

ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY

Shobhavan Campus, Mijar, Moodbidri - 574225

(Affiliated to Visvesvaraya Technological University, Belagavi)

Approved by AICTE, New Delhi & Recognized by Government of Karnataka)



Research Activity Report on

**“ALVA’S
CENTER FOR ADVANCED RESEARCH”**

(Common Research Facility for UG-PG-PhD Projects)

Academic Year

2023 - 2024

1. Mission, Vision, Objectives of the Lab

Vision: Creation of a common research center to support the theme of Project-based learning through UG/PG/PhD Research Projects leading to enhancement of knowledge and institutional status.

Mission

- Identification of research projects in the field of Health, Energy, Environment, Water, Communication etc.
- Enhances the ability to perform research in a global community
- Supports strong infrastructure for interdisciplinary research
- Involvement of Resource persons from premier institutes;
- Enhancement of Faculty/student knowledge through UG/PG/PhD Research Projects;
- Setting up common research facility with partial support from Govt. funded schemes (KCTU, DST, VGST, BRNS, CPRI and others);
- Publications and Patents of research results;
- Reduction of industry-academia gap through Industry-Relevant Research Projects;

Objectives

- To focus research on gas sensors, fuel cells, optical materials and other materials related research.
- Implementation of projects by involving Faculty and students from UG and PG level; Ph.D Research students are the key to connect and implement UG/PG/PhD research projects.
- Enhancement of student placement through UG/PG/PhD Research Projects;
- Enhancement of institutional outreach through Conferences and Seminars;
- Overall enhancement of institutional status

2. Establishment details of Lab

Alva's center for advanced research (ACAR) is **established in the year 2017**. ACAR is envisioned to be a state-of-the-art research center for achieving excellence in important areas of science and technology. It is known that technology advances due to the advancement of science. Research based Projects connect science and technology leading to industrial products for the benefit of society. Further, teaching and research go together in most of the Institutes/universities in the world. Hence, most of the basic research based projects for industries are carried out in institutes and universities which bridge the industry-academia gap. However, the industry-academia gap is large in India due to which the quality of higher education is neglected in majority of Institutions/Universities in India which largely affects placement of students.



Entrance picture of ACAR Lab

Though the projects are mandatory for UG/PG students a per VTU/MU norms, they are not research based and hence, lack novelty; they also may lack faculty involvement and may not be industry-relevant thereby affecting both publications and placement. Further, teaching load of faculty, more so with labs, is high with little time for research; also lack of research advisors and resource persons hampers the introduction and sustenance research in most engineering institutions. Lack of basic common research facility for students/faculty to carryout UG/PG/PhD research based projects is the main reason for widening the industry-academia gap which affects placement.

3. Components or equipment in the labs with specifications and details

Equipment at ACAR

1) Spray Pyrolysis Setup for growth of thin films

Purchased year: 2020

**Make: M/s Excel Instruments,
Vasai, Mumbai.**



Specifications: Film growth chamber, 250mm Diameter, 250 mm height with observation windows 2 Nos., Mounted on a laminated work table with castor wheels having dimensions: 600mm x 600mm area, height 750mm, with substrate heater having 50mm diameter with PID controller; Maximum Temp. 800deg C;

Nebulizer assembly: The nebulizer is to be integrated on a 250mm diameter SS chamber with height adjustable (100mm to 200mm) stage for spray pyrolysis; It will have flowmeters, 2nos. for 2 gases, each having flowrates 0-5L/min and with exhaust connection at bottom of 250mm diameter SS Chamber, exhaust flow 100 CFM;

X - Y scan system with SS platform for substrate heater: The X-Y scan system will have scan range of 50mm x 50mm complete with stepper motors and drive system;

2) Gas sensor measurement setup



Purchased year: 2020

Make: M/s Excel Instruments, Vasai, Mumbai.

Specifications:

- Flowmeter-1: 0-70ml for test gas
- Flowmeter-2: 0-5000ml for N₂ dilution
- Mixing chamber with 2 inch dia SS and 4 inch long
- Measurement chamber with a lid with a window
- Heater upto 500°C with on/off controller
- Gas valve and Kf-16 pump valve
- 4 leads for measurements
- Dial gauge for vacuum measurements

3) General purpose Spinner






Purchased year: 2019

Make: M/s Spektron Instruments Inc., Chennai

Specifications:

- Actuator: Brushless DC motor
- Spinning speed: 60 - 9999 rpm
- Substrate diameter: 30 mm to 70 mm
- Power input: 230V, 50Hz
- Read out: 20 x 4 line LCD
- Spin chamber: Nylon
- Acceleration: 5 - 1000 rpm / sec
- Spinning Speed Accuracy: < 5%
- Programmable parameters: Speed, acceleration, dwell time and no. of steps
- Maximum no of steps: 9
- Program memory: 9 programs (non - volatile)
- Dimension: 400mm Depth x 275mm W x 500mm H
- Oil free diaphragm vacuum pump: Capacity: 75 LPM

4) Electrochemical Work station	
	Purchased year: 2017 Funding: Alva's Education Foundation Cost: Rs. 8,36,109.00 Specifications: <ul style="list-style-type: none"> ○ Potentiodynamic Polarization Studies ○ Electrochemical Impedance Method ○ Cyclic Voltammetry Studies ○ Chrono Potentiometric, Amperometric studies
5) DC Power Analyzer, KeySight N6705C	
	Purchased year: 2017 Funding: Alva's Education Foundation & VGST Grant Cost: Rs. 5,95,433.34 Specifications: Monolayer and Multilayer Deposition of Alloys Using Different Power Patterns
6) DC Power Analyzer, APLAB Make 0-32V/0-5A dual channel	
	Purchased year: 2017 Funding: Alva's Education Foundation Cost: Rs. 32000 Specifications: Monolayer Deposition of Alloys

4. Compositions of lab

4.1 Coordinator details and Faculty Lab in-charge details.

Coordinator details

Dr. Richard Pinto
Dean Research
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Faculty Lab in-charge details.

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Signature of the Coordinator

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1. Research Activities for the Academic Year 2023–24

At ACAR, our collaborative efforts in 2023–24 advanced several key areas of research, with a focus on hydrogen fuel cells, photocatalytic green hydrogen production, and the development of nanostructured materials. The following are the key highlights:

- **Hydrogen Fuel Cell Technology:**
 - Electrochemical discharge machining was employed to create serpentine micro-channels in fused quartz, used for in-situ hydrogen generation.
 - UV-irradiated Nafion membranes enhanced proton conductivity, doubling the performance potential in hydrogen fuel cells.
- **Photocatalytic Innovations:**
 - Development of novel photocatalytic materials using metal-organic frameworks for hydrogen storage and generation.
 - Enhanced photocatalytic hydrogen evolution through synergistic use of nano-structured catalysts and UV exposure.
- **Nanostructured Superhydrophobic Surfaces:**
 - Formation of nanostructured aluminum surfaces using Nd laser techniques.
- **Collaborative Workshops and Outreach:**

- Hosted the "Clean Energy Innovations" workshop in collaboration with CPRI, focusing on advancing hydrogen fuel technologies.

2. Research Student Details

Internal Ph.D. Students

1. **Mrs. Rashmi K.R**
 - *USN*: 4AL19PPY01
 - Ph.D. awarded on 6th February 2024.
 - *Guide*: Dr. Jayarama A, Department of Physics.
2. **Mrs. Shubhava Shetty**
 - Ph.D. ongoing in the Department of Physics.
 - *Guide*: Dr. Jayarama A.
3. **Mr. Ganesh V.N**
 - Assistant Professor, Mangalore Institute of Engineering and Technology.
 - Ph.D. awarded during 2023–24.

External Ph.D. Students

1. **Mr. Shrivathsav**
 - Research student at MIT Manipal, Department of Electronics and Communication Engineering.
 - Co-guided by Dr. Jayarama A.

3. Collaborations

ACAR maintained active collaborations with leading institutions and experts in 2023–24:

1. **Dr. Siddhartha Duttagupta**, Professor, IIT Bombay.
 - Expertise: Electrical Engineering, UV-irradiated materials for energy solutions.
2. **Dr. Richard Pinto**, Dean Research, AIET.
 - Expertise: Electronics and hydrogen fuel cell technology.
3. **Dr. Poornesh KK**, Assistant Professor, NITK Surathkal.
 - Expertise: Material science and nanotechnology.

4. Research Outcomes/Publications

ACAR achieved significant milestones in publications during 2023–24, reflecting the depth of its research activities. Key publications include:

- 1) S.R. Shankara, K.M. Eshwarappa, S.K. Kumara Swamy, D. K, S. Vidya, J. A, R. Pinto, The functional moieties impact on optical, thermal, and nonlinear properties of chalcone derivatives. A comprehensive study on FT2MP, Opt. Mater. (Amst). 157 (2024) 116083.

<https://doi.org/10.1016/j.optmat.2024.116083>.

- 2) A. B., J. A., A.S. Rao, S.S. Nagarkar, A. Dutta, S.P. Duttagupta, S.S. Prabhu, R. Pinto, Challenges in photocatalytic hydrogen evolution: Importance of photocatalysts and photocatalytic reactors, *Int. J. Hydrogen Energy*. 81 (2024) 1442–1466. <https://doi.org/10.1016/j.ijhydene.2024.07.262>.
 - 3) A.R. Yuvaraj, A. Jayarama, D. Sharma, S.S. Nagarkar, S.P. Duttagupta, R. Pinto, Role of metal-organic framework in hydrogen gas storage: A critical review, *Int. J. Hydrogen Energy*. 59 (2024) 1434–1458. <https://doi.org/https://doi.org/10.1016/j.ijhydene.2024.02.060>.
 - 4) [4] S.R. Shankara, K.M. Eshwarappa, J. A, S. Prabhu, R. Pinto, Enhancing nonlinear optical responses via Methoxy Positional Isomerism in Chalcone-Based Materials, *Mater. Chem. Phys.* 312 (2024) 128662. <https://doi.org/https://doi.org/10.1016/j.matchemphys.2023.128662>.
 - 5) A.S. Rao, B.S. Sannakashappanavar, A. Jayarama, R. Pinto, Study of rectifying properties and true Ohmic contact on Sn doped V2O5 thin films deposited by spray pyrolysis method, *Results Chem.* 7 (2024) 101533. <https://doi.org/https://doi.org/10.1016/j.rechem.2024.101533>.
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5. Patents Filed and Granted

Several patents were filed and granted during 2023–24, showcasing ACAR’s contributions to innovation:

Patents Filed in 2023–24

1. **Eco-solutions: Repurposing dairy waste for sustainable construction and packaging**
 - *Application No:* 202341073154
 - *Date Filed:* 27th October 2023
 2. **A kind of hand-operated and automated arecanut dehusker**
 - *Application No:* 202341090193
 - *Date Filed:* 30th December 2023
 3. **A novel photocatalytic hydrogen fuel cell device with in-situ hydrogen generation**
 - *Application No:* 202441007383
 - *Date Filed:* 3rd February 2024
 4. **Process for producing stable vanadium pentoxide thin film by spray pyrolysis using aqueous combustion mixture**
 - *Application No:* 202341089667
 - *Date Filed:* 29th December 2023
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Patents Published in 2023–24

1. **Low-frequency vibration sensors and energy harvesters using microcantilever beams**
 - *Application No:* 202341068917
 - *Publication Date:* 24th November 2023
 2. **Process for producing stable vanadium pentoxide thin film by spray pyrolysis using aqueous combustion mixture**
 - *Application No:* 202341089667
 - *Publication Date:* 12th January 2024
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Patents Granted in 2023–24

1. **A process for enhancing hydrogen fuel cells performance with Nafion proton exchange membrane optimal**
 - *Application No:* 201941035383
 - *Date Granted:* 22nd December 2023
2. **Smart shockwave velocity measurement system based on P(VDF-TrFE) piezosensors and Arduino**
 - *Application No:* 201941024087
 - *Date Granted:* 28th February 2024
3. **A process of synthesizing novel methyl substituted chalcone molecules - Potential cancer inhibitors**
 - *Application No:* 201941046359
 - *Date Granted:* 22nd March 2024
4. **Enhancement of direct methanol fuel cell performance with Nafion proton exchange membrane optimally exposed to ultraviolet rays**
 - *Application No:* 201941009746
 - *Date Granted:* 30th May 2024
5. **A process for fabrication of P(VDF-TrFE) piezoelectric beams and cantilevers as vibration sensors and energy harvesters**
 - *Application No:* 201841030070
 - *Date Granted:* 14th March 2024

6. Submitted/Sanctioned/ongoing Proposals

ACAR actively pursued funding for cutting-edge research projects in 2023–24:

Submitted Proposals

1. **DRDO**
 - *Title:* Development of novel prototype high-performance hydrogen fuel cell stacks powered by photocatalytic green hydrogen.
 - *Budget:* ₹94.6 Lakhs
 - *Status:* Under Review
 - *Date of Submission:* 5th May 2023
2. **VGST KFIST-II**
 - *Title:* Creation of nanostructured stainless steel and aluminum surfaces for realizing superhydrophobicity using Nd YAG laser.
 - *Budget:* ₹30 Lakhs
 - *Status:* Submitted
 - *Date of Submission:* 5th May 2023
3. **VGST KFIST-I**
 - *Title:* A cost-effective and eco-friendly solution for enhanced plastic degradation, upcycling, and fuel-compost generation in urban and rural areas.
 - *Budget:* ₹20 Lakhs
 - *Status:* Submitted

- *Date of Submission:* 5th May 2023
 - 4. **VGST-GRE**
 - *Title:* Enabling clean energy independence: Transforming household waste into hydrogen for urban and rural communities.
 - *Budget:* ₹40 Lakhs
 - *Status:* Submitted
 - *Date of Submission:* 19th May 2023
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Sanctioned Proposals

1. **DST-SERB (Core Research Grant)**
 - *Title:* Electrochemical discharge machined serpentine micro-channels in fused quartz for photocatalytic in-situ hydrogen evolution in hydrogen fuel cells.
 - *Budget:* ₹52 Lakhs
 - *Status:* Sanctioned / ongoing
2. **CPRI**
 - *Title:* Photocatalytic generation of green hydrogen and development of novel low-cost, high-performance hydrogen fuel cell stacks.
 - *Budget:* ₹62.3 Lakhs
 - *Status:* Sanctioned
 - *Date of Sanction:* 21st March 2023
3. **Visvesvaraya Technological University (Research Grant Scheme)**
 - *Title:* Formation of nanostructured aluminum surfaces for realizing superhydrophobicity using Nd: YAG laser.
 - *Budget:* ₹12 Lakhs
 - *Status:* Sanctioned
 - *Year:* 2023–24
4. **Visvesvaraya Technological University (Research Grant Scheme)**
 - *Title:* Novel nanostructured photocatalyst-assisted in-situ hydrogen generation in hydrogen fuel cells with laser micro-machined anode plates.
 - *Budget:* ₹5 Lakhs
 - *Status:* Sanctioned
 - *Year:* 2023–24

The ACAR report for 2023–24 highlights significant advancements in hydrogen fuel cell technology, photocatalytic green hydrogen production, and nanostructured material research. Key achievements include the development of serpentine micro-channels for hydrogen evolution, enhanced UV-treated Nafion membranes, and superhydrophobic aluminum surfaces using Nd: YAG lasers. Collaborative efforts with IIT Bombay, NITK Surathkal, and CPRI Bengaluru led to impactful research, resulting in multiple high-impact publications and patents, such as innovations in fuel cell performance and photocatalytic devices. With over ₹300 Lakhs in submitted proposals and ₹79.3 Lakhs in sanctioned projects, ACAR strengthened its position as a leading research hub, driving innovations in clean energy and advanced materials while supporting Ph.D. students and fostering interdisciplinary collaboration..



Signature of the Coordinator