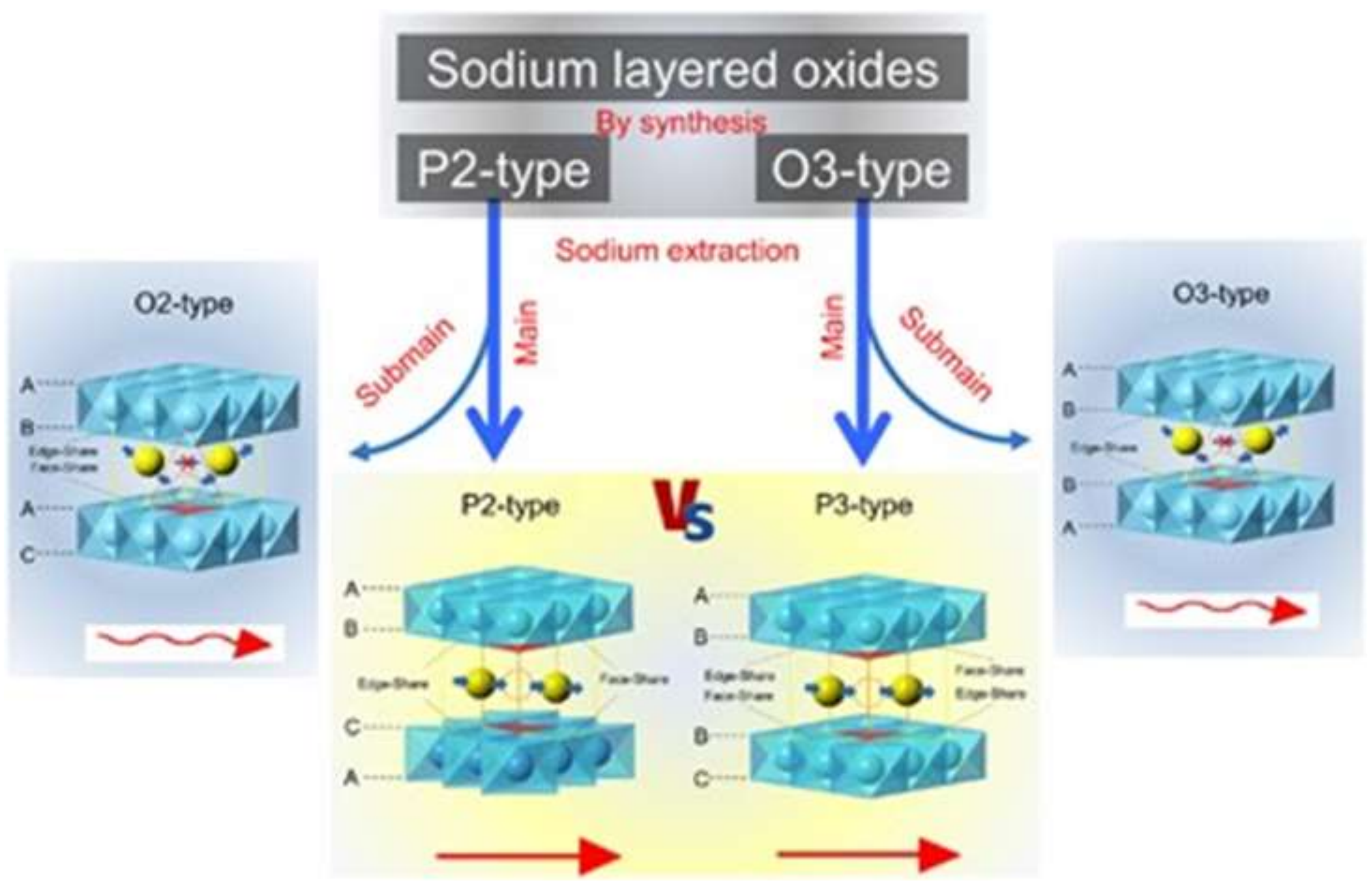
Energy Storage Laboratory

Lead PI: Prof. Yogesh Sharma

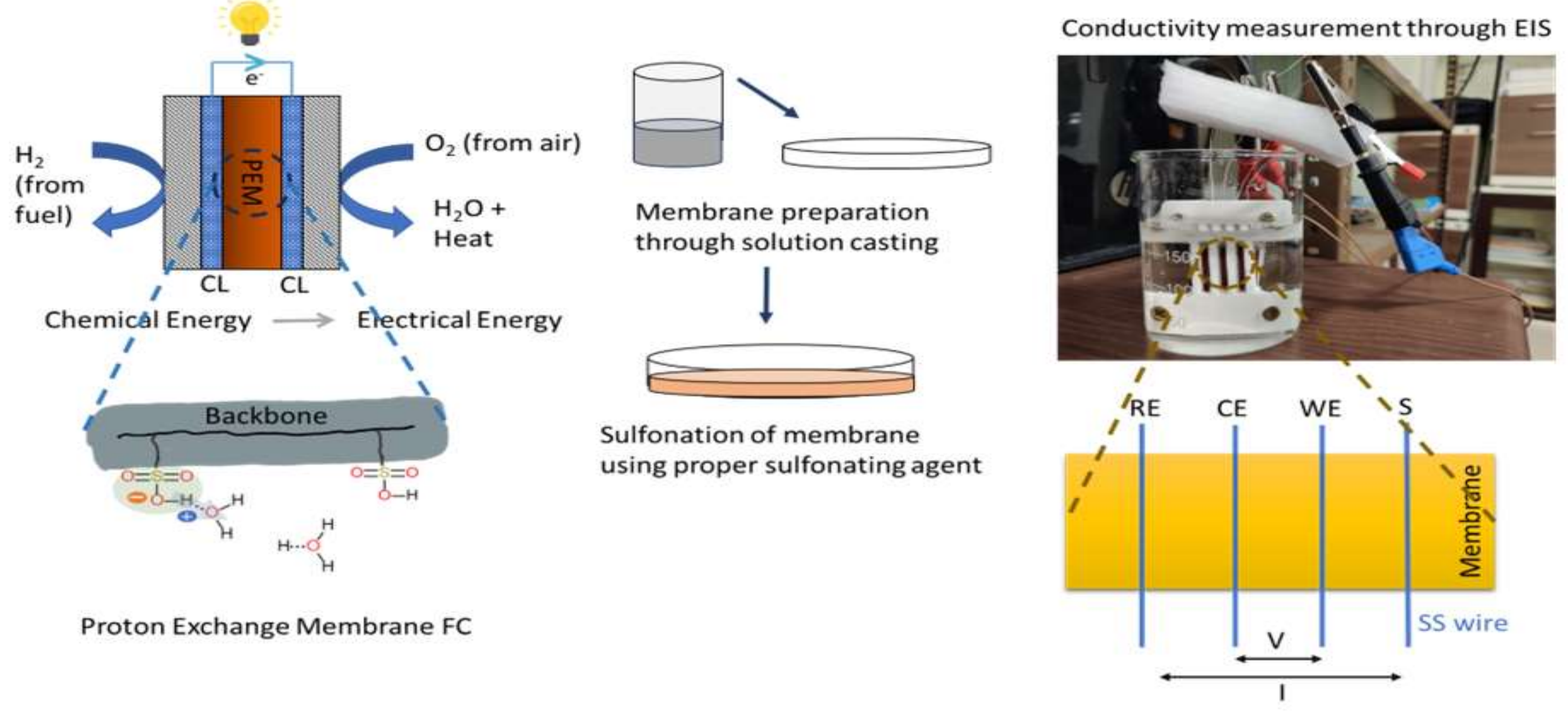


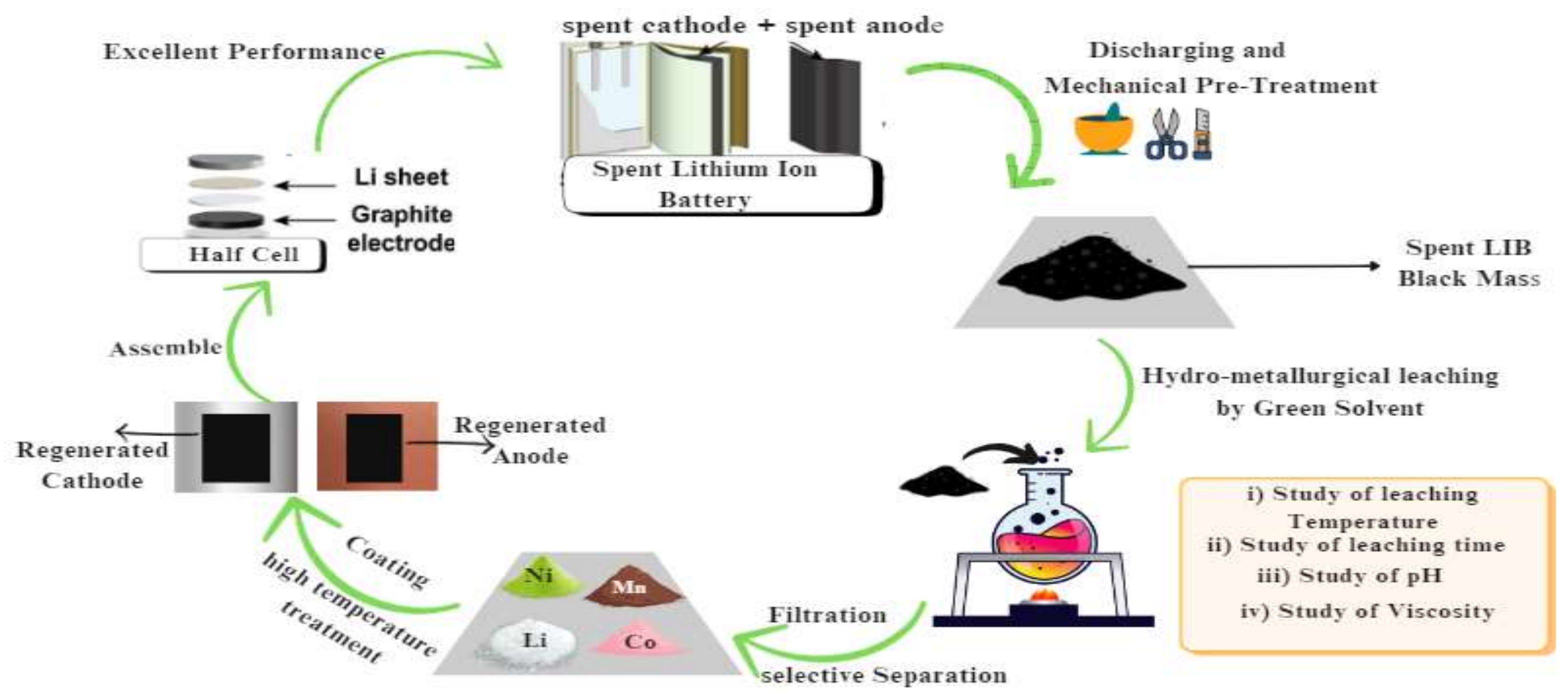
Layered Transition Metal Oxide (Na_xMO_2) Cathode for Sodium-Ion Battery

Layered transition metal oxides Na_xMO_2 (M = Fe, Co, Ni, and Mn) have been extensively researched as one kind of prospective cathode material for NIBs. Na_xMO_2 compounds are composed of sheets of MO_6 octahedra and they function similarly to Lithium-ion batteries. According to the environment of Na and the amount of oxygen stacking sequences, typical Na_xMO_2 may be separated into two categories. In essence, the latter identifies the location of Na-ions, while the number shows the number of times transition metal layers are repeated inside a unit cell. For the P_2 and O_3-phases, Na-ion is found in trigonal prismatic (edge-sharing or face-sharing) sites with an AB BA oxygen sequence, and at octahedral (edge-sharing) sites including an AB CA BC oxygen arrangement.

Development of polymer electrolyte membrane for Fuel Cell

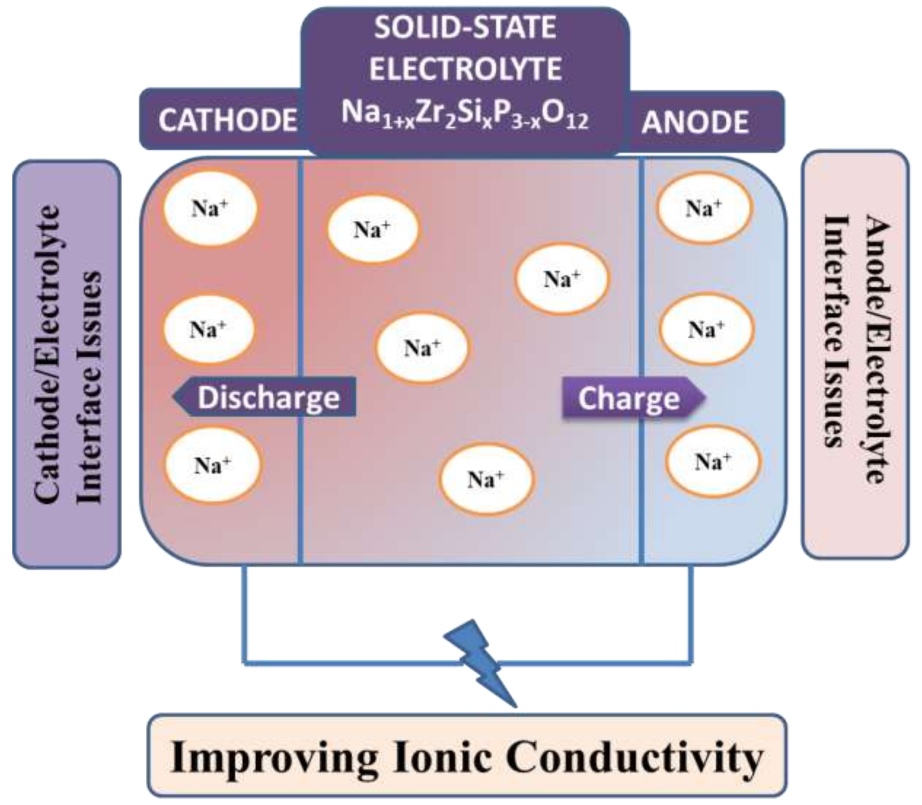
Commercially available perfluorinated have limitations such as high dependance on water content for conduction, limited chemical stability, reduced conductivity at elevated temperature and high cost. We are developing non-fluorinated poly-aromatic polymer electrolyte membrane with enhance conductivity and robust chemical and mechanical strength for fuel cell applications.





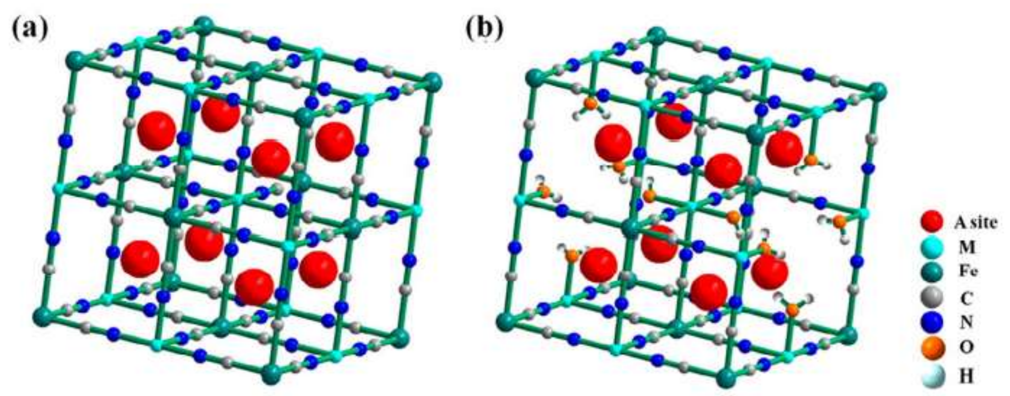
Closed loop recovery of Lithium and other critical metals from spent LIBs

Our laboratory is committed to advancing sustainable energy solutions through cutting-edge research in battery recycling and circular economy approaches. We focus on the recovery, regeneration, and reuse of valuable components from spent batteries to reduce dependence on virgin raw materials. Our work aims to develop environmentally responsible strategies that minimize waste and maximize resource efficiency. By integrating materials recovery with electrode re-fabrication, we strive to establish closed-loop systems for next-generation energy storage. Through these efforts, our lab contributes to building a greener and more resilient energy future.



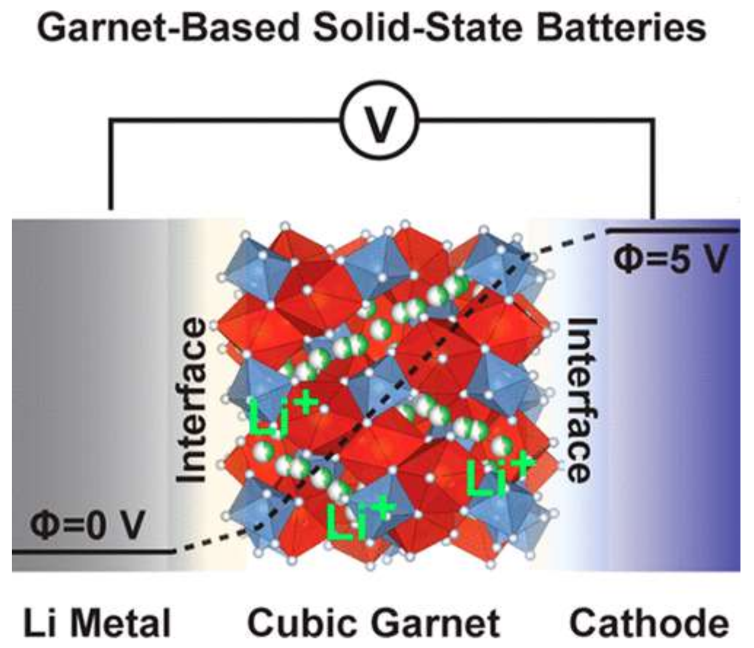
Development of Na-ion Conductors for Solid-State Sodium Batteries

The work aims to develop a sodium-ion conductor for all-solid-state Na-ion batteries. Among all the probable candidates suitable for sodium-ion conductors, NASICON-type electrolytes (NZSP) are the most promising in terms of their higher electrochemical stability, high ionic conductivity (~mS/cm), and wide electrochemical window. But there are still some interfacial and charge-kinetic issues to be resolved pertaining to ASSBs. Different elemental doping strategies are adopted to mitigate these issues related to SSEs and further improve their ion-transport properties.



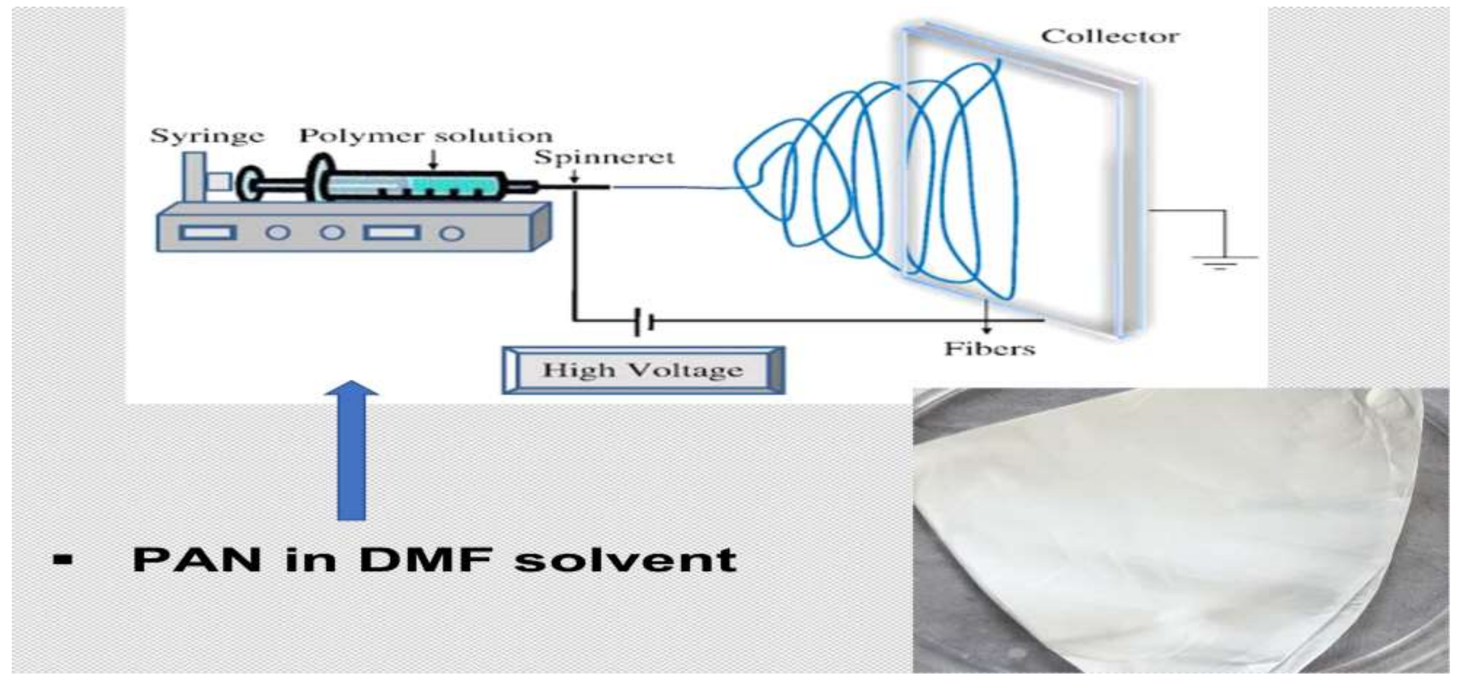
Prussian Blue: A Novel Cathode Material for Na-ion Batteries

The research progress of PB/PBAs-based cathode materials of metal-ion batteries in terms of their synthesis, structural/composition characteristics, electrochemical performance, functional mechanisms, applications, and recycling in electrical energy storage are being analyzed thoroughly.



Design and Development of Oxide-based Solid Electrolytes for All-Solid-State Batteries

The research progress is on oxide-based SEs for the ASSBs with respect to the use of Li metal. We especially focusing on research progress on garnet-type solid electrolytes ($Li_7La_3Zr_2O_{12}$) solid ionic conductor and their doped variant towards the development of all solid-state batteries because they have high ionic conductivity, good chemical stability with Li metal, and a wide electrochemical potential window.



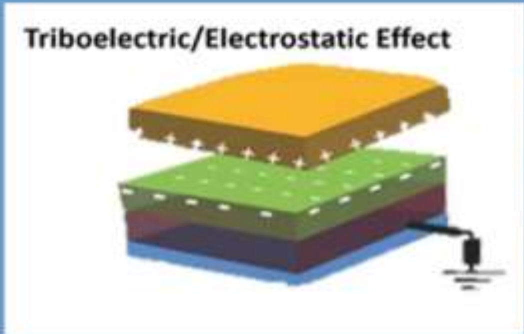
Mass Production of Carbon Nanofibers and Electrolyte/separator for Batteries

One-dimensional electrospun nanofibers have emerged as a class of promising building blocks for the key components of flexible EES devices, including those in supercapacitors, metal-ion batteries, and metal-air batteries. Here we are trying to overcome the existing challenges and prospects of these electrospun nanofiber-based flexible EES in developing the optimal high-performance and low cost flexible EES devices for long-awaited practical applications.

PI: Dr. Kaushik Parida

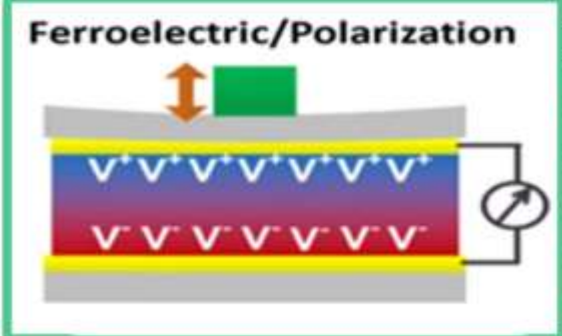
Key Contributions:

- ❑ Our group works on developing Next-generation Energy & Electronic Devices.
- ❑ Published 45+ publications across energy storage devices, self powered electronics, stretchable devices, self-charging supercapacitor, Piezo-electric nanogenerator, and Tribo-electric nanogenerator.



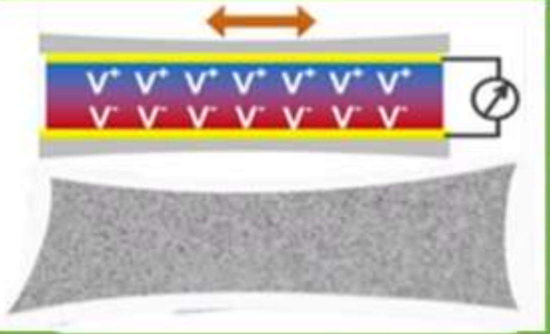
Triboelectric Nanogenerator

One of the major focus areas of our research in the development of Triboelectric Nanogenerators (TENGs). We delve into pioneering advancements that harness the intriguing phenomenon of triboelectricity to revolutionize energy harvesting technologies. Through innovative design and material engineering, our work aims to enhance the efficiency, scalability, and practicality of TENGs as sustainable power sources for practical industrial applications. With a focus on developing cutting-edge materials, polymers, and novel device concept we strive to contribute to the transformative landscape of renewable energy generation and pave the way for a more self-sufficient and sustainable future.



Piezoelectric Nanogenerator

In the realm of piezoelectric nanogenerators, our research is at the forefront of developing novel materials and developing novel strategies to improve the energy harvesting performance. Our investigations are centered around understand the ferroelectric and piezoelectric properties of intrinsic piezoelectric materials. We strive to push the boundaries of piezoelectric nanogenerators, in terms of enhancing their efficiency, reliability, and adaptability for diverse applications.



Stretchable & Self-healing Electronics

In the dynamic realm of stretchable and self-healing electronics, our research is dedicated to pioneering transformative advancements that fuse mechanical resilience with autonomous recovery in electronic systems. Our work focuses on the development of cutting-edge materials and innovative design strategies that empower electronics to not only endure substantial strains and deformations but also possess intrinsic self-healing capabilities for next-generation skin-inspired electronics.