunal.

23.2. The number of the arbitrators and the appointing authority will be as under:

Claim amount (excluding claim for interest and counter claim, if any)	Number of arbitrator	Appointing authority
Up to Rs 5 crore	Sole Arbitrator	OECT
Above Rs 5 crore	3 Arbitrators	One arbitrator by each party and the 3rd arbitrator, who shall be the presiding arbitrator, by the two arbitrators.

23.3. The parties agree that they shall appoint only those persons as arbitrators who accept the conditions of this arbitration clause. No person shall be appointed as arbitrator or presiding arbitrator who does not accept the conditions of this arbitration clause.

23.4. Parties agree that there will be no objection if the Arbitrator appointed holds equity shares of OECT and/or is a retired officer of OECT / any PSU. However, neither party shall appoint its serving employee as arbitrator.

23.5. If any of the Arbitrators so appointed dies, resigns, becomes incapacitated or withdraws for any reason from the proceedings, it shall be lawful for the concerned party/arbitrators to appoint another person in his place in the same manner as aforesaid. Such person shall proceed with the reference from the stage where his predecessor had left if both parties consent for the same; otherwise, he shall precede *de novo*.

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23.6. Parties agree that neither party shall be entitled for any pre-reference or pendente-lite interest on its claims. Parties agree that any claim for such interest made by any party shall be void.

23.7. The arbitral tribunal shall make and publish the award within time stipulated as under:

Amount of Claims and Counter Claims (excluding interest)	Period for making and publishing of the award (counted from the date of first meeting of the arbitrators):
Up to Rs 5 Crore	Within 8 months
Above Rs 5 Crore	Within 12 months

The above time limit can be extended by the arbitrator, for reasons to be recorded in writing, with the consent of the parties.

23.8. Arbitrators shall be paid fees at the following rates (as amended from time to time):

Amount of Claims and Counter Claims (excluding interest)	Lump sum fees (including fees for study of pleadings, case material, writing of the award, secretarial charges etc.) payable to each arbitrator (to be shared equally by the parties)
Up to Rs 50 lacs	Rs 7,500/- per meeting subject to a ceiling of Rs 75,000/-
Above Rs 50 lac to Rs 1 crore	Rs 90,000/- plus Rs 1,200/- per lac or a part there of subject to a ceiling of Rs 1,50,000/-
Above Rs 1 Crore and up to Rs 5 Crores	Rs 1,50,000- plus Rs 22,500- per crore or a part there of subject to a ceiling of Rs 2,40,000
Above Rs 5 Crores and up to Rs 10 Crores.	Rs 2,40,000/- plus Rs 15,000/- per crore or a part there of subject to a ceiling of Rs 3,15,000/-
Above Rs 10 crores	Rs 3,15,000/- plus Rs 12,000/- per crore or part thereof subject to a ceiling of Rs 10,00,000/-

For the disputes above Rs 50 Lakhs, the Arbitrators shall be entitled to an additional amount @ 20% of the fee payable as per the above fee structure.

23.9. If after commencement of the Arbitration proceedings, the parties agree to settle the dispute mutually or refer the dispute to conciliation, the arbitrators shall put the proceedings in abeyance until such period as requested by the parties. Where the proceedings are put in abeyance or terminated on account of mutual settlement of dispute by the parties, the fees payable to the arbitrators shall be determined as under:

(i) 25 % of the fees if the claimant has not submitted statement of claim.

(ii) 50 % of the fees if the award is pending

23.10. Each party shall pay its share of arbitrator's fees in stages as under:

(i) 25% of the fees on filing of reply to the statement of claims.

(ii) 25% of the fees on completion of evidence.

(iii) Balance 50% at the time when award is given to the parties.

23.11. Each party shall be responsible to make arrangements for the travel and stay etc of the arbitrator appointed by it. Claimant shall also be responsible for making arrangements for

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travel I stay arrangements for the Presiding Arbitrator and the expenses incurred shall be shared equally by the parties.

In case of sole arbitrator, OECT shall make all necessary arrangements for his travel stay and the expenses incurred shall be shared equally by the parties.

23.12. The Arbitration shall be held at the place from where the AGREEMENT has been awarded i.e. Delhi. However, parties to the AGREEMENT can agree for a different place for the convenience of all concerned.

23.13. The Arbitrator(s) shall give reasoned and speaking award and it shall be final and binding on the parties

23.14. Subject to aforesaid, provisions of the Arbitration and Conciliation Act, 1996 and any statutory modifications or re-enactment thereof shall apply to the arbitration proceedings under this clause.

24.0 CONTINUANCE OF THE AGREEMENT

Notwithstanding the fact that settlement of dispute(s) (if any) under arbitration may be pending, the parties hereto shall continue to be governed by and perform the Project Work in accordance with the provisions under this AGREEMENT.

25.0 INTERPRETATION

The titles and headings of the sections in this AGREEMENT are inserted for convenient reference only and shall not be construed and limiting or extending the meaning of any provisions of this AGREEMENT.

26.0 NOTICES AND ADDRESSES:

For the purposes of this AGREEMENT, the addresses of the parties will be as follows and all correspondence and notices in relations to the present Agreement sent to the parties at the addresses mentioned below-By Fax/Courier/Registered post/Mail/Hand Delivery shall be deemed to be sufficient service of notice on the parties. All such notices as well as reports, invoices and other relevant material shall be addressed to the parties as per the address given below:

For IISc-Bangalore	For OECT
Dr K Paneer Selvam, Advisor (Extramural Research), Centre for Sponsored Schemes and Projects, Indian Institute of Science, Bengaluru-560012 Tel: 91-80-2293 2501 Email: pselvam@iisc.ac.in	Dr. Sanjeev Katti Director General, ONGC Energy Centre Core- 2, 2nd Floor, Scope Minar, Laxmi Nagar, Delhi-110092 Tel: 011 22406041 Fax: 011 22011783 Email: Sanjeev_katti@ongc.co.in

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27.0 ENTIRE AGREEMENT

This AGREEMENT supersedes all prior AGREEMENTs and commitments, whether oral or in writing between the parties concerning the subject matters thereof. The right of either party to require strict performances will not be affected by any previous waiver or course of dealing. Neither this AGREEMENT nor any modification will be binding on a party unless signed by an authorized representative of IISc-Bangalore and OECT.

In witness whereof, the Parties through its authorized officer has set its hand and stamp on this 18th day of July 2019 at IISc, Bangalore -12

(Signature)	(Signature)
For & on behalf of OECT	For & on behalf of IISc-Bangalore
Date: 18 July 2019	Date:
संजीव श्री कट्टी / Sanjeev S. Katti महानिदेशक / Director General ओएनजीसी एनर्जी सेन्टर ONGC Energy Centre स्कोप मीनार, लक्ष्मी नगर, दिल्ली – 110092 SCOPE Minar, Laxmi Nagar, Delhi - 110092	Dr. K. Panneer Selvam Advisor (Extramural Research) Centre for Sponsored Schemes and Projects Indian Institute of Science Bengaluru - 560 012

WITNESS NO. 1	**WITNESS NO. 1**
(Signature) 18/7/19 D. PARVATHAM Sugam, Domain OEC, Lead	(Signature)
Full name and official address (in legible letters)	Full name and official address (in legible letters) S. Venugopal Associate Professor Dept. of Chemical Engineering Indian Institute of Science Bangalore - 560 012
WITNESS NO. 2	**WITNESS NO. 2**
(Signature)	(Signature)
Full name and official address (in legible letters) Narendra M. Dixit	Full name and official address (in legible letters) GANAPATHY AYAPPA Chairman Dept. of Chemical Engineering Indian Institute of Science Bangalore - 560 012

ONGC Energy Centre

Professor
Dept. of Chemical Engineering
Indian Institute of Science
Bangalore - 560 012

Centre for Sponsored Schemes and Projects, Indian Institute of Science, Bengaluru 560 012

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Annexure I

Printed Electrocatalyst Layers for PEMFC/DMFC

PROJECT PROPOSAL

Submitted to

ONGC Energy Centre Trust

By

Dr. VENUGOPAL SANTHANAM
Department of Chemical Engineering
Indian Institute of Science
Bangalore 560 012

February 2019

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1. **Project Title:** Printed Electrocatalyst Layers for PEMFC/DMFC

2. **Duration in months:** 18

3. **Total Estimated Budget:** ₹ 24 ,13, 353/-

4. **Principal Investigator:** Dr Venugopal Santhanam

Designation: Assistant Professor

Department: Chemical Engineering

Institute Name: Indian Institute of Science Bangalore

Address: Lab 2A, Department of Chemical Engg, IISc-Bangalore, 560012

Telephone: 80-22933113, 9448833358

Fax: 80-23608121

E-mail ID: svgpal@iisc.ac.in

5. **Co-Principal Investigator:** : Prof. Ganapathy Ayappa

Designation: Professor

Department: Chemical Engineering

Institute Name: Indian Institute of Science Bangalore

Address: Lab 2A, Department of Chemical Engg, IISc-Bangalore, 560012

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SECTION - A

Certificate from the Principal Investigator and Collaborating Institute/ Organization

Project Title: Printed Electrocatalyst Layers for PEMFC/DMFC

I am submitting the above-titled project proposal to OECT as a collaborative research/technology development project.

1. I agree to abide by the terms and conditions of OECT for supporting research/technology development projects including the posting of OECT manpower in the project team.
2. I have not submitted the project proposal elsewhere for financial support.
3. I have requested for funds for the items, which are not available with the institution for the proposed work and are absolutely essential.
4. I will not proceed on long term/ study leave/deputation during the period of project implementation, without prior intimation to OECT.

Place: Bangalore
Date: 05/02/2019

(Name & Signature of Principal Investigator)

Endorsement by the Head of the Institution/Organisation

Certified that Project Proposal entitled "Printed Electrocatalyst Layers for PEMFC/DMFC " is prepared by Dr. Venugopal Santhanam and has not been submitted to any other institution/organisation for funding. This institute/organisation will provide necessary regular staff, administrative support and required infrastructure facilities for the project work and such facilities have not been requested in the proposal. The institute/organisation will ensure compliance of the terms and conditions of project funding by OECT and other conditions governing the implementation of the project.

(Name, Signature & Seal

Place: Bangalore
Date:

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SECTION – B

1.0 Project Title: Printed Electrocatalyst Layers for PEMFC/DMFC

2.0 Project Type (Choose from the following):

- Basic Research
- **Lab Scale Product /Process/Technology Development** □
- Product/Process/Technology Improvement
- Pilot Scale Development
- Pre-Industry Model Development
- Technology Demonstration/Validation
- Field Implementation/Trials of Product/Process/Technology developed
- Others

3.0 Introduction and Review of Literature:

Polymer Electrolyte (or proton exchange) Membrane fuel cells (PEMFC) and Direct Methanol fuel cells (DMFC) are energy-efficient alternatives to combustion engines for automotive(Mark K Debe 2012) and mobile/remote applications,(Joghee et al. 2015; Sundarrajan, Allakhverdiev, and Ramakrishna 2012) and are on the cusp of mass-production. Fuel cells directly convert the bonding energy of the fuel into useful work and are significantly more efficient than combustion engines. However, considerable innovation is required to achieve US Fuel Cell Technologies Office (FCTO - Multi-Year Research, Development, and Demonstration Plan) targets of cost (platinum group metal – PGM loading < 125 $\mu g/cm^2$), durability (<40% loss of activity after 30k cycles), and performance (0.44 A/mgpt @0.9 V).

Significant advances have been made in PEMFC/DMFC system design over the last three decades in terms of cost-reduction and structural design.(Gasteiger et al. 2005) The membrane electrode assembly (MEA), especially the electrode, is considered as 'the heart' of a fuel cell and is designed to accommodate constraints imposed by the cost of platinum used for electrocatalysis, as well as the need for efficient transport of electrons, reactants and heat. Consequently, the structure and composition of the 'electrode' has been significantly altered over the years, from utilizing platinum black films with a platinum loading of 10 gpt/cm^2 in 1970s to present-day platinum/PGM nanoparticle coated carbon black particles (Pt/C) that use about 0.3 $mgpt/cm^2$ (Costamagna and Srinivasan 2001) The use of highly-dispersed nanoparticles on carbon black particles enables substantial gains in surface area for a given mass of catalyst, but concomitant durability problems due to carbon support corrosion and loss of surface area under PEMFC working conditions,(Cao, Wu,

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and Cao 2014; Ferreira et al. 2005; Paddison and Gasteiger 2013) especially during start-up or shut down cycles have led to renewed interest in carbon-free nanostructured electrodes,(Antolini and Perez 2011) which employ a thin coating of platinum or PGM based catalytic layer on a mesostructured conductive support.(van der Vliet et al. 2012; Inaba et al. 2015; M. K. Debe 2013; Ge et al. 2009; Biener et al. 2011; Cheng et al. 2015; Liu et al. 2009; Kloke et al. 2012; Alia et al. 2010; Kloke et al. 2011) Such thin film architectures can also lead to reductions in platinum loadings to about 0.05 mg/cm^2, (Zeis et al. 2007)' (Tiwari et al. 2018) while reducing surface area losses due to nanoparticle agglomeration and preventing corrosion of the underlying substrate.(Mark K. Debe et al. 2006)

3.1 Current status of Work being done in other Institutions and Industries in the country:

Lab-scale colloidal synthesis of catalysts for PEMFC applications has been extensively studied by various groups in India over the last decade. (Ghosh et al., 2013; Sahoo et al., 2015; Baronia et al., 2018; Sha and Badhulika, 2018; Radhakrishnan and Sandhyarani, 2019) A brief account of literature reports from Indian Institutions over the last 5 years on ORR/MOR electrocatalysts with low PGM content or enhanced durability is provided herein.

A simple, scalable, single-step synthesis method was adopted to develop platinum-free, palladium-cobalt alloy supported on nitrogen-doped reduced graphene oxide (Pd3Co/NG) nanocomposite (Chandran, Ghosh, and Ramaprabhu 2018). The low value of the reported maximum power density of 0.07 W/cm^2 using 0.5 mg/cm^2 of catalyst highlights the difficulty of platinum-free strategies for fuel cell electrocatalysis. A self-limiting electroless shell deposition method for synthesizing Pt overlayer coated Pd/C catalysts for ORR was demonstrated.(Mahesh and Sarkar 2018) Platinum nanoparticles deposited on Mn, Fe and Co based spinal oxides, synthesized by co-precipitation method followed by sintering at high temperature, exhibited high ECSA value of 132 m^2/gpt, a maximum power density of 0.7 W/ cm^2 in a fuel cell configuration, specific activity of 0.2 A/mgpt, and a 17% loss of activity after 1000 cycles.(Mohanraju et al. 2017) Pt/V-TiO2 nanocomposite catalyst, prepared via a sol-gel and microwave assisted chemical reduction route, were found to lose only 20% activity after 6000 cycles of accelerated stress testing.(Bharti and Cheruvally 2017) Nano ceria supported nitrogen doped graphene as a highly stable and methanol tolerant electrocatalyst for oxygen reduction was synthesized using a single- step solvothermal process.(Soren et al. 2016) A ~30% enhancement of the durability of Pt/C catalyst on oxygen and nitrogen functionalized nanocarbon supports was attributed to the presence of large amount of pyrrolic nitrogen and highly oriented graphitic nature of the catalyst supports.(Karthikeyan et al.

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2015) They reported ECSA of 24 m^2/gpt and a maximum power density of 0.4 W/ cm^2.(Puthusseri and Ramaprabhu 2016) The use of ascorbic acid as a functionalizing agent to enhance anchoring of Fe2O3-Pt core-shell as well as reducing and capping agent was studied (Dhavale and Kurungot 2012).

3.2 Current status of work being done on an International scale:

The DOE Merit Review meeting, 2018 provides an excellent overview of the current status of research directions aimed at reducing the cost and improving the durability of catalysts while maintaining high specific activity. The multi-pronged approach being pursued in catalyst development includes theoretical computations aimed at understanding and providing material leads for circumventing the sluggishness of ORR kinetics, (Solomon and Stahl 2018) developing strategies for synthesizing nanomaterials with tailored morphology, such as nanoframes, core-shell etc. to enhance intrinsic activity. (Stamenkovic et al. 2017; Li et al. 2016) Interestingly, Nanostructured thin film catalysts were found to exhibit a x8 fold increase in activity over polycrystalline platinum facets. These approaches are capable of addressing some of the DOE targets in terms of durability or activity or PGM content at the lab-scale (https://www.energy.gov/eere/vehicles/annual-merit-review-presentations), but several obstacles need to be surmounted prior to scaling-up these findings. Amongst the several approaches, nanostructured thin film architecture for electrocatalyst layer is a promising route for cost-effective scaling up to manufacturing scale.

Nanostructured thin film catalyst layers have been deposited either using top-down approaches such as sputter deposition(van der Vliet et al. 2012; Ge et al. 2009)or atomic layer deposition (ALD) (Inaba et al. 2015) onto organic mesostructures that are *a priori* coated with a conductive layer or bottom-up techniques that utilize nanoporous metallic films, formed by dealloying, as a conductive substrate onto which thin platinum layers are deposited by chemical (Zeis et al. 2007) or electrodeposition (Kloke et al. 2012; Alia et al. 2010; Kloke et al. 2011; McCurry et al. 2011)routes. The reported values of the electrochemically active surface areas (ECSA) for thin film nanostructured catalyst layers are much lower than that of conventional Pt/C layers, but their performance under fuel cell test conditions are equivalent to that of Pt/C layers, and this is attributed to enhanced specific activity associated with bulk-like polycrystalline grains as well as enhanced electrical conductivity of the catalyst layer.(M K Debe 2010) Presently, the thicknesses of the metallic films used in such electrodes are of the order of 100 nm to provide macroscopic uniformity of coating and ensure electrical connectivity. Despite these advancements, there is

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ample scope for developing simpler and cost-effective additive fabrication processes and novel designs of the electrocatalyst layer to further reduce platinum/PGM loading of thin film nanostructured electrodes.

3.3 Details of previous work and ongoing work of PI and Institute/Organisation in this field and expertise available with PI/Group/Institution/Organisation:

Our group has developed a simple process for fabricating nanostructured metallic thin films on paper and plastic substrates using a simple desktop inkjet printer (Media Highlight-Science Monitor, DD Rajya Sabha TV, 08/08/2015). The process chemistry is based on the well-developed silver halide chemistry used in the field of photography. [1] Apart from this, we fabricated and characterized the electrochemical performance of ultralow-platinum loading (<5 $\mu g/cm^2$) electrodes for fuel cells using self-assembled monolayers of Au@Pt nanoparticles as the building blocks. [2,3] Therein, we have developed expertise in handling and characterizing electrodes for PEMFC applications. Over the past year, Mr Khantesh Agrawal has successfully adapted the printing process to Nafion membrane to form a nanostructured porous conductive layer. [3] He is currently involved in optimizing conditions for Platinum overlayer deposition onto silver nanowires.

1. S. K. Parmar, and V. Santhanam, " In situ formation of silver nanowire networks on paper", Curr. Sci. 107(2), 262-269 (2014)
2. I. Banerjee, V. Kumaran, and V. Santhanam, "Synthesis and Characterization of Au@Pt Nanoparticles with Ultrathin Platinum Overlayers", J. Phys. Chem. C , 119 (11), 5982–5987 (2015)
3. I. Banerjee, V. Kumaran, and V. Santhanam, "Fabrication of Electrodes with Ultralow Platinum Loading by RF Plasma Processing of Self-Assembled Arrays of Au@Pt Nanoparticles", Nanotechnol. 27, 305401 (2016)
4. K. Agrawal, "Printed Electrodes for PEMFC", M Tech Report, IISc, 2018

3.4 Patent search reports and the details of patents filed and granted to the PI/institute in the related field(s) if any: -NA-

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4.0 Project Objectives:

- **Broad Objective**: Fabrication of conductive, electrocatalytically active, nanostructured films with Ultralow Platinum loading on Nafion membranes for PEMFC/DMFC applications
- **Specific objectives:**
  1) Use of pulsed electrodeposition technique to form 1-10 atomic layer thick platinum shells onto metallic nanostructured films.
  2) Electrochemical characterization of pulse-deposited Platinum films for benchmarking activity parameters for PEMFC/DMFC applications, such as ECSA values, Mass activity, CO tolerance, durability

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5.0 Relevance of the work / Benefit to OECT/Country:

The ability to prepare ultra-low platinum loading electrodes for PEMFC/DMFC applications using an additive, roll-to-roll compatible process, will be a significant impetus for enabling widespread adaptation of fuel cells. Although, a few groups have reported the use of inkjet printers to fabricate MEAs using inks formulated from ionomer containing slurries of Pt/C particles, our proposed methodology will eliminate the need for colloidal ink formulation and can also enhance platinum utilization while lowering platinum loading by forming atomic overlayers onto inkjet printed conductive, nanoporous thin film substrates.

In the context of OECT, lowering the cost of PEMFC will enable the "Hydrogen" economy and provide a source for the utilization of natural gas. With Methanol being a lightweight energy carrier, DMFCs are actively pursued as an energy-efficient and quiet alternative to supply off-grid power for months – without any user intervention, e.g. for powering automatic control systems and fulfilling the electrical power demand for safety and security control aspects on off-shore oil rigs or other remote locations (https://www.efoy-pro.com/en/applications/oil-gas/).

6.0 Project need and Justification:

Please also include definition of the problem)

The Oil and Gas industry faces a formidable task of meeting increasing energy demands while committing to significant reductions in gas emissions to combat global climate change. The most significant emitter of greenhouse gasses on offshore installations is gas turbines accounting for 81% of total greenhouse gas emissions. DMFCs are being considered as potential alternatives for such off- grid power supply applications. A recently undertaken SWOT analysis of fuel cell technology finds it competitive with gas turbines in terms of efficiency, emission, maintenance and downtime. But, significantly lagging in terms of cost [1].

Significant advances have been made in fuel cell system design over the last three decades concerning cost-reduction and structural design (see Section 3). But cost and durability problems associated with carbon support corrosion and loss of active surface area under PEMFC working conditions, especially during start-up or shut down cycles have led to renewed interest in carbon-free nanostructured electrodes. In this context, there is scope for developing additive manufacturing processes, as well as novel electrocatalyst designs to further reduce platinum/PGM loading. The goal of our research is to develop a cost-effective, additive process for manufacturing of membrane electrode assemblies with ultralow platinum loading for low-temperature fuel cells.

The print-expose-develop technique developed in our group [2] has been used to fabricate porous,

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conducting silver nanostructures on Nafion membranes. We have been working on the idea of utilizing a self-terminating process for platinum monolayer deposition [3] onto inkjet-printed silver nanostructures to form conductive, porous, electrocatalytically active catalyst layers for PEMFC/DMFC applications. Our preliminary results confirm platinum deposition on metallic nanostructures with loading of <100 $\mu gPt/cm^2$, but optimization of process parameters is required to enhance electrocatalytic activity [4]. The ease of printing silver nanostructures using a simple inkjet printer and the ability to coat them with atomic-layers of platinum via cycling of electrode potential can pave the way for reducing the costs of PEMFC/DMFCs.

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2. Parmar et al. *Current Science* (2014): 262-269
3. Liu, Yihua, et al. Science 338.6112 (2012): 1327-1330.
4. Agrawal, K, Master's Thesis, IISc "Printed Electrodes for PEMFC". 2018

7.0 Methodology and Work Plan:

1. Additive fabrication of catalyst layer

i. The print-expose-develop process developed in our group will be used to fabricate porous and conductive silver nanostructure films with particle or nanowire morphology on Nafion membrane

ii. We will use a self-terminating electrochemical deposition technique to fabricate platinum overlayers, in steps of monoatomic shells, on printed silver nanowire networks.

iii. Electrochemical characterization of MOR/ORR activity will be carried out.

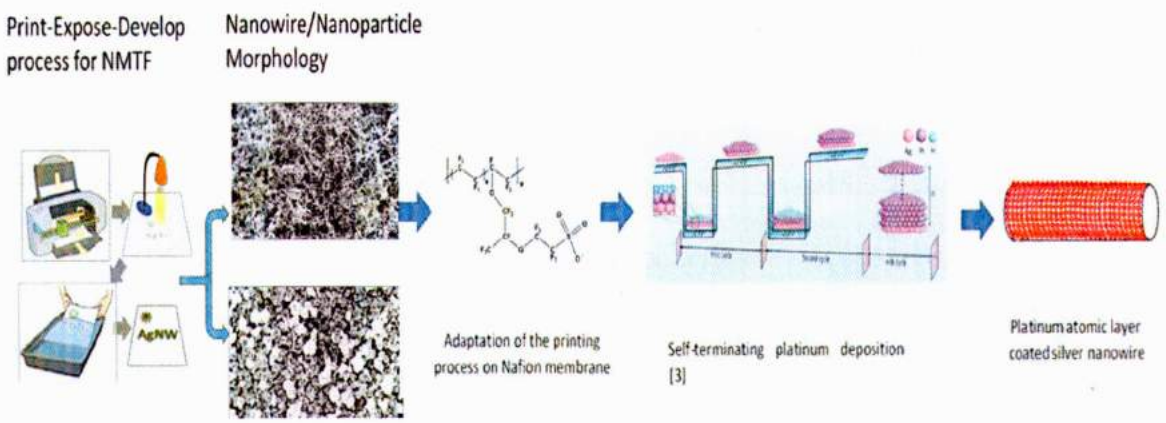

Fig.1 Schematic illustrating the process flow for forming Electrocatalyst layers

7.1 Time Schedule for Activities through Bar Chart:

Sl. No.	Major Activities	Time Period		
		(6 months)	(12 months)	(18 months)
1	**Proof of Concept** - Optimization of protocol for pulsed electrodeposition of platinum atomic layers			
2	**Procurement** of Rotating Ring Disk Electrode setup			
3	**Lab-Scale Demonstration -** Electrochemical characterization of MOR/ORR activity			

7.2 Milestones to monitor the Progress & Release of Installments:

No.	Milestones/Targets	Month from Start Date	Estimated Amount Requirement (Rs.)	Justification
i)	Initial release: Signing the agreement	0	12,00,000	Purchase of RDE setup, PMRF fellowship and consumables
ii)	Half-yearly Report, Procurement of RDE setup, **Proof of concept** Fabrication of Platinum coated conductive, electrocatalytically active nanostructures on Nafion membranes with **loading < 50 µg/cm^2**	6	5,00,000	PMRF fellowship and consumables, travel contingency
iii)	Annual progress report, preliminary electrochemical characterization	12	5,00,000	PMRF fellowship, contingency and consumables Overheads for 1st year
iv)	**Lab-scale Demonstration** Optimization of number of platinum overlayers for enhanced electrocatalytic performance with **ECSA values > 80 m^2/gpt** and **Specific activity @0.9V of 0.44 A/mgpt** Submission of Final Technical Report and Audited statements	18	2,13,353	Final settlement
	Total		**24,13,353**	

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8.0 Potential Users, Market Assessment and suggested Plan of action for utilization of expected Project Output:

Alternative Energy and Automotive sectors will benefit from the development of low-cost printed electrocatalyst layers for fuel cells. The project output can seed the development of scaling-up strategies of the additive manufacturing process for fabricating low-cost fuel cell catalyst layers for pilot scale implementation and characterization of stability and durability. After pilot-scale study and technology optimization, field-trials can commence.

9.0 Deliverables:

9.1 Please specify the Project Specific Output:

- Additive fabrication process for carbon-support free nanostructured, electrocatalytically active and electrically-conductive thin film with ultralow platinum loading (< 50 µg/cm2)
- Electrochemical characterization results for ORR/MOR activity and demonstration of optimal configuration(s) with ECSA > 80 m^2/g_{pt} and specific activity @0.9V >0.44 A/mg_{pt}

9.2 The other deliverables during / at the end of the project among other things will include:

a) Details of Research Papers/Technical Documents;

b) Project Reports (half-yearly);

c) IPR/Patents etc. including supply of samples of product/materials, essential for demonstration of process/protection of IPR or validation (For example: For biotechnology/microbiology project bacterial cultures, nutrient medium recipes, maintenance and deposition protocols for the isolates is required).

9.3 On completion of the project, other deliverables will include:

a) Final Project Report;

b) Detailed Documentation on proposed Technology/ Know-how on the Process/ Product and Safety Protocols (if applicable), which are prerequisite for further scaling up or pilot production;

c) Audited financial documents;

d) Audited list of assets.

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SECTION-C

10.0 Budget

10.1 Budget Estimates (Budget head wise break-up for the proposed project period)

Budget Head	1st Year (Rs.)	2nd Year (Rs.)	Total (Rs.)
Capital Equipment	6,00,000	0	6,00,000
Manpower	5,15,712	2,57,856	7,73,568
Consumables	4,00,000	2,00,000	6,00,000
Travel	25,000	25,000	50,000
Contingency	50,000	25,000	75,000
Any Other (Scientific fee)	----	----	----
Overheads @ 15%	2,38,607	76,178	3,14,785
Total Estimated Budget excluding GST	**18,29,319**	**5,84,034**	**24,13,353**

11.0 Justification for Budget (to be given for all the heads in Budget Estimates)

11.1 Equipment:

Sl. No.	Generic Name of the Equipment	Estimated Cost(Rs.)	Purpose
1.	RDE (Rotating Disk Setup)	6,00,000	For characterizing the ORR/MOR specific activity of fabricated samples without diffusion limitations
	Total (Rs.)	**6,00,000**	

11.2 Manpower:

Sl. No.	Designation	Yearly Rate (Rs.)	Duration in Months	Estimated Amount (Rs.)	Purpose
1.	PMRF fellow	5,15,712	18	7,73,568	OECT contribution towards PMRF fellowship for JRF

11.3 Consumables:

Sl. No.	Item	Estimated Amount (Rs.)	Purpose
1	Nafion membranes, Metal salt precursors etc	3,00,000	For preparing samples
2	CeNSE usage fees	3,00,000	Facility charges for materials characterization
	Total (Rs.)	**6,00,000**	

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SECTION – D

12.0 Details about the Institute/Organization (Please also specify whether Central/ State/ Private / Autonomous):

IISc, Bangalore -- Autonomous Institute under MHRD

13.0 Infrastructural Facilities including capital equipment available with the Institute (relevant to the project work):

Fuel cell Test station, Material Characterization facility

14.0 Details of any MoU or NDC with any other Agency/ Institute/ Industry in the proposed and/or related field(s):

15.0 Biodata of Principal Investigator with details of previous experience of Project Proposer in proposed area of work, patents and publications etc., if any:

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Bio-Data of PI

1. **Name and full correspondence address:** S. Venugopal (Venugopal Santhanam),
Department of Chemical Engineering,
Indian Institute of Science, Bangalore-560012.
http://chemeng.iisc.ac.in/venu
2. **Email(s) and contact number(s):** svgpal@iisc.ac.in/venu.iisc@gmail.com
Ph: 080 22933113, Mob: 9448833358, Fax: 080 2360812
3. **Institution:** Indian Institute of Science
4. **Date of Birth:** 25/03/1975
5. **Gender (M/F/T):** M
6. **Category Gen/SC/ST/OBC:** Gen
7. **Whether differently abled (Yes/No):** No
8. **Academic Qualification (Undergraduate Onwards)**

	Degree	Year	Subject	University/Institution
1.	B. Tech (Hons.)	1996	Chemical Engg	IIT Kharagpur
2.	M.S.	1998	Chemical Engg	Louisiana State Univ, Baton Rouge, USA
3.	PhD	2002	Chemical Engg	Purdue University, USA

9. **Ph.D thesis title, Guide's Name, Institute/Organization/University, Year of Award.**

Thesis: "Fabrication of nanoelectronic devices using self- assembled 2D arrays of monolayer protected clusters."
Advisor: Prof. Ronald P. Andres. Purdue University, Dec 2002.

10. **Work experience (in chronological order).**

S. No.	Positions held	Name of the Institute	From	To
1	BAT-IIA Research Scientist	RWTH-Aachen	April 2003	Dec 2004
2	Assistant Professor	IISc, Bangalore	Dec 2004	Present

11. **Professional Recognition/ Award/ Prize/ Certificate, Fellowship received**

S. No	Name of Award	Awarding Agency	Year
1	Associate Member	Indian Academy of Sciences	2009
2	Humboldt Fellowship for Experienced Researchers	AvH foundation, Germany	2013

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12. Publications relevant to proposal (Last 5 years)

Peer Reviewed Journals (Corresponding author/s underlined)

1. P. Joshi and V. Santhanam, "Inkjet-based fabrication process with control over the morphology of SERS active silver nanostructures ", *Ind. Eng. Chem. Res.* 57 (15), 5250–5258 (2018)
2. I. Banerjee, V. Kumaran, and V. Santhanam, "Fabrication of Electrodes with Ultralow Platinum Loading by RF Plasma Processing of Self-Assembled Arrays of Au@Pt Nanoparticles", *Nanotechnol.* 27, 305401 (2016)
3. I. Banerjee, V. Kumaran, and V. Santhanam, "Synthesis and Characterization of Au@Pt Nanoparticles with Ultrathin Platinum Overlayers", *J. Phys. Chem. C.* 119(11), 5982–5987 (2015)
4. S. Parmar, V. Santhanam, "*In situ* formation of silver nanowire networks on paper", *Curr. Sci.* 107(2), *262- 269 (2014).*

Detail of patents

S. No	Patent Title	Name of Applicant(s)	Patent No.	Award Date	Agency/Country	Status
1	Methods for preparing metal and metal oxide nanoparticles	**V.Santhanam**, S.K. Sivaraman	US 8361188	Jan 2013	**USPTO, USA**	**Owned by Intellectual Ventures**
2	Microelectronic component with electrically accessible metallic clusters	G. Schmid, U. Simon, D. Jaeger, **V. Santhanam**, T. Reuter	US 7602069; EP 1748501	Oct 2009	**USPTO, USA; EPO, Germany**	**Owned by Univ. of Duisburg-Essen**

13. Books/Reports/Chapters/General articles etc.

S. No	Title	Author's Name	Publisher	Year of Publication
1	"Scalable synthesis of noble metal nanoparticles" in Nanoscale and Microscale Phenomena , Eds. Y. Joshi, S. Khandekar,	**V. Santhanam**	Springer, India	2015
2	"Metal Nanoparticles: Self-assembly into Electronic Nanostructures", in The Dekker Encyclopedia of Nanoscience and Nanotechnology , 3rd edition, Eds. S.E. Lyshevski,	**V. Santhanam**, R.P. Andres	CRC Press, Taylir & Francis Group	2014

Any other Information (maximum 500 words)

The underlying theme of research activities in my group at IISc is the development of a process engineering 'toolkit' comprising of cost-effective and environmentally-benign processes that will enable the use of nanoparticles as building blocks in future nanoelectronic and energy conversion devices. We are also involved in the development of low-cost, additive fabrication techniques for forming nanostructured devices on flexible substrates

S. SK.

Annexure-II

MONTHLY/QUARTERLY PROGRESS REPORT

Month: .....20..... /Quarter: From ..... 20.....to..... 20.....

(Monthly report should be submitted latest by 27th of the same month. The quarterly report should be submitted by 10th of the month following that quarter)

1. Project Title:
2. Name of Institute/Organisation:
3. Principal Investigator:
4. Co-Project Investigator:
5. OECT Agreement No. & Date:
6. Scheduled Project Completion Date:
7. Project Budget:
8. Total Instalment Amount received till Date:
9. Project Objective:

10. Work Planned during the Month/Quarter:

11. Progress Achieved during the Month/Quarter:

12. Milestone to be Achieved in the Month/Quarter:

13. Progress in Achieving the Milestone:

14. Problems/Issues Experienced, if any (Pl. Specify) & Actions taken to resolve them:

15. Any other Information:
16. Other Details (to be given only with Quarterly Progress Reports)

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a) Financial Details:

Sl. No.	Sanctioned Budget Head	Approved Budget (in `)	Amount Released Till Date (in `)	Expenditure Till Date (in `)	Committed Expenditure, if any (in `)	Balance Available for expenditure, (in `) (3)-(4)+(5)+(6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i.	Equipment					
ii.	Manpower					
iii.	Consumable					
iv.	Travel					
v.	Contingency					
vi.	Any Other					
vii.	Overheads					
	Total (`)					

b) Details of Equipment Purchased/Under Purchase/Planned:

c) Manpower Recruitment (In Position/Planned):

d) Publications (Sent for Publication/Published)

(Signature with Seal PI)

ONGC ENERGY CENTRE

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BENGALURU 560 012

Annexure-III

Project Completion Report (PCR)

[5nos. of the physical (bound) and electronic copy should be sent within one month of the completion or termination of the project]

1. Title of the Project:
2. Name of the Institution:
3. Principal Investigator & Address:
4. Co-Principal Investigator & Address:
5. OECT Agreement No.:
6. Project Commencement Date:
7. Approved Date of Completion:
8. Actual Date of Completion:
9. Objectives of the Project:
10. Work Plan & Methodology adopted:
11. Detailed progress report giving detailed information on work carried out, experimental work, and detailed analysis of results including discussions and inferences indicating contributions made towards increasing the state of knowledge in the subject:
12. Summary of the Project works, especially with respect to the project objectives and proposed output:
13. **Output of the Project (**originally planned vis-à-vis achieved):

a) Nature of Output: Material/Process/Product/Equipment/Pilot scale demonstration/Any other (Please Specify)

b) Performance specifications: Purity of Materials, Process Details, Product Specifications (Capacity, Rating, Efficiency, Test results), Equipment (Performance features, Capacity, Bill of Materials),Pilot Production(Capacity, Through-put, Yield, Test results)

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c) Details of Engineering Designs/Drawings (plans and sections) and Prototype/Pilot/ Full Scale, Specifications, Process Flow Diagrams, Inventory of materials etc.

d) Details of Specifically isolated/designed microorganisms for projects involving development of biotechnological/microbiological processes/technologies, nutrient medium recipes, maintenance and deposition protocols and other detailed information on the isolates to OECT required for safe deposition, preservation and subsequent use.

e) Details of Patents Filed/Planned,if any:

Sl. No.	Title of the Patent	Type of Patent	Date of Application	Country/ Countries	Status/Remarks

f) List of Research publications (a copy of the papers should be attached):

Sl. No.	Authors	Title of paper*	Name of the Journal	Volume	Pages	Year

g) List of Technical Documents prepared (a copy of each of the documents must be attached):

h) Awareness, training camps, etc. organized:

14. Details of work which could not be completed(if any):

15. Suggestions on further work on the subject of Research/Technology Development:

16. Manpower deployed for the Project Work (including OECT Manpower, if any), Including PI:

Sl. No.	Name	Designation	Institute/ Organization	Period of Deployment

17. **Project Expenditure:**

(Please enclose copies of year-wise audited UC and SoEas per OEC format)

S.S.K

Sl. No.	Budget Head	Amount Sanctioned (in `)	Actual Amount Received (in `)	Actual Expenditure (in `)	Balance Amount to be refunded to OECT (in `) (4)-(5)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Capital Equipment					
	Manpower					
	Consumable					
	Travel					
	Contingency					
	Any Other					
	Overheads					
	Total					

18. **Details of Assets Acquired under the Project:**

Sl. No.	Description of Equipment/Asset & Accessories	Purchase Order No. & Date	Supplier's Name & Address	Date of Commissioning	Cost of Purchase (`)	Remarks

Signature of Principal Investigator

Seal

Date:

Place:

Signature of Head of Institute/Organization

Seal

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Annexure-IV

Request for Release of Milestone Based Installment

1. Title of the Project
2. Name of the Institution/Organization
3. Principal Investigator
4. OECT Agreement No. & date
5. Project Budget
6. Total amount received from OECT so far (Date)
7. Total Expenditure Incurred so far (Date)
8. Balance available (6 – 7)
9. Interest accrued on Bank deposits (Date)
10. Total amount available (8 + 9)
11. Committed Expenditure, if any (Date)
12. Net amount available for expenditure (10-11)
13. Requirement as per installment
14. Amount actually requested for release by OECT
15. Details of Milestone/Target achieved
16. Budget Head wise Details of Receipts, Expenditure & fresh Requirement

Sl. No.	**Budget Head**	**Amount Approved by OECT (2)**	**Amount Released so far OECT (3)**	**Expenditure so far (4)**	**Amount available for Expenditure (3-4) (5)**	**Amount Proposed for release by OECT (6)**	**Balance amount available for future release (2-3-6)**
1	Capital Equipment						
2	Manpower						
3	Consumable						
4	Travel						
5	Contingencies						
6	Overheads *						
7	Any other						
	Total						

* Overhead amount will be due only after completion of FY and submission of audited Statement of Expenditure for previous FY.

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CERTIFIED THAT :-

(a) I/We have satisfied that the terms and conditions on which the funds have been released by O E C T have been fulfilled and that I/We have exercised the following checks to ensure that the amount released by OECT was actually utilized for the purpose for which it was provided by OECT.

Kinds of checks exercised:

1.

2.

3.

(b) The institute/organization will claim only that amount which is actually spent for any specific activity under any budget head. The balance amount available, if any, will be treated as a part of next installment due .for the project

(c) Theaudited accounts of this installment submitted by the Institute shall be either at the time of requesting next installment or before that.

(d) All purchases and works will be made strictly in accordance with the laid down procedure prescribed in the Institute/organization.

(e) Two copies of audited Statement of Expenditures for previous financial year --- are enclosed.

(f) Two copies of audited Statement of Expenditure for current financial year up to the month of _____20__ are enclosed.

(g) Two copies of Progress Report up to the month of _____20__ are enclosed.

(Signature of PI)With seal	**Signature of Head Finance/ Internal Auditor with Seal**	**Signature)of Head of Institute/ Organization or authorized personnel(with seal**

SSK

Annexure-V

Final Audited Statement of Expenditure (SOE)

(From:.....20..... to .....20.....)

1. Title of the Project:
2. Name of the Institution:
3. Name of Principal Investigator:
4. OECT Agreement No. & Date:
5. Approved Duration: ....Years....Months (from .....20.... to .....20.....)
6. Approved Project Budget:
7. Bank Interest Accrued, (if any)
8. Total Expenditure Incurred
9. Balance available/due from OECT:
10. Details of F Y wise Expenditure:

Sl. No.	Budget Head/ Instalment/Year	Amount Approved by OECT	Actual Expenditure Incurred (Financial Year wise)			Total Expenditure	Balance amount available with the Institute, if any or Due from OECT	Reasons for variations, if any	Remarks
			20.... - 20....	20.... - 20....	20.... - 20....				
1	Capital Equipment								
2	Manpower								
3	Consumable								
4	Travel								
5	Contingency								
6	Any Other								
7	Overheads								
	Total								

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CENTRE FOR SPONSORED SCHEMES AND PROJECTS * INDIAN INSTITUTE OF SCIENCE * BENGALURU 560 012

Certified that

1. The expenditure of (Rupees..... was actually incurred on implementation of above mentioned collaborative project of ONGC Energy Centre Trust (OECT), strictly in accordance with the terms and conditions of the Agreement signed by the institute/organisation with OECT.
2. The Capital Equipment purchased by the Institute/Organisation under the project are in working order and their purchase has been recorded in the Assets Register. An audited copy of the Asset Register along with copies of purchase orders/invoices are enclosed with this certificate.
3. All procurements, works and payments for the project related activities have been completed strictly as per the laid down procedure of the institute/organization. Records are maintained by the institute/organisation for all procurements and works.
4. All records and financial documents concerning the activities under the project have been duly checked and verified by the external auditor.
5. Certified that the institute has availed a sum of Rs.....under Input Tax Credit which has been returned to OECT.

OR

Certified that the Institute has not availed any kind of Input Tax Credit.

Name & Signature of Principal Investigator with Seal

Name & Signature of the Head Finance with Seal

Name & Signature of the Head of Institute/Organisation with Seal

Place & Date:

Place & Date

Place & Date

Name & Signature of the External Auditor with Seal

Place & Date

SSK

Annexure-VI

Utilization Certificate (U. C.)

For the Financial Year20 -20 (Period: 20 to 20)

1. Title of the Project
2. Name of the Institution/Organization
3. Principal Investigator
4. OECT Agreement No & date
5. Amount brought forward from the Previous Financial year, if any:
6. Amount received during the Current Financial year:

Sl. No.	Installment No.	OECT Letter No. & Date	Installment Amount Received (`)
	Total amount received during the current F Y		

7. Bank Interest accrued during the year, if any,

8. Total amount that was available for expenditure during the current financial year (Sr. No. 5+6+7)
9. Actual Expenditure incurred during the current financial year (up to 31st March)

Sl. No.	**Budget Head**	**Current F Y**		**Cumulative**		**Remarks**
		Approved	**Actual Expenditure**	**Approved**	**Actual Expenditure**	
1	Equipment					
2	Manpower					
3	Consumable					
4	Travel					
5	Contingency					
6	Any Other					
7	Overheads					
8						
	Total (`)					

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10. Balance amount available at the end of the financial year

11. Committed funds, but expenditure not incurred/payment made

12. Amount to be carried forward to the next financial year (if applicable)

Certificate:

(a) Certified that I/We have satisfied that the terms and conditions on which the budget was sanctioned by OECT and payment of installments made, have been fulfilled and that I/We have exercised the following checks to see that the amount was actually utilized for the purpose for which it was approved and paid by OECT.

Kinds of checks exercised:

i)

ii)

iii)

Place & Date:

Name, Signature & Seal of PI

Name, Signature & Seal of Head Finance/
Auditing Authority

Name, Signature & Seal of Head of the Institute/Organization
Or Authorized Personnel

Name & Signature of the External Auditor with Seal

Place & Date

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Annexure-VII

Assets acquired under Collaborative Project of OECT

(Register to be maintained by Institution/Organization)

1. Title of the Project:
2. Name of Institution:
3. OECT Agreement No. & Date:
4. Project Budget:
5. Total Cost of Assets actually credited or acquired as .....:
6. Details of the Assets acquired a son.....:

Sl. No.	Description of Equipment/ Asset & Accessories	Purchase Order No. & Date	Supplier's Name & Address	Date of Commissioning	Cost of Purchase	Remarks

(Signature of Project Investigator) **(Signature of Head Finance)** **(Signature Head of the Institution/Organization)**

Name: **Name:** **Name:**

Date: **Date:** **Date:**

Seal **Seal** **Seal**

S.S.K.

Annexure-VIII

Request for OECT Approval for Filing of Patent

1. Title of the Invention:
2. Title of the Project under which Invention made :
3. OEC Agreement No. & date:
4. Name of the Principal Investigator:
5. Present stage of development (including scale of operation, production, validation, quality etc.):
6. Novelty, non-obviousness and inventive step(s):
7. Any Patent filed by PI or Institute/Organization on the similar work. If yes give the details:
8. Present national and international knowledge on the utility of this invention:
9. Need for filing application for patenting of the invention with detailed justification:
10. Type of Patent Application proposed to be Filed: Indian/PCT/Convention/Other
11. Countries proposed for filing of patent with justification:
12. Name and Address of Patent/Receiving Office, where Application for Patent filing is to be submitted:
13. Enclose complete application to OECT for seeking approval (provided in seal cover) with all relevant enclosures & drawing etc., which are to be submitted to concerned patent office.

List of Enclosures:

14. Whether Services of Expert Agency/ Consultant is being availed for Patent filing: Yes/No

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15. Name, address & contact details of Expert Agency/Consultant, if yes:

16. Estimated Expenditure towards Patent Filing with break-up:

17. Amount required from OECT:

18. Name, Contact Details of the Inventors:

Sl. No.	Name	Address	Telephone No.	Fax No.	e-mail ID

19. Name, Address & Contact Details of the Authorized Signatory from the Institute:

Declaration:

I/We hereby certify and declare that all the information provided above is true and correct to the best of my/our knowledge and belief. Further, to the best of our knowledge and belief, proposed Patent does not infringe any existing patent.

Signature of Principal Investigator	Signature of Head of Institute/Organization
Name:	Name: Dr. K. Panneer Selvam, Advisor (Extramural Research), Centre for Sponsored Schemes and Projects, Indian Institute of Science, Bengaluru - 560 012
Designation:	Designation:
Date:	Date: 18/07/2019
Seal:	Seal:

S.S.K.

Annexure-IX

Request for Extension of Tenure of the Project

1. Title of the Project
2. Name of the Institution/Organization
3. Principal Investigator
4. OECT Agreement No. & date
5. Project Budget
6. Total amount received from OECT so far (Date)
7. Project Completion date as per the agreement
8. Details of Milestone/Target achieved so far
9. Activities Remaining as per the agreed Scope of work
10. Reason for delay
11. Justification for Extension& Methodology to Complete the remaining work (Use separate sheets)
12. Revised Activity Chart for the Extended Period

Signature of Principal Investigator

Seal

Date:

Signature of Head of Institute/Organization

Place:

Seal

S.S.K.