CENTRE FOR ADVANCED ELECTRONICS & PHOTOVOLTAIC ENGINEERING (CAEPE)

Progress & Portfolio Annual Report 2023-2024

INTERNATIONAL ISLAMIC UNIVERSITY, ISLAMABAD

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Pro Chancellor, IIUI

Prof. Dr. Samina Malik
Rector, IIUI

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President, IIUI

Engr. Prof. Dr. Ahmed Shuja Syed
Founding Executive Director (CAEPE)

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FOREWORD

The Center for Advanced Electronics and Photovoltaic Engineering (CAEPE) at the International Islamic University Islamabad (IIUI) has consistently strived to achieve excellence in the fields of electronics and photovoltaic engineering. Our mission is to foster innovation, facilitate advanced research, and contribute significantly to the global scientific community. In this report, we present the latest advancements and achievements of CAEPE, highlighting the relentless efforts of our faculty, researchers, and students. We also reflect on the center's impact on both academic and industrial fronts, showcasing our commitment to pushing the boundaries of knowledge and technology.

ABOUT CAEPE

BACKGROUND

The Centre for Advanced Electronics duly approved in the 76th meeting of university's Board of Governors was re-named as Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) in the 80th meeting of the same esteemed board in 2017. Islamic Development Bank (IsDB), KSA's back-to-back international grants paved the way to establish a fully functional state-of-the-art Centre in Pakistan.

VISION

To create knowledge, develop and invent in the emerging areas of electronics and energy technologies.

MISSION

To conduct advanced electronics & photovoltaic engineering research that produces:

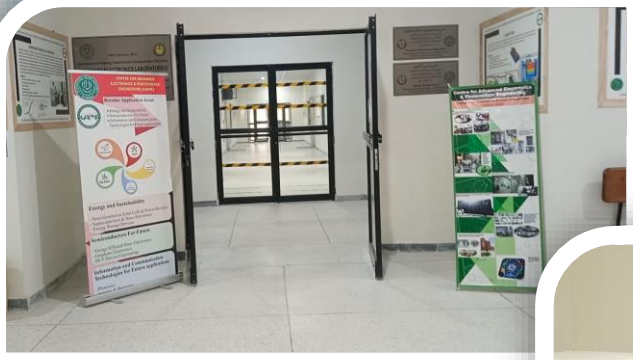
- New Technologies
- Processes
- Systems that may provide new or significantly enhanced knowledge for direct benefit to economic opportunity in Pakistan

RESEARCH PORTFOLIO

- Technology behind the Chip (Physical Layer Design)
- Semiconductor Fabrication
- Process Reliability
- Materials & Device Characterization
- Internet of Nano Things
- Power & Energy Electronics
- Photonics
- Novel Materials Devices, Circuits & Systems for Sensing, Detection, Communication & Computing


The New Space and Expansion
Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE)
H.E. Prof. Ahmed Salem Alomari
Pro-Chancellor (KU)
H.E. Dr. Hathal Hamoud Alotaibi
President, (KU)
On 7th November, 2023


CAEPE

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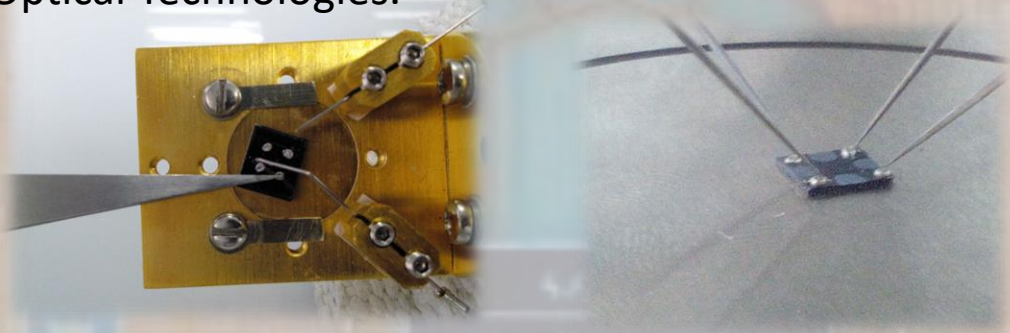
DIVE INTO THE WORLD OF ATOMIC SCALE TECHNOLOGY

Illuminating solutions and empowering progress with Optical Technologies.

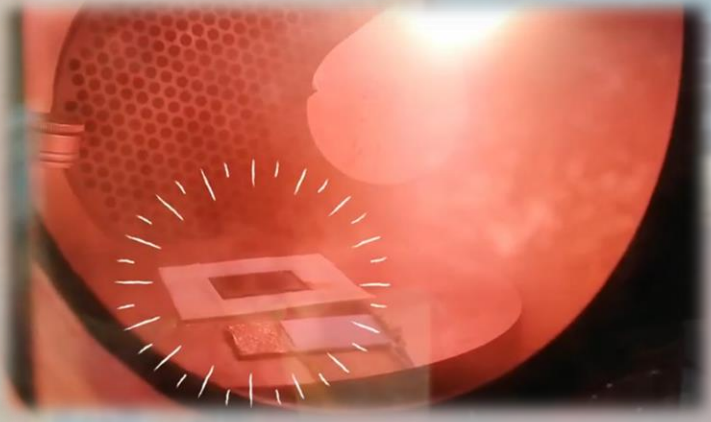


Device Innovation Hub: Where state-of-the-art semiconductor technology drives progress in electronics.

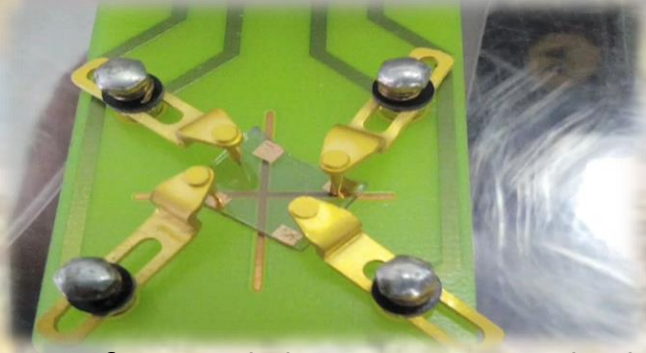
Harvesting the Future: Developing energy solutions with advanced harvesting devices and sustainable technologies.

Leading advancements in Nanoscale devices within contamination free environments.

Creating advanced sensor technology to revolutionize data collection.



Contributing towards the landscape of power electronics with innovative and sustainable solutions.

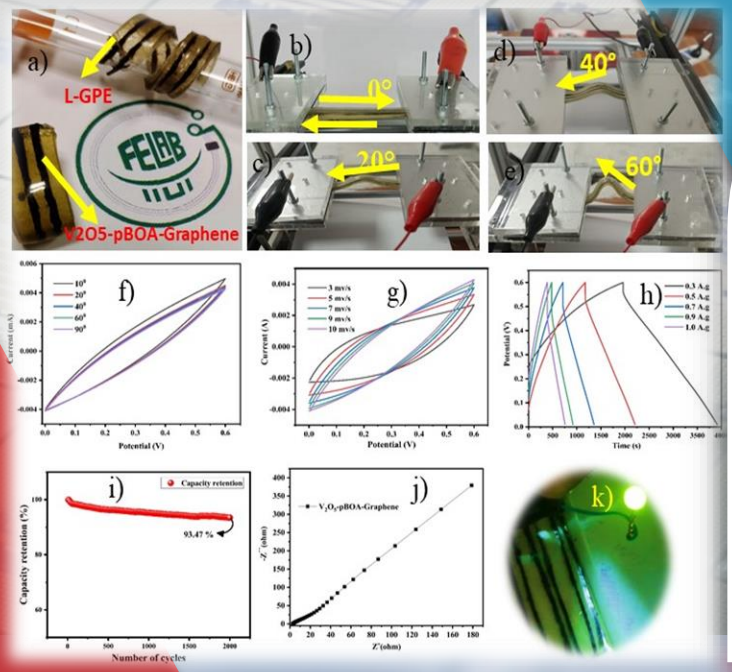


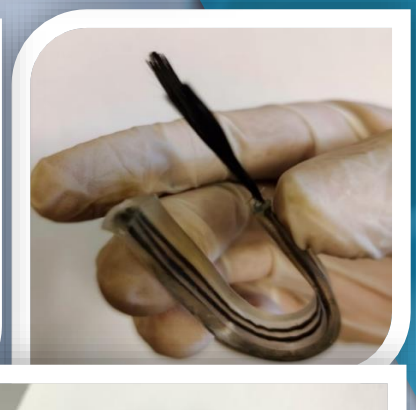
Looking into the ways of optical detection to unlock new levels of performance and quantum efficiency.

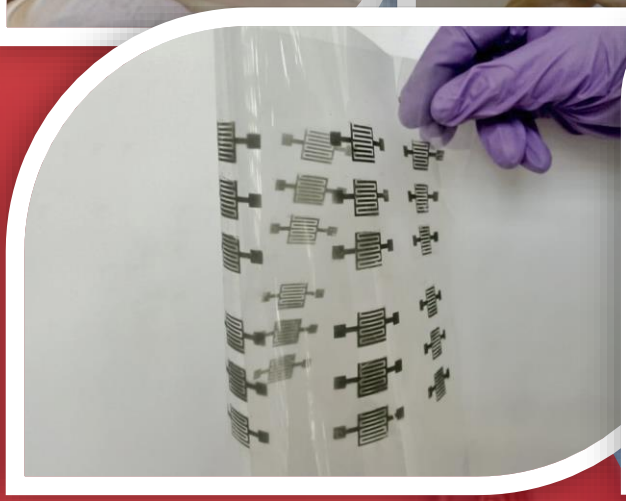
RESEARCH & INNOVATION

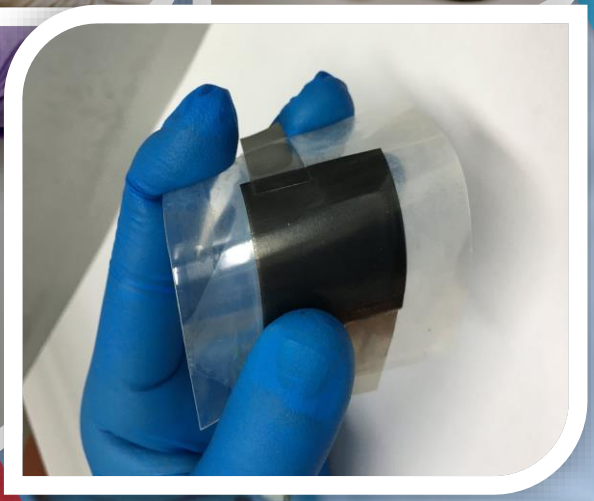
At the Center for Advanced Electronics and Photovoltaic Engineering (CAEPE) of the International Islamic University Islamabad (IIUI), research and innovation are the cornerstones of our mission. Our dedicated team of students and researchers is committed to exploring the frontiers of nanoelectronics, Optoelectronics, photonics, as well as the diverse fields of power electronics, semiconductor devices, energy harvesting devices, and sensors. Through rigorous experimentation and scholarly inquiry, we aim to generate new knowledge and develop advanced technologies that significantly contribute to the global scientific community. At CAEPE, we foster an environment that encourages inventive thinking and the practical application of research findings, ensuring continual technological progress.

INNOVATIONS



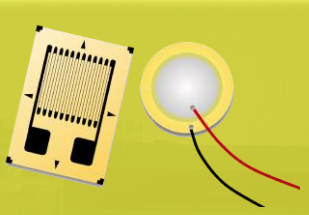




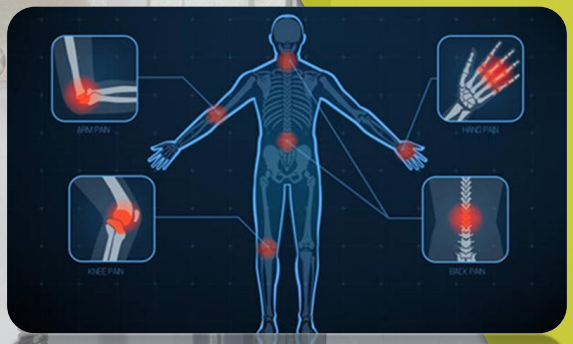


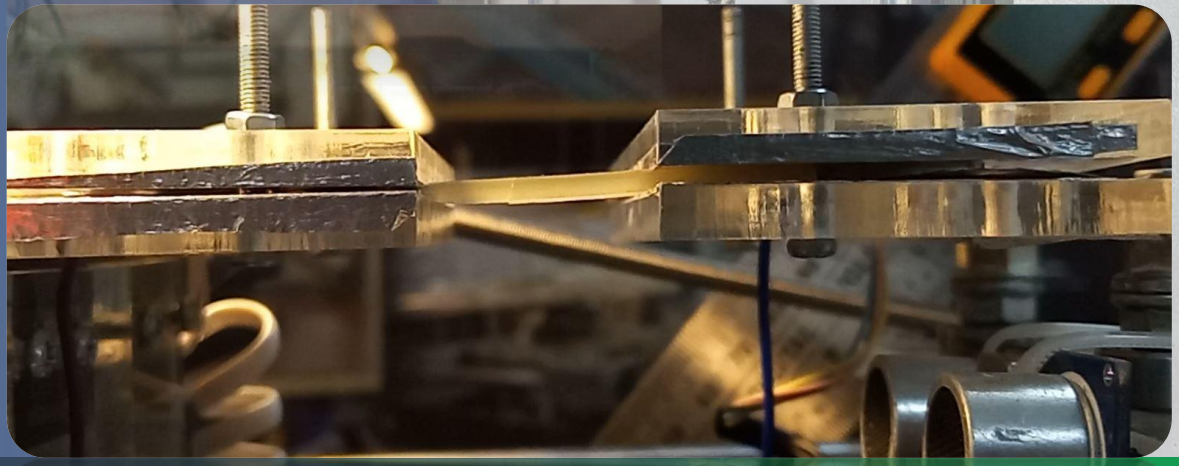
Supporting energy storage with our state-of-the-art flexible supercapacitor devices

INNOVATIONS



Real time data collection at very precise scale with the composition of highly innovative materials and enhancing the capabilities of final device.

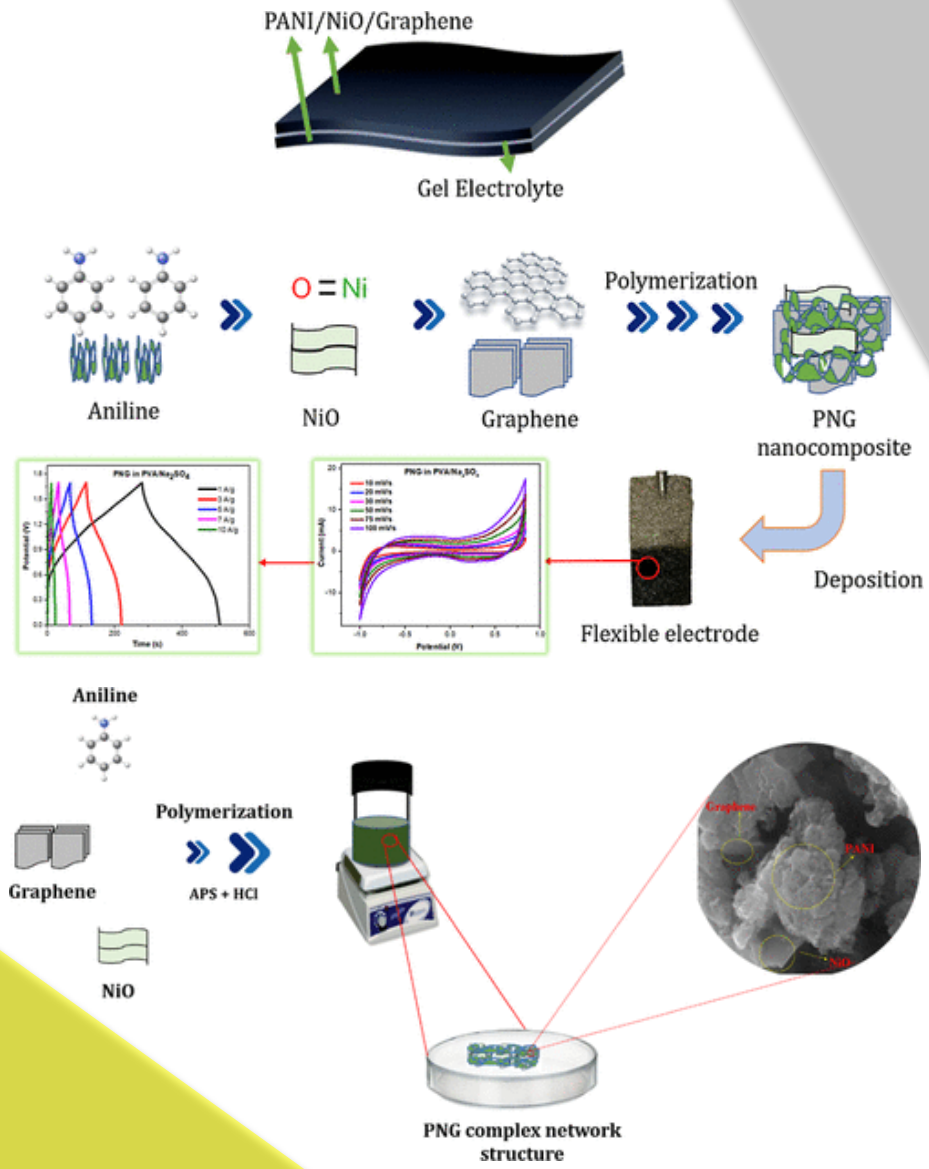




Driving excellence in sensor technology

INNOVATIONS

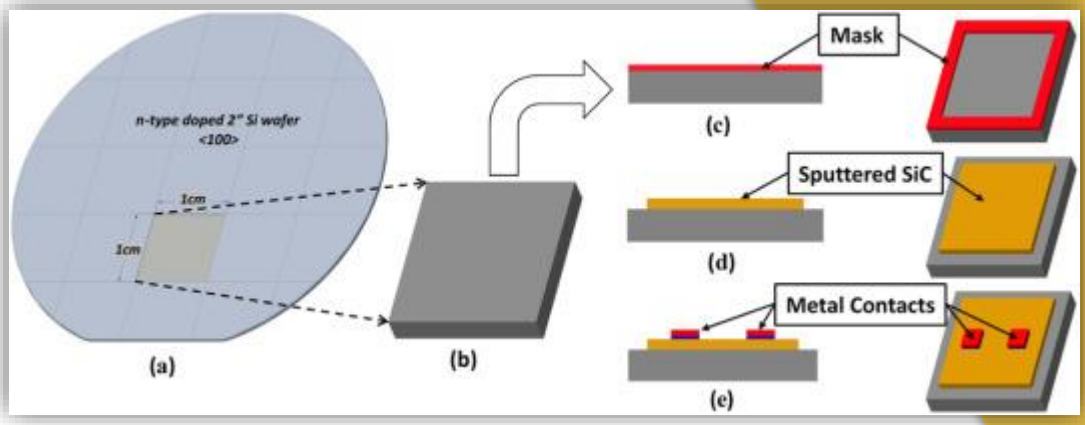
Our latest advancement features a symmetric supercapacitor device harnessing the power of a PANI/NiO/Graphene nanocomposite. Coupled with a cutting-edge hybrid PVA/Na_2SO_4 electrolyte, this innovation unleashes unprecedented energy density and efficiency. Discover the future of high-performance energy solutions with this phenomenal technology.

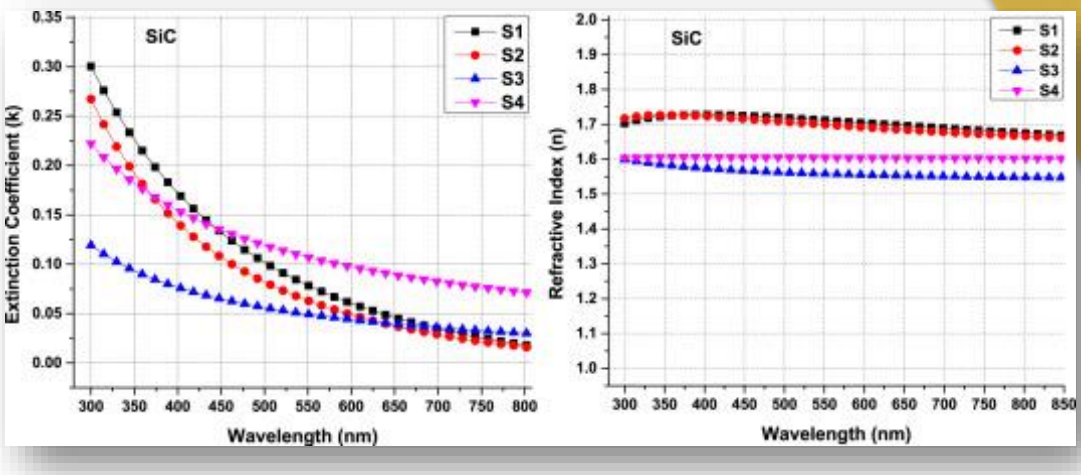


Triggering the Energy Efficiency with Enhanced Supercapacitor Technology

INNOVATIONS

Elevate photovoltaic performance with our work on SiC-based transparent passivating contacts. Our fabrication and characterization efforts are focused on optimizing these advanced contacts to enhance solar cell efficiency.

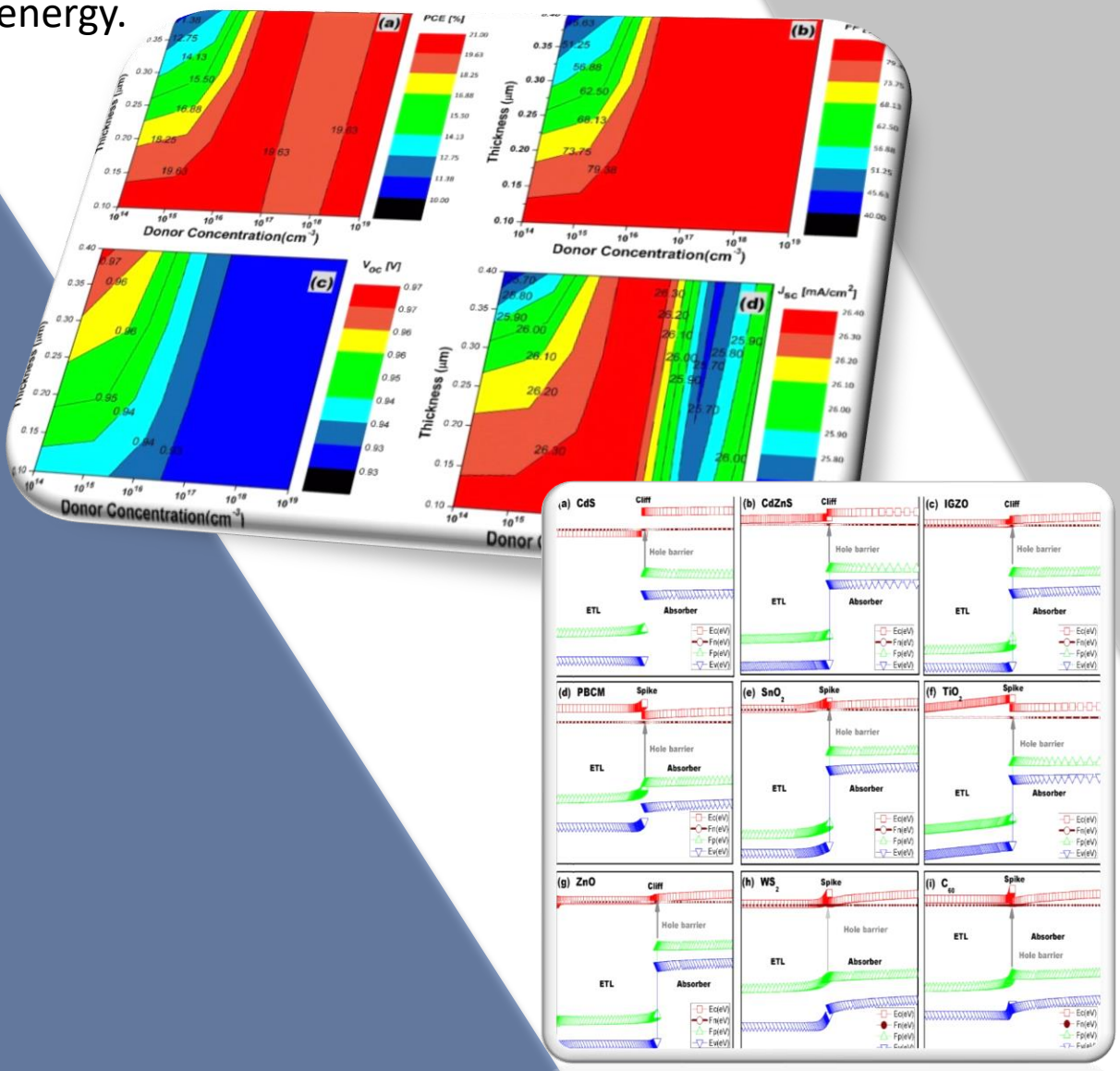




SiC-Based Transparent Passivating Contacts for better Photovoltaic Performance

INNOVATIONS

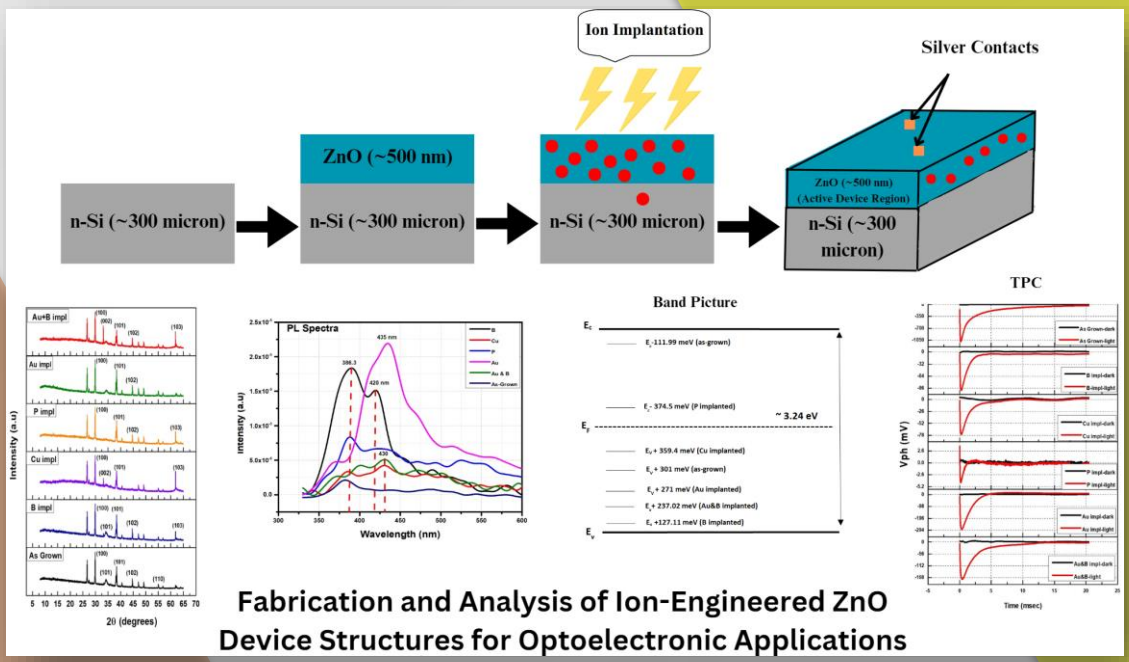
Unlock the potential of perovskite solar cells with our comprehensive numerical analysis guidelines for designing efficient novel NIP structures. These guidelines pave the way for optimizing performance by addressing critical parameters and innovative configurations. Elevate your solar technology with insights that drive efficiency, enhance stability, and push the boundaries of renewable energy.

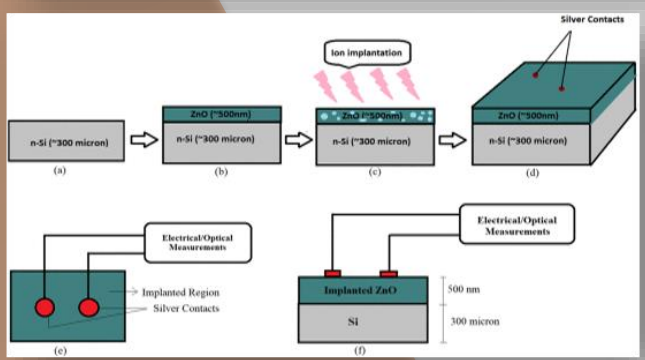


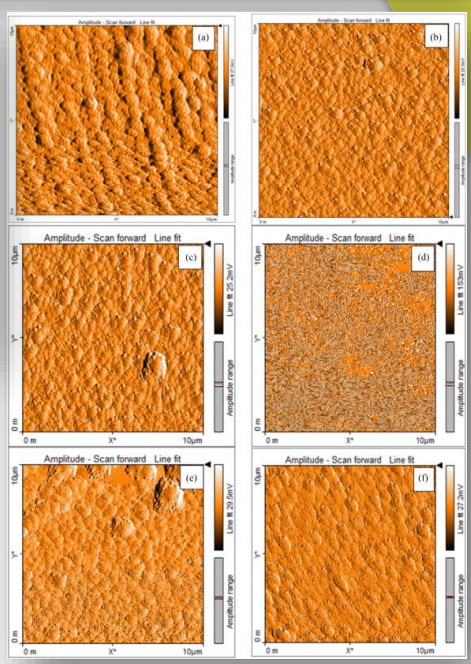
Leading towards the precision Engineering for Perovskite Solar Cells Innovation

INNOVATIONS

Exploiting the optoelectronic applications with our pioneering work on ion-engineered ZnO device structures. This cutting-edge approach promises significant improvements in optoelectronic devices.



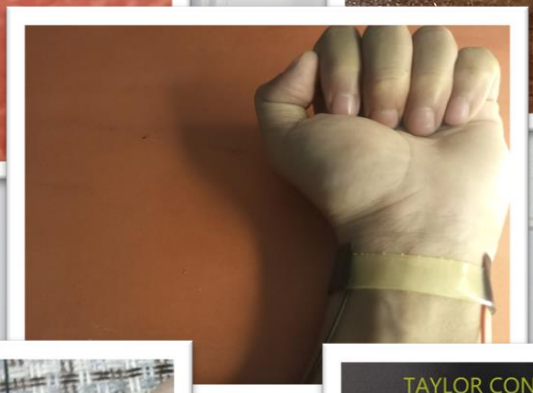


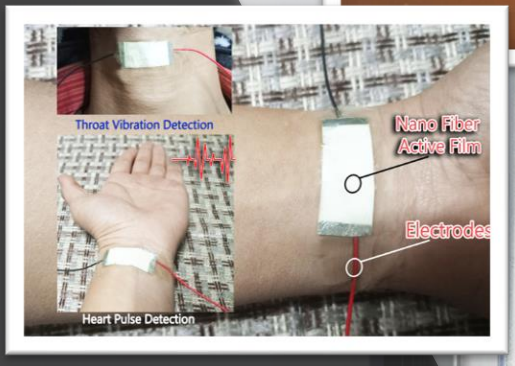


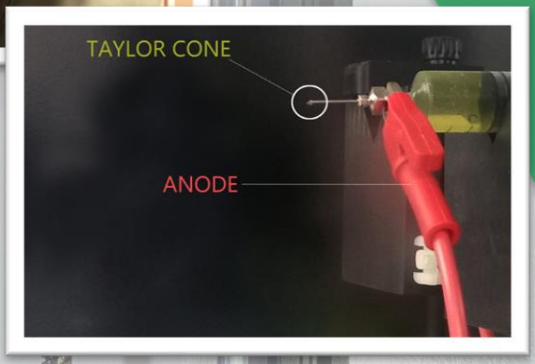
A paramount set of regimes, to play with optoelectronics

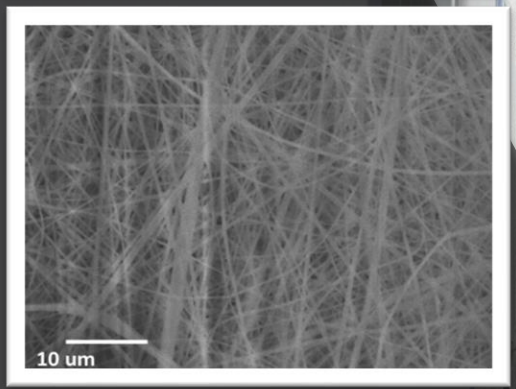
INNOVATIONS

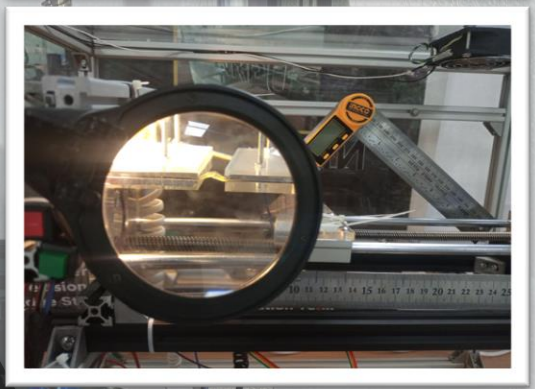
Our advanced capabilities and materials expertise drive the development of next-generation solutions. Experience the future of Flexible technology with our precision-engineered hydrogels and nanofibers.







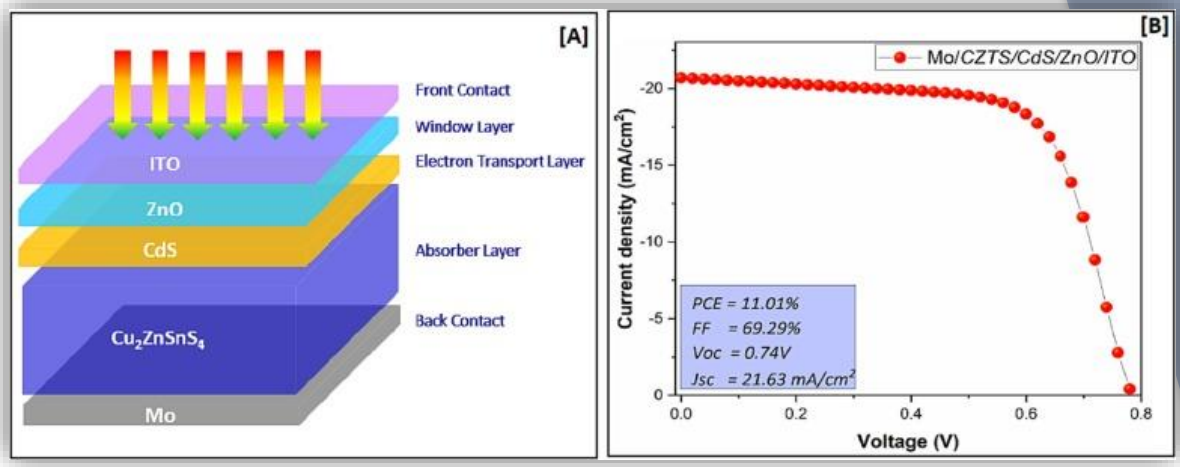


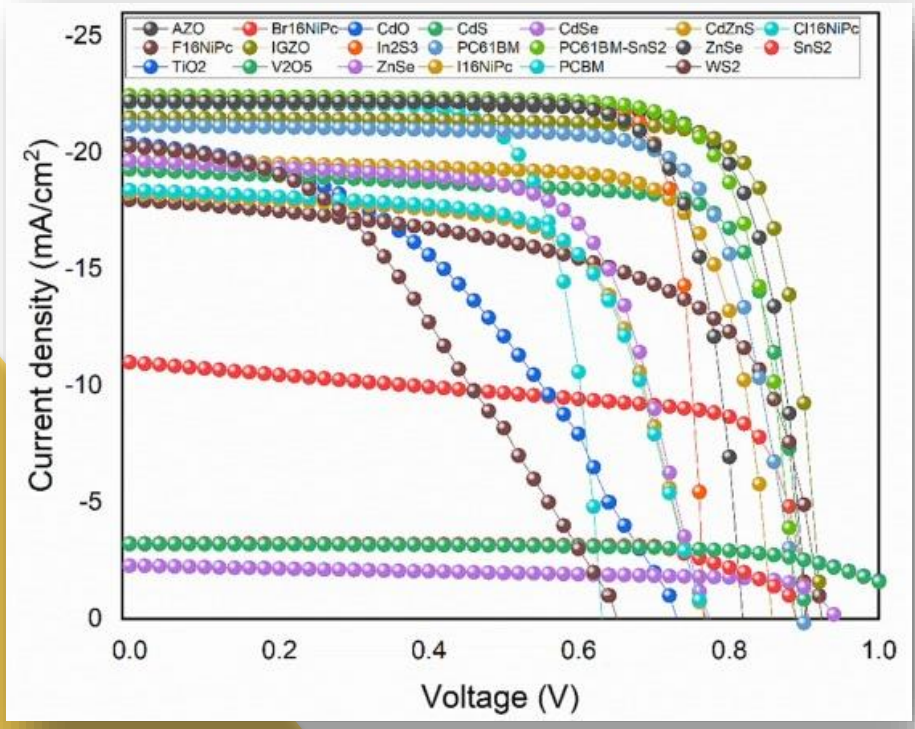


Efficient Fabrication of Nanofibers and Hydrogels for Advanced Applications

INNOVATIONS

Explore the future of solar technology with our systematic numerical investigation into next-generation kesterite solar cells. By examining innovative structures and design variants, we aim to push the boundaries of photovoltaic performance.

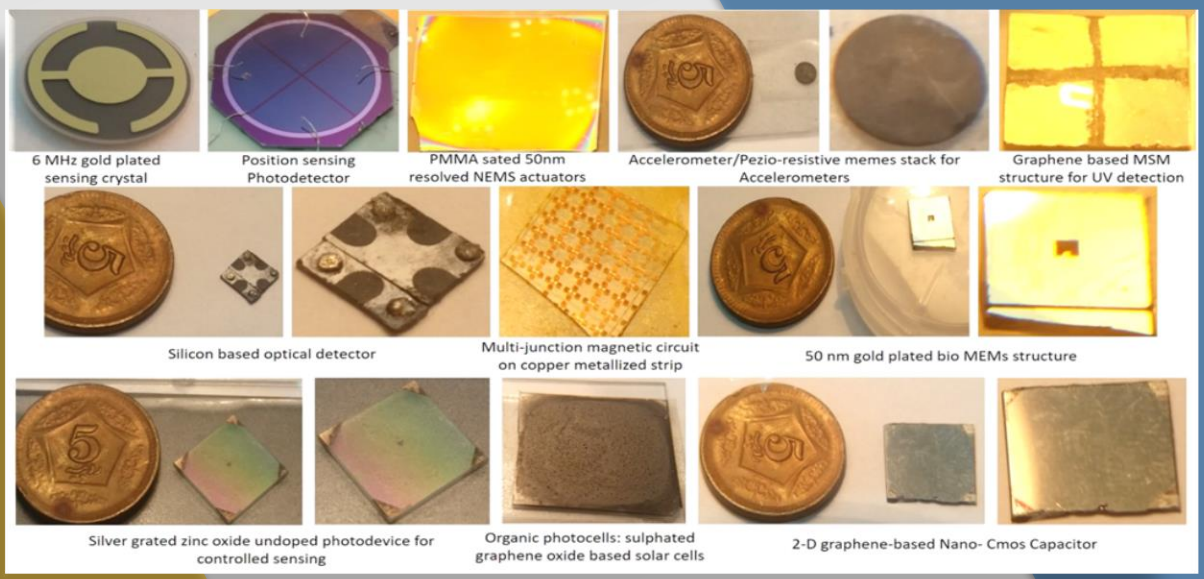


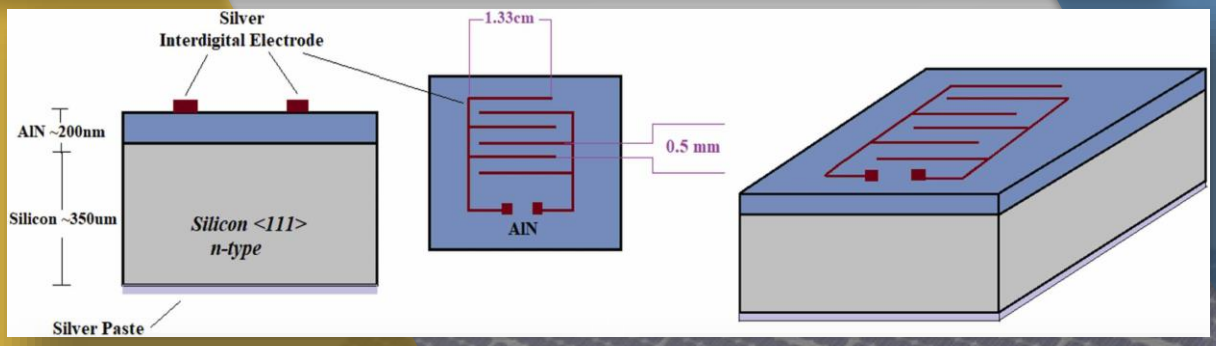


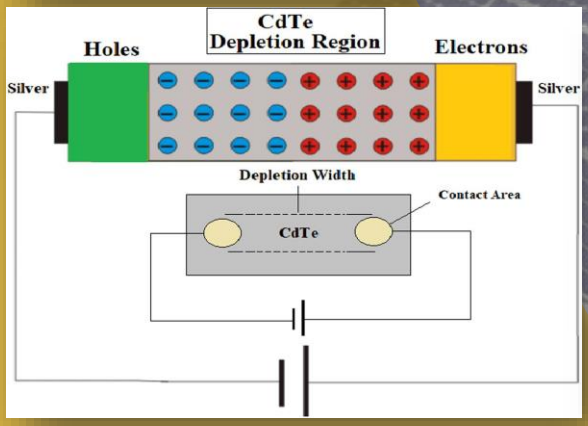
Systematic Numerical Insights for Designing Next-Generation Kesterite Solar Cells

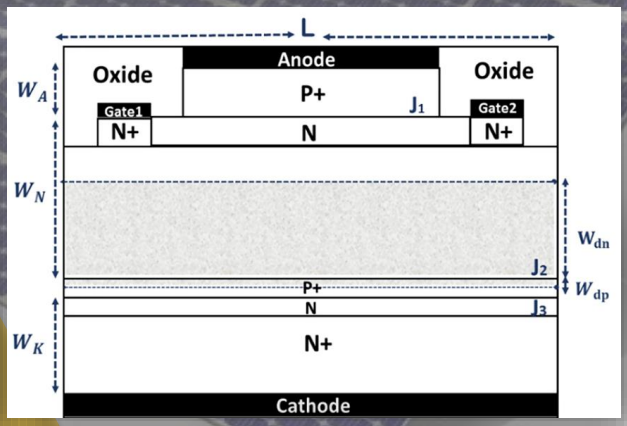
INNOVATIONS

Developing photodetection technology for next-gen imaging and communication. Let's Empower intelligent systems with advanced sensor technologies.







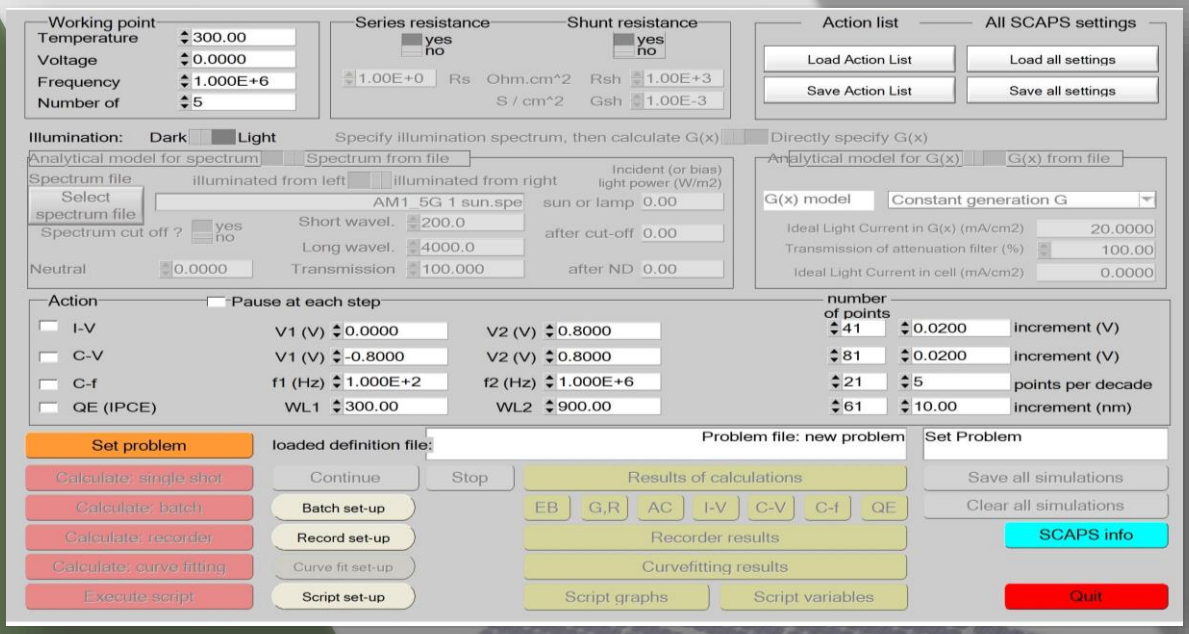


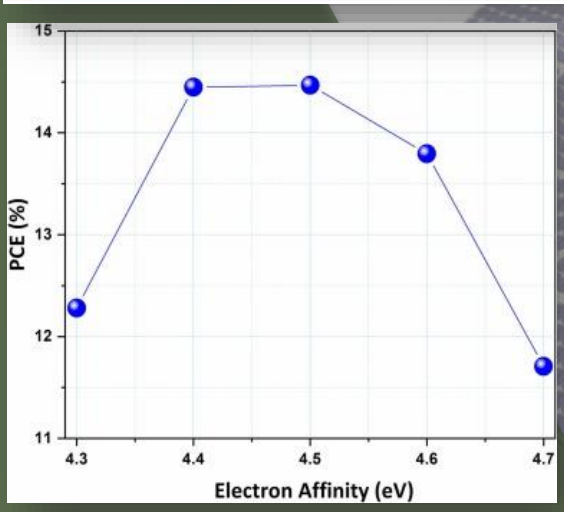
Precision in the advanced realm of optics, where every detail is defined by the behavior of photons

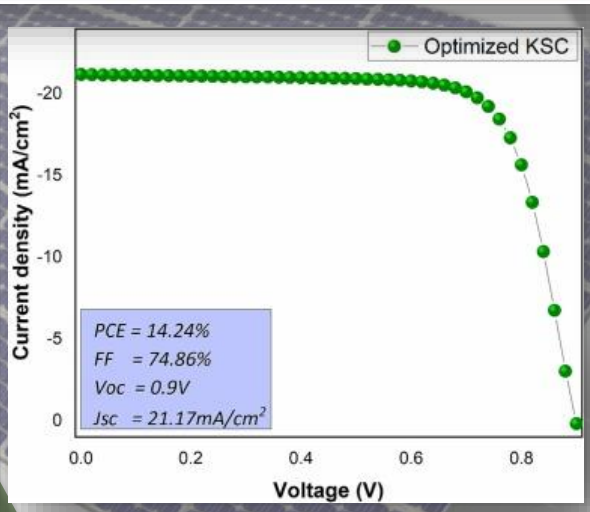
INNOVATIONS

A state-of-the-art simulation tool revolutionizing the analysis of one-dimensional semiconductor devices. With its advanced capabilities, SCAPS-1D delivers precise modeling of electrical characteristics

SCAPS-1D







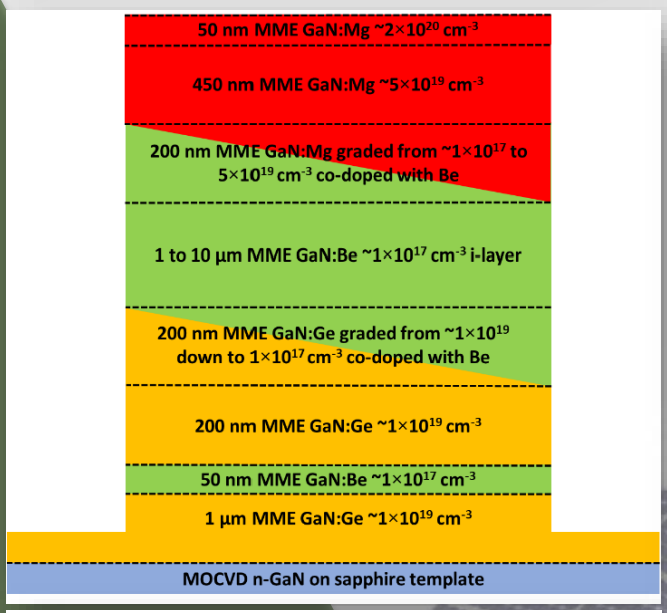
From simulation to new protocols with Software Platforms

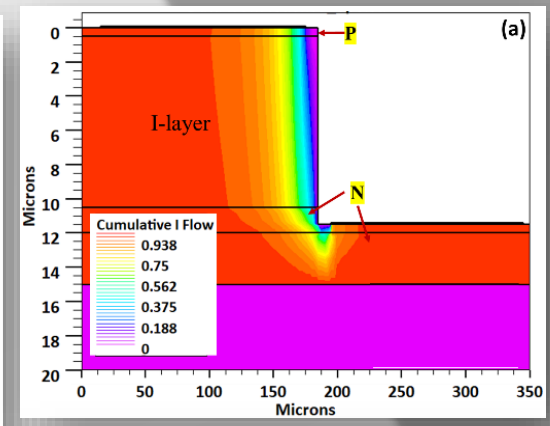
INNOVATIONS

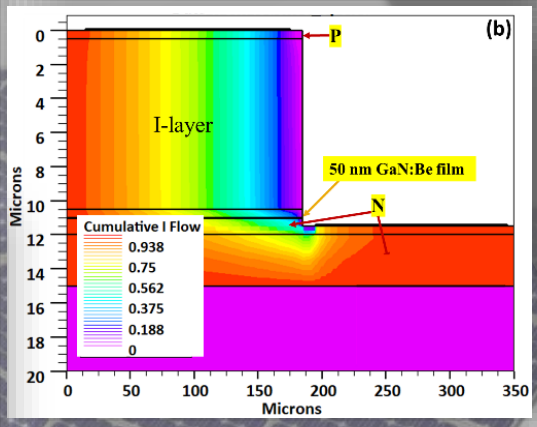
Optimize device performance reliability & Transforming ideas into breakthrough technologies and drive innovation in electronics with simulation software.

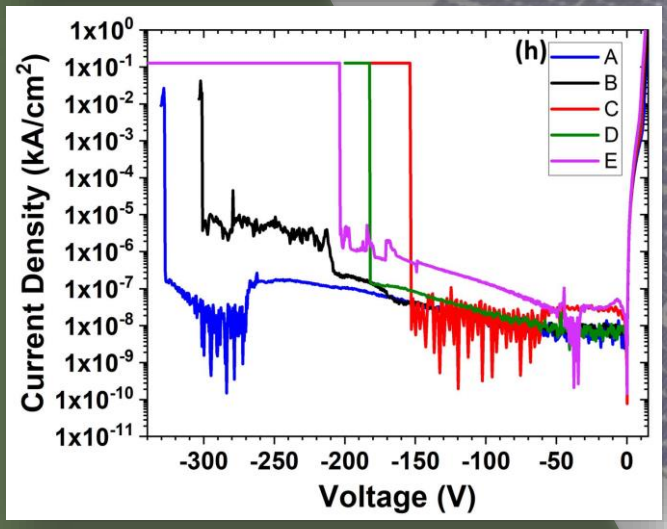
SILVACO TCAD

GaN:Be I-Layer-Based High-Power p-i-n Diodes Achieving Large Quasi-Vertical MBE Breakdown Performance







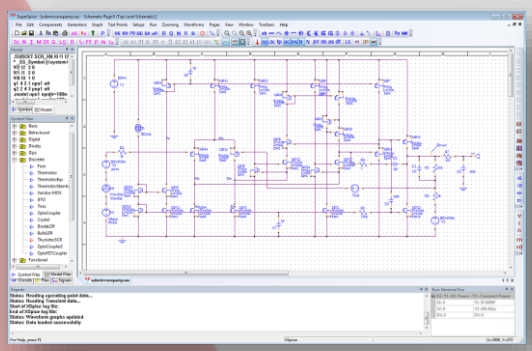


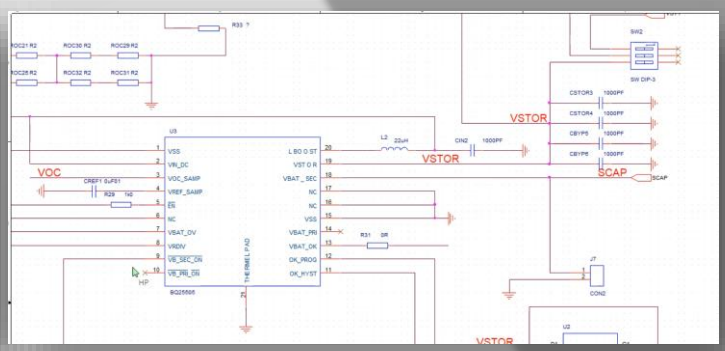
From simulation to new protocols with Software Platforms

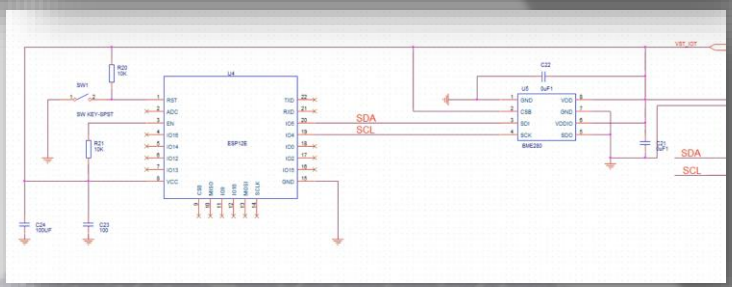
INNOVATIONS

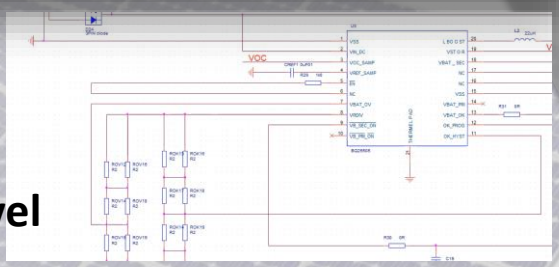
With its sophisticated algorithms, SPICE enables engineers and researchers to model, analyze, and optimize complex circuits with exceptional accuracy. Circuit behaviors can be analyzed before proceeding to final fabrication process.

SPICE









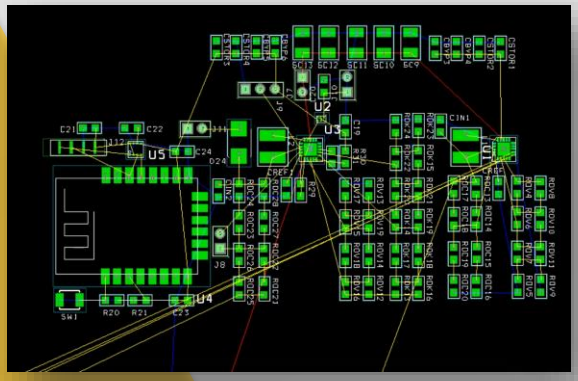
- ❑ **Advanced Circuit Design Optimization**
- ❑ **Development & Testing of Novel Electronic Components**
- ❑ **Power Management Solutions**
- ❑ **Integration of Emerging Technologies**
- ❑ **User Friendly GUI to Step towards Innovation**

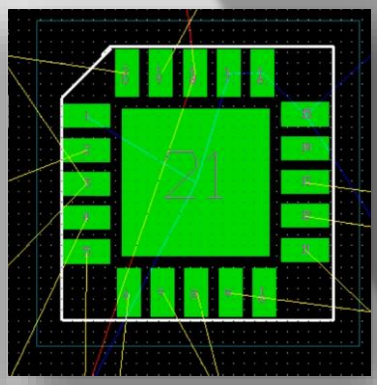
From simulation to new protocols with Software Platforms

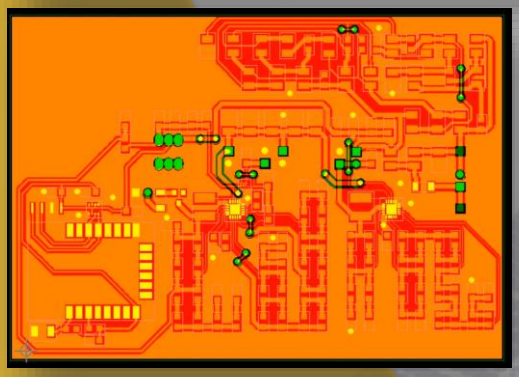
INNOVATIONS

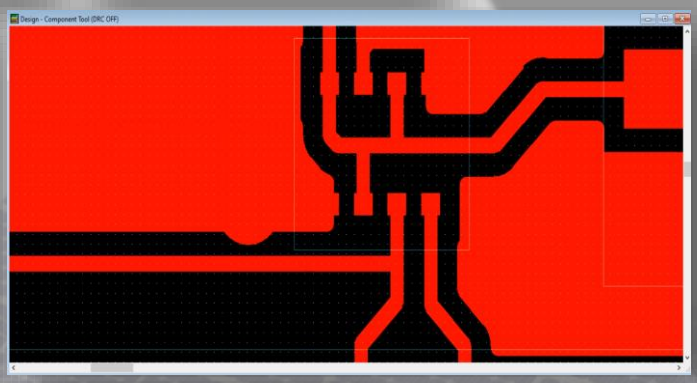
PCB design, IC design, and system verification. Its advanced capabilities drive innovation by offering powerful tools for designing and optimizing complex electronic systems with detailed precision.

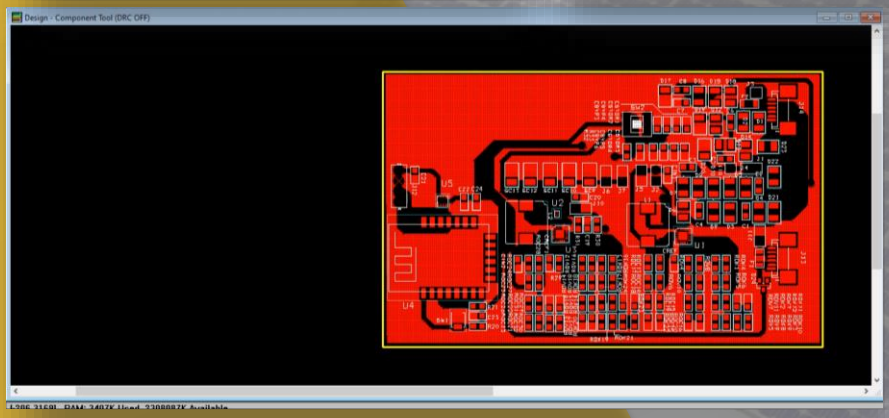
OrCAD X











From simulation to new protocols with Software Platforms

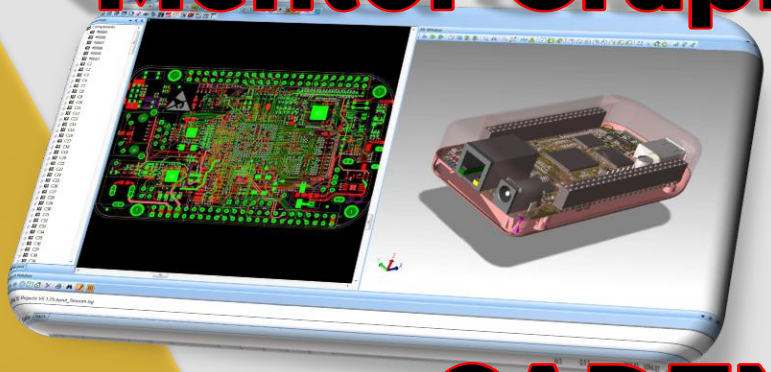
INNOVATIONS

Several IP's being filed

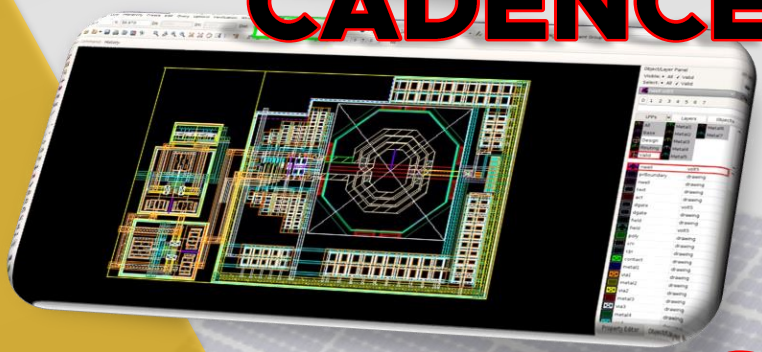
INNOVATIONS

Innovate our research with multiple simulation platforms and pave the way with precise results. Design, analyze the devices visually and proceed to the final fabrication procedure.

Mentor Graphics



CADENCE



MEMS Pro

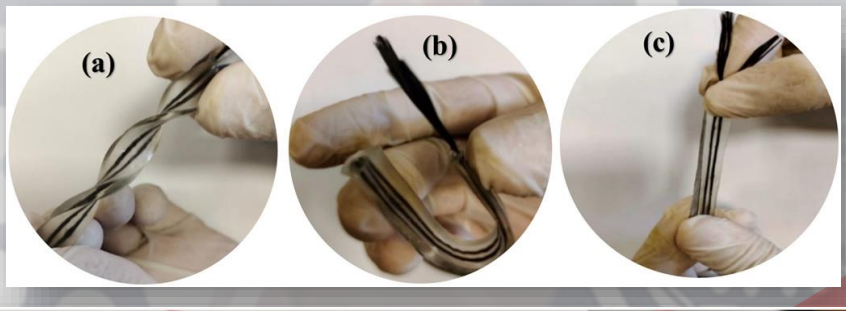
From simulation to new protocols with Software Platforms

RECENT PUBLICATIONS

- **Tailored NiO-pBOA-GNP ternary nanocomposite: Advances in flexible supercapacitors and practical applications for wearable technology and environmental monitoring. *Journal of Energy Storage*, *86*, 111128, (2024).**

ABSTRACT

This study presents a tailored NiO-pBOA-GNP ternary nanocomposite for flexible supercapacitors, created using a cost-effective in-situ chemical oxidative polymerization method. The nanocomposite integrates nickel oxide (NiO), polybenzoxazole (pBOA), and graphene nanoplatelets (GNP) to form a well-defined structure with uniform distribution. Demonstrating exceptional versatility, the supercapacitor powered a temperature and humidity sensor for approximately 600 seconds, highlighting its suitability for wearable technology and environmental monitoring. In LED applications, a series configuration of four supercapacitors powered a red LED with a 2.4V charge, emitting light for 180 seconds. The device's success in these practical demonstrations underscores its potential in energy storage and flexible electronics. The symmetric structure of the NiO-pBOA-GNP nanocomposite, with its extensive surface area and increased porosity, enhances supercapacitive performance. GNP improves conductivity and stability, while the symmetrical electrodes and gel polymer electrolyte extend the device's voltage range and flexibility.

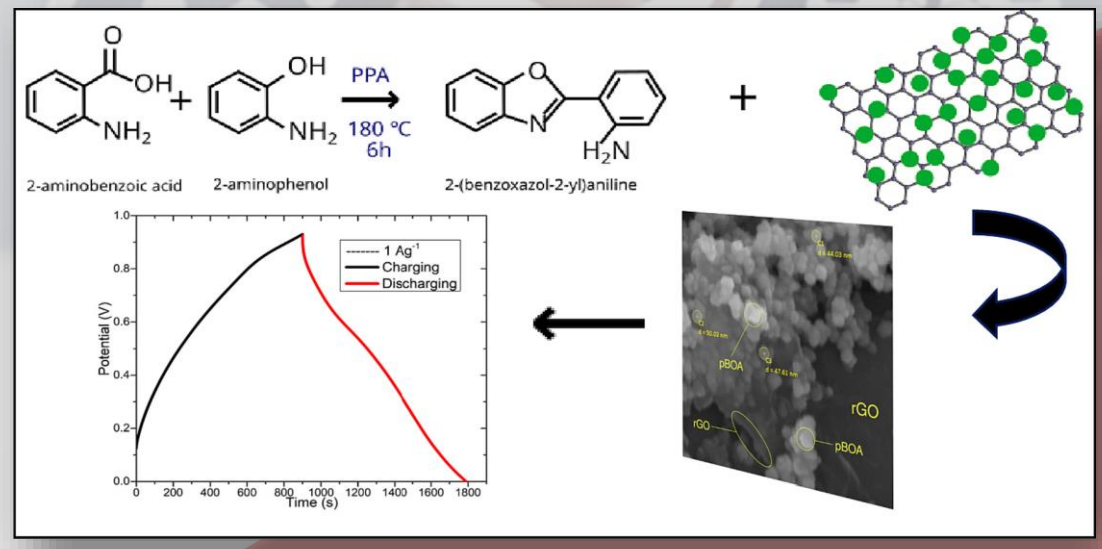


RECENT PUBLICATIONS

- **Unveiling the electrochemical advantages of a scalable and novel aniline-derived polybenzoxazole-reduced graphene oxide composite decorated with manganese oxide nanoparticles for supercapacitor applications. *Journal of Energy Storage*, *73*, 109109, (2023).**

ABSTRACT

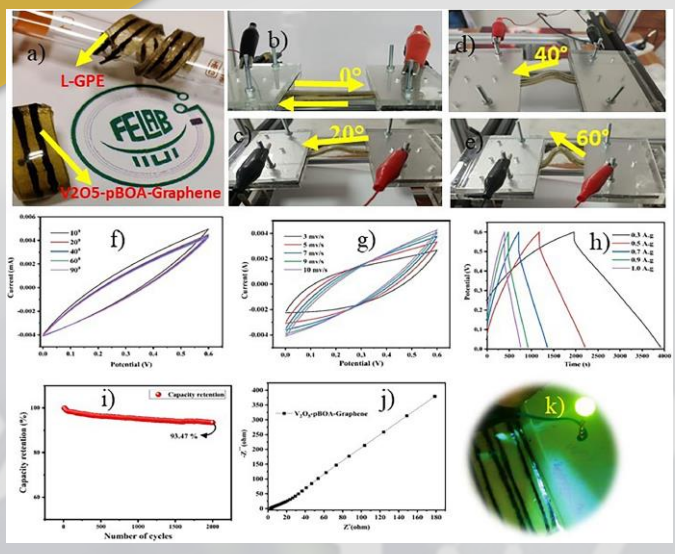
In the quest for better supercapacitor performance, materials with high energy storage, rapid charge transfer and excellent charge-discharge capabilities are crucial. However, improving energy density and optimizing electrode materials for supercapacitors remains a challenge. Within this perspective, we developed a novel aniline-derived polybenzoxazole-reduced graphene oxide composite (Mn_3O_4-pBOA-rGO) for supercapacitor applications. An electrode for supercapacitor applications was then fabricated using the synthesized composite. Various characterization techniques, such as X-ray diffraction, scanning electron microscopy, Fourier transform infrared spectroscopy and nuclear magnetic resonance spectroscopy, were employed to analyze the structure of the material and cyclic voltammetry, electrochemical impedance spectroscopy and galvanostatic charge-discharge tests were performed to evaluate the supercapacitive performance. Remarkably, the Mn_3O_4-pBOA-rGO ternary nanocomposite-based electrode exhibited enhanced electrochemical performance achieving an energy density of 116 $Whkg^{-1}$ in a 1M aqueous Na_2SO_4 electrolyte at a current density of $1Ag^{-1}$. In comparison, the Mn_3O_4-pBOA binary nanocomposite recorded an energy density of 25 $Whkg^{-1}$, while bare Mn_3O_4 yielded $10Whkg^{-1}$. The significantly improved electrochemical properties of the Mn_3O_4-pBOA-rGO composite present a promising and viable solution for supercapacitor applications.



RECENT PUBLICATIONS

- **Energy on-the-go: V2O5-pBOA-Graphene nanocomposite for wearable supercapacitor applications. *Electrochimica Acta*, *486*, 144119, (2024).**

ABSTRACT



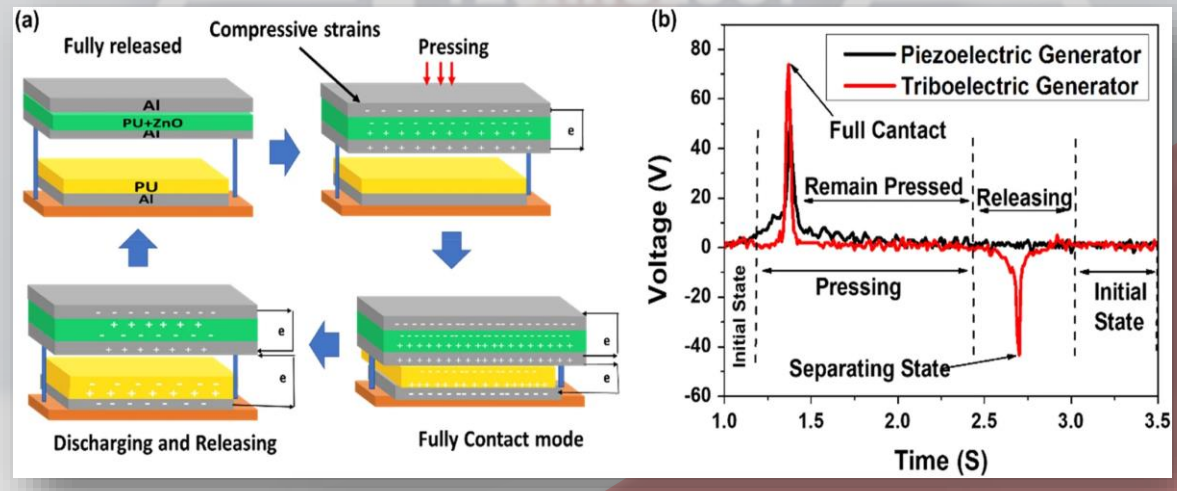
The emerging field of wearable electronic devices has propelled the demand for advanced energy storage solutions. Among these, wearable supercapacitors have garnered significant attention due to their intrinsic advantages, including high stability, rapid charging discharging capabilities, and cost-effectiveness. This paper unveils the latest strides in flexible and wearable supercapacitors, placing a spotlight on the exceptional performance of a novel V_2O_5-pBOA-Graphene nanocomposite. Synthesized through a straightforward chemical approach, the materialis meticulously characterized using X-ray diffraction, scanning electron microscopy, cyclic voltammetry, galvanostatic charge-discharge, and electrochemical impedance spectroscopy. The electrochemical behavior of the fabricated wearable supercapacitor devices is scrutinized, revealing an outstanding specific capacitance of 986 Fg^{-1} in a two-electrode system, coupled with an impressive energy density of 49 $Whkg^{-1}$. The nanocomposite's robust cycling stability is showcased, with a capacitance retention of 93.47 % over 2000 cycles. Moreover, the device's flexibility is assessed by bending it at various angles, and it retains more than 91 % capacitance even at a 90° angle, underscoring its suitability for wearable applications. The choice of electrode materials, encompassing vanadium pentoxide (V_2O_5), poly benzoxazole aniline (pBOA), and graphene, synergistically contributes to the nanocomposite's remarkable electrochemical performance. V_2O_5, with its pseudocapacitive behavior, is complemented by the conductivity and mechanical stability offered by pBOA and graphene. The ternary V_2O_5-pBOA-Graphene nanocomposite emerges as a frontrunner for wearable supercapacitor applications, promising enhanced flexibility, efficiency, and practical utility in real-world scenarios. The findings underscore the potential of the V_2O_5-pBOA-Graphene nanocomposite as a key player in the future of wearable energy storage, opening avenues for further exploration, optimization, and integration into practical applications.

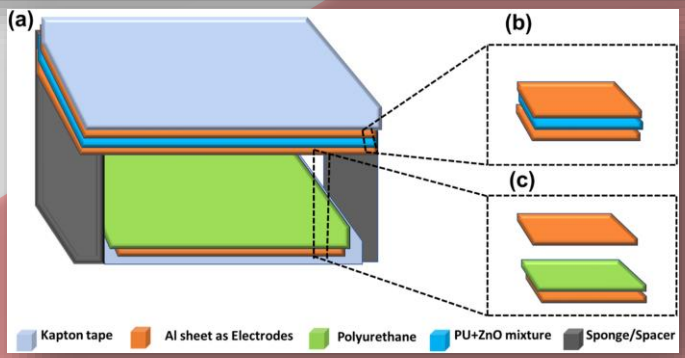
RECENT PUBLICATIONS

- **Fabrication of self-healing hybrid nanogenerators based on polyurethane and ZnO for harvesting wind energy. *Journal of Materials Science: Materials in Electronics*, *33*(7), 3982-3993, (2022).**

ABSTRACT

Energy is the most dependable need of the current era. With the tendency in portable electronics and self-powered systems, researchers have been developing nanogenerators and utilizing them as self-powered energy source. High output and optimum efficiency are always a key concern. Hence, in this research work, a hybrid NG based on both piezoelectric and triboelectric phenomena is proposed and utilized for harvesting wind energy. The UV curable polyurethane (PU) and a composite of zinc oxide (ZnO) in powder form with UV curable PU (ZnO + PU) are utilized for fabricating the triboelectric NG (TENG) and Piezoelectric NG (PNG), respectively. To combine the effect of both PNG and TENG, these two nanogenerators are stacked using a sponge as a spacer by providing a uniform air gap for triboelectrification. The hybrid nanogenerator module was connected in parallel to collect the electrical energy harvested. The fabricated hybrid nanogenerators effectively produced an open-circuit voltage of ~ 120 V and current density of ~ 140 μA cm^{-2} across 50 Ω resistor during fast speed wind from a stand fan. Apart from that, the developed hybrid NG can light up to 50 commercial LEDs, implying that the proposed hybrid NG can be used as a self-powered energy source in portable electronics, wireless and monitoring systems.



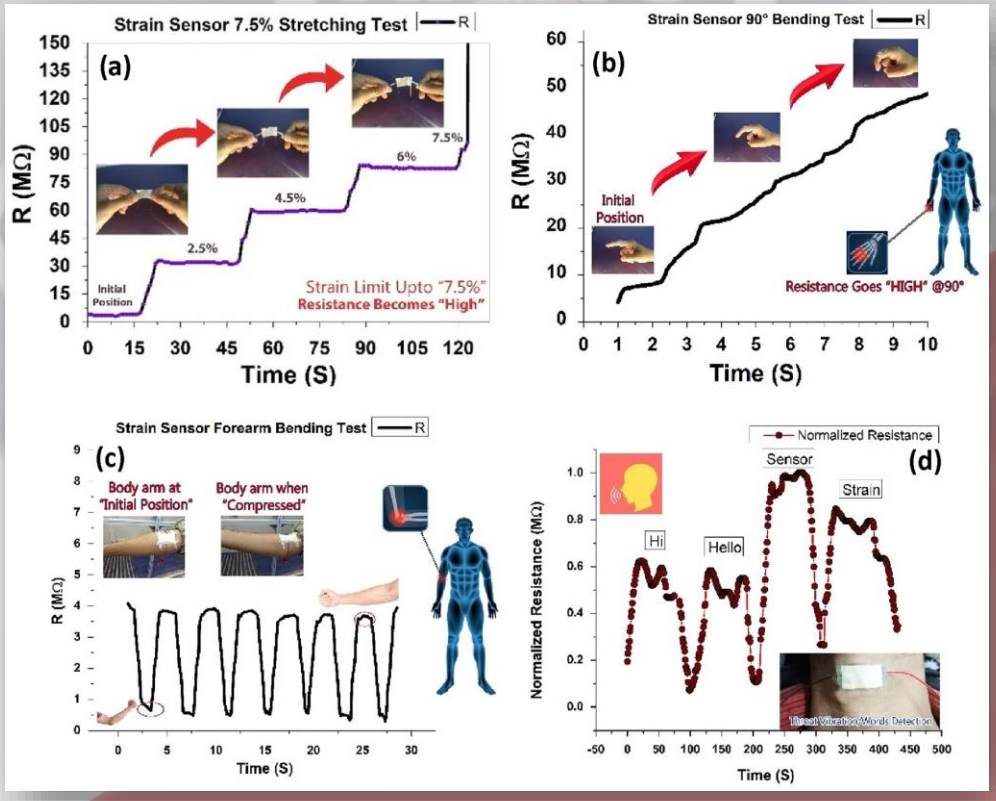


RECENT PUBLICATIONS

- **Highly sensitive strain sensor based on ZnO nanofiber mat for medical applications. *Journal of Materials Science: Materials in Electronics*, *35*(18), 1227, (2024).**

ABSTRACT

The demand for highly sensitive and reliable strain sensors is increasing in the fields of wearable technology and medical diagnostics. Here, we report a novel approach to fabricating a strain sensor specifically designed for medical applications using zinc oxide (ZnO) nanofiber mats as its matrix. A composite material containing zinc oxide and PVP polymer has been synthesized together to generate ZnO nanofiber mats by employing an electrospinning method which allows precise control over morphology, alignment of the fibers, and for device fabrication, we utilize magnetron sputtering. Using scanning electron microscopy (SEM), the structural and morphological characteristics of the as-synthesized multiple nanofiber mats are characterized. The fabricated strain sensor demonstrates outstanding sensitivity, with a gauge factor (*GF*) of 1653 having very small diameter, enhancement in stretching limits of up to 7.5%, a reaction time of 300 ms, and the fabricated strain sensor recovering its morphology within 420 ms. Furthermore, the sensor has outstanding biocompatibility and can be used to detect human motion, forearm movements, pulse, wrist bendability, and speech for individuals who are unable to speak. Overall, this work demonstrates an effective strategy for the fabrication of highly sensitive strain sensors for use in medical applications.

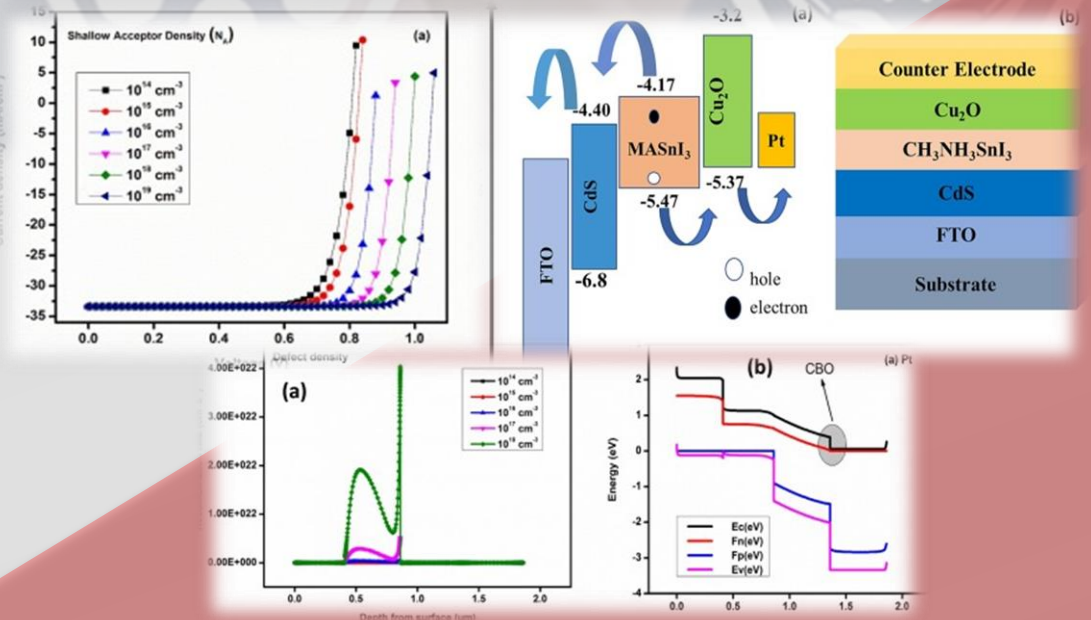


RECENT PUBLICATIONS

- **Simulation and numerical modeling of high performance CH3NH3SnI3 solar cell with cadmium sulfide as electron transport layer by SCAPS-1D. *Results in Optics*, *14*, 100595, (2024).**

ABSTRACT

This work includes the numerical modeling (NM) of solar cells consisting of the active layer of $CH_3NH_3SnI_3$ and electron transport layer of CdS, by employing a software SCAPS-1D. Organic-inorganic lead-based perovskites are superior in terms of power conversion efficiency. However, there are some serious drawbacks associated with them including poor stability, shorter life time and toxicity. Therefore, it is the demand of the hour to explore alternative materials to overcome these shortcomings. In this regard, tin is a competitive alternative to lead because it has similar electronic and chemical properties. Moreover, it is nontoxic, making it environmentally friendly. However, Sn based perovskite devices are reported with inferior power conversion efficacy, to date. In the present work, we have worked on a novel architecture of solar cells containing $CH_3NH_3SnI_3$ as a light absorber layer and CdS as electron fetching layer. Optimization of the device was performed numerically by varying physical parameters related to the active layer such as thickness, defect density and shallow acceptor concentration. The proposed architecture of solar cells was proved as an efficient system with J_{sc} of 33.40 mA/cm^2, V_{oc} of 0.878 V, FF of 85.25 %, and PCE of 25.02 %. The temperature analysis has revealed that, temperature higher than 300 K increases the reverse saturation current, seriously degrading the structure of the device, hence limiting the power conversion performance of the solar cell. Furthermore, a rear electrode made of the high work function materials like Pt forms an ohmic junction at the HTL/anode interface, enhancing the performance of the device. Results of this study have paved the way for experimentalists to explore opportunities, to rationalize this architecture for real time applications such as inhouse lighting and laptop/smartphone charging.

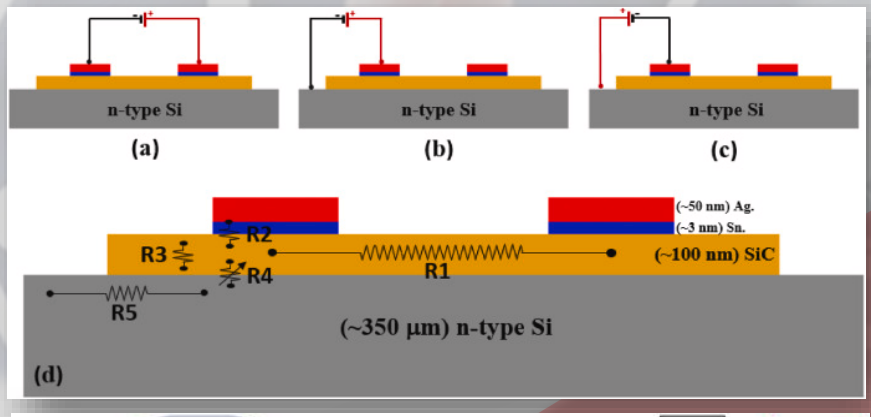


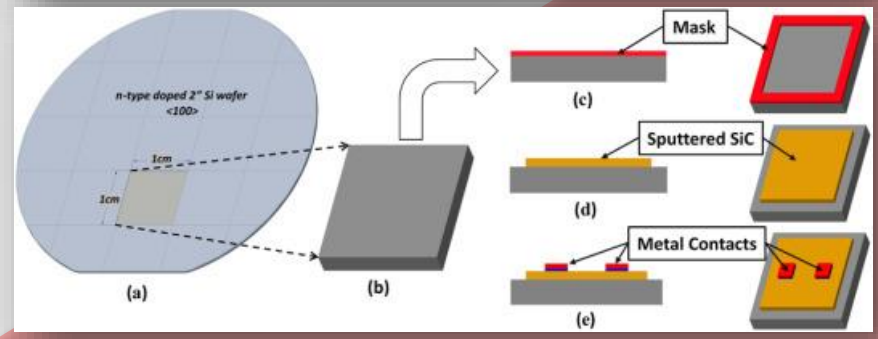
RECENT PUBLICATIONS

- **Fabrication and characterization of SiC-based transparent passivating contacts for enhanced photovoltaic performance. *Optical Materials*, *144*, 114276, (2023).**

ABSTRACT

Silicon Carbide (SiC) passivating contacts are thought to be an emerging solution to bridge the existing gap in the silicon-based solar market. Passivating contacts directly tackle the intrinsic metal-semiconductor interfaces issues like recombination losses and Fermi-level pinning. Considering this approach, SiC-based Transparent Passivating Contacts (TPC) are fabricated on n-Si <100> using RF magnetron sputtering at multiple RF powers for enhanced solar cell performance. All said contacts were convolved through a variety of optical, and electrical techniques. It is confirmed that the passivating contacts grown by higher RF power have an enhanced provision for both transmission and contact passivation. Additionally, it has been found that a sufficient amount of oxygen vacancies (V_O) are located at the SiC/Si interface and are mainly responsible for limiting of the contact passivation. This issue might be resolved by opting for larger RF power during the SiC growth that may suppress V_O impact. Further, purely optical and electro-optical parameters and their dependence on V_O have been readily studied. Most importantly the extent of contact passivation has been readily measured by the transient of photo voltages and Q-DLTS techniques and cross-verified by current kinetics studies. It is found by the current-voltage and energy band picture that the SiC grown at higher RF would provide better contact passivation with surface resistance of ~10^9 Ω and positive trap centers, respectively.



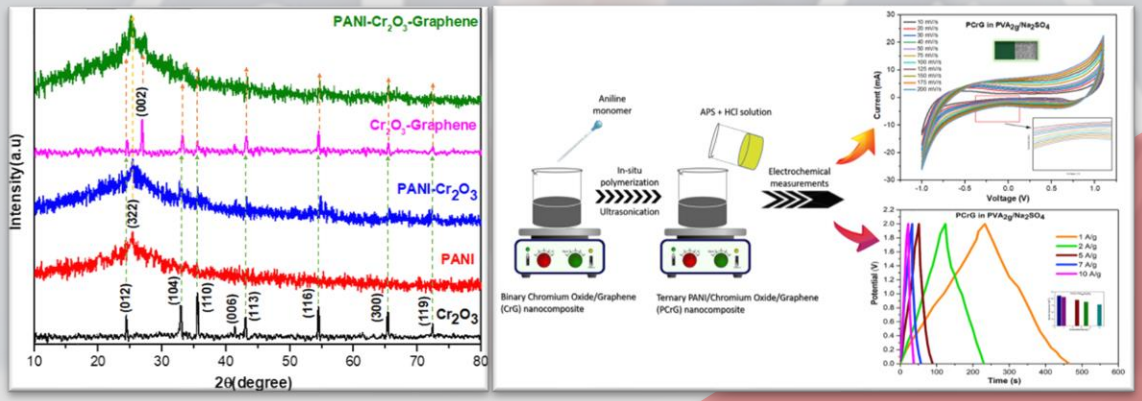


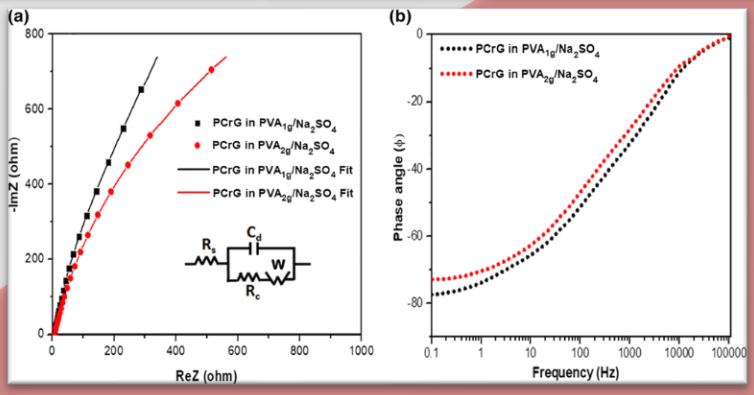
RECENT PUBLICATIONS

- **Exploring the synergistic effect of a PANI/Cr_2O_3/graphene nanocomposite in a hybrid gel electrolyte for supercapacitor performance. *Journal of Electronic Materials*, *52*(11), 7576-7589, (2023).**

ABSTRACT

This study focuses on the large-scale production of a high-energy-density supercapacitor through the cost-effective polymerization of a PANI/Cr_2O_3/graphene nanocomposite, utilizing commercially available flexible substrate and cost-effective chemicals. To explore the synergistic effect, a PANI/Cr_2O_3/graphene nanocomposite is evaluated in a hybrid gel electrolyte with varying polyvinyl alcohol (PVA) concentrations. The investigation is aimed at enhancing the electrochemical performance of electrode material for supercapacitors. Two symmetric devices are fabricated to assess the specific capacitance and energy density of the prepared nanocomposite. In the PVA_{2g}/Na_2SO_4 electrolyte, the energy density is increased to 61.71 Wh kg^{-1}, accompanied by an enhanced potential window of 1.95 V. Furthermore, the prepared composite demonstrates good electrochemical stability, retaining 94% of its initial capacitance after 2000 cycles at 2 Ag^{-1} in 2 g PVA/Na_2SO_4 gel electrolyte. The remarkable electrochemical properties of the composite can be attributed to the effective contact and synergistic effect among PANI, Cr_2O_3, and graphene, making it a promising candidate for supercapacitor applications. Moreover, this facile process is easily scalable to meet commercial demands and can be utilized to enhance the energy density of various carbon-based materials with limited initial performance.



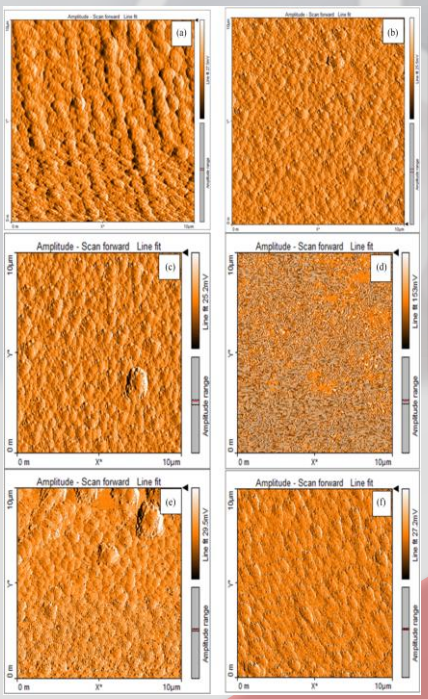


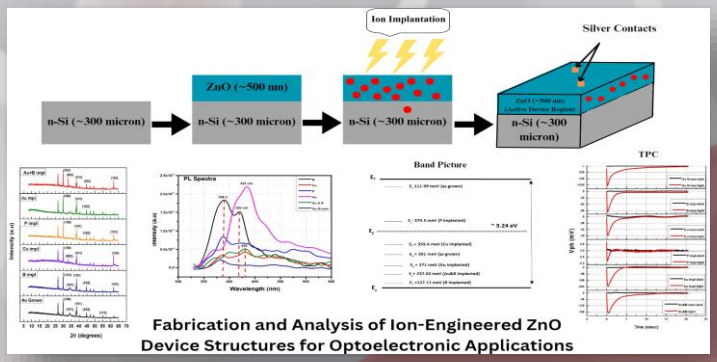
RECENT PUBLICATIONS

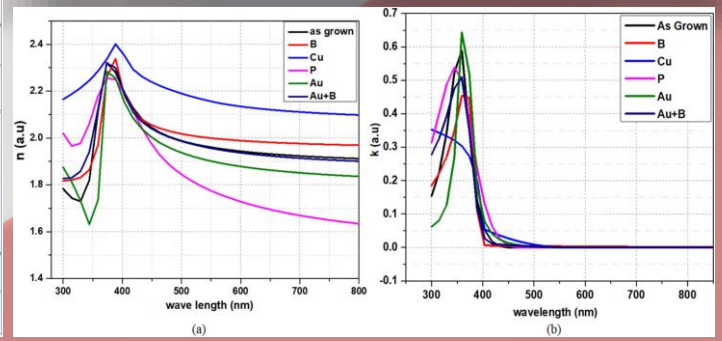
- **Fabrication and Analysis of Ion-Engineered ZnO Device Structures for Optoelectronic Applications. *IEEE Photonics Journal*, 15 , 5, (2023).**

ABSTRACT

ZnO-based devices are highly promising for applications involving light-matter interaction. This work explores the impact of light-matter interaction on ion-induced ZnO structures and their respective energy band profiles. Incorporation of various ions, (Au^+, B^+, Cu^+, P^+) into the ZnO lattice, deposited via magnetron sputtering on an n-type Si substrate was investigated in detail. To assess the impact of these ions on the ZnO surface, monte-carlo simulations at low energies were performed and optimal ion dose and energy conditions were determined. The resulting post-fabrication devices underwent comprehensive structural, morphological, optical, and electrical diagnostics. X-ray diffraction (XRD) analysis confirmed the well-maintained crystal structure of the ZnO lattice along the <100> direction for all implant sequences. Notably, the gold (Au^+) implant exhibited the highest light extinction into the ZnO matrix, as indicated by the extinction coefficient and refractive index data. This observation suggested that Au^+ implantation could effectively generate electron-hole pairs. The photovoltage and dark/light current measurements provided further evidence of enhanced light-matter interactions and responsivity in the Au^+-implanted devices owing to light-induced currents. Furthermore, the energy bands of all implant cases were profiled by Charge Deep Level Transient Spectroscopy (Q-DLTS) measurements by evaluating discrete energy states within the ZnO lattice.





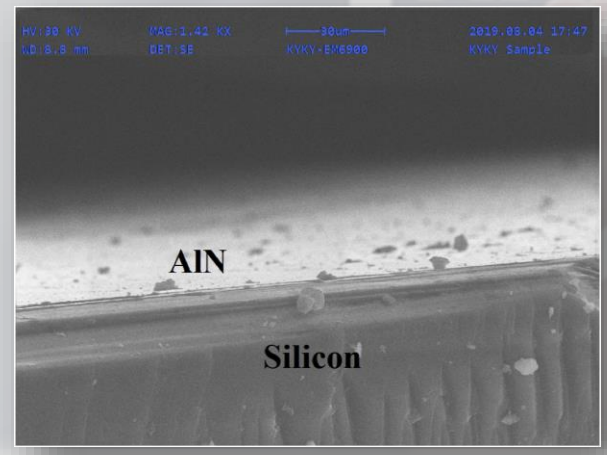


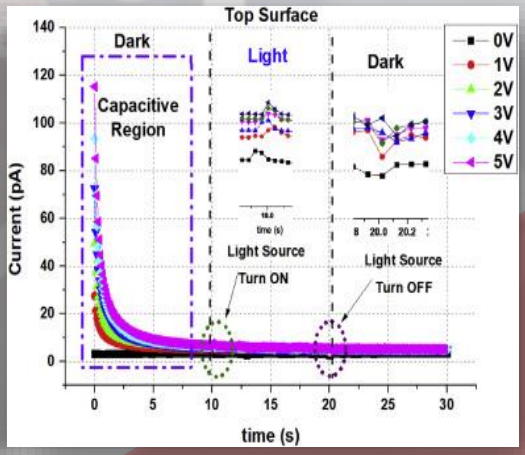
RECENT PUBLICATIONS

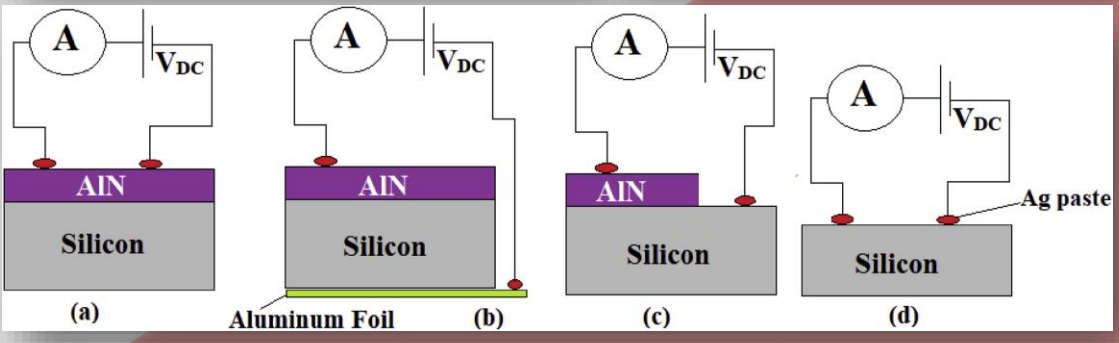
- **Advanced electrical characterization of AlN/Si based heterogeneous junction for photonic applications. *Materials Science in Semiconductor Processing*, 138, 106292, (2022).**

ABSTRACT

AlN/Si based heterogeneous junction is investigated, herein, for photonic applications. A hyperfine layer of AlN onto the n-type Silicon substrate is fabricated, and a detailed analysis of subject stack has been carried out by variety of techniques such as Scanning Electron Microscope (SEM), Current-Voltage (I–V), Capacitance-Voltage (C–V), Charge Deep Level Transient Spectroscopy (Q-DLTS), Transient of Photo-voltages (TPV) and Kinetics of Dark and Luminous Currents. The occurrence of Si_3N_4 layer at the interface of AlN and Si has been witnessed and extensively studied by the electrical diagnostic approaches to identify a crucial role of the charges, which may directly affect the properties and operation of whole AlN/Si stack. The optical measurements have also been performed and evidence of Si_3N_4 layer formation at the AlN and Silicon interface, which plays pivotal role to the overall AlN/Si stack. Furthermore, the defect levels and their respective qualitative as well as quantitative analysis near the valence and conduction band edges of AlN is also reported. The given stack has been investigated by multi-bias and switched voltage (positive/negative) routines at different active areas of subject AlN device matrix for their potential usage in Deep ultra-violet (DUV) and other photonic application.





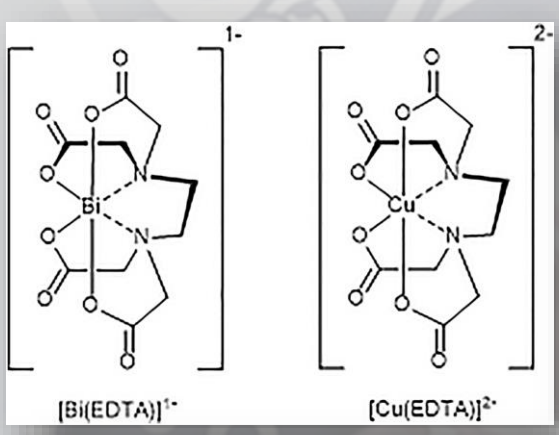


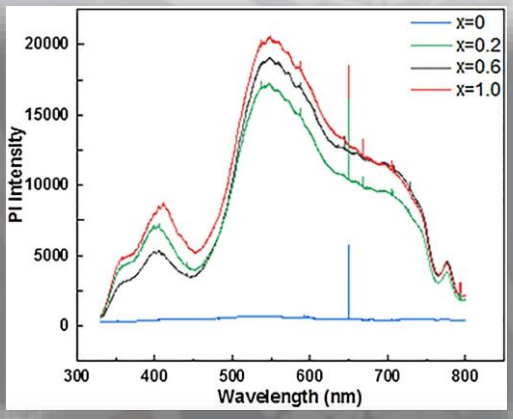
RECENT PUBLICATIONS

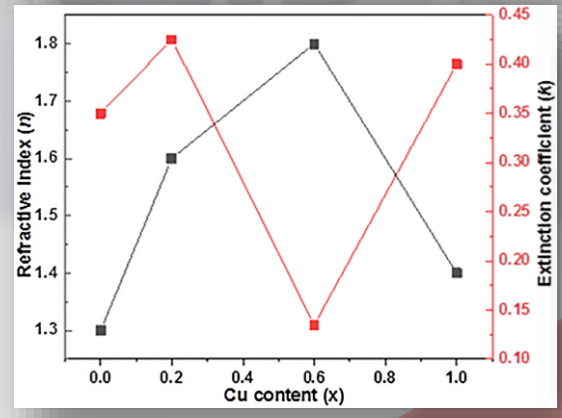
- **Optoelectronic analysis of bismuth sulfide and copper-doped bismuth sulfide thin films. *Jom*, *74*(7), 2809-2816, (2022).**

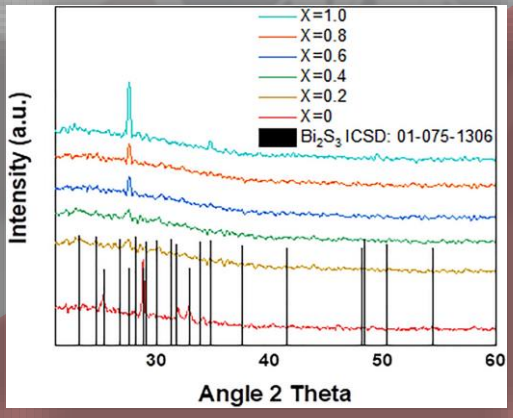
ABSTRACT

Bismuth sulfide (Bi_2S_3), which has an optimal bandgap range and high absorption coefficient, is an attractive candidate for photovoltaic applications. Undoped and Cu-doped Bi_2S_3 thin films with different Cu content have been deposited by the solution growth technique. Bismuth nitrate and thioacetamide were used as bismuth and sulfur precursors, while ethylene diamine tetra-acetic acid was used as the complexing agent. The results show that all the deposited thin films are appreciated absorbers in the UV–Vis region. Results from the spectrophotometer showed that values of refractive index (*n*) ranged between 1.4 and 1.8 with an extinction coefficient (*k*) of 0.12–0.42. PL analysis showed a strong characteristic peak of Bi_2S_3 at 555 nm while the intensity gradually reduces with increasing Cu^{2+} content. Parental intrinsic defects of orthorhombic Bi_2S_3 make it an *n*-type charge carrier which incorporates Cu^{2+} in the orthorhombic crystal phase. The crystal lattice also prefers to act as a donor by increasing the number of electron carriers in Bi_2S_3 thin films.







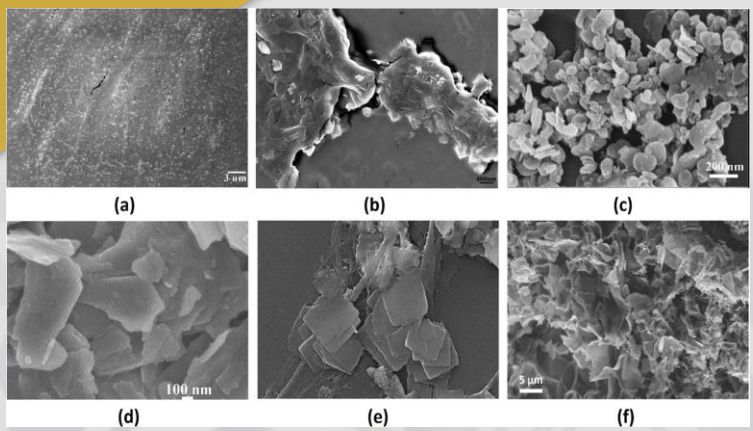


RECENT PUBLICATIONS

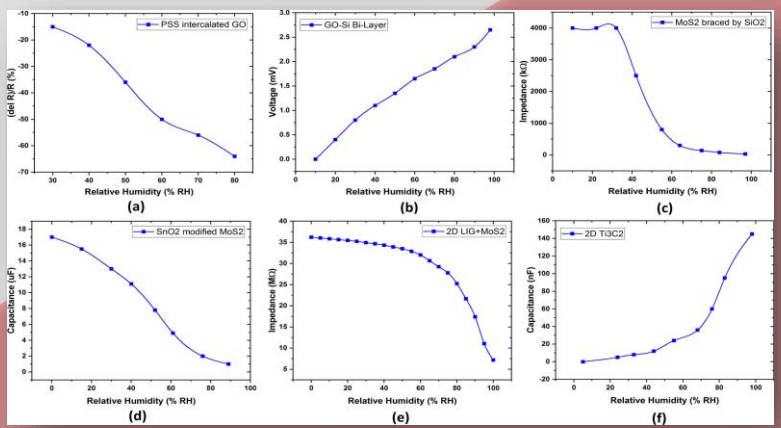
- **Progress and future of relative humidity sensors: a review from materials perspective. *Bulletin of Materials Science*, *45*(4), 238, (2022).**

ABSTRACT

Measurement of relative humidity demands sensors with different requirements and specifications. There has been a lot of work done on the development of humidity sensors with more than 100,000 research articles already published. The huge research magnitude suggests huge potential



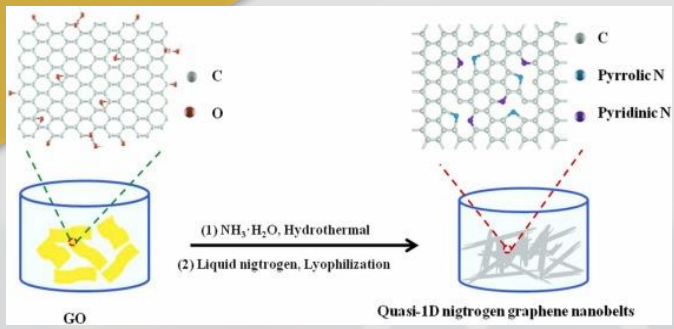
in this field but the question arises as to why such a seemingly simple task requires so much research efforts? Which parameters are exactly targeted? What are the difficulties faced? And, what are the different approaches adopted to achieve the requirements? The research on humidity sensors usually targets improvement of various performance parameters while keeping the cost low and the fabrication process easy. As many parameters are interdependent, the criteria to prioritize some parameters over others based on the target application are also considered. A major portion of research work in this field is based on the development of novel materials to achieve these targets, which are set according to desired applications. This focus review discusses the most widely employed and the best performing material categories including polymers, composites, 2D materials and carbon-based materials for the development of humidity sensors. The material properties, selection process, sensing mechanism, and the pros and cons of various categories for different target applications are discussed. A comprehensive overview of commercial humidity sensors is also presented. The aim of this review is to provide clear guidelines for researchers working in this field, so as to provide a new path which needs to be adopted and to discourage redundant research related to humidity sensors development.



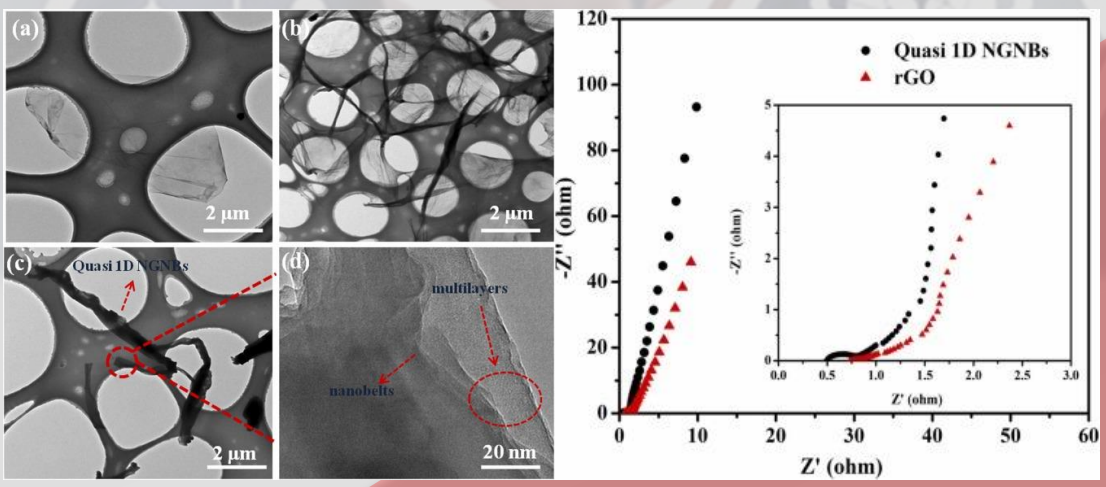
RECENT PUBLICATIONS

- **Controlled synthesis of the state-of-the-art quasi one-dimensional graphene nanostructure for high performance supercapacitor, *Synthetic Metals*, 289, 117131, (2022).**

ABSTRACT



We have reported the fabrication of novel quasi one-dimensional nitrogen doped graphene nanobelts (quasi 1D NGNBs) by a simple and cost-effective method. The growth of such a unique structure was achieved by treating graphene with ammonia under hydrothermal conditions, followed by low temperature treatment with nitrogen liquid. After the removal of ice template by lyophilization, the synthesized quasi 1D NGNBs were obtained. The synthesized quasi 1D NGNBs were examined by SEM, TEM, Raman, XPS, BET and TGA. The prepared quasi 1D NGNBs exhibit higher surface area (718 $m^2\ g^{-1}$), good structural stability, high electrical conductivity, less internal resistance (0.5 Ω), and many active sites than reduced graphene oxide. The electrochemical analysis reveals that quasi 1D NGNBs have a specific capacitance of 286 F g^{-1} at current density of 1.0 A g^{-1} that is greater as compared to 112 F g^{-1} for rGO and also exhibit enhanced cyclic stability with excellent retention above 79.03% after 20,000 times. So, this indicates that quasi 1D NGNBs possess high capacitance due to distinct folded structure of π-π stacking and can be used for high performance supercapacitors.

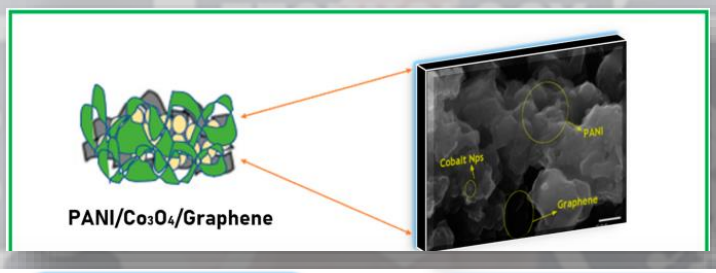


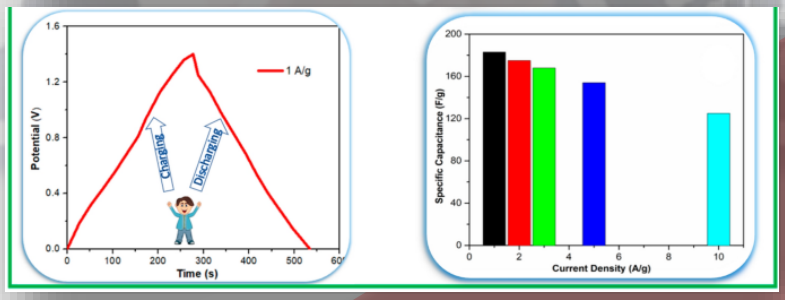
RECENT PUBLICATIONS

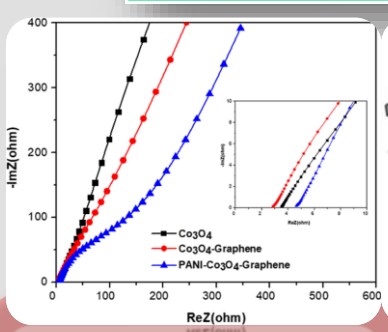
- **Enhanced Energy Density of PANI/Co_3O_4/Graphene Ternary Nanocomposite in a Neutral Aqueous Electrolyte of Na_2SO_4 for Supercapacitor Applications. *Journal of Electronic Materials*, 51 (9), 5417-5428, (2022).**

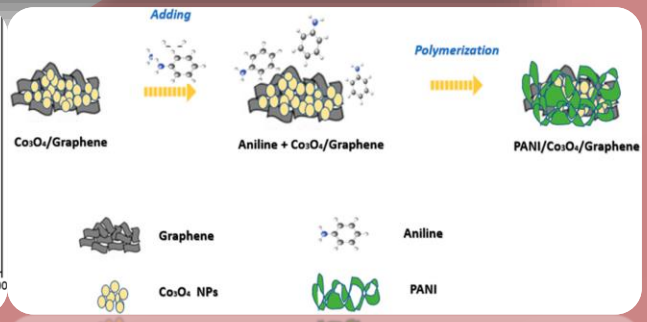
ABSTRACT

We report a cost-effective, chemical polymerization route to synthesize PANI/Co_3O_4/graphene (PCG) ternary nanocomposite for supercapacitor applications to achieve enhanced energy density in a cost-effective, non-toxic, and non-corrosive neutral aqueous electrolyte of 1M Na_2SO_4. These properties are advantageous for a supercapacitor assembling procedure, being favorably facile and inexpensive. The electrochemical analysis was carried out to check analyte performance with cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS). The PCG ternary nanocomposite exhibits a specific capacitance of 183 F g^{-1} at 1 A g^{-1} in a two-electrode device, and retains its 93% of initial specific capacitance after 2000 cycles. The energy density of PCG ternary nanocomposite is 49.81 Wh Kg^{-1} with a power density of 697.72 W Kg^{-1}. The excellent electrochemical properties of the PCG ternary nanocomposite are credited to the good contact and the synergistic effect between the PANI nanofibers, Co_3O_4 nanoparticles, and graphene nanosheets. This indicates that this synthesized ternary nanocomposite material could be used as a promising candidate for supercapacitor electrode material.







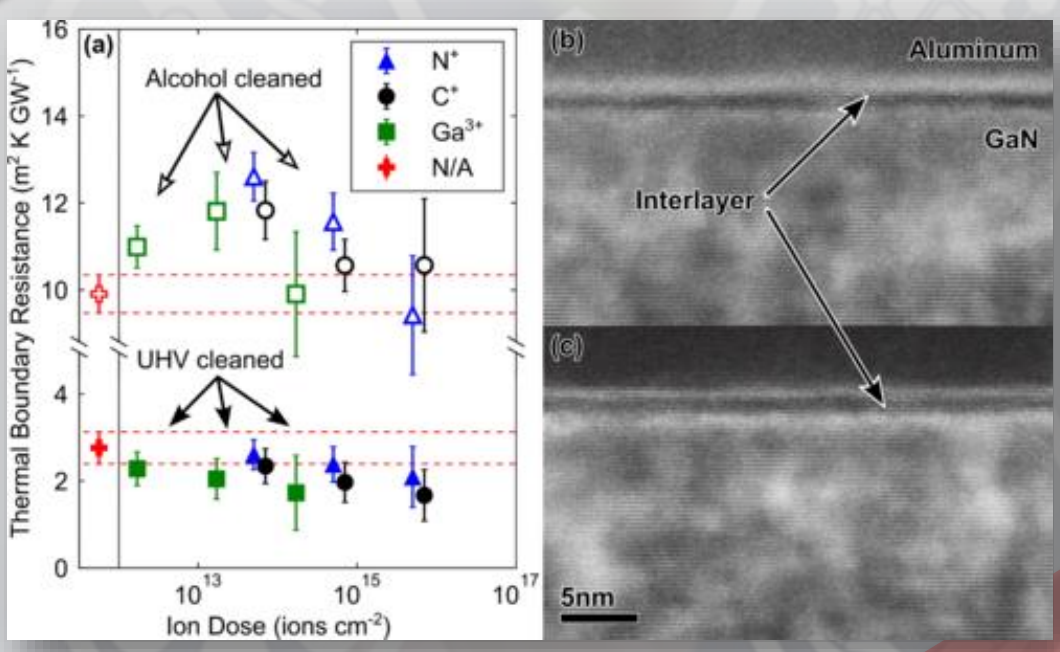


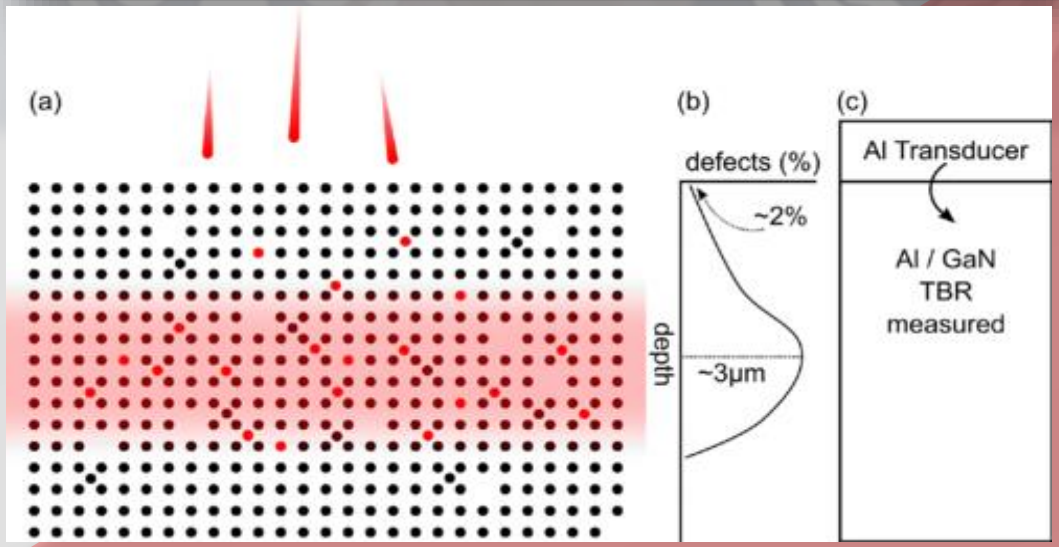
RECENT PUBLICATIONS

- **Ion irradiation induced crystalline disorder accelerates interfacial phonon conversion and reduces thermal boundary resistance. *Physical Review B*, *109*(16), 165421, (2024).**

ABSTRACT

Traditional understanding of the thermal boundary resistance (TBR) across solid-solid interfaces posits that the vibrational densities of states overlap between materials dictates interfacial energy transport, with phonon scattering occurring at the interface. Using atomistic simulations, we show a mechanism for control of TBR; point defects near an interface can lead to both short- and midrange disorder, accelerating the conversion of vibrational energy between bulk and interfacial modes, ultimately reducing the TBR. We experimentally demonstrate this reduction through ion irradiation of gallium nitride and subsequently measuring the TBR across Al/GaN interfaces.



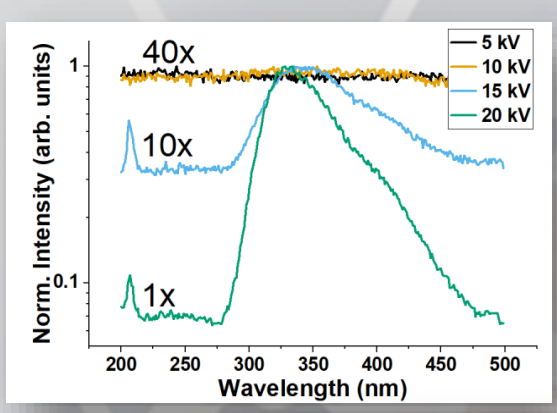


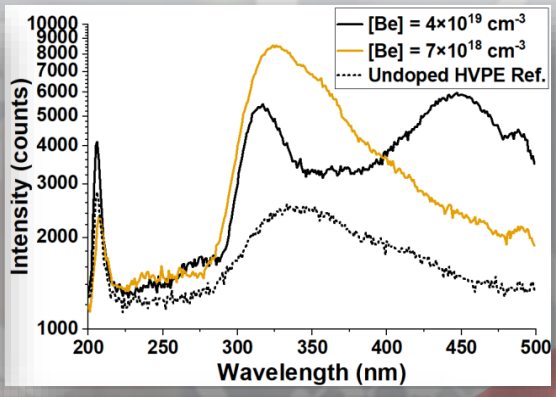
RECENT PUBLICATIONS

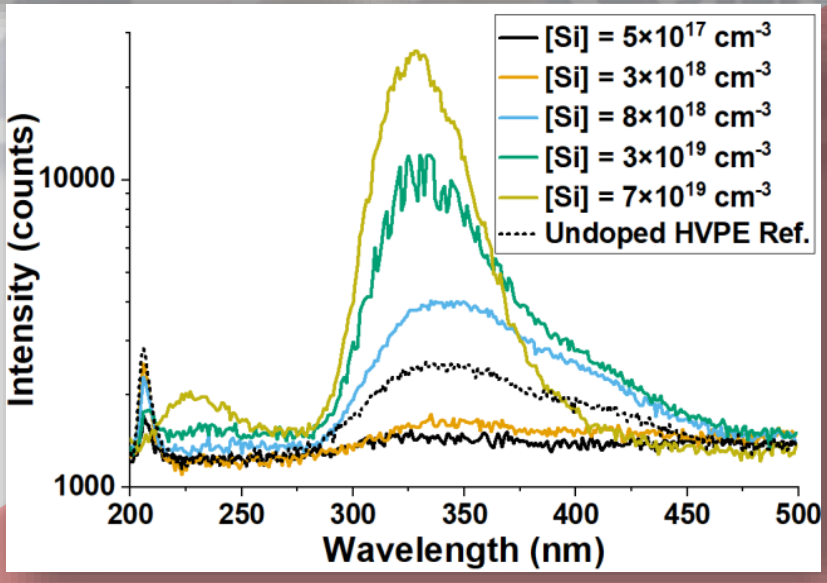
- **Cathodoluminescence investigation of defect states in n-and p-type AlN. *Applied Physics Letters*, *124*(5), (2024).**

ABSTRACT

State-of-the-art semiconducting aluminum nitride (AlN) films were characterized by cathodoluminescence (CL) spectroscopy in the range of 200–500 nm in an attempt to identify the energy levels within the bandgap and their associated defects. Near-band edge emission (around 206 nm) and high-intensity peaks centered in the near UV range (around 325 nm) are observed for both n- and p-type AlN films. The near UV peaks are potentially associated with oxygen contamination in the films. The p-type AlN films contain at least two unidentified peaks above 400 nm. Assuming that the dopant concentration is independent of compensation (i.e., in the perfect doping limit), three effective donor states are found from Fermi–Dirac statistics for Si-doped AlN, at ~0.035, ~0.05, and ~0.11 eV. Similarly, a single effective acceptor energy of ~0.03–0.05 eV (depending on the degeneracy factory considered) was found for Be doped AlN. CL investigation of doped AlN films supports claims that AlN may be a promising optoelectronic material, but also points to contaminant mitigation and defect theory as major areas for future study.





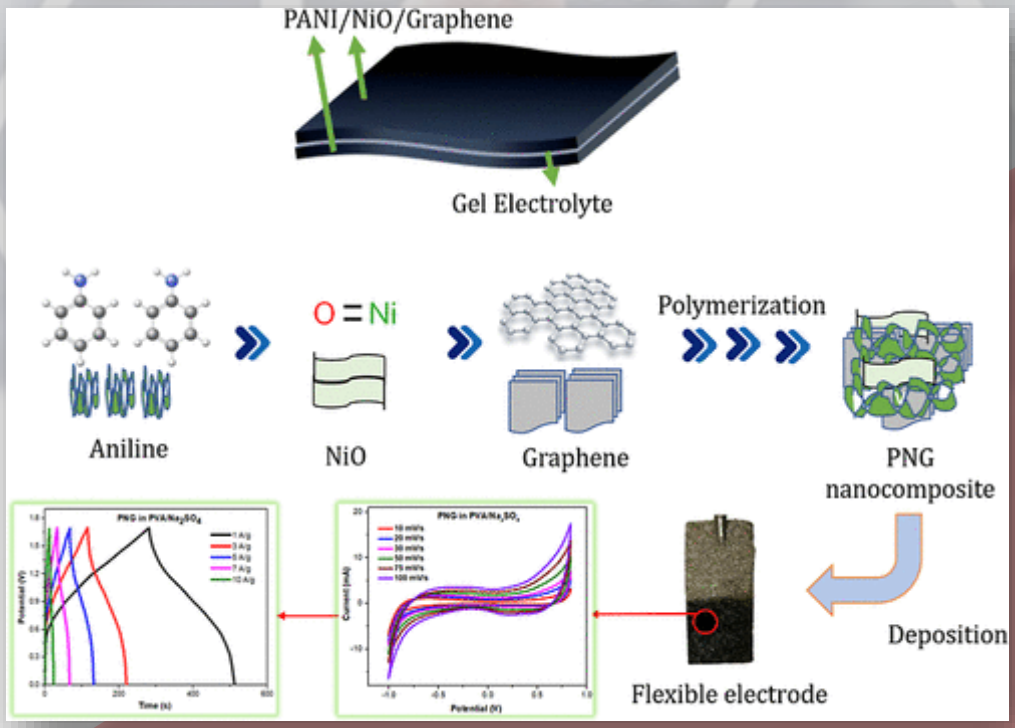


RECENT PUBLICATIONS

- **Unleashing enhanced energy density with PANI/NiO/graphene nanocomposite in a symmetric supercapacitor device, powered by the hybrid PVA/Na2SO4 electrolyte. *ACS omega*, *8*(48), 46002-46012, (2023).**

ABSTRACT

In this study, a PANI/NiO/Graphene (PNG) nanocomposite was synthesized using a cost-effective wet chemical polymerization method. This nanocomposite was used to fabricate supercapacitor electrodes in a nontoxic, noncorrosive, and neutral hybrid gel polymer (PVA/Na_2SO_4) electrolyte. The electrodes made from the PNG material underwent analysis using electrochemical techniques, including cyclic voltammetry (CV) and electrochemical impedance spectroscopy in a three-electrode system. For a deeper exploration of the supercapacitive properties of the PNG material, galvanostatic charge–discharge was employed. A practical two-electrode symmetric device powered by the hybrid PVA/Na_2SO_4 electrolyte was fabricated to calculate specific capacitance, energy density, and power density. The designed PNG material demonstrates excellent electrochemical behavior, exhibiting an improved energy density of 59.41 W h/kg at 850 W/kg. Furthermore, the PNG electrode shows excellent reversibility along with enhanced energy density and retains 89% of its capacitance after 2000 cycles. These outstanding properties of the PNG material can be attributed to the synergistic effect of PANI nanofibrous, NiO, and graphene two-dimensional structures.

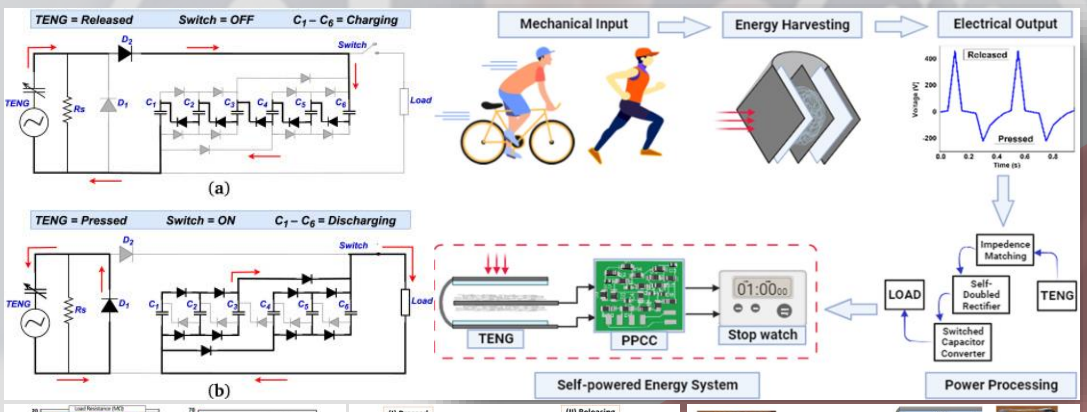


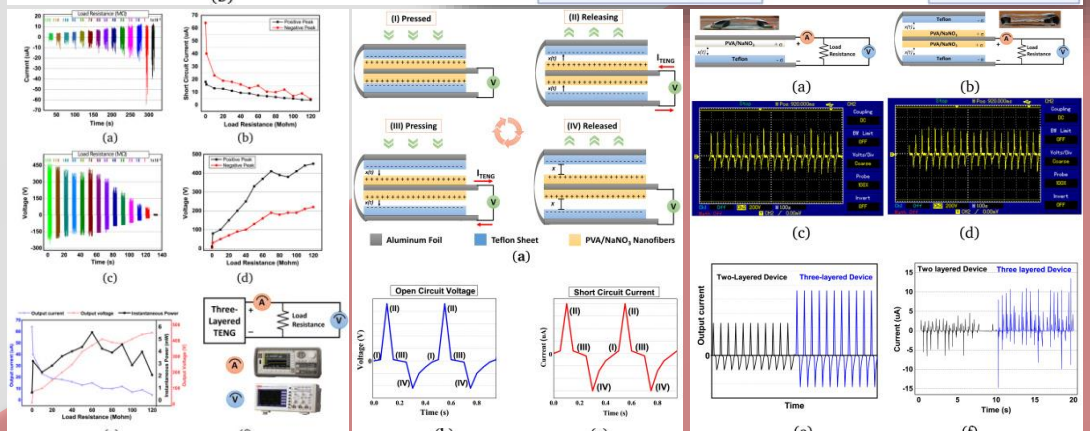
RECENT PUBLICATIONS

- **Output current boosting in triboelectric nanogenerators for applications in self-powered energy systems. *Engineering Science and Technology, an International Journal*, *55*, 101749, (2024).**

ABSTRACT

Sustainable and portable power solutions are the dire need of wearable devices. To ensure the sustainable powering of smart electronics, a portable self-powered system has been developed. A multi-layer Nanogenerator is fabricated using the state of the art Nanofiber Technology. In this work, the authors have dedicatedly encountered one of the major issues regarding the larger output impedance of the nanogenerator that significantly produces poor electrical performance while sinking to the electronic loads. We have modeled and practically designed the intermediate stage of power converter circuitry. This specialized circuitry not only reduces the peak output voltage (>450 V) produced from nanogenerators to an acceptable limit (5–10 V) but also increases the output currents to a larger extent. In this way, a significant increase in the output currents from the nanogenerators can enhance the overall system performance. Also, we have rigorously mapped the output impedance of the nanogenerators and designed a specialized encounter mechanism by inserting tunable passive power electronic components into the overall power handling circuit. So, a specialized power-efficient circuit is designed and developed that could handle technology-independent nanogenerators with significantly larger output currents and have the capability to power 20+ LEDs in a single run.





BOOK CHAPTERS

- Graphene-based Nanoelectronic Biosensors, in Nanotechnology in Electronics: Materials, Properties, Devices, 25-61 (ISBN:9783527346738, 2023) [Book Chapter: Wiley-VCH GmbH]
- Smart polymeric nanocomposites: synthesis and applications, in Smart Polymer Nanocomposites, 61-91 (ISBN: 978-0-323-91611-0, 2023) [Book Chapter: Elsevier Inc.]
- Smart electronic textiles, in Smart Polymer Nanocomposites, 395-412 (ISBN: 978-0-323-91611-0, 2023) [Book Chapter: Elsevier Inc.]
- Nano-inks and their applications in packaging industries, in Smart Multifunctional Nano-inks, 687(ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]
- MXenes for energy applications, in Smart Multifunctional Nano-inks, 475 (ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]
- Smart multifunctional polymeric inks for supercapacitor applications, in Smart Multifunctional Nano-inks, 429 (ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]
- Smart nanomaterials and three-dimensional printing for flexible solar cell applications, in Smart Multifunctional Nano-inks, 389 (ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]
- Electronic applications of carbon nano-dots, in Smart Multifunctional Nano-inks, 227 (ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]
- Introduction to smart multifunctional metal nano-inks, in Smart Multifunctional Nano-inks, 1 (ISBN: 978-0-323-91145-0, 2023) [Book Chapter: Elsevier Inc.]

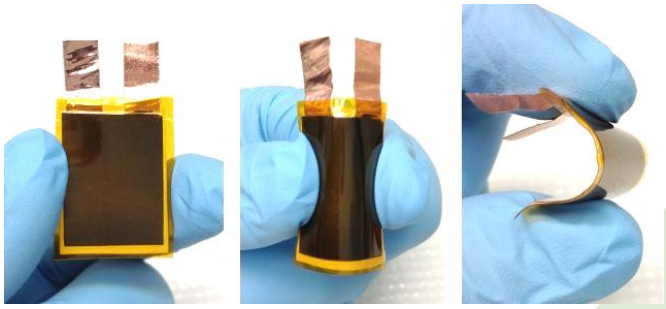
FILED PATENTS RECENTLY

CAEPE is proud to announce the filing of important patents, solidifying our position as frontrunner in the country in advanced electronics and photonics research. These patents mark a significant milestone in our journey towards innovation, reflecting our commitment to transforming cutting-edge ideas into real-world solutions. With each patent filed, we continue to push the boundaries of technology, ensuring a future where our pioneering work makes a lasting impact on industries and society.

FILED PATENTS RECENTLY

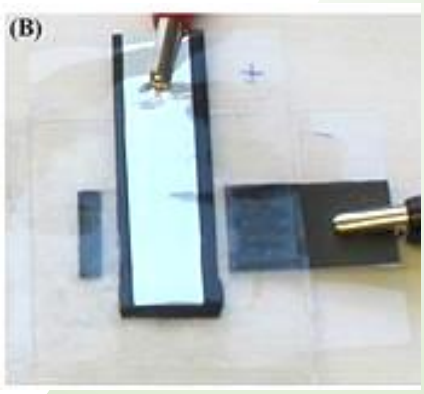
Patent No. 1

- Methods of producing novel thiophene-2, 5-diester supercapacitive electrochromic materials for energy storage applications



Patent No. 2

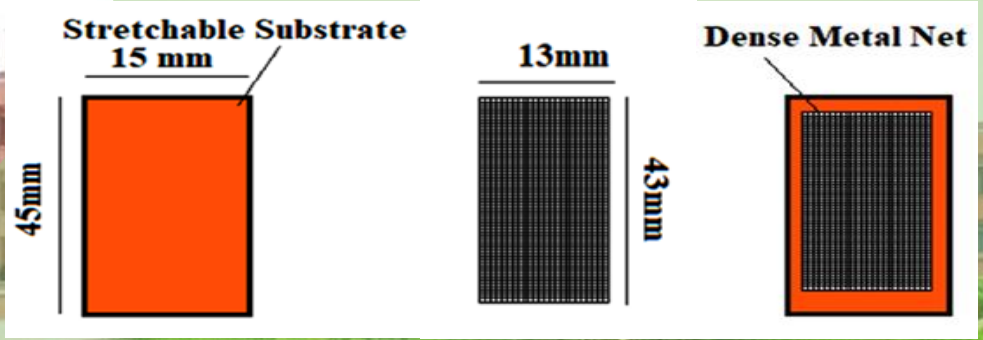
- Novel thienothiophene polymer and its synthesis method for electrochromic and flexible supercapacitor applications



(Disclaimer: Inventions covered under Intellectual Property Rights)

Patent No.3

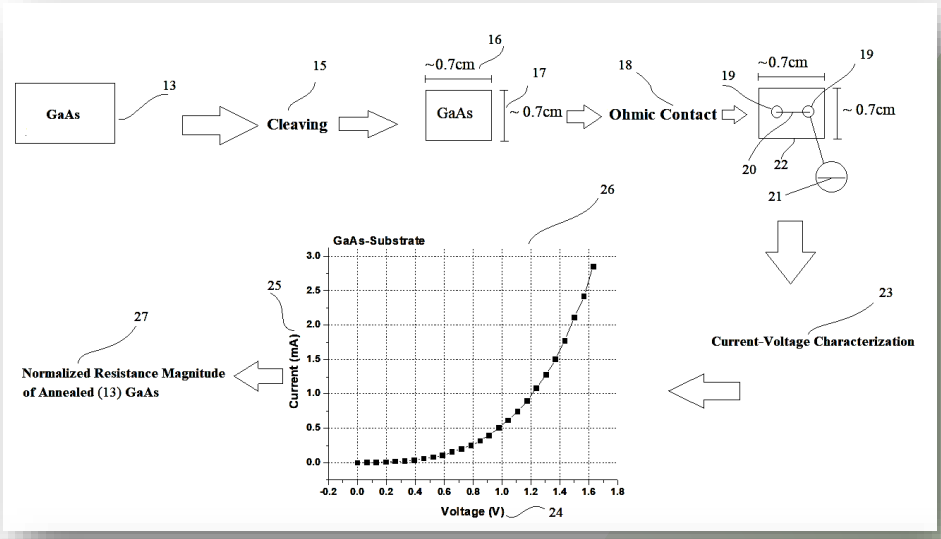
- A novel method for the performance evaluation of stretchable and foldable supercapacitor for energy storage applications

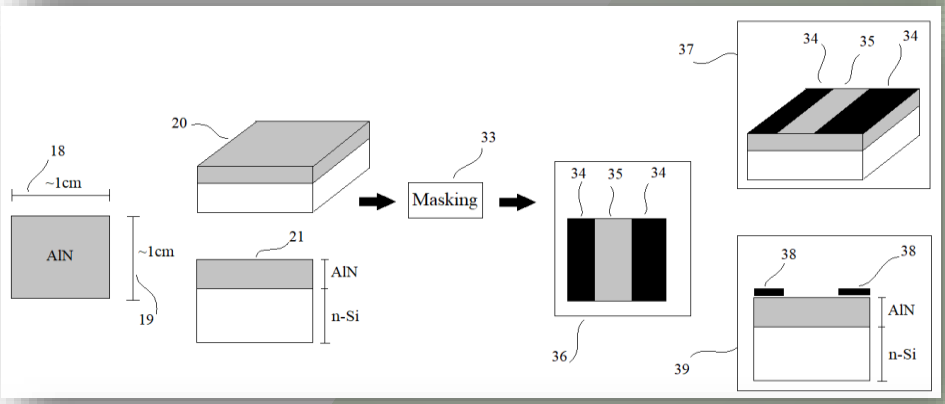


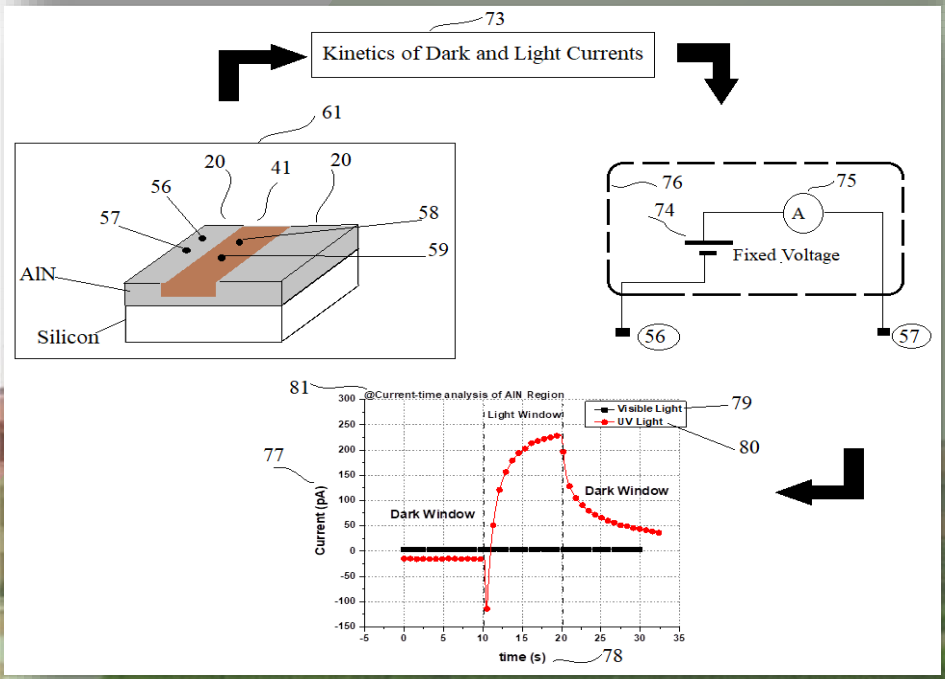
FILED PATENTS RECENTLY

Patent No.4

- **An Electrical Isolation induced novel method for the fabrication of GaAs and InP based Photo Detectors**







FUNDING & COLLABORATIONS

CAEPE has secured funding for several pioneering projects, driving forward our mission in advanced electronics, photonics and energy research. These funded initiatives are a testament to our commitment to innovation and excellence, empowering our talented researchers to explore new frontiers. With each project, we aim to deliver transformative solutions that will have a profound impact on technology and society.

BRITISH COUNCIL

UNIVERSITY OF THE WEST of SCOTLAND UWS

PAK UK Education Gateway
HEC/British Council Innovative & Collaborative Research Grants

INTERNATIONAL ISLAMIC UNIVERSITY ISLAMABAD

HEC

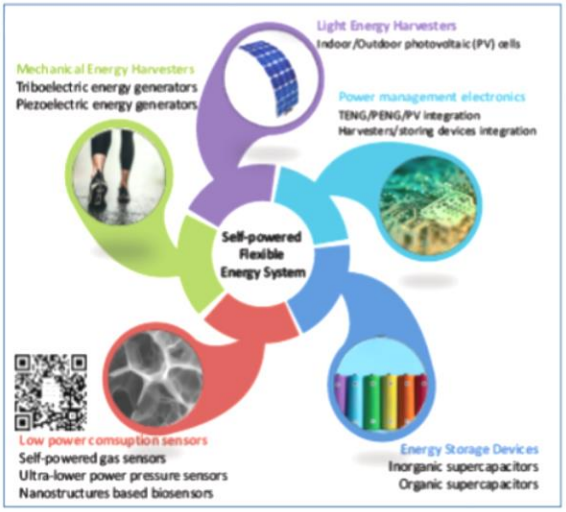
FleEnSys

Investigation in Advanced Energy Harvesters and Energy Storage Devices for Self-powered Flexible Energy System

Grantee: Dr. Imran Murtaza (International Islamic University, Islamabad)
Co-Grantee: Prof. Dr. Ahmed Shuja Syed (International Islamic University, Islamabad)
PI from UK: Dr. Carlos Garcia Nuñez (University of the West of Scotland)

Project Budget: PKR 100 million; Commencement date: 28th June, 2021
HEC Grant No: 20-ICRG-165/RGM/HEC/2020

Overview

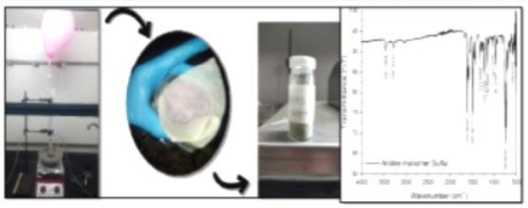


Objectives

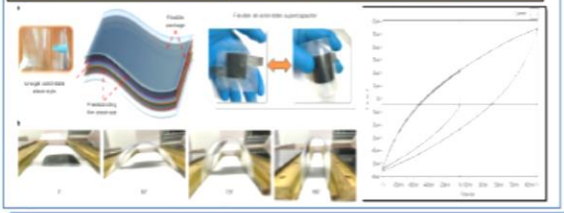
1. Synthesis & characterization of flexible materials: polymers & 2D structures
2. Fabrication of polymer & Graphene/MXene flexible supercapacitors (**SCs**)
3. Fabrication of flexible triboelectric & piezoelectric energy generators and PV cells.
4. Fabrication of SPAES based on SCs and energy harvesting devices.
5. Encapsulation & testing of optimized devices through FleEnSys industrial partner.
6. Validation, prototyping and up-scaling of self-powered electronics & sensing platforms

Research Outputs of IIUI

1. Synthesis and characterization of Polyaniline monomers

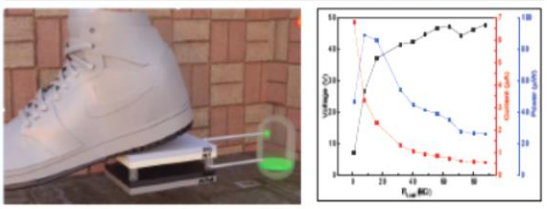


2. Development and testing of flexible Supercapacitors

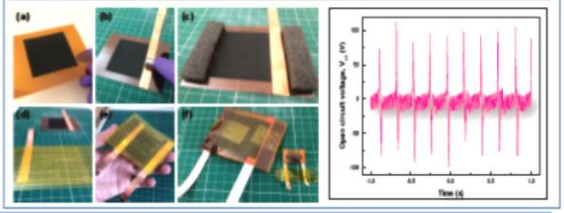


Research Outputs of UWS

1. Development and testing metal oxide based TENG



2. Development and testing of 3D graphene based TENG



Way Forward/Outcomes

Testing and validation of TEG, PV and SC devices based on newly designed and synthesized materials

Confirmation of continuous powering based on TEG+PV SPAES

Confirmation of SPAES as valid energy source for wearable tech

TFSI University of Glasgow meLAB lightricity NIZAM ENERGY UAM Universidad Autónoma de Madrid

NRPU

National Research Program for Universities

TOWARDS

Wearable Electronic World

Smart Self-Healing Flexible and Ultra Stretchable Strain Sensors and Devices for Medical Applications

Project No.: IIUI/ORIC/NRPU/2021

FUNDED BY

HIGHER EDUCATION COMMISSION PAKISTAN

Dr. Gul Hassan
Principle Investigator of Project
Postdoc Electrical Engineering
Assistant Professor (CAEPE)

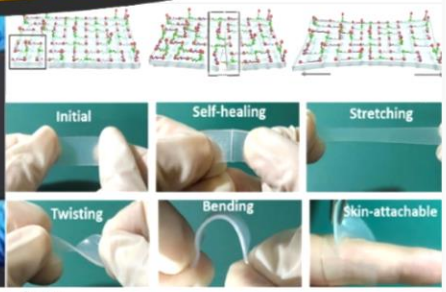
Prof. Dr. Ahmed Shuja Syed
Co-Principle Investigator of Project
Phd Electrical Engineering
Executive Director (CAEPE)

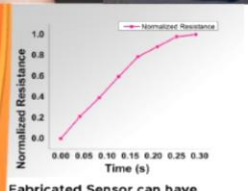
Phd Scholar
Engr. Arfa Asif

MS Scholar
Ms. Maryam Bibi

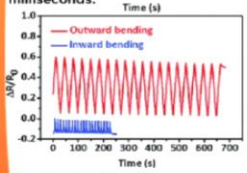
WEARABLE ELECTRONICS FOR MEDICAL APPLICATIONS

PROJECT ONGOING

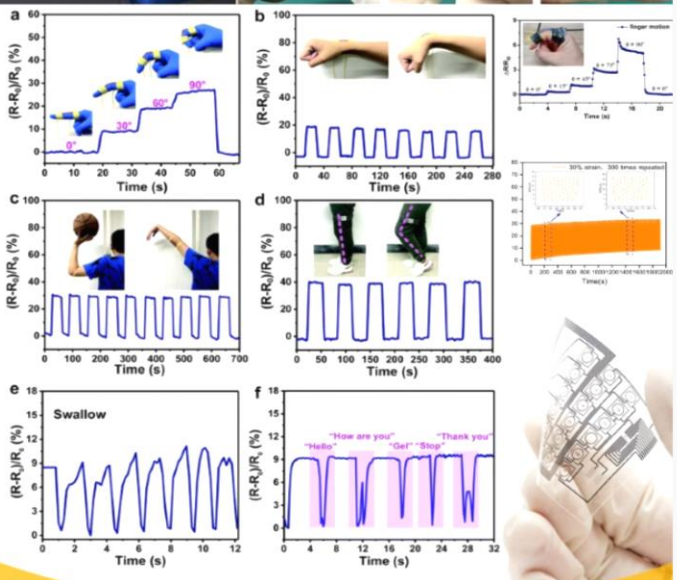




Fabricated Sensor can have phenomenal response Time in milliseconds.



Excellent and stable Bending/Relaxing plots.



CENTRE FOR ADVANCED ELECTRONICS AND PHOTOVOLTAIC ENGINEERING

US-Funded Workshops for Exposure of High School Students to Nanotechnology for Sustainable Energy in Pakistan

Introduction to the Centre CAEPE

The Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) at International Islamic University, Islamabad is a university-wide Centre aimed to create knowledge and develop the cross-disciplinary market-driven research focused on the applications of Advanced Electronics & Photovoltaic Engineering via processes, components and systems. The Centre is supported by various national and international grants.

Introduction to the Event

The project aims to organize scientific enrichment workshops for public and private SSC and HSSC science students across Islamabad and Rawalpindi aimed at scientific exposure to Pakistan's energy and nanotechnology requirements. These workshops will be a single day activity per week in July/August 2023 at (CAEPE), IIUI. One hundred direct and thousands of indirect students at their career defining phases would benefit from these workshops. The students would be educated through hands-on learning and scientific fun activities via state-of-the-art nanotechnology tools. They would also be given take-home aid materials.

Project Work Plan

Sr. No	Activity	Date
1	1. Introduction 2. Lab visits 3. Scientific fun activities 4. Provision of literature 5. Group discussions 6. Session on U.S. educational experiences and its nanotechnology facilities 7. Closing ceremony.	July 12th, 2023
2	1. Introduction 2. Lab visits 3. Scientific fun activities 4. Provision of literature 5. Group discussions 6. Session on U.S. educational experiences and its nanotechnology facilities 7. Closing ceremony.	July 19th, 2023
3	1. Introduction 2. Lab visits 3. Scientific fun activities 4. Provision of literature 5. Group discussions 6. Session on U.S. educational experiences and its nanotechnology facilities 7. Closing ceremony.	July 26th, 2023
4	1. Introduction 2. Lab visits 3. Scientific fun activities 4. Provision of literature 5. Group discussions 6. Session on U.S. educational experiences and its nanotechnology facilities 7. Closing ceremony.	August 2nd, 2023

Experts/Resource Persons

- Prof. Dr. Ahmed Shuja Syed, E.D CAEPE
- Dr. Habib Ahmad, A.P CAEPE/DECE
- Dr. Gul Hassan, A.P CAEPE
- Engr. Shoaib Alam, Lab's Manager CAEPE
- Engr. Muhammad Ali, Research Associate CAEPE

Program

Timing:
09:00 am – 05:00 pm
Venue:
Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) at International Islamic University, Sector H-10, Islamabad.

Activities

- Device fabrication facility visit (Concept of Cleanroom)
- Starting wafer material cleaning & Preparation
- Testing of solar cell
- Imaging of human hair and devices using optical and electron microscope
- X-ray of semiconductors
- Concept of conductor, semiconductor, and insulators
- Temperature impact on devices
- Physical demonstration of Fabrication of photodetector using highly sophisticated tools
- Demonstration of Ohm's law in devices

Who Should Attend?

This activity is planned for the SSC and HSSC science students who are at their career defining phases. The activity will provide them with the opportunity to learn about nanotechnology field in Pakistan and in the USA.

Refreshment will be served

P.I. of the Project

Dr. Habib Ahmad (Assistant Professor CAEPE/DE CE)

Contact

051-9019927,051-9019779, habib.ahmad@iiu.edu.pk

ASG SEVENTH CYCLE

ASG
ALUMNI SMALL GRANT PROGRAM

GRANTEE

HABIB AHMAD

PROJECT

US-FUNDED WORKSHOPS FOR EXPOSURE OF HIGH SCHOOL STUDENTS TO NANOTECHNOLOGY FOR SUSTAINABLE ENERGY IN PAKISTAN

ExchangeAlumni

To Apply for Funding https://pakusalumninetwork.org/grants/

EDUCATION AND TALENT

At the Centre for Advanced Electronics and Photovoltaic Engineering (CAEPE) of the International Islamic University Islamabad (IIUI), we are committed to fostering education and nurturing talent. Our world-class research facility provides a dynamic environment where students and researchers alike can thrive, pushing the boundaries of photonics, nanoelectronics, Power electronics, Energy systems and Nanoscience & Engineering. Through a combination of cutting-edge research, innovative projects, and comprehensive educational programs, CAEPE is dedicated to developing the next generation of leaders and innovators.

MS and PhD Programs

Current Academic Program

Centre is the custodian of Department of Electrical Engineering's MS/PhD program with strength in **Advanced Electronics** stream. Besides Centre is also partnering with Faculty of Engineering and Technology and Faculty of Sciences for MS/PhD **Energy Systems Engineering** and **Nano Science & Engineering** program.

Facility Usage in Regular Teaching Hours Undergraduate courses:

- Microelectronics technology
- VLSI technology
- Optoelectronics
- Selected FYPs

Almost 100 undergraduate students, both from male and female sections of BS Electrical Engineering Program are being taught in the Centre for hand-on sessions in multiple courses.

Graduate (MS/PHD) Courses offered in the Centre

- Microelectronic Devices
- Microsystems Technology
- Optoelectronic Devices
- Microwave and Millimeter-wave Devices
- Advanced Computer Architecture
- Advanced VLSI Design
- Photonic Devices & Circuits
- MEMS and Micromachining
- Advanced Microelectronic Technology
- Advanced Semiconductor Devices
- Modeling and Simulation of Semiconductor Devices
- Photovoltaic Electronics

MS and PhD Programs

- Power Semiconductor Devices
- Photovoltaic Material system
- Analytical Methods in Nano-scale Electronics
- Micro fluidics and Lab-on-a-chip Systems
- Advanced Multiprocessor Systems
- VLSI Test Principle and Challenges
- Integrated Circuits (IC) Packaging
- Integrated Chip (IC) Manufacturing Technology
- Semiconductor Device Reliability
- Organic Electronics
- Smart Sensors Technology
- Infrared Detectors & Systems
- Energy Materials Design
- Advanced Thermoelectric Technology
- Special Topics in Nanoelectronics
- Advanced Nano-scale Photovoltaics
- Compound Semiconductor Device Processing
- Quantum Information Process Devices
- Computational Nano electronics
- Special Topics in Electronic Design Technology
- Special Topics in Micro and Nanosystem
- Special Topics in Optoelectronics and Photonics

Data Statistics

- A large number of students are getting trained, guided and supervised in the Centre since the very inception of the laboratories.

- Each project has an average tenure of almost 1 year for MS and 2-3 years for PhD research students, respectively, for experimental training and facility usage.

- Currently over 60+ students from graduate program alone from the **Department of Electrical Engineering**, **Department of Energy Systems Engineering** and **Department of Nano Science & Engineering** are engaged with the Centre for taught courses and research access and supervision. Students and faculty members from other departments in the university and other organization are separately recorded with unique project's identification numbers.

Post- Doctoral Training Program

A paradigm shift in electronics and energy research

These trainings are designed to provide a dynamic environment where scholars can further enrich their research and expertise in their respective fields. Participants in our post-doctoral trainings will have access to state-of-the-art advanced equipment and will work alongside leading experts in their fields. Our training aims to nurture the next generation of scientific leaders by offering opportunities for groundbreaking research, professional development, and collaborative projects that address some of the most pressing technological challenges of our time. Through this comprehensive training, CAEPE is committed to advancing knowledge and driving innovation.

Post- Doctoral Training Program

A paradigm shift in electronics and energy research

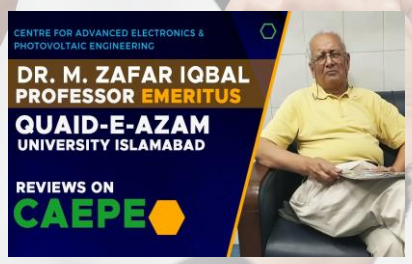
Hands-on Trainings & Quality Assurance

CAEPE provide hands-on-trainings with diversified machines being used by our students and researchers. It ensures quality research outcomes that should be recognized globally as well. Quality assurance has always been our first and foremost priority to make the equipment reliable and use for sustainable future.

CAEPE & SOCIETY

The relentless efforts of the CAEPE research society play a pivotal role in accomplishing desired milestones. The trend of innovation is remarkably maintained by our expertise, reflecting the international standards of research being carried out at this facility. The increasing demand for small-scale features with high efficiency has been a challenging regime, and CAEPE is at the forefront of addressing these challenges. The CAEPE research society is dedicated to developing solutions that have a profound impact on various industries, contributing significantly to the global advancement of knowledge and technology.

Explore Our YouTube Community!



www.youtube.com/@CAEPEIIUI

INTERNSHIPS

Transform the career with a CAEPE internship program.

WORKSHOPS & CONFERENCES

One Day National Workshop on 13th March, 2023

Flexible Energy Systems (FleEnSys: Technology Perspective from Materials to Circuits

Pakistan Semiconductor Summit on 18 April, 2024

Hosted by **GSME USA**

Founder and CEO: **Mr. Farhat Jahangir**

CAEPE team was invited on Pakistan Semiconductor Summit held on 18th of April, 2024. The event was focused to promote semiconductor industry where the motive was to build the capacity of producing advanced technological chips. Industrial experts exchanged their ideas to not only globalize nanotechnology but also to make revolutions in power electronics as well. **Engr. Prof. Dr. Ahmed Shuja Syed** was one of the panelist from CAEPE to share their invaluable thoughts on how we can transform the world of technology behind chips.

Building the Talent Pool

Pakistan Semiconductor Summit on 18 April, 2024

Hosted by **GSME USA**

Founder and CEO: **Mr. Farhat Jahangir**

One-Day National Workshop and Interactive Session on 14th May, 2024

"Energizing the Future: Flexible Devices and Systems for Versatile Applications"

Organized By

CAEPE and Flexible Electronics Laboratory at Department of Physics proudly concluded the large-set international grant under Pak-UK Gateway Program supported by the Higher Education Commission of Pakistan and British Council. The grant wass focused on creating viable solutions for flexible self-powered energy systems while targeting the niche in energy harvesting and energy storage devices. Prestigious research groups from University of Glasgow, University of the West of Scotland and an Oxford based industry were partnering in this project. This was the third workshop in the backdrop of the funded project, that had not only showcased some of the outcomes of the grant but created an opportunity to benefit from some of the most outstanding researchers in the field as well as notable science, technology and innovation leaders.

One-Day National Workshop and Interactive Session on 14th May, 2024

"Energizing the Future: Flexible Devices and Systems for Versatile Applications"






4TH PEC INTERNATIONAL
DEANS CONFERENCE

6TH - 7TH May, 2024

Marriott Hotel, Karachi, Pakistan

The session on "Cutting-edge and Interdisciplinary Synergies & Engineering Practices and Ethics" was a highlight of this prestigious event organized by **Pakistan Engineering Council.** The session was chaired by the esteemed Engr. Prof. Dr. Bhawani S. Chowdhry and co-chaired by Engr. Abdul Rehman Sheikh. This insightful session featured a notable presentation by **Engr. Prof. Dr. Ahmed Shuja**, who delivered an invited talk titled "Interdisciplinary Synergies; Some Case Examples and Success Stories."

International Conference on Renewable Energy Materials

June 25-26, 2024

Jointly Organized by Department of Physics Govt. College University, Faisalabad and Department of Physics, Kohsar University Murree

Venue

Kashmir Point Campus, Kohsar University *Murree, Murree Pakistan.*

GUEST LECTURES

We were honored to host distinguished guest lecturers from Jeju National University. These esteemed scholars delivered insightful presentations that showcased their cutting-edge research and advancements in the fields of semiconductor electronics, nanotechnology, flexible electronics and energy storage devices. Their expertise and innovative approaches have significantly contributed to the academic and scientific community, inspiring our students and faculty alike. The lectures provided a valuable opportunity for knowledge exchange and fostered collaborative efforts between CAEPE and Jeju National University, further strengthening our commitment to excellence in research and education.

Dr. Shenawar Ali Khan (Postdoc)
Mr. Sheikh Abdur Rehman &
Mr. Shahzad Iqbal (PhD Scholars)

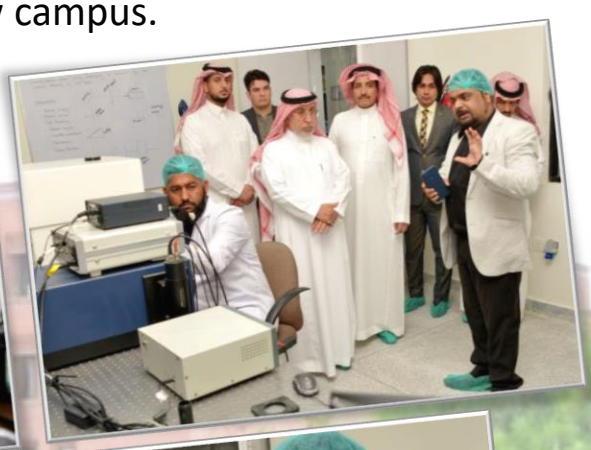
From Jeju National University, South Korea

VISITS

International and local visits from distinguished universities have been an integral part of the CAEPE experience. We were privileged to invite esteemed scholars, scientists, professors and researchers from renowned institutions worldwide. These visits fostered and enriched minds with an insightful exchange of knowledge, catalyzing revolutionary ideas and collaborative opportunities. The interactions provided a platform for discussing cutting-edge advanced technological developments, benefiting both our visitors and the CAEPE community. Such engagements have elevated the levels of motivation for the students in the research phase and provoked their capacity of innovating new ideas as well.

VISITS

H.E. Professor Dr. Ahmad Salem Muhammad Al- Ameri, Pro-Chancellor , International Islamic University (IIU) and President. Imam Muhammad Ibn Saud University inaugurated the recently shifted Centre for Advanced Electronics & Photovoltaic Engineering (CAEPE) that has been established in newly built block at the new campus.



VISITS

Dr. Tabbi Wilber force Awo Twe (**kings college London**). Dr. Gareth Andrew Thomsen **(Aston university, UK)**. Dr. Sarah Javaid **(Aston University UK)**, Dr. Faheha Azway **(Warvick university UK),** alongside with Chairman **Dr. Shahid ikram** & former Dean **Dr. Nadeem Ahmed Shiekh** visited the Centre to witness the breakthroughs of research being carried out at CAEPE.

Prof. Dr. Muhammad Sabieh Anwar, former Dean of LUMS, visited the Centre. His visit facilitated valuable discussions, Enriched our ideas and elevated research outcomes to some advanced levels.

VISITS

Visit of Dr. Shenawar Ali Khan **(Postdoc)** Mr. Sheikh Abdur Rehman & Mr. Shahzad Iqbal **(PhD Scholars)** from Jeju National University, South Korea.

Prof. Dr. Murtaza Najabat Ali, Founding Director at (Medical Devices Development Center MDDC), Founding CEO at N-ovative Health Technologies and Founding HoD and Professor of Biomedical Engineering Department at NUST visited the Centre.

VISITS

Mr. Farhat Jahangir Founder and CEO of GSMicroelectronics, San Jose, USA visited the Centre and discussed the possibilities of collaborative work in the area of semiconductors.

World renowned Distinguished Scientist, **Dr. Zahid Hussain** from **Berkeley Labs USA** visited the Centre and gave an invited talk on some of his pioneering work in the field of soft X-rays.

VISITS

Prof. Dr. Hammad Omer (COMSATS University Islamabad) and **Dr. Fareeda Anjum** (Director Research & Innovation) Higher Education Commission visited the Centre

Dean Faculty of Computing and Director Business Incubation Centre visited the Centre.

VISITS

Dr. Ahmed Zoha (University of Glasgow, UK) and team from UET Taxila comprising of **Prof. Dr. Muhammad Haroon Yousuf**, **Dr Junaid Mir** and **Dr Ali Javaid** visited the Centre.

NATIONAL & INTERNATIONAL COLLABORATIONS

The Centre for Advanced Electronics and Photovoltaic Engineering (CAEPE) is proudly indulged with the vast network of national and international collaborations. Our esteemed partners include prestigious institutions and organizations such as the **British Council**, **University of Glasgow**, **National Natural Science Foundation of China**, **Islamic Development Bank**, **Pakistan Science Foundation**, **Universidad Autónoma de Madrid**, **ME Lab**, **Lightricity**, and the **Institute of Thin Films, Sensing and Imaging**. These collaborations significantly enhance our research capabilities. Through these strategic partnerships, CAEPE has been recognized globally with meticulous efforts in research platform. Our affiliations facilitate young scholars and researchers to polish their skills and stand alongside with the level where the world is revolutionizing right now. These collaborative efforts not only provoke the stamina to conduct research but also brings the image of excellence that our country Pakistan has fabulous capabilities to exploit such a small scale devices in such advanced semiconductor and power electronics era.

Collaboration between ***Prof. Dr. Ahmed Shuja Syed*** and the ***University of Glasgow UK*** exemplifies the bond to shape the new era of technology.

Dr. Gul Hassan's collaboration with the Chinese team on CZ growth system training is a motivation for enhancing the production of Silicon Wafers.

Dr. Habib Ahmad's collaboration with the Georgia Tech USA, empowering the young talent to get their expertise in semiconductor technology, leading to innovation and excellence in the field.

SERVICES

USAGE & TRAINING

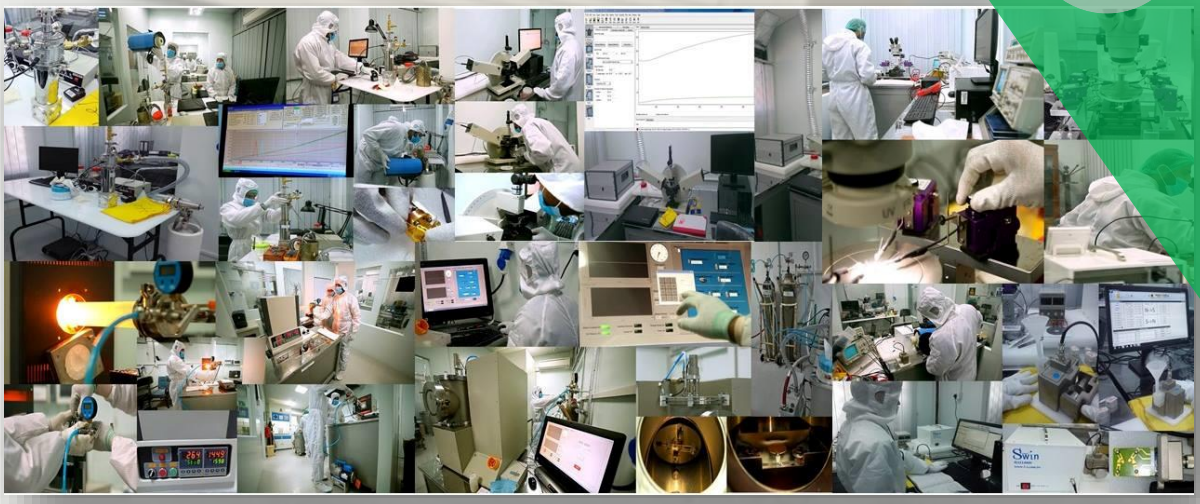
The facility is an open access to IIU students and faculty as well as other universities and scientific organizations on a University's BOG approved Service Cost Model.

Entry into the Centre's facilities requires Safety Training through the Master Users. One should follow the General as well as Specialized Training Requirements to utilize the services. Other specific Health and Safety training may be required depending upon the machine to be used. Your technical contact will provide additional information as needed.

Individual equipment training is required and can be scheduled by contacting the appropriate technical or administrative staff for each facility.

Viable Experience; International & National Relevance

- About 15 Years of Device Design Experience on International Industrial Simulators/ Modeling Tools
- Connected to World-wide FABs
- About 9 years of rigorous Quality Assurance of Centre Process Characterization Tools
- Indigenous Machine Engineering
- Over 650+ Nation-wide returning users on variety of projects since the formal inauguration of the facility
- Continuing ties with the strategic organization
- National and International Funded projects on the forefront of Advanced Electronics and Photovoltaic engineering, as part of Centre's portfolio



Turn the visionary ideas into reality with CAEPE.

Access Support

CAEPE, being a leading user facility, has also access to the Epitaxial Growers, Ion Implantation Services, Fabs for Standard CMOS development, III-V Devices, MEMS/ Microsystems applications; with experience in taping out the chips and discrete devices.

CAEPE is also in collaboration with some of world's top of the line research groups and experimental facilities.

Access to the Centre Facilities

The Centre provides an open access to its facilities for all the users who wish to use its capabilities for their respective research. All the facilities are charged through the CAEPE Service Cost Model

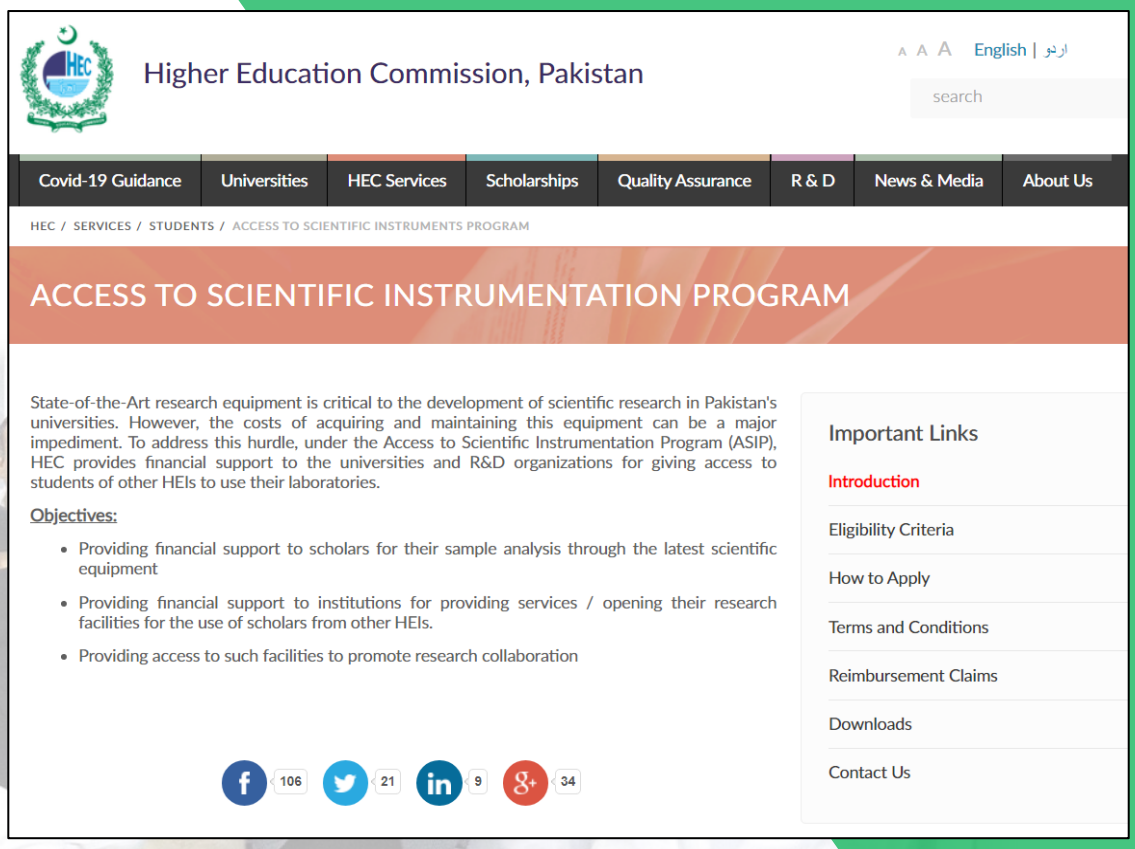
https://www.iiu.edu.pk/caepe

New addition to CAEPE's Technology Development Portfolio

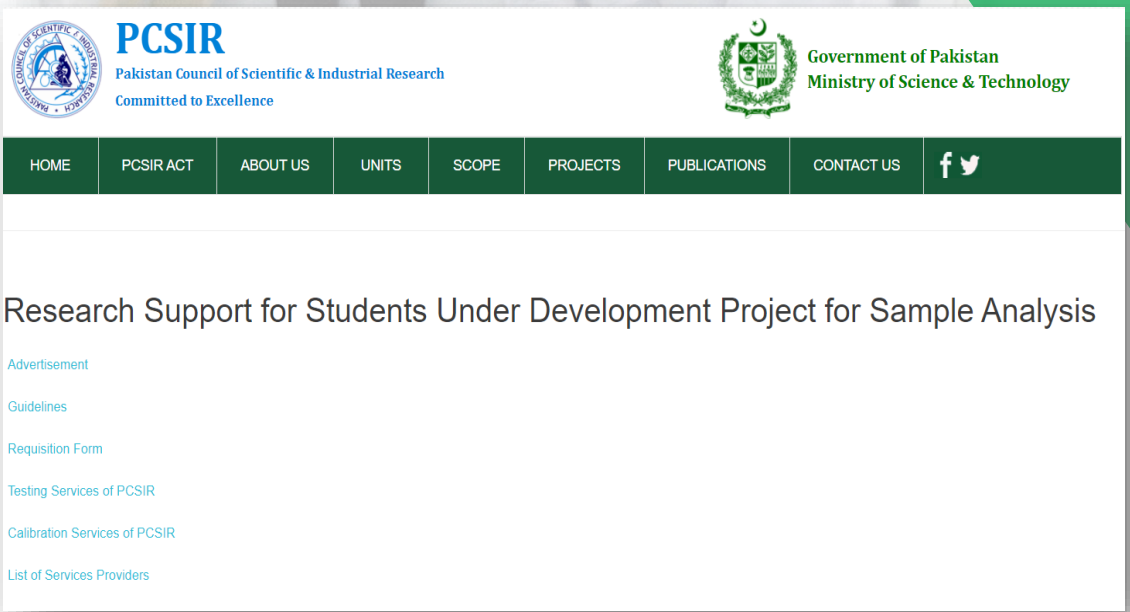
Our New, Bigger and Better Clean Room (ISO-5) for Micro- and Nano-device fabrication

CZ Growth System for Semiconductors and Optoelectronics Wafer Development Technology

In order to provide wide users with the facilities that are available inhouse, CAEPE has became part of the HEC "Access to Scientific Instrumentation Program" and providing the access to the users outside the university as well



Apart from HEC ASIP portal CAEPE is also part of the "Research Support for Students Under Development Project for Sample Analysis program" started by Pakistan Council of Scientific and Industrial Research (PCSIR) in the year 2022.



ELECTRONIC DEVICE DESIGN SUITE..

This part of the Centre, incepted in year 2009, is focused to facilitate students and researchers to design and model VLSI/ULSI devices, circuits and systems. The "Design Suite" is equipped with state of the art, trade-off commercial design tools.

Device Modeling and Simulation explores scaling and process development of advanced electronic and photonic devices. These tools cover device transport and performance as well as process modules. These predictive tools help to provide physical insights into new devices, new physical phenomena arising from nano-size geometry, new materials and interfaces.

Licensed Software	• Description
Silvaco TCAD	•Physical Layer designing and simulation software with capability to test and optimize the fabrication processes.
Cadence (Analog/Custom/digital IC design bundle)	•System and Circuit level designing and simulation software.
Soft MEMS (Mems Pro)	•To cater with the designing of the Micro-Electro mechanical systems where the systems have some form of moving part. Sensor and multiple detectors can be designed and simulated.
Mentor Graphics HEP	•IC Nanometer design; Design, Verification & Test; PCB Expedition.
IBM SRIM/TRIM and SUSPRE	•Ion Implantation simulations for electronically testing the impact of the different ion on to the sample/device. Mapping the damage and doping profile.
COMSOL	•With this software one can create physics-based models and simulation applications. This Model Builder enables you to combine multi-physics in any order for simulations of real-world phenomena. The Application Builder gives you the tools to build your own simulation application.

IsDB - FUNDED ADVANCED ELECTRONICS LABORATORIES..

The primary objective of this crosscut facility is the development of metrology and characterization tools to support patterning, nano-engineered device processing and overall integrated circuit fabrication for variety of application areas.

The specific focus is on micro- and nano-engineered devices with unique properties that enable continuation of functional scaling, where existing technology tapers off, and supports a research environment and portfolio that explores critical nanometer scale semiconductor manufacturing, facilitating a world-class student resource and measurable value through novel materials, devices and Fab-less manufacturing options.

Equipment	• Description
Multi-Head Probe Station	•For the characterizations of the systems that are larger in size and containing many different components placed on a single wafer. The system has highly precise probes that can be moved in micrometers through external control to either independently or cumulatively characterized.
Nano-Chip Reliability Grade Hall Effect System	•This is a initial electrical characterization system. The system has the capability to get the required electrical parameters such as mobility, conductivity, carrier concentration, etc.
ASMEC- Electro-Physical Characterization System	•This hyper sensitive system is the consortium of many different techniques with the capability to map the defect levels, Sensitive charge analysis, extremely low conductivity and mobility. The system is also equipped with the capability to lower and increase the temperature of the samples; that way real time efficiency of the devices can be extracted.
Metrology Grade Spectroscopic Ellipsometer	•For mapping the thickness and numerous other optical parameters such as refractive index, extinction coefficient, dielectric coefficient, etc. The machine shines a light on to a sample surface and based on the reflective data and sample model, the optical parameters are extracted.
Atomistic Layer Nanomaster Deposition System	•This system has the capability to deposit extremely thin layers in the regime of nanometers on to the sample surface. The system is the advanced version of the direct current heating system and has the capability to control the growth rate and the end thickness of the layer.
Rapid Thermal Processing (Annealing, Synthesis and RT-CVD System)	•Rapid thermal Processing or RTO is the annealing system with the capability to provide heat flux to the sample surface. The system can provide a constant temperature of maximum 1400°C on to the sample and can achieve this high temperature within few seconds.
Impedance Spectroscopy System	•This system is used for BODE and Nyquist analysis of charge storage devices. The system has the frequency range of milli hertz to kilohertz.
MEMS Grade Spin Coating, Stirring and Baking	•This system is used for spin coating of different materials on the sample/device surface.
Fume Hood/Wet Bench/Dual Glovebox for Sample Preparation, Etching and Cleaning	•These systems are used for clean-environment-specific sample preparation, cleaning, dicing, cleaving and etching of the sample and devices.

IsDB- FUNDED PHOTOVOLTAIC ENERGY ENGINEERING LABORATORIES..

The project is focused to cater the needs for development of the skilled human resource in the broader area of energy research with a special emphasis on PV engineering. The development of this laboratory in International Islamic University, Islamabad is university's first formal initiative to conduct teaching and research and produce trained manpower in this much desired area. In nutshell; the PV Engineering lab's project is targeted to:

- Capacity building of education and research in the PV engineering/energy sector in the country
- Producing high quality S&T manpower in the key areas of science and engineering of Photovoltaic technology

Equipment	• Description
Class 100 Clean room	•The facility is equipped with a class 100 cleanroom which is the first one in any educational Institution in Pakistan and is capable of facilitating the fabrication of Nano scale electronics and structures.
Class AAA Sun Simulator with complete diagnostics	•This system is capable of creating wavelength same as our sun so that we can test the solar cell inside the lab. The system is capable of accurately mapping the important parameters of the solar cells such as packing fraction and efficiency.
Plasma Enhanced Chemical Vapor Deposition System	•This system is used for the deposition of different layers through chemical reaction inside a closed chamber. The gases flow is controlled and the reaction potency is maintained for the growth of finer layers.
Magnetron Sputtering System	•This deposition system utilizes sputtering technique where the charged ions of the inert gas such as Argon are used to break the molecule of a material which are then transferred to the sample surface for the creation of a layer.
Scanning Electron Microscopy	•This system is used for the quantification of the sample surface and its composition. The system uses highly charged electrons to interact from the sample surface and gather information of the sample surface features. The system can see features as low as 5 nm.
Temperature Dependent Photo/Electro Luminescence Spectroscopy System	•This system is used for mapping the luminescence effect on the devices. The system uses laser of fixed wavelength to be illuminated on to the sample and the reflected data of light is passed through different analysis equipment to get the optical band gap and other important parameters.
EUV Lithography	•This system is used to transfer the pattern on to the sample/device surface. The system uses ultraviolet light to shine through a mask that is placed in-between the sample and the light source. The sample is quoted with a light sensitive material which changes its properties when exposed to the incoming light. With this system extremely small features in Nano meters in length can be made.

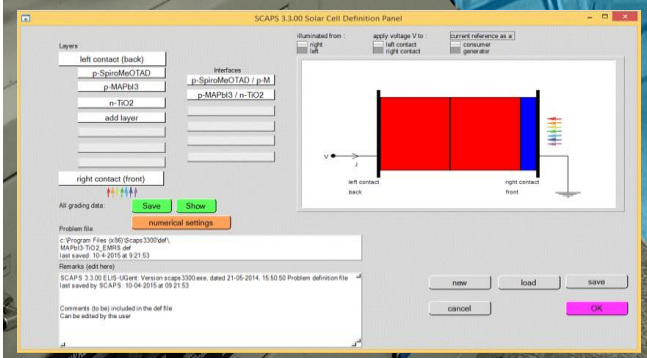
MODEL SIMULATION LABORATORY

The Lab is focused to simulate the model cleanroom assisted device design and process knowledge for the students by providing them with the licensed tools and audio-visual facilities. These tools are used to design and simulate the solid-state devices as well as system level computation for diverse application in Nano-electronics, Energy, Optoelectronics and Artificial Intelligence variables.

Licensed Software	• Description
TCAD OMNI	•Physical Layer designing and simulation software with capability to test and optimize the fabrication processes.
AI Assisted Computational Test BED	• A Cloud based Multi Node Tele Health Framework Supported by AI & BIGDATA that can help us easily connect to "different data sources / nodes, which would help to decide the line of action on the basis of numbers, analytics and Trend-forecasting in COVID-19 and similar future pandemic scenarios.
SCAPS	•SCAPS (a Solar Cell Capacitance Simulator) is a one dimensional solar cell simulation programme capable of mapping different important parameters of the solar cell.

Upscaling of an AI enabled data mining platform for "Informed Decision Making (IDM)" in COVID-19 and future pandemic scenarios for Government of Pakistan

- Project's Official Website
- Software Core System
  - User Management & Policies
  - Direct Node Views (Hospitals, Diagnostic Labs, Patients, Snap Checkers, Bullet Cameras, Thermal Sensing Doors, SMS Survey, Automated Calls)
  - Telemedicine (Audio / Video Consultation)
  - Centralized Electronic Medical Record (EMR)
  - Survey Stats
  - Analytics Board
  - Forecasting
- SMS Input & Survey System
- Automated Calling Survey System
- Mobile Applications (Android / IOs)
- WhatsApp AI bot
- Project Management Application



DEVICE PROCESSING & FABRICATION FACILITIES

The Lab has multiple systems that are capable of growing different thin and thick layers, films, device components etc. The processes are designed in such a way that several types of devices can be fabricated. The lab also comprises of the tools that can quantify the process outcomes and provide important information about the fabrication process efficiency.

Equipment	• Description
CZ Crystal Grower System with Vacuum Chamber for Oxide Single Crystals	•This system is used to make the starting wafers of Silicon for subsequent device manufacturing. The system can be tuned to get the desired doping and mobility ranges in the wafer. (Under procurement)
1200°C Quartz Tube Furnace (2'' O.D) with Glove Box Purification System	• The system is capable of providing calculated heat flux to the system with in few second to alter the structural morphology of the device. The system can be used to provide Oxidation and Nitridation to the sample surface.
Electrospinning & Electrosparying Unit for Nano-Materials	•This system is used for the growth of very fine Nano fibers and sacrificial layers. The system is fully automated while using fine control of voltage, spraying angle and delivery amount. One can laydown very fine pattern on to the device surface.
Multi-function Film Coater with Turbo Pump: Thermal Evaporating + Carbon Coating + Plasma Sputtering	•This system uses all the profound physical growth techniques to grow the layers specific to your requirement. The system can chose between different growth strategy to get the optimum results.
Compact Precision Screen Printing Film Coater	•The machine is used to develop and print circuits and systems on to a varity of substrates and surfaces with precise accuracy and low latency.
DC/RF Dual-Head High Vacuum Magnetron Plasma Sputtering Coater with Film Thickness Tracking System	•This system uses both RF and DC techniques to sputter and grow layer on the device surface. This way the process acceptance of the machine is increased and the machine can grow almost all type of films.
PECVD Split Tube Furnace	•The system is capable of chemically grow multiple layer in a single machine operation cycle and can grow different material layers by CVD process. The system has 4 channel gas mixture and can provide low pressure environment for better operation.
Long Tape Casting Coater	•This system is used to laydown the layers of different material on to the long sheets and substrates. The system is profoundly used in the fabrication of solar cells and Super Capacitors.

DEVICE CHARACTERIZATION, TESTING & EVALUATION FACILITIES

The lab is equipped with the facilities and techniques that can characterize devices that are fabricated in-house. The lab has many diverse systems, targeting different paradigm of research. The lab can characterize solid state devices, sensors, detectors, solar cells, and printed circuits. This crosscut facility has some of the most latest systems that are essential for analysis at material, device and system level.

Equipment	• Description
Femto/Pico ampere meter	•This system is used for ultra low current measurement. The usage of this machine is profound and important when one is working with hyper sensitive electronics.
Film/Coating Thickness Profilometer	•This system uses stylus to move over a surface to profile the roughness, different small pattern that are grown on to the sample surface. The system is of keen interest for the researchers that are working in MEMS, NEMS and Nano structures.
Precision Grinding / Polishing Machine	•This system is used to cure the surface of the device to remove any dupree or any residual from the previous processes. This way the next process preformed on the device will not be hindered.
X-Ray Diffraction	•The system uses X-rays to scan the sample/device to find its composition, its planes and vectors. The system is actively used by material scientists, engineers, biologist and Chemist to examine their samples structures and crystallography.
Atomic Force Microscope & Scanning Probe System	•This system is used to see the atomic structures, bonding and roughness. The system can clearly map the layout of the devices at atomic level.
Vibrating Sample Magnetometer	•This system uses magnets to map the effect of magnetism on to the sample working and characteristics. The system can cool the sample down to liquid nitrogen temperatures and see its output from device perspective.

FACTS & FIGURES

FACTS & FIGURES

Research Strength

- Technology behind the Chip (Physical Layer Design)
- Semiconductor Fabrication
- Process Reliability
- Materials & Device Characterization
- Internet of Nano Things
- Power & Energy Electronics
- Photonics
- Novel Materials Devices, Circuits & Systems for Sensing, Detection, Communication & Computing

Impact Quantification

Impact Parameters	Quantum
Extent of Utility and Access	>650+ scientific projects
Engagement of Returning Users	78%
Knowledge Creation & Dissemination in Process	>345 projects
Continual Skill Development	>8700 Runs
Responsiveness (Qualified Manpower Creation with Terminal Degrees in Dedicated Specialization; Collaborative Connections; Joint International Projects)	Manifold Increase on Yearly Basis

Sr. #	Content	No. of projects
1	Total number of the projects/users	650+
No. of student trained by the lab staff including BS Level Trainings on Design Suite		
2	Training Level - 1 (4 to 6 weeks)	300+
3	Training Level - 2 (Extensive Machine Training)	240+
4	No. of the department of Electrical Engineering (DEE), Faculty of Engineering & Technology (FET) students (MS/PhD) associated with the Centre (CAEPE)	100+
5	No. of Q.A Sessions on the machine	5600+
6	No. of International Training conducted of the lab staff	7
7	No. of National training conducted of the lab Staff	13

FACTS & FIGURES

Programs & Projects

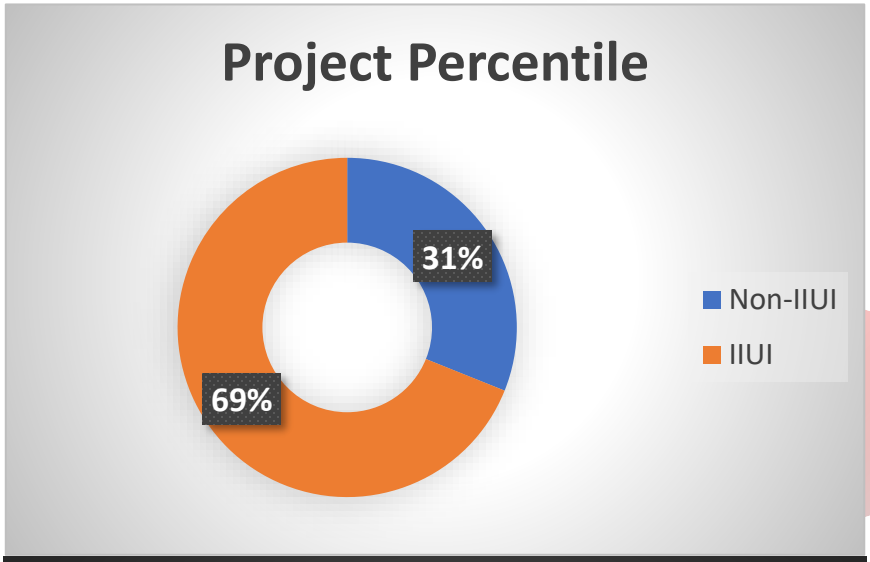
User's Spread within the Scientific disciplines

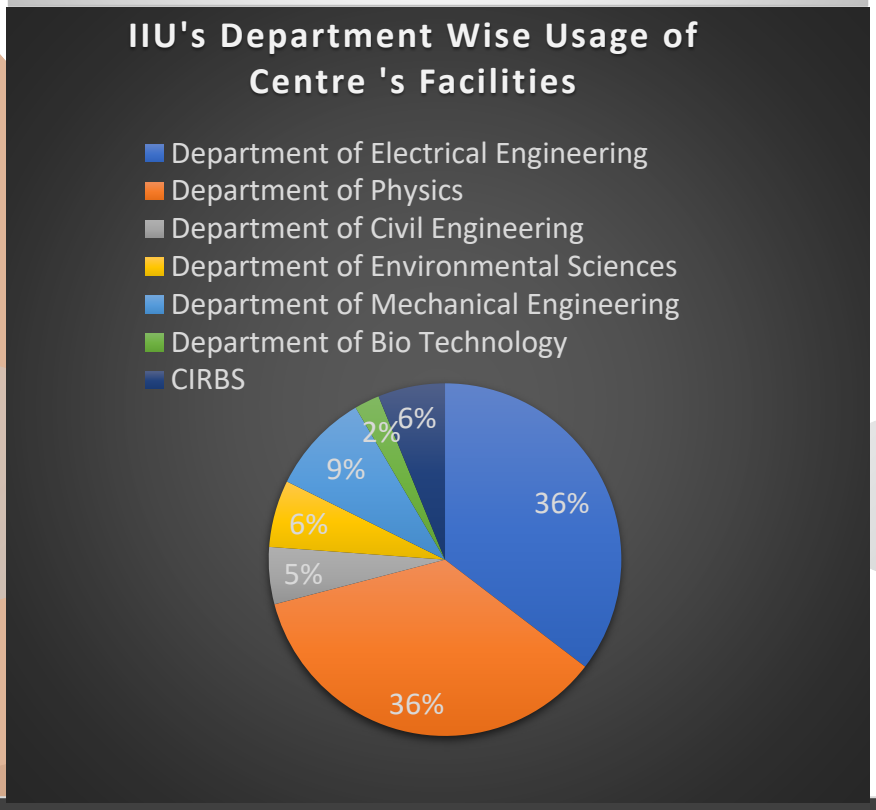
- Electrical and Electronic Engineering
- Physics/Nanotechnology
- Mechanical Engineering/Engineering Science/Materials Engineering
- Chemical & Process Engineering/Environmental Processes/ Civil Engineering
- Biomedical Engineering/ Bio Physics & Technology

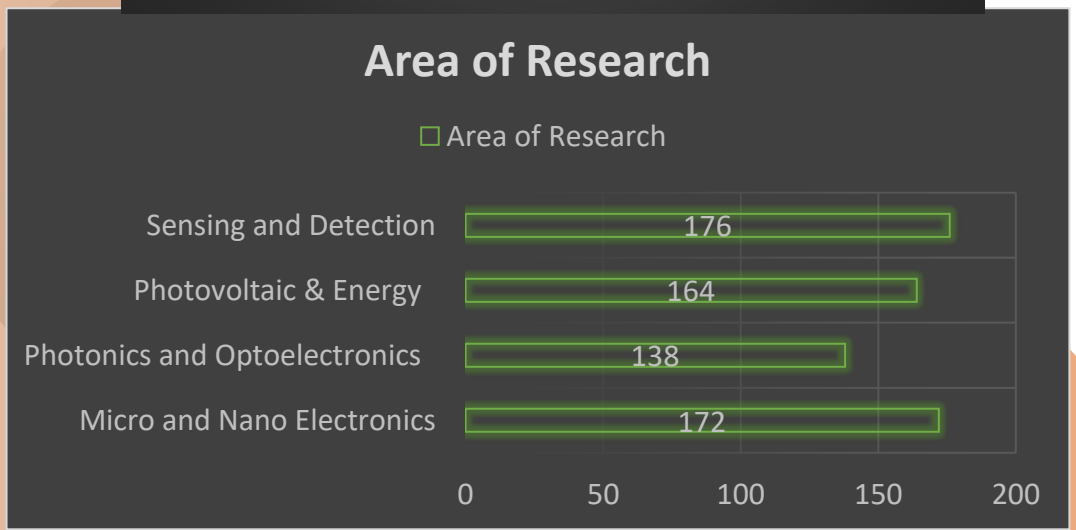
Some of the frequent users of the Centre's facilities having **multiple and diverse** scientific projects are listed below:

	SOME OF THE FREQUENT USERS
▪	Department of Electrical Engineering (International Islamic University, Islamabad)
▪	Department of Mechanical Engineering (International Islamic University, Islamabad)
▪	Department of Civil Engineering (International Islamic University, Islamabad)
▪	Department of Physics (International Islamic University, Islamabad)
▪	Department of Environment Sciences (International Islamic University, Islamabad)
▪	Department of Biotechnology (International Islamic University, Islamabad)
▪	Sulaiman Bin Abdullah Aba Al-Khail – Centre for Interdisciplinary Research in Basic Science (SA-CIRBS) (International Islamic University, Islamabad)
▪	Bahria University, Islamabad
▪	School of Chemical & Material Engineering (NUST)
▪	College of Electrical and Mechanical Engineering (NUST)
▪	U.S Pakistan Center for Advanced Studies in Energy (NUST)
▪	KRL (Khan Research Laboratories), Pakistan
▪	COMSATS Institute of Information Technology, Abbottabad
▪	Gomal University, D.I Khan
▪	National Institute Of Lasers & Optronics (NILOP)
▪	The National Engineering and Scientific Commission (NESCOM)
▪	Riphah University, Islamabad
▪	The Islamia University of Bahawalpur
▪	Ummal - Qura university Makkah, KSA
▪	Federal Urdu University of Arts, Science & Technology, Karachi
▪	Mirpur University of Science and Technology
▪	University of Kotli, AJK
▪	Abdul Wali Khan University, Mardan
▪	Ghulam Ishaq Khan Institute (GIKI, Topi)
▪	National University of Computer and Emerging Sciences (FAST)
▪	Quaid-i-Azam University
▪	University of Sahiwal
▪	Sardar Bahadur Khan Womens University
▪	University of Engineering and Technology (UET, Taxila)
▪	National University of Technology (NUTECH)
▪	Fatima Jinnah Women University, Rawalpindi
▪	National Center of Excellence in Physical Chemistry, University of Peshawar
▪	Pir Mehr Ali Shah Arid Agriculture, University Rawalpindi
▪	Allama Iqbal Open University
▪	University of Haripur
▪	COMSATS Institute of Information Technology, Islamabad
▪	Pakistan Atomic Energy Commission

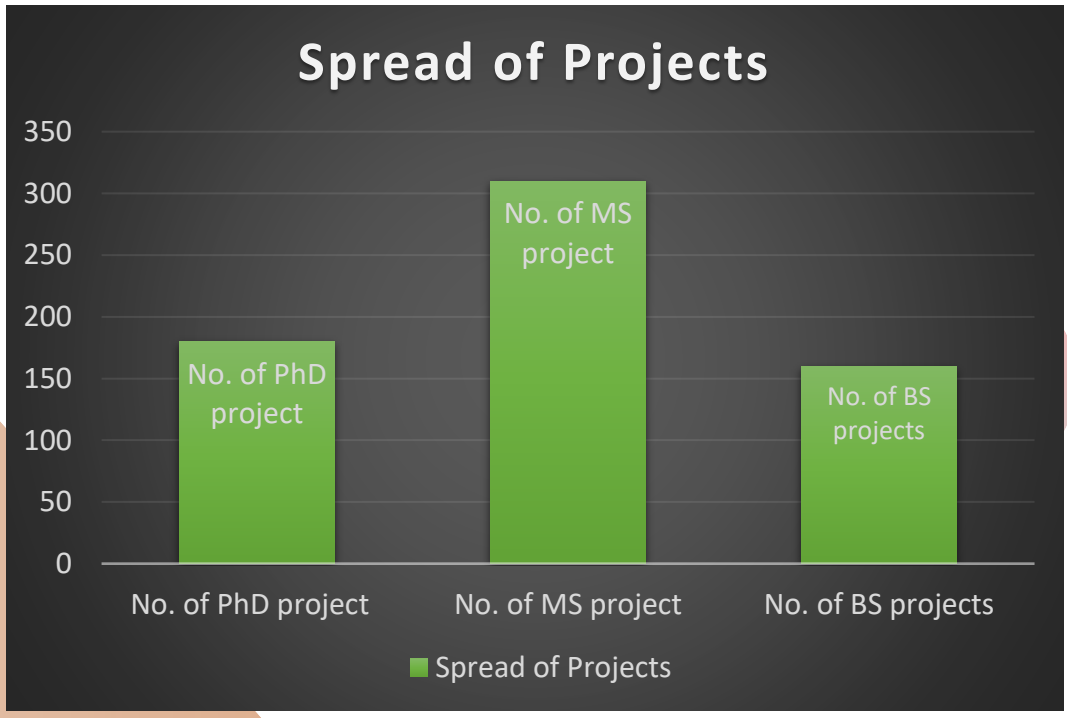
FACTS & FIGURES



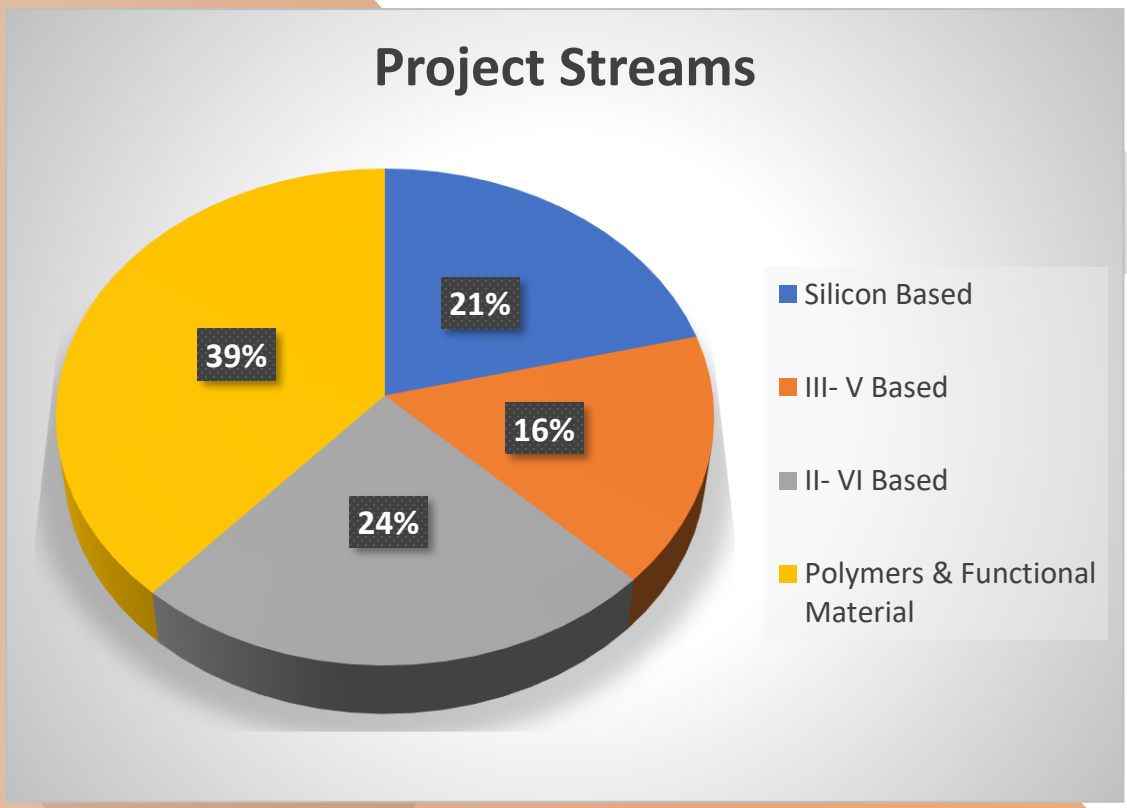




FACTS & FIGURES



Proportion of Student - wise Usage of Facilities



Electrical & Optical Materials – Wise Usage of Centre's Facilities

FACTS & FIGURES

TEAM AND COLLABORATION

- **Prof. Dr. Ahmed Shuja Syed**
- Vice President (R & E), IIUI/Founding Executive Director CAEPE
- **Dr. Gul Hassan**
- Assistant Professor/ Cleanroom Manager
- **Dr. Habib Ahmad**
- Assistant Professor /DECE/CAEPE
- **Dr. Humaira Arshad**
- Post Doctorate Research Associate ICRG project
- **Dr. Naimat ullah**
- Post Doctorate Research Associate ICRG project
- **Engr. Shoaib Alam**
- Research Associate/Laboratories Manager
- **Engr. Muhammad Ali**
- Research Associate/Research Liaison Manager
- **Engr. Faraz Qayyum**
- Lab Engineer/I.T & Networking Manager (Focal Point: Device Design Suite)
- **Mr. Shah Fahad**
- Research Assistant ICRG Project
- **Engr. Yousra Abid**
- PhD Scholar ICRG Project
- **Engr. Fakhra Farid**
- MS Scholar ICRG Project
- **Engr. Fatima Sajid**
- MS Scholar ICRG Project
- **Engr. Arfa Asif**
- PhD Scholar NRPU Project
- **Ms. Maryam Bibi**
- MS Scholar NRPU Project
- **Mr. Shoaib Waqas**
- Lab Technician
- **Engr. Majid Khattak**
- Lab Technician
- **Engr. Hammad Shakil**
- Lab Technician
- **Engr. Muhammad Bashir**
- Internee CAEPE
- **Engr. Zaigham abbas**
- Internee CAEPE

CAEPE AFFLIATES

- Dr. Imran Murtaza (IIUI)
- Dr. Muhammad Sohail (IIUI)
- Dr. Yousaf Hameed Khattak (FUUAST)
- Dr. Faisal Baig (FUUAST)
- Dr. Zeeshan Najam (MNS UET)

FACTS & FIGURES

GRANT PORTFOLIO

The Centre is inherited with several local and international grants and user access portfolio acquired such as:

- IIU Research Fund for the Development of Device Design Lab
- IDB, KSA Technical Assistance Grant Program- Establishment of Advanced Electronics Laboratories
- IDB, KSA Technical Assistance Grant Program- Establishment of Photovoltaic Energy Engineering Laboratory
- USA's Department of Energy's Lawrence Berkeley Lab's User's Facility Access Program
- HEC's Grant for the Development of Model Simulation Suite
- Govt. of Pakistan's PSDP/Mega PC-1 Award Allocation for the capacity building of the Centre- Civil Works for the dedicated space development (~ 20,000 Sqft) & Central Laboratories Facility Development
- Pakistan Science Foundation – National Science Foundation, China, Joint Research Project
- Pakistan Science Foundation – Triple Helix Project Funding to fight Covid – 19 and future Pandemic
- Startup Research Grant Program SRGP, HEC
- Pak-UK Education Gateway, Innovative and Collaborative Research Grant (ICRG)
- National Research Program for Universities- NRPU grant, "Towards Wearable Electronic World: Smart Self-Healing Flexible and Ultra-Stretchable Strain Sensors and Devices for Medical Applications"
- US-Funded Workshops for Exposure of High School Students to Nanotechnology for Sustainable Energy in Pakistan

The Centre has been most active entity in the university by targeting the national and international funding calls including Asia Connect, Pakistan Science Foundation Consortium Projects, UNESCO – IUPAC, EPSRC – GCRF, British Counsel's ICRG, HEC's NRPU and HEC's GCF etc.

A PARADIGM SHIFT IN ELECTRONICS AND ENERGY RESEARCH

CAEPE has contributed to the development of Pakistan's first National Semiconductors Plan-2022-2023

CAEPE team is also contributing a great deal in developing the first National Electronics Policy

CAEPE is also advising on several national and international fora pertinent to the Science, Technology and innovation (STI) interventions

ALUMNI VOICE

ALUMNI VOICE

Engr. Iftikhar Ali
PhD Scholar From University of the West of England.

Being part of the Centre for Advanced Electronics and Photovoltaic Engineering (CAEPE) at IIUI during my Master's thesis was a cornerstone of my research career. CAEPE's well-equipped facilities and supportive environment greatly enhanced the quality and scope of my research. I am deeply grateful for the opportunities and experiences offered by CAEPE, which have profoundly enriched my academic journey.

Dr. Zeeshan Najam
CEO Ultimate Engineering Consultants

CAEPE is a Centre of Excellence for the IC Design, testing, micro fabrication, verification and validation. With state of the art facilities available, the centre provides the scientists, Engineers and students an opportunity to work on the cutting edge technologies and generate knowledge. As an Alumni I am proud to be associated with the CAEPE since is inception in 2014.

M. Shahid Khan
PhD Scholar IIUI

My experience as a PhD student at CAEPE under the ICRG project has been incredibly enriching. The dynamic research environment, excellent resources, and supportive supervision significantly contributed to my academic and personal growth. The professional development opportunities, including workshops and seminars, have enhanced my skills in scientific communication and project management. I am deeply grateful for the guidance and support from my supervisor and colleagues throughout this rewarding journey. Thank you for the opportunity to be part of the CAEPE community.

ALUMNI VOICE

CAEPE excelled in several areas, particularly with its state-of-the-art research facilities and dedicated faculty. The institution was equipped with cutting-edge laboratories and resources that greatly supported innovative research and academic growth. Additionally, the collaborative environment fostered by the faculty and peers created a vibrant learning community, making it an ideal place for intellectual and personal development.

Dr. Waqas Ahmad

Postdoctoral Research Associate from University of Electronic Science and Technology of China.

I earned my PhD from CAEPE on a PSF-NSFC project. My research was focused on the Fabrication and Characterization of Stretchable Supercapacitors for Energy Systems Applications, providing me with extensive hands-on experience in advanced fabrication techniques. The skills I gained have been instrumental in my role as CEO of Itsolera, where I apply innovative solutions in the IT sector.

Dr. Hafeez ur Rehman

CEO of Itsolera

I completed my MS in Electrical Engineering with a specialization in Advanced Electronics from the Center of Advanced Electronics and Photovoltaic Engineering. This center is renowned for its efficiency and pivotal role in the field of Nanoelectronics. The center has significantly enhanced my knowledge of thin film electronics and emerging memory devices through its comprehensive suite of nanoelectronics fabrication and characterization facilities. This environment has been instrumental in fostering my research and academic growth, allowing me to contribute to the advancement of electronic technologies.

Engr. Illahi Jan Shah

Lecturer in the Department of Electronics at the University of Chakwal Pakistan.

الجامعة الإسلامية العالمية

STRATEGIC PLAN

(2022-2026)

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International Islamic
University, Islamabad

The Centre for Advanced Electronics and Photovoltaic Engineering (CAEPE) has aligned with the **Target Priority Area Number 1 (Growth and Academic Excellence)** and **Number 2 (Research and Collaborations) of IIUI's Strategic Plan 2022-26; Its strategies, Interventions and KPIs.**

ADDRESS

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www.youtube.com/CAEPE Research Society

Talk:

- Prof. Dr. Ahmed Shuja Syed (Founding Executive Director)
- Dr. Gul Hassan (Cleanroom Manager)
- Engr. Shoaib Alam (Laboratories Manager)

CAEPE PROGRESS REPORT 2023-2024

Designed by Engr. Arfa Asif PhD Scholar (CAEPE)