Center for Flexible Electronics

Department of Electronics & Communication Engineering

Key Faculty Members

Dr. P. S. Srinivasa Babu, Professor
Research Area: Flexible Printed Electronics & Supercapacitors

Dr. S. Arunmetha, Associate Professor
Research Area: Solar Energy Harvesting, Photocatalysis, Hydrogen Evolution

Dr. C. Santhosh, Associate Professor
Research Area: Nanomaterials, Supercapacitors and Electrochemistry

Dr. V. Vivekananthan, Associate Professor
Research Area: Nanomaterials, Flexible TENGs & PENGs, Wearable Energy Harvesters & Self-Powered Sensors

Dr. S. R. Srither, Associate Professor
Research Area: Energy Harvesting using TENGs, Batteries & Supercapacitors

Funded Projects

7.5 Crores Worth of Projects are on-going

- DST PURSE (on-going)
- SERB-TARE (on-going)
- Royal Society of Chemistry, UK (on-going)
- UGC-DAE (on-going)
- KLEF Internal Funding (on-going)

Research Areas

- Flexible Printed Electronic Sensors
- Flexible Supercapacitors
- Wearable Body Conformal Antennas
- Flexible TENG & PENG based Energy Harvesters
- Flexible Batteries
- Flexible Solar Cells
- Wearable Self-powered Sensors

Instrumentation Facilities

- Electrochemical Impedance Spectroscopy
- Electrometer 6514
- Electrospinning Unit
- UV Visible Spectrometer
- Tubular Furnace & Box furnace
- Hot Air Oven & Vacuum Oven
- Linear Motor Setup
- Hydraulic Press & Digital Weighing Balance

Key Publications in 2023

- **Vivekananthan V et. al.,** "Revolutionizing self-powered robotic systems with triboelectric nanogenerators". ***Nano Energy. 2023 Oct 1;115:108729***. **[Impact Factor- 17.5]**
- **Vivekananthan V et. al.,** "Crystalline Porous Material-Based Nanogenerators: Recent Progress, Applications, Challenges, and Opportunities". ***Small. 2023:2306209.*** **[Impact Factor- 13.3]**
- **Vivekananthan V et. al.,** "Hybrid Nanogenerators for Ocean Energy Harvesting: Mechanisms, Designs, and Applications", ***Small, 2023, 19, 2300847***. **[Impact Factor- 13.3]**
- **P S Srinivasa Babu et. al** "Designed Construction of Hierarchical Cobalt Sulfide Nanonetwork as a High-Capacity and Binder-Free Cathode for Hybrid Supercapacitors", ***Energy & Fuels 37 (22), 17535-17544*** **[Impact Factor- 5.3]**
- **P S Srinivasa Babu et. al "**Rational design of Cu-doped Co3O4@ carbon nanocomposite and agriculture crop-waste derived activated carbon for high-performance hybrid supercapacitors", **Journal of Industrial and Engineering Chemistry, 116, pp.428-437 [Impact Factor- 6.1]**
- **P S Srinivasa Babu et. al. "**Metal organic framework-derived MnO@ carbon composites for highly durable Li-ion batteries and hybrid electrochemical cells", **Journal of Power Sources, 549, p.232113. [Impact Factor- 9.2]**
- **Arunmetha, S, et. al, "**Bayberry-like Cu3BiS3 with 2D layered nanosheets of rGO and g-C3N4 for effective electrochemical HER activity***", International Journal of Hydrogen Energy, 49, pp.295-308.*** **[Impact Factor- 7.2]**
- **Arunmetha, S, et. al, Bismuth ferrite (BiFeO3) 2D-nanoflakes for the photocatalytic degradation of chromogenic dyes under solar irradiation,** ***Surfaces and Interfaces, 41, 103240*** **[Impact Factor- 6.2]**
- **Arunmetha, S, et. al,** "A survey paper on design and implementation of multipliers for digital system applications"**.** ***Artificial Intelligence Review, 55(6), pp.4575-4603.*** **[Impact Factor- 9.2]**

List of Publications

S.No	Authors	Title	Year	Source title
1	Jo J.; Panda S.; Kim N.; Hajra S.; Hwang S.; Song H.; Shukla J.; Panigrahi B.K.; Vivekananthan V.; Kim J.; Achary P.G.R.; Keum H.; Kim H.J.	Hybrid nanogenerator for self-powered object recognition	2024	Journal of Science: Advanced Materials and Devices
2	Chandrasekhar A.; Basith S.A.; Vivekananthan V.; Khandelwal G.; Joseph Raj N.P.M.; Purusothaman Y.; Kim S.J.	Smart maracas: An innovative triboelectric nanogenerator for earthquake detection and energy harvesting	2024	Nano Energy
3	Hajra S.; Ali A.; Panda S.; Song H.; Rajaitha P.M.; Dubal D.; Borras A.; In-Na P.; Vittayakorn N.; Vivekananthan V.; Kim H.J.; Divya S.; Oh T.H.	Synergistic Integration of Nanogenerators and Solar Cells: Advanced Hybrid Structures and Applications	2024	Advanced Energy Materials
4	Sukumaran C.; Abdul Basith S.; Vivekananthan V.; Kim S.-J.; Chandrasekhar A.	Touch-Enabled Self-Powered Elastomeric Keypad for Mapping Human Input and an Emergency Alert via Triboelectric Effect	2024	Energy Technology
5	Vivekananthan V.; Chandrasekhar A.; Dudem B.; Khandelwal G.; P Silva S.R.; Kim S.-J.	Contact-electrification enabled water-resistant triboelectric nanogenerators as demonstrator educational appliances	2024	JPhys Energy

6	Rajaboina R.K.; Khanapuram U.K.; Vivekananthan V.; Khandelwal G.; Potu S.; Babu A.; Madathil N.; Velpula M.; Kodali P.	Crystalline Porous Material-Based Nanogenerators: Recent Progress, Applications, Challenges, and Opportunities	2024	Small
7	Swain J.; Hajra S.; Das N.; Parhi P.; Panda S.; Priyadarshini A.; Panda J.; Sahu A.K.; Alagarsamy P.; Vivekananthan V.; Kim H.J.; Sahu R.	Spent Catalyst-Derived Mo-MOF: Triboelectric Nanogenerators and Energy Harvesting	2023	Energy Technology
8	Divya S.; Hajra S.; Panda S.; Vivekananthan V.; Mistewicz K.; Joon Kim H.; Hwan Oh T.	A review on the next generation of healing: Exploring the use of triboelectric nanogenerators in wound care	2023	Chemical Physics Letters
9	Panda S.; Hajra S.; Kim H.G.; Jeong H.; Achary P.G.R.; Hong S.; Dudem B.; Silva S.R.P.; Vivekananthan V.; Kim H.J.	Carbohydrate-protein interaction-based detection of pathogenic bacteria using a biodegradable self-powered biosensor	2023	Journal of Materials Chemistry B
10	Munirathinam P.; Anna Mathew A.; Shanmugasundaram V.; Vivekananthan V.; Purusothaman Y.; Kim S.-J.; Chandrasekhar A.	A comprehensive review on triboelectric nanogenerators based on Real-Time applications in energy harvesting and Self-Powered sensing	2023	Materials Science and Engineering: B

11	Munusamy S.; Venkatesan R.; Divya S.; Gnanamoorthy G.; Narayanan V.; Vivekananthan V.; Ansar S.; Oh T.-H.; Kim S.-C.	Electrochemical and photochemical characteristics of organic dyes and biological molecules at conducting polymer-modified electrodes of indium oxide-polypyrrole nanohybrids	2023	Materials Science and Engineering: B
12	Hajra S.; Panda S.; Khanberh H.; Vivekananthan V.; Chamanehpour E.; Mishra Y.K.; Kim H.J.	Revolutionizing self-powered robotic systems with triboelectric nanogenerators	2023	Nano Energy
13	Panda S.; Hajra S.; Oh Y.; Oh W.; Lee J.; Shin H.; Vivekananthan V.; Yang Y.; Mishra Y.K.; Kim H.J.	Hybrid Nanogenerators for Ocean Energy Harvesting: Mechanisms, Designs, and Applications	2023	Small
14	Sahadevan J.; Sanjay R.; Esakki Muthu S.; Kim I.; Vivekananthan V.; Ansar S.; Sivaprakash P.	Investigation on structural, morphological and magnetic properties of Barium Cobaltite (BaCoO3) nanoparticle	2023	Materials Science and Engineering: B
15	Vivekananthan V.; Arunmetha S.; Srither S.R.; Babu P.S.S.; Hajra S.; Dudem B.	A Highly Wearable Single-electrode Mode Triboelectric Nanogenerator Made of Flexible Polyvinylidene Fluoride Transparent Film for Muscular Motion Monitoring	2023	Journal of Physics: Conference Series

16	Pecunia V.; Silva S.R.P.; Phillips J.D.; Artegiani E.; Romeo A.; Shim H.; Park J.; Kim J.H.; Yun J.S.; Welch G.C.; Larson B.W.; Creran M.; Laventure A.; Sasitharan K.; Flores-Diaz N.; Freitag M.; Xu J.; Brown T.M.; Li B.; Wang Y.; Li Z.; Hou B.; Hamadani B.H.; Defay E.; Kovacova V.; Glinsek S.; Kar-Narayan S.; Bai Y.; Kim D.B.; Cho Y.S.; Å½ukauskaitÄ— A.; Barth S.; Fan F.R.; Wu W.; Costa P.; del Campo J.; Lanceros-Mendez S.; Khanbareh H.; Wang Z.L.; Pu X.; Pan C.; Zhang R.; Xu J.; Zhao X.; Zhou Y.; Chen G.; Tat T.; Ock I.W.; Chen J.; Graham S.A.; Yu J.S.; Huang L.-Z.; Li D.-D.; Ma M.-G.; Luo J.; Jiang F.; Lee P.S.; Dudem B.; Vivekananthan V.; Kanatzidis M.G.; Xie H.; Shi X.-L.; Chen Z.-G.; Riss A.; Parzer M.; Garmroudi F.; Bauer E.; Zavanelli D.; Brod M.K.; Malki M.A.; Snyder G.J.; Kovnir K.; Kauzlarich S.M.; Uher C.; Lan J.; Lin Y.-H.; Fonseca L.; Morata A.; Martin-Gonzalez M.; Pennelli G.;	Roadmap on energy harvesting materials	2023	JPhys Materials

	Berthebaud D.; Mori T.; Quinn R.J.; Bos J.G.; Candolfi C.; Gougeon P.; Gall P.; Lenoir B.; Venkateshvaran D.; Kaestner B.; Zhao Y.; Zhang G.; Nonoguchi Y.; Schroeder B.C.; Bilotti E.; Menon A.K.; Urban J.J.; Fenwick O.; Asker C.; Talin A.A.; Anthopoulos T.D.; Losi T.; Viola F.; Caironi M.; Georgiadou D.G.; Ding L.; Peng L.-M.; Wang Z.; Wei M.-D.; Negra R.; Lemme M.C.; Wagih M.; Beeby S.; Ibn-Mohammed T.; Mustapha K.B.; Joshi A.P.			
17	Dudem B.; Dharmasena R.D.I.G.; Riaz R.; Vivekananthan V.; Wijayantha K.G.U.; Lugli P.; Petti L.; Silva S.R.P.	Wearable Triboelectric Nanogenerator from Waste Materials for Autonomous Information Transmission via Morse Code	2022	ACS Applied Materials and Interfaces
18	Sahu M.; Vivekananthan V.; Hajra S.; Khatua D.K.; Kim S.-J.	Porosity modulated piezo-triboelectric hybridized nanogenerator for sensing small energy impacts	2021	Applied Materials Today

19	Khandelwal G.; Maria Joseph Raj N.P.; Vivekananthan V.; Kim S.-J.	Biodegradable metal-organic framework MIL-88A for triboelectric nanogenerator	2021	iScience
20	Hajra S.; Vivekananthan V.; Sahu M.; Khandelwal G.; Joseph Raj N.P.M.; Kim S.-J.	Triboelectric nanogenerator using multiferroic materials: An approach for energy harvesting and self-powered magnetic field detection	2021	Nano Energy
21	Sathya Prasanna A.P.; Vivekananthan V.; Khandelwal G.; Alluri N.R.; Maria Joseph Raj N.P.; Anithkumar M.; Kim S.-J.	Green Energy from Edible Materials: Triboelectrification-Enabled Sustainable Self-Powered Human Joint Movement Monitoring	2021	ACS Sustainable Chemistry and Engineering
22	Vivekananthan V.; Kim W.J.; Alluri N.R.; Purusothaman Y.; Khandelwal G.; Kim S.-J.	A highly reliable contact-separation based triboelectric nanogenerator for scavenging bio-mechanical energy and self-powered electronics	2021	Journal of Mechanical Science and Technology
23	Chandrasekhar A.; Vivekananthan V.; Khandelwal G.; Kim S.-J.	A Sustainable Blue Energy Scavenging Smart Buoy toward Self-Powered Smart Fishing Net Tracker	2020	ACS Sustainable Chemistry and Engineering
24	Chandrasekhar A.; Vivekananthan V.; Khandelwal G.; Kim W.J.; Kim S.-J.	Green energy from working surfaces: a contact electrificationâ€“enabled data theft protection and monitoring smart table	2020	Materials Today Energy

25	Sukumaran C.; Vivekananthan V.; Mohan V.; Alex Z.C.; Chandrasekhar A.; Kim S.-J.	Triboelectric nanogenerators from reused plastic: An approach for vehicle security alarming and tire motion monitoring in rover	2020	Applied Materials Today
26	Kim S.-J.; Kim W.J.; Vivekananthan V.; Khandelwal G.; Chandrasekhar A.	Encapsulated triboelectricâˆ’electromagnetic hybrid generator for a sustainable blue energy harvesting and self-powered oil spill detection	2020	ACS Applied Electronic Materials
27	Vivekananthan V.; Chandrasekhar A.; Alluri N.R.; Purusothaman Y.; Kim S.-J.	A highly reliable, impervious and sustainable triboelectric nanogenerator as a zero-power consuming active pressure sensor	2020	Nanoscale Advances
28	Vivekananthan V.; Kim W.J.; Alluri N.R.; Purusothaman Y.; Abisegapriyan K.S.; Kim S.-J.	Correction to: A sliding mode contact electrification based triboelectricâ€‘electromagnetic hybrid generator for smallâ€‘scale biomechanical energy harvesting (Micro and Nano Systems Letters, (2019), 7, 1, (14), 10.1186/s40486-019-0093-6)	2020	Micro and Nano Systems Letters
29	Chandrasekhar A.; Vivekananthan V.; Kim S.-J.	A fully packed spheroidal hybrid generator for water wave energy harvesting and self-powered position tracking	2020	Nano Energy

30	Sahu M.; Vivekananthan V.; Hajra S.; Abisegapriyan K.S.; Maria Joseph Raj N.P.; Kim S.-J.	Synergetic enhancement of energy harvesting performance in triboelectric nanogenerator using ferroelectric polarization for self-powered IR signaling and body activity monitoring	2020	Journal of Materials Chemistry A
31	Vivekananthan V.; Maria Joseph Raj N.P.; Alluri N.R.; Purusothaman Y.; Chandrasekhar A.; Kim S.-J.	Substantial improvement on electrical energy harvesting by chemically modified/sandpaper-based surface modification in micro-scale for hybrid nanogenerators	2020	Applied Surface Science
32	Alluri N.R.; Maria Joseph Raj N.P.; Khandelwal G.; Vivekananthan V.; Kim S.-J.	Aloe vera: A tropical desert plant to harness the mechanical energy by triboelectric and piezoelectric approaches	2020	Nano Energy
33	Chandrasekhar A.; Vivekananthan V.; Khandelwal G.; Kim S.J.	A fully packed water-proof, humidity resistant triboelectric nanogenerator for transmitting Morse code	2019	Nano Energy
34	Vivekananthan V.; Chandrasekhar A.; Alluri N.R.; Purusothaman Y.; Joong Kim W.; Kang C.-N.; Kim S.-J.	A flexible piezoelectric composite nanogenerator based on doping enhanced lead-free nanoparticles	2019	Materials Letters

35	Chandrasekhar A.; Vivekananthan V.; Khandelwal G.; Kim S.-J.	Sustainable Human-Machine Interactive Triboelectric Nanogenerator toward a Smart Computer Mouse	2019	ACS Sustainable Chemistry and Engineering
36	Purusothaman Y.; Alluri N.R.; Chandrasekhar A.; Venkateswaran V.; Kim S.-J.	Piezophototronic gated optofluidic logic computations empowering intrinsic reconfigurable switches	2019	Nature Communications
37	Vivekananthan V.; Kim W.J.; Alluri N.R.; Purusothaman Y.; Abisegapriyan K.S.; Kim S.-J.	A sliding mode contact electrification based triboelectric-electromagnetic hybrid generator for small-scale biomechanical energy harvesting	2019	Micro and Nano Systems Letters
38	Vivekananthan V.; Chandrasekhar A.; Alluri N.R.; Purusothaman Y.; Khandelwal G.; Pandey R.; Kim S.-J.	Fe2O3 magnetic particles derived triboelectric-electromagnetic hybrid generator for zero-power consuming seismic detection	2019	Nano Energy
39	Vivekananthan V.; Alluri N.R.; Chandrasekhar A.; Purusothaman Y.; Gupta A.; Kim S.-J.	Zero-power consuming intruder identification system by enhanced piezoelectricity of K0.5Na0.5NbO3 using substitutional doping of BTO NPs	2019	Journal of Materials Chemistry C
40	Maria Joseph Raj N.P.; Alluri N.R.; Vivekananthan V.; Chandrasekhar A.; Khandelwal G.; Kim S.-J.	Sustainable yarn type-piezoelectric energy harvester as an eco-friendly, cost-effective battery-free breath sensor	2018	Applied Energy

41	Purusothaman Y.; Alluri N.R.; Chandrasekhar A.; Vivekananthan V.; Kim S.-J.	Regulation of Charge Carrier Dynamics in ZnO Microarchitecture-Based UV/Visible Photodetector via Photonic-Strain Induced Effects	2018	Small
42	Alluri N.R.; Vivekananthan V.; Chandrasekhar A.; Kim S.-J.	Adaptable piezoelectric hemispherical composite strips using a scalable groove technique for a self-powered muscle monitoring system	2018	Nanoscale
43	Khandelwal G.; Chandrasekhar A.; Alluri N.R.; Vivekananthan V.; Maria Joseph Raj N.P.; Kim S.-J.	Trash to energy: A facile, robust and cheap approach for mitigating environment pollutant using household triboelectric nanogenerator	2018	Applied Energy
44	Chandrasekhar A.; Khandelwal G.; Alluri N.R.; Vivekananthan V.; Kim S.-J.	Battery-Free Electronic Smart Toys: A Step toward the Commercialization of Sustainable Triboelectric Nanogenerators	2018	ACS Sustainable Chemistry and Engineering
45	Purusothaman Y.; Alluri N.R.; Chandrasekhar A.; Vivekananthan V.; Kim S.-J.	Direct in Situ Hybridized Interfacial Quantification to Stimulate Highly Flexile Self-Powered Photodetector	2018	Journal of Physical Chemistry C

46	Vivekananthan V.; Alluri N.R.; Purusothaman Y.; Chandrasekhar A.; Selvarajan S.; Kim S.-J.	Biocompatible Collagen Nanofibrils: An Approach for Sustainable Energy Harvesting and Battery-Free Humidity Sensor Applications	2018	ACS Applied Materials and Interfaces
47	Chandrasekhar A.; Alluri N.R.; Vivekananthan V.; Park J.H.; Kim S.-J.	Sustainable Biomechanical Energy Scavenger toward Self-Reliant Kids' Interactive Battery-Free Smart Puzzle	2017	ACS Sustainable Chemistry and Engineering
48	Chandrasekhar A.; Alluri N.R.; Vivekananthan V.; Purusothaman Y.; Kim S.-J.	A sustainable freestanding biomechanical energy harvesting smart backpack as a portable-wearable power source	2017	Journal of Materials Chemistry C
49	Vivekananthan V.; Alluri N.R.; Purusothaman Y.; Chandrasekhar A.; Kim S.-J.	A flexible, planar energy harvesting device for scavenging road side waste mechanical energy: Via the synergistic piezoelectric response of K0.5Na0.5NbO3-BaTiO3/PVDF composite films	2017	Nanoscale
50	Alluri N.R.; Chandrasekhar A.; Vivekananthan V.; Purusothaman Y.; Selvarajan S.; Jeong J.H.; Kim S.-J.	Scavenging Biomechanical Energy Using High-Performance, Flexible BaTiO3 Nanocube/PDMS Composite Films	2017	ACS Sustainable Chemistry and Engineering

CFE lab equipment details

S.No	Equipment Name	Cost	Sponsored by
1	Electrochemical Impedance Spectroscopy	3,95,000	KLEF
2	Electrometer 6514	1,011,480	KLEF
3	Electrospinning Unit	10,00,000	KLEF
4	UV Visible Spectrometer	3,10,000	KLEF
5	Tubular Furnace & Box furnace	4,28,500	KLEF
6	Hot Air Oven & Vacuum Oven	65,000	KLEF
7	Linear Motor Setup	1,00,000	KLEF
8	Hydraulic Press & Digital Weighing Balance	55,000	KLEF