Dhamotharan. D
B. Tech in Metallurgical and Materials Engineering
IDDD in Advanced Materials and Nanotechnology
Indian Institute of Technology Madras

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Education

Indian Institute of Technology Madras *September 2020 – July 2025*
B. Tech in Metallurgical and Materials Engineering and *CGPA: 8.61 /10.00*
Inter-Disciplinary M. Tech in Advanced Materials and Nanotechnology

CEOA Matriculation Higher Secondary School, Madurai *June 2019 - March 2020*
Class XII, State Board of Secondary Education, Tamil Nadu *Percentage: 94.3*

Kaviyan Matriculation School, Ammayanaickanur *June 2017 – May 2018*
Class X, State Board of Secondary Education, Tamil Nadu *Percentage: 98.2*

Personal statement

A STEM enthusiast bridging science and engineering through the foundations of chemistry and physics. With a deep passion for nanotechnology, I explore the microscopic world to engineer materials with transformative potential. I continuously refine my expertise and analytical thinking in materials science and engineering, driving advancements in material and device fabrication, characterization, and performance optimization. My work focuses on nanotechnology, electrochemistry, semiconductors, ceramics, alloys and polymers. My goal is to contribute to next-generation electronics through innovative materials-device co-design.

Areas of Interest

• **Nanoscale Material & Device Development (Emerging Focus):** Nanoscale-engineering of active materials for electronic applications, including thin-film deposition via electrochemical methods, defect engineering and interface engineering.
• **Advanced Materials for Electronics (Current Expertise):** Functional oxides and 2D materials for device integration, Template-assisted synthesis of nanowires/nanopores, Correlating material properties (defects, crystallinity) with electronic performance
• **Nanofabrication & Characterization (Core Strength):** Precision synthesis via electrochemical, wet chemical and thermal routes; material characterization (SEM, XRD, etc.); process optimization for reproducibility and scalability

Patent

• **202441060984 - A flexible ceramic nanogenerator and a method of manufacture thereof** *February 2024 – March 2025*
Co-inventors: Prof. Ravikumar, Mr. Abishek Muthukumar, Dr. Ganesh Babu *IIT Madras, India*
- Developed and filed a patent (provisional & full) on the methodology for fabricating highly flexible, easily scalable, and complete ceramic systems designed for nanogenerators, specifically triboelectric nanogenerators

Paper

• **LiVO3/LiZnVO4 Nanocomposite: High performance Electrocatalyst for Ambient Nitrogen Reduction to Ammonia**
Authors: Naina Goyal [a], Dhamotharan D.[b], Fabio Pires [a], Ravikumar [b], Sanjay Mathur [a,b]
- Manuscript under review in ***Advanced Engineering Materials*** (Manuscript ID: adem.202501627, submitted on June 17th 2025)

Achievements & Awards

• **Prof. K. Gopinath & Mrs. Padmini Gopinath Prize 2024-25** *IIT Madras*
- Secured for the best academic performance of Inter Disciplinary Dual Degree Programme in Advanced Materials and Nano Technology branch
• **Institute Merit Prize 2024-25** *IIT Madras*
- Secured for high cumulative grade in 7th & 8th semesters of IDDD program in Advanced materials and Nano Technology branch

Conferences

• **International Symposium on Emerging Research in Advanced Materials** *June 2025*
Co-authors: Mr. Abishek Muthukumar, Prof. Ravikumar *IIT Madras*
- Presented an oral talk titled "*Flexible ceramic based tribo-positive electrodes for durable and high-efficiency wearable energy harvesting*" at the International Symposium on Emerging Research in Advanced Materials (ISERAM-1) jointly organised by IIT Madras and Nagoya University held from 27th -29th June 2025

• International Conference on Advanced Ceramics for Sustainability *November 2024*
Co-authors: Mrs. Naina Goyal, Prof. Ravikumar, Prof. Sanjay Mathur *IIT Madras*
- Secured third place for oral presentation "*High selectivity electrocatalytic green ammonia synthesis via LiZnVO4/ LiVO3 biphasic compound under acidic conditions*" in International Conference on Advanced Ceramics for Sustainability under student session

Research Projects

• Novel rapid and room temperature synthesis of metal nitrides *January 2025 - Present*
Guide: Prof. Ravikumar, Dept. of Metallurgical and Materials Engineering, IIT Madras
- Working on a novel, *rapid, room-temperature synthesis* route for *nitrides* by optimizing the solid-state metathesis process. This approach shows promise for both *transition metal*-based systems and post-transition metal nitrides such as *gallium nitride*.

• Flexible Ceramic-Based Triboelectric Nanogenerators for Efficient Waste Mechanical Energy *August 2023 - Present*
Guide: Prof. Ravikumar, Dept. of Metallurgical and Materials Engineering, IIT Madras
- Pioneered flexible ceramic TENGs via in situ fabricated material-electrode synergy, achieving *<3mm bend radius* with stability retention over *1000 cycles*. Developed scalable thin-film protocols enabling high-throughput production of such energy harvesters.
- Engineered *ceramic-SiOC interfaces* to control *dielectric polarization* and *surface charge* distribution, achieving sustained high-output TENG performance which I currently drafting the work for *manuscript submission*.

• Electrocatalytic green ammonia synthesis using $LiZnVO_4$/ $LiVO_3$ nanocomposite *June 2024 – August 2024*
Guide: Prof. Sanjay Mathur, University of Cologne, Germany
- Synthesized LiZnVO4/LiVO3 nanocomposites using a novel *silazane-based sol-gel* method in *Stock line* that has a potential control for desired stoichiometric compound formation. Phases evolution using XRD, FT-IR with temperature dependency were studied.
- XPS, SEM, Raman and TG-DSC were employed for structural analysis. Individual phase compounds were also synthesized using the same methodology, and XRD, FT-IR characterizations were carried out for structural property correlation.
- Overcame *intrinsic HER limitations* in NRR via a novel Li-engineered composite catalyst, achieving *45% Faradaic Efficiency* for NH_3 yielding *$53 \mu g\ h^{-1}\ mg_{cat}^{-1}$* in the proton-rich electrolytes. Comparison studies revealed composite has very high activity

• Electrocatalytic behaviour of Cu-based nanowires for Nitrate Reduction *February 2023 – July 2023*
Guide: Prof. Lakshman Neelakantan, Dept. of Metallurgical and Materials Engineering, IIT Madras
- Synthesized *Cu nanowires* (78±10nm diameter) via galvanic displacement in AAO templates with barrier layer thinned, achieving >90% pore filling (SEM). Fabricated *Cu-Pd nanowires* through DC electrodeposition with alloy composition (Cu_xPd_{100-x}).
- Compared nitrate reduction performance of AAO-templated *Cu, $Cu_{20}Pd_{80}$,* and a *novel functionalized Cu nanowires* through CV and LSV. Achieved enhanced *sensitivity* (50 μA/μM) and *lower detection limit* (10 nM) with functionalized Cu versus bimetallic system.

• Self-Ordered Nano-porous AAO templates Fabrication by Mild and Hard Anodization *July 2022 - December 2022*
Guide: Prof. Lakshman Neelakantan, Dept. of Metallurgical and Materials Engineering, IIT Madras
- Executed Mild Anodization (45V DC, 0.3M oxalic acid) with tunning pore diameter from 20 nm to 80 nm via two step-anodization *barrier layer thinning* and pore widening. Conducted systematic *Hard Anodization* trials (150-200V, <5°C, current density <500 mA/cm²), to advance process scalability and reliable *high-speed fabrication* with anode *dielectric breakdown* prevention.

Professional Experience

• The Titan Company Jewellery Division *May 2022 - July 2022*
R&D Intern Hosur, Tamil Nadu
- Contributed to a project aimed at developing a cost and time-efficient manufacturing route for *gold bangle production* by replacing conventional metal forming and machining from rectangular blocks with continuous casting of hollow cylindrical semifinished product
- Optimized production of *18K white gold rods* (3–8mm diameter) for *Nick plate* applications using *vacuum induction melting*, reducing purity deviations, improving yield, and lowering costs.

Course Projects

• Fabrication and characterization of Permalloy thin films via DC sputtering *January 2024 - April 2024*
Advanced Materials and nanotechnology lab course project IIT Madras
- Fabricated Permalloy ($Fe_{20}Ni_{80}$) thin films (thickness ~316±20 nm) on glass substrates using *DC sputtering*. Confirmed structural properties via XRD and surface and cross-sectional morphology were observed through SEM imaging.
- Magnetic characterization using *Vibrating Sample Magnetometry (VSM)* revealed soft magnetic behavior with a narrow hysteresis loop. Extracted key parameters including coercivity, intrinsic coercivity, saturation magnetization, and retentivity from M–H curves.

• Synthesis and Characterization of InSb thin films via E-beam evaporation *January 2024 - April 2024*
Advanced Materials and nanotechnology lab course project IIT Madras
- Synthesized Indium Antimonide (InSb) pellets and deposited thin films (~980 ± 17 nm) using *electron beam evaporation*; XRD confirmed preferred crystallographic growth along (111), (022), and (113) planes, with peak broadening in thin films.
- SEM-EDS analysis revealed film composition of $In_{47}Sb_{53}$; performed temperature-dependent *four-probe and Hall measurements*, confirming p-type conductivity due to In vacancies, highlighting unintentional doping in *compound semiconductor* films.

Technical Skills

• Material Characterization Experience:
X-ray photoelectron spectroscopy (XPS), X-ray diffraction, Scanning electron microscopy, Nuclear magnetic resonance (NMR), Atomic Force Microscopy (AFM), Raman Spectroscopy, UV-visible spectroscopy, Electrochemical impedance spectroscopy, FT-IR spectroscopy, TG-DSC, Vibrating Sample Magnetometry (VSM).

• Material Synthesis & Deposition Experience:
Vacuum Deposition: E-beam evaporation, thermal evaporation, DC sputtering; ***Wet chemical synthesis***: , Solgel synthesis (with Schlenk line), solution combustion, Co-precipitation; ***Electrochemical methods:*** Electro-polymerization, Electrodeposition;
Solid state reactions: Metathesis (both liquid & solid state), SPRT synthesis

• Relevant Courses:
Advanced CMOS technology, Advances Memory technology, Compound semiconductors and devices, Fundamentals of Semiconductor and physics, Introduction to plastic electronics, Nanomaterials and nanoscience, Introduction to nanoscience, Science and technology of solid state, Topics in nanomaterials, Smart materials, Non-metallic materials, Composite materials, Advanced materials and nanotechnology lab, Materials characterization, Materials characterization lab, Material processing lab, Environmental degradation of materials, Physics of materials, Deformation and failure of materials, Principles of physical metallurgy.

Positions of Responsibility

• Strategist, Saarang Nova, IIT Madras *June 2022- May 2023*
• Co-ordinator, Saarang Publicity and Hospitality, IIT Madras *June 2022- May 2023*
• Co-ordinator, Media Club, IIT Madras *December 2021- May 2022*
• Mentor, Saathi Mentorship Cell, IIT Madras *December 2021- May 2022*

Extra-Curricular Activities

Martial Arts: Bronze Medallist at an International Karate Kumite Championship and holds the prestigious rank of Nidan (Black Belt II) in Budokan Karate-Do India. Officially certified as an Instructor & Examiner, demonstrating leadership in martial arts
Fine Arts: Secured first place twice in the Primary Level under Category E of the Camel Art Contest
Choreo: Member of the NCA Chorea Team, showcasing dedication and teamwork in dance performances.