# IIT Roorkee

## Details on latest innovations and technological developments

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| Sl. No. | Title of Technology/Innovation | Brief Description about the technology/Innovation (including details about the innovator/developer) | If patented (Yes/No) with patent number | Technology Readiness Level (1-9) | Benefits | Potential Applications | Pictures/Videos, if any showcasing the Technology (Weblink) |
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| 1. | PORPHYRIN-BASED COVALENT ORGANIC FRAMEWORKS AND SYNTHESIS METHOD THEREOF | The present invention relates to a covalent organic framework (COFs) compound having conjugated structure of formula I. More particularly, the COFs of formula I is a nitrogen-rich porphyrin-based covalent organic frameworks synthesized using Suzuki-Miyaura cross-coupling. The robust carbon–carbon linked frameworks are formed from a borylated porphyrin core and nitrogen-containing aromatic linkers including benzene, bipyridine, phenanthroline. The COFs exhibit high crystallinity, tunable meso-porosity and enhanced nitrogen content, leading to superior electrochemical properties as supercapacitor electrodes, including high specific capacitance, cycling stability without reliance on a specific electrolyte having potential | Yes<br><br>Application no.: 202511114631 | **3** | Reduces production and replacement costs for energy storage devices. Enables long device lifetimes and minimizes carbon footprint and electronic waste. Supports broad market adoption in supercapacitor and battery sectors. Environmentally friendly: avoids hazardous reagents, uses recyclable materials, and supports renewable energy adoption. Facilitates rapid technology transfer from laboratory to industry due to scalability and | • Advanced batteries and hybrid energy storage systems.<br>• This technology can be used in for portable devices, Electrical vehicles (EV) and grid-scale.<br>• Flexible and wearable electronics requiring stable, high-capacitance materials.<br>• Sustainable energy solutions supporting renewable integration and carbon reduction.<br>• Industrial demand for scalable, robust, and cost-effective electrode materials. | **https://drive.google.com/drive/folders/1x_pQ6Fv-RiaFzWQCyAxvEee9Pcf_wCIO?usp=sharing** |

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| | | application in energy storage materials.<br><br>**Inventors:** M. Sankar, Ankit Kumar Deval and Ikrar Ahmad | | | compatibility with existing manufacturing infrastructure. | | |
| 2. | ROBOTIC ONE-DOF NEEDLING SYSTEM WITH REAL-TIME FORCE AND POSITION FEEDBACK | The present disclosure particularly relates to a robotic-assisted single-degree-of-freedom (1-DOF) needling system for real-time percutaneous intervention. The system comprises a robotic actuation mechanism configured to insert a passive surgical needle along a single translational axis; a force sensor configured to measure three-dimensional tissue interaction forces and torques during the needle advancement towards a tissue; a position sensor configured to track real-time three-dimensional position and orientation of a needle tip of the needle inside the tissue, and a multi-sensor integration framework configured to achieve synchronized real-time feedback by combining force sensor data with positional data on a unified platform, wherein the system includes a socket-based communication layer configured to stream an output data from the force sensor online.<br><br>**Inventors:** Felix Orlando Maria Joseph and Bulbul Behera | Yes<br><br>Application no.: 202511115088 | **2** | 1. Real-time force/position feedback<br><br>2. Over comes JR3 limitations<br><br>3. Integration in unified platform<br><br>4. Enhanced surgical safety and accuracy | The robotic-assisted 1-DOF needling system of the present invention finds its application in the field of robot-assisted surgeries, especially percutaneous surgical procedures. | **https://drive.google.com/drive/folders/1ZXyEVSyNZ-Eko2Pr0DjT8AYBrV0h2Kz9?usp=sharing** |

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| 3. | GAN MMIC ARCHITECTURE FOR ENHANCED POWER AND EFFICIENCY USING INTRINSIC HARMONIC INJECTION | The present disclosure provides Gallium Nitride (GaN) Monolithic Microwave Integrated Circuit (MMIC) architecture for enhanced power and efficiency using intrinsic harmonic injection. The architecture includes a plurality of Gallium Nitride (GaN) transistors configured in a monolithic microwave integrated circuit (MMIC), where the plurality of Gallium Nitride (GaN) transistors are configured to receive a radio frequency (RF) input. A harmonic network is coupled to the plurality of Gallium Nitride (GaN) transistors for RF harmonic management of the plurality of Gallium Nitride (GaN) transistors. A control structure is configured with each of the plurality of GaN transistors to optimize frequency harmonics associated with the plurality of GaN transistors. A power-combining network is configured to combine amplified RF signals from the plurality of GaN transistors and provide a RF output.<br><br>**Inventors:** Karun Rawat and Avinash Singh | Yes<br><br>Application no.: 202511120562 | **3** | The present invention utilizes the intrinsic non-linear drain-to-source capacitance of the Gallium Nitride (GaN) device to realize second-harmonic active loading in a Continuous Class-F (CCF) mode power amplifier, thereby improving power-added efficiency compared to conventional designs that rely on auxiliary harmonic-injection circuitry.<br><br>It supports multiple GaN devices in parallel at the output stage with power-combining, enabling decade-level output power scalability and facilitating future designs capable of achieving kilowatt-class output power while maintaining high efficiency.<br><br>The present disclosure uses intrinsic device capacitance for harmonic generation and enhances the | The GaN MMIC architecture is applicable in high-power, high-efficiency RF and microwave systems such as 5G/6G base stations, radar, satellite and aerospace communication systems. The technology enables compact, scalable, and energy-efficient RF power amplifiers, making it suitable for mass-manufactured telecom and defense electronics. | **https://drive.google.com/drive/folders/1kIBUSKa95CwGV1Y9-ptbiH83nf6HG90K?usp=sharing** |

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| | | | | | feasibility of monolithic integration, enabling compact, reliable, and repeatable Monolithic Microwave Integrated Circuit (MMIC) fabrication suitable for high-volume manufacturing<br><br>It uses multi-device configuration and a continuous waveform-shaping approach which improves thermal distribution across the amplifier structure, reducing thermal stress and enhancing long-term reliability in high-power applications.<br><br>It increases amplifier efficiency, lowers direct current (DC) power requirements, and eliminates auxiliary circuits that contribute to reduced energy consumption and thermal dissipation, extending device lifetime and supporting environmentally sustainable high-frequency system deployment. | | |

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| 4. | A METHOD FOR THE INCLUSION OF BORON, SULPHUR, PHOSPHORUS, AND IODINE INTO NITROGEN-ENRICHED NANOPOROUS POLYTRIAZINE FRAMEWORKS | The present invention relates to a method for incorporating heteroatoms, specifically boron (B), sulphur (S), phosphorus (P), and iodine (I), into nitrogen-enriched nanoporous polytriazine frameworks (NENPs) to form heteroatom-engineered materials designated as X-NENPs, where X = B or S or P or I. The method comprises reacting melamine and cyanuric chloride in equal molar ratios with 0.1–1.5 moles of a selected heteroatom precursor in a polar organic solvent, followed by either thermochemical heating at 100–200°C for 10–30 h or microwave-assisted treatment at 100–200°C for 10–45 min at 200–600 W. Unlike NENP, X-NENPs exhibit a stacked layered structure due to structural ordering after inclusion of heteroatoms in the NENP framework. The polytriazine frameworks are enriched with as high as 55 wt% of heteroatoms and have high specific surface areas up to 600 m2 g-1, with pore hierarchy<br><br>**Inventors:** Paritosh Mohanty & Tanya Gupta | Yes<br><br>Application no.: 202511121386 | **3** | • Sustainable, metal-free design, reducing environmental impact and cost by replacing noble metals in various applications.<br>• Increased chemical and thermal stability from robust triazine and heteroatom linkages, making materials suitable for challenging process conditions.<br>• The technology enables electrocatalysis, photocatalysis, sensors, adsorption, $CO_2$ capture and conversion, energy storage, and water treatment, all via tailored heteroatom inclusion and hierarchical porous architectures. | • These frameworks are used as electrocatalysts, photocatalysts, sensors, adsorbents, supercapacitors, $CO_2$ capture and conversion, and water treatment, driven by their high surface area, electronic structure tunability, and multifunctional heteroatom sites.<br>• Growing market demand is driven by the increasing need for sustainable, metal-free materials that can be produced at large-scale for energy, environmental, and catalytic applications. | **https://drive.google.com/drive/folders/1VJOCnrCW0svwsEpPt45sm3IUlu8iOG4p?usp=sharing** |
| 5. | A PROCESS FOR THE PRODUCTION OF BIOCHAR IMMOBILIZED UREA | The present invention relates to a process for producing a slow-release fertilizer known as biochar immobilized urea (BIU). The process | Yes<br><br>Application no.: 202511121387 | **3** | 1. Enhanced Nitrogen Use Efficiency (NUE): Ensures gradual nitrogen release, | 1. Agricultural fertilizer: Ideal for use as a slow-release nitrogen fertilizer for major crops. | **https://drive.google.com/drive/folders/18lIUxYxzp** |

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| | | uses molten-urea-based encapsulation of biochar, calcium sulphate, sulfur, and calcium bentonite to form a multi-nutrient matrix that releases nitrogen slowly, reduces nutrient losses, and enhances nitrogen use efficiency. The method is sustainable and can be readily integrated into conventional urea manufacturing plants.<br><br>**Inventors:** Basheshwer Prasad and Rishabh Didel | | | making more nitrogen available to plants over time.<br>2. Reduced Environmental Impact: Minimizes nitrogen losses via leaching, volatilization, and denitrification.<br>3. Improved Soil Health: Increases organic carbon, cation exchange capacity (CEC), and microbial activity in soil.<br>4. Water Retention and Structure: Biochar improves soil water holding capacity, aeration, and aggregate stability.<br>5. Multi-nutrient Supply: Provides nitrogen, sulfur, carbon, and calcium overcoming nutrient imbalance caused by conventional urea usage.<br>6. Cost-effective and Scalable: Can be implemented in existing urea manufacturing plants with minimal addition.<br>7. Sustainable Agriculture: Supports long-term soil fertility, | 2. Sustainable farming: Supports carbon sequestration and reduction of greenhouse gas emissions.<br>3. Soil rejuvenation: Improves soil fertility, structure, and microbial activity through biochar enrichment.<br>4. Water conservation: Enhances soil water retention, beneficial in drought-prone and arid regions.<br>5. Environmental compliance: Helps reduce nitrogen leaching and water contamination from excessive urea use.<br>6. Government initiatives: Aligns with India's $CO_2$ capture, carbon-neutral, and sustainable agriculture goals.<br>7. Industrial potential: Can be integrated into existing urea plants with minimal process changes.<br>8. Market opportunity: Addresses rising demand for eco-friendly, efficient fertilizers and reduces subsidy burden on the government. | 1RMQcdAmm1yFeI5_1xxWbhW?usp=sharing |

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| | | | | | reduces fertilizer dependency, and contributes to carbon sequestration. | | |
| 6. | A RECYCLED COPPER-BASED CONDUCTIVE INK FOR ROTOGRAVURE, SCREEN AND FLEXOGRAPHIC PRINTING APPLICATIONS | The present invention relates to a recycled copper-based conductive ink prepared by utilizing industrial copper waste, an acrylic emulsion binder synthesized via emulsion polymerization, and conductive polypyrrole filler obtained through oxidative polymerization. The copper powder recovered from rotogravure cylinder engraving units is sieved and incorporated at 35 wt % into the formulation, producing a stable, water-based conductive ink with superior adhesion and electrical properties. The developed ink demonstrates conductivity up to 1340 µS/m, drying within 15–20 seconds, and long-term stability up to 120-180 days. It is suitable for rotogravure, screen and flexographic printing, providing an eco-friendly route for industrial copper waste utilization in flexible electronics and packaging inks.<br><br>**Inventors:** Vibhore Kumar Rastogi, Brahma Prakash and Anurag Kulshreshtha | Yes<br><br>Application no.: 202511121388 | **3** | The technology provides a recycled copper-based conductive ink utilizing industrial copper waste, thereby reducing material wastage and enabling sustainable manufacturing. The ink exhibits excellent electrical conductivity, strong adhesion, rapid drying time, and long-term storage stability, while being water-based and suitable for high-performance printing processes. | The conductive ink is suitable for rotogravure, screen, and flexographic printing on paper, polymeric films, and metallic foils. The ink is applicable for use in printed electronics, flexible packaging, electronic applications, and packaging purposes. | **https://drive.google.com/drive/folders/1DbWG_z92rJMScLc4uotSwcqsqQ0iUE6B?usp=sharing** |

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| 7. | ANTIBACTERIAL PEPTIDE CONJUGATE | The present disclosure relates to an antibacterial peptide conjugate of formula (I), wherein "R" is independently selected from lysine, histidine, and arginine, and 'n' is an integer selected from 10 to 14, or an isomer or a pharmaceutically acceptable salt thereof. A pharmaceutical composition comprising the peptide conjugate is also disclosed.<br><br>**Inventors:** Saugata Hazra, Arindam Banerjee, Subhecchha Baidya, Swapnendu Deb and Mousumi Hazra | Yes<br><br>Application no.: 202511122752 | **3** | The disclosed antibacterial peptide conjugate enhances the effectiveness of existing antibiotics against multi-drug-resistant bacteria by acting synergistically to disrupt bacterial membranes and improve antibacterial potency. It enables reduced antibiotic dosage, helps overcome resistance mechanisms, and provides a stable, cost-effective alternative to conventional antimicrobial systems. | The present invention provides antibacterial peptide conjugates, which can self-assemble as scaffolds. When combined with β-lactam antibiotics they exhibit synergistic effects offering a promising strategy for overcoming antibiotic resistance and improving treatment outcomes in MDR bacterial infections. | **https://drive.google.com/drive/folders/1wBTlo638wUmVAFxsB2pLkr1E-NefeRbP?usp=sharing** |
| 8. | A PROCESS FOR DIRECT THERMAL LIQUEFACTION OF LIGNOCELLULOSIC BIOMASS | The present invention provides a sustainable and efficient method for the direct thermal liquefaction of lignocellulosic biomass using a refinery stream solvent system, further supported by a phenolic co-solvent. The process achieves high bio-oil yields under relatively mild operating conditions and does not require catalysts, hydrogen, or carbon monoxide input, making it more economical and environmentally friendly. A distinctive feature of the method is the recovery and recycling of the solvent, which ensures consistent | Yes<br><br>Application no.: 202511127046 | **3** | The developed technology provides a sustainable and energy-efficient method for converting lignocellulosic biomass into bio-oil with significantly higher yield compared to conventional hydrothermal processes. It operates under relatively milder conditions, making it more energy efficient. An important | • Production of bio-oil from lignocellulosic biomass as a renewable feedstock for transportation fuels.<br>• Integration of bio-oil with existing petroleum refinery streams for co-processing.<br>• Utilization of low-cost refinery solvents, reducing overall process economics.<br>• Scalable and sustainable approach supporting circular economy | **https://drive.google.com/drive/folders/1olg-a0TCREG3YNDUd38gGfO8pHpSJy6M?usp=sharing** |

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| | | performance across multiple runs and reduces operational costs. The bio-oil produced can be directly integrated into existing petroleum refinery infrastructure for upgrading into transportation fuels.<br><br>**Inventors:** Shushil Kumar and Manvendra Singh | | | advantage of the process is the recovery and recycling of solvents, which lowers operating costs while minimizing environmental impact. In addition to supporting sustainable waste management by utilizing agricultural residues, the bio-oil produced can be further processed in petroleum refineries as a renewable feedstock. Overall, the technology reduces dependence on fossil fuels and contributes toward lowering carbon emissions. | initiatives.<br>• Strong market demand driven by rising energy needs and pressure to reduce fossil fuel dependence.<br>• Alignment with government policies promoting renewable and cleaner energy sources. | |
| 9. | A SYNERGISTIC DESIGN AND SYNTHESIS OF AZO-BASED Fe(II) COMPLEX–PANI HYBRID COMPOSITES AS SELFADHESIVE ELECTROCATALYSTS | The present invention relates to the hybrid electrocatalysts comprising azo-based Fe(II) molecular complexes and Fe(II) coordination polymers embedded within a polyaniline (PANI) matrix, enabling synergistic catalytic performance for the hydrogen evolution reaction (HER) under both acidic and alkaline conditions. Azo-based Fe(II) complex and Fe(II) coordination polymer were synthesised and embedded within a polyaniline matrix that demonstrated the remarkable electrochemical stability | Yes<br><br>Application no.: 202511125475 | **3** | 1-Cost-Effective Alternative: Replaces expensive noble metals (e.g., Pt) with earth-abundant and low-cost iron.<br><br>2-High HER Efficiency: Delivers strong catalytic activity with low overpotential and fast hydrogen evolution kinetics.<br><br>3-Enhanced Durability: | 1-Hydrogen Production Systems: Efficient HER electrocatalyst for water electrolysis units.<br><br>2-Catalyst Platforms: Adaptable design for other electrochemical reactions (e.g., HER). Rising Global Hydrogen Demand: Driven by the transition toward carbon-neutral energy systems.<br><br>3-Cost Reduction Needs: | **https://drive.google.com/drive/folders/1k-y-sH-_UiexKEi2wJVdM6PnBQZlPBTb?usp=sharing** |

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| | | required for a potential electrocatalyst to be used for the hydrogen evolution reaction in acidic conditions. Moreover, PANI integrated azo-Fe(II) complex and polymer exhibited a small overpotential of (-0.170 V vs RHE) and (-0.105 V vs RHE), respectively, to attain a current density of 10 mA/cm2. The calculated Tafel slope values are 59mV/dec and 50mV/dec<br><br>**Inventors:** Sonal Sharma, Samresh Ghosh and Anasuya Bandyopadhyay | | | Exhibits excellent long-term electrochemical stability under continuous operation.<br><br>4-Superior Conductivity: Conductive polyaniline (PANI) matrix ensures rapid electron transfer during HER.<br><br>5-Synergistic Effect: Fe(II) centers and PANI structure work together to optimize active site exposure and charge transport.<br><br>6-Scalable Synthesis: Simple, hydrothermal fabrication method suitable for large-scale industrial production.<br><br>7-Eco-Friendly Composition: Free of toxic or rare elements, supporting sustainable and green energy technologies.<br><br>8-Structural Stability: Polymer encapsulation prevents agglomeration and corrosion of active sites. | Replacement of platinum with low-cost Fe-based catalysts reduces overall electrolyzer costs.<br><br>4-Decarbonization Goals: Governments and industries are investing heavily in clean hydrogen technologies.<br><br>5-Expansion of Green Hydrogen Projects: Rapid growth in renewable-powered electrolysis installations worldwide.<br><br>6-Hydrogen Economy Growth: Increasing applications in transportation, power generation, and industrial processes.<br><br>7-Scalability and Process Compatibility: Fe–PANI composites can be synthesized via scalable, low-temperature methods suitable for industrial adoption. | **Video included** |

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| | | | | | 9-Tunable Properties: Adjustable electronic structure and surface chemistry enable performance optimization.<br><br>10-Supports Green Hydrogen Economy: Contributes to low-cost, large-scale hydrogen generation for clean energy systems. | | |
| 10. | NANO-HYDROGEL AND METHOD OF PREPARING IT | A nano-hydrogel comprising L-cysteine functionalized (i) transition metal carbide MXene and (ii) two-dimensional carbon nanosheets for detecting CYFRA 21-1 and a method of preparation thereof are disclosed. An immunosensor comprising the nano-hydrogel is also disclosed.<br><br>**Inventors:** Gopinath Packirisamy, Shivam and Damini Verma | Yes<br><br>Application no.: 202511130847 | **4** | The disclosed nano-hydrogel enables sensitive and selective detection of protein biomarkers with good reproducibility and repeatability. It supports rapid and non-invasive analysis using saliva samples and shows reliable performance in the presence of interfering substances. The preparation method is simple, making the technology suitable for practical sensor applications. | The present invention provides nano-hydrogel and method for preparing it. The method of preparing the disclosed hydrogel is simple and easy. An electrochemical immunosensor comprising the disclosed nano-hydrogel demonstrates remarkable selectivity, reproducibility, repeatability, maintaining its performance even in the presence of other interfering agents. The immunosensor is therefore highly reliable. The immunosensor enables rapid, easy, as well as sensitive determination of protein | **https://drive.google.com/drive/folders/1fxGgzMlpU8cAD-_uq4_IzTzuBkk5Ys8F?usp=sharing** |

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| | | | | | | biomarkers such as CYFRA 21-1. The immunosensor can be implemented in point of-care diagnostic applications, for example, in early-stage cancer screening. It may, for example, be used in early-stage oral cancer screening using non-invasive saliva samples. | |
| 11. | PROCESS FOR RECOVERING INDIUM TIN OXIDE | The present disclosure relates to a reagent-free, energy-efficient process for recovering ITO from ITO-containing materials. The process comprises obtaining an enriched ITO black mass from an ITO-coated glass substrate, subjecting the enriched ITO black mass to a first-stage pyrolysis under an inert gas atmosphere at 350–400°C to remove organic and halogen-containing impurities, followed by a second-stage pyrolysis under an inert gas atmosphere at 500–800°C to stabilize oxide phases. The inert gas atmosphere is subsequently replaced with an oxygen atmosphere at 500–800°C to oxidatively remove residual carbon and regenerate crystalline ITO.<br><br>**Inventors:** Nikhil Dhawan and Rohit Gahlot | Yes<br><br>Application no.: 202511132209 | **3** | The present invention provides a simplified, energy-efficient, and reagent-free process for recovering ITO directly from waste LCD panels and related electronic substrates. | The recovered ITO is directly reusable in value-added applications, such as transparent electrodes, thin-film coatings, and optoelectronic devices, thus closing the resource loop for indium and tin in a circular economy framework. | https://drive.google.com/drive/folders/14uNLMyn2CNlgiHKGW2Uc36RaxLLd6KM1?usp=sharing |

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