AMAL M M

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Phone: +91 8891826346 **Nationality:** India

Research Interests

Lithium-Ion and Sodium-Ion Batteries • Polymer and Solid-State Electrolytes • Electrochemical Interfaces • High-Energy Anodes • Interfacial Chemistry and Ion Transport • Operando/In-Situ Characterisation

Education

2022 - 2026 **B.Tech. in Chemical and Electrochemical Engineering | CGPA:** 8.19/10 (~ 3.27/4)
CSIR – Central Electrochemical Research Institute (Affiliated to Anna University, Chennai)

Research Experience

Project Associate, RISE – TCG CREST **July 2026 – Present**
Research Intern, RISE – TCG CREST **May 2026 – July 2026**
Supervisor: Dr Abhik Banerjee
Research Institute for Sustainable Energy (RISE), The Chatterjee Group Centres for Research and Education in Science and Technology (TCG CREST), Kolkata, West Bengal, India

Polymer Electrolytes for Lithium- and Sodium-Ion Batteries

- Developed an external-initiator-free, in-situ polymerisable vinyl ether-based polymer electrolyte, achieving an ionic conductivity of 3×10^{-3} S cm^{-1} and oxidative stability up to 4.6 V.
- Advancing a high-silicon lithium-ion battery platform using this polymer electrolyte with 70 wt% silicon anodes, with initial Coulombic efficiency (ICE) exceeding 85%.
- Investigating electrolyte–electrode interfacial behaviour, electrochemical performance, and the applicability across lithium-ion, sodium-ion, and solid-state battery architectures.
- Preparing a provisional patent application for the polymer electrolyte technology.

SHINERS-Assisted Operando Raman Spectro-electrochemical Platform

- Designing an operando SHINERS-Raman platform based on the EL-CELL Opto-STD cell for real-time investigation of electrode–electrolyte interphases in lithium- and sodium-based batteries.
- Synthesising shell-isolated Au@SiO_2 nanoparticles (SHINERS) to enhance Raman sensitivity while preserving electrochemical behaviour.
- Correlating operando Raman spectroscopy with electrochemical measurements to investigate electrolyte decomposition and solid-electrolyte interphase (SEI) evolution.

Lithium Metal Batteries: Dendrite Suppression and Fast Lithium Deposition

- Led the major experimental and manuscript revision of a research article submitted to ***Advanced Energy Materials (Wiley)*** on a compliance-driven mechanism for lithium dendrite suppression.
- Designed and conducted the additional electrochemical experiments required to address reviewer comments and strengthen the mechanistic understanding of lithium deposition at high current densities.
- Analysing electrochemical performance and lithium-deposition morphology, preparing revised figures, and writing the revised manuscript for resubmission.

Undergraduate Research Assistant **June 2023 – May 2026**
Supervisor: Dr P Tamilarasan
Electrodics and Electrocatalysis Division, CSIR–Central Electrochemical Research Institute (CSIR–CECRI), Karaikudi, India

External Electromagnetic Fields in Electrochemical Systems (Undergraduate Thesis)

- Investigated the influence of high-frequency electromagnetic fields on electrochemical measurements using custom-designed experimental platforms.
- Fabricated Ni–Co layered double hydroxide electrocatalysts and evaluated hydrogen and oxygen evolution activity using CV, LSV, and Tafel analysis.
- Demonstrated reference electrode polarisation as the primary source of field-induced measurement artefacts.

Plasmonic Nanostructures for Surface-Enhanced Raman Spectroscopy

- Designed and optimised an evanescent-wave-based plasmonic substrate for destruction-free in situ Raman measurements. Performed FDTD Simulations to find the optimum geometry of the substrate. Developed a substrate having less than a 10-degree acceptance angle. Prepared a first-author manuscript and got selected for presentation at prestigious stages.

Single-Atom Electrocatalysts for Electrochemical Energy Conversion

- Developed magnetron sputtering strategies for platinum-based electrocatalysts by introducing substrate heating to promote atomic Pt dispersion. Investigated substrate-temperature effects on Pt nucleation, metal–support interactions, and catalyst stability using TEM and XRD. Optimised sputtering parameters to improve thin-film quality and catalyst reproducibility.

Visiting Research Intern *(TEEP Fellow)* **July 2025 – September 2025**

Supervisor: Dr Vincent. K. S. Hsiao *(蕭桂森)*

Department of Applied Materials and Optoelectronic Engineering, National Chi Nan University, Puli, Taiwan

Tunable Multi-Wavelength Reflection in Porous Silicon Bragg Reflectors

- Simulated porous silicon Bragg reflectors using the Transfer Matrix Method (MATLAB) to engineer multi-wavelength reflectance. Fabricated porous silicon photonic structures through silver nanoparticle-assisted electrochemical etching. Characterised fabricated structures using SEM and XPS.

Electromagnetic Field–Induced Electrochemical Dynamics

- Investigated Tesla coil-assisted electromagnetic effects on electrochemical systems using chronoamperometry. Designed contactless electrochemical experiments to evaluate field-induced perturbations. Correlated transient electrochemical responses with electromagnetic field exposure.

PUBLICATIONS

Peer-Reviewed Journal Articles

Hsiao-Han Hsu, Sheng-Yang, **Amal Muhammed Musthafa**, I-An Lin, Chia-Man Chou, and Vincent K. S. Hsiao. "Tuning Multi-Wavelength Reflection Properties of Porous Silicon Bragg Reflectors Using Silver-Nanoparticle-Assisted Electrochemical Etching." *Micromachines* 16 (2025): 1198.

First Author Manuscripts in preparation

Amal M. M., Tamilarasan Palanisamy.
Design and Simulation of an Evanescent Wave-Based SERS Substrate: Geometric Analysis and Optimisation.
Amal M. M., Tamilarasan Palanisamy, Vincent K. S. Hsiao.
Unveiling Interfacial Dynamics with Contactless High-Frequency Magneto-Inductive Electrochemistry.
Amal M. M., Tamilarasan Palanisamy, Vincent K. S. Hsiao.
Understanding the Effect of External Electromagnetic Fields on Electrochemical Systems.

Invited / Selected Presentations

Selected among the Top 10 research presentations nationwide *for the* ***ICTS Open Day 2025****, International Centre for Theoretical Sciences (ICTS), Tata Institute of Fundamental Research (TIFR), Bengaluru, India. Presented research on* ***Surface-Enhanced Raman Spectroscopy (SERS)****.*

Conference Presentations

Amal M. M., Tamilarasan Palanisamy.
FDTD Simulation of an Evanescent Wave-Based SERS Substrate for the Detection of Electrochemical Intermediates. Electrochemistry for Industry, Health and Environment (EIHE-25), Bhabha Atomic Research Centre, Mumbai, India, January 2025.

Amal M. M., Tamilarasan Palanisamy.
Evanescent Wave-Based SERS Substrate, International Conference on Materials and Applied Science for Society (ICMASS 2025), Alagappa University, India, March 2025.

Pavadharani V., Murugasenapathi N. K., **Amal M. M.**, Tamilarasan Palanisamy.
Realistic Modelling of Plasmon-Enhanced Nanocatalysts. National Convention of Electrochemists (NCE-23), Chennai, India, January 2024.

Awards, Fellowships & Honours

- **Taiwan Experience Education Program (TEEP) Fellowship, National Chi Nan University, Taiwan | 2025.** A fellowship by the Ministry of Education (MoE), Government of Taiwan (R.O.C)
- **INSA-IASc-NASI | Indian Academy of Sciences Summer Research Fellowship 2025.** Selected for the Indian Academy of Sciences (IASc) Summer Research Fellowship Programme.
- **ICTS Open Day 2025 – Top 10 Research Showcase. International Centre for Theoretical Sciences (ICTS), Tata Institute of Fundamental Research (TIFR) | 2025.** Selected as one of the **Top 10 research projects nationwide**.

Technical Expertise

Battery & Electrochemical Research
- Lithium-based solid-state batteries
- Lithium & Sodium Battery Systems
- Polymer electrolytes
- Coin-cell assembly
- In-situ Raman
- CV, LSV, EIS, CA, CP, galvanostatic cycling

Experimental & Research Infrastructure
- Glovebox
- Custom electrochemical cell design
- 3D printing
- ISO Class 7 cleanroom

Materials & Characterisation
- Electrodeposition
- Magnetron sputtering
- Raman, FTIR
- FESEM, TEM
- XRD, XPS
- TGA, DSC

Computational
- FDTD (Ansys Lumerical)
- MATLAB, Python
- OriginPro
- LaTeX

Professional Leadership

President
The Electrochemical Society (ECS) Student Chapter, CSIR-CECRI, June 2025 – April 2026
- *Led the student chapter in organising academic activities, technical seminars, and scientific engagement initiatives for undergraduate students & Graduate researchers.*

President
INTERSECT 2026 – National Level Technical Symposium, CSIR-CECRI, 2026
- *Coordinated the planning and execution of a national-level scientific symposium involving researchers, faculty members, and students.*

Deputy Lab Safety Head
Analytical Microsystems Laboratory (AML), PI: Dr P Tamilarasan, CSIR-CECRI
- *Assisted in implementing laboratory safety practices, equipment management, and compliance with laboratory safety protocols.*

Languages

English: TOEFL iBT (106/ 120) ***Malayalam (Native)*** ***Tamil (Professional Proficiency)***