TECHNOLOGY COMPENDIUM

सीएसआईआर - राष्ट्रीय अंतर्विषयी विज्ञान तथा प्रौद्योगिकी संस्थान

CSIR - NATIONAL INSTITUTE FOR INTERDISCIPLINARY SCIENCE AND TECHNOLOGY

Our Leaders

Shri. Narendra Modi
Hon'ble Prime Minister of India and President, CSIR

Dr. Jitendra Singh
Hon'ble Minister of Science and Technology and Vice President, CSIR

Dr. N. Kalaiselvi
Director General, CSIR and Secretary DSIR

Welcome Message

Dr. C. Anandharamakrishnan
Director

It is my privilege to welcome you to the vibrant and innovative world of CSIR-NIIST. As the Director of this esteemed institution, I am honored to lead a dedicated team of scientists, researchers, staff and students who are committed to pushing the boundaries of scientific discovery and technological advancement.

CSIR-NIIST has a rich legacy of excellence in research, and our mission is to continue fostering a culture of innovation and collaboration. We take pride in our contributions to cutting-edge research across various disciplines, and we are dedicated to addressing the complex challenges of our times.

I invite you to explore the panorama of our pathbreaking technologies that could push the frontiers of knowledge to new horizons. Come to us if these technologies can cater for your business needs, or let us collaborate to customize them to address your unique challenges, thereby making a meaningful difference to society.

OUR FOCUS

- Chemical Sciences
- Food & Nutraceuticals
- Light Metals and Alloys
- Sustainable Energy
- Agro-processing
- Environmental Research
- Functional Materials
- Microbial Processes
- Academic Activities

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Preamble

CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) is one of the thirty-seven constituent laboratories of the Council of Scientific and Industrial Research (CSIR), the premier R & D organization under the Ministry of Science and Technology, Government of India. Tagged as the interdisciplinary face of CSIR, the Institute stands as a beacon of excellence, with our legacy etched in cutting-edge research works and innovative breakthroughs that have transformed the landscape of various domains.

Known for its excellence in scientific research, our journey is marked by remarkable achievements in a diverse array of fields, including food processing, post-harvest technologies, fortified foods, functional materials, and environmental research. These accomplishments are complemented by our substantial contributions to chemical sciences, drug delivery and theranostics, smart molecular materials, pharmaceutical formulations, industrial enzymes, 2G ethanol, microbial processes, and metal casting. We are proud to be at the forefront in translating our knowledge into prototypes and products of commercial significance. But our reach doesnt end there. CSIR-NIIST is actively shaping the future in hydrogen energy, championing regional interests in coir and rubber, and unlocking the potential of rare earth metals for functional applications.

In the world of academia, we foster a dynamic environment through our academic activities under the esteemed umbrella of AcSIR. We empower young minds through programs like Jigyasa and skill development, nurturing the next generation of scientific leaders. In the realm of service, we hold a unique position as the sole NABET accredited laboratory for environmental impact assessment studies in mining, ports, and the harbor sector in Kerala. Additionally, our NABL certifications for dioxin and PCB analysis, as well as water and wastewater analysis, reflect our unwavering dedication to precision and quality. The institute is gearing up for accreditations within food and agri sectors, with the aim of becoming a hub for testing and analytical services.

To support the aspirations of academia and industry alike, we have established a centralized instrument facility unit. This facility caters to the analytical needs of a broad spectrum of stakeholders, making us a hub for cutting-edge research and development. The Institute's unwavering dedication to scientific research, innovation, and sustainable solutions remains at the core of its activities.

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DEHUMIDIFICATION DRIER FOR FOOD/AGRI PRODUCES

Technology Outline

The Dehumidification Drier for Food and Agricultural Products represents an advanced technology in food preservation, addressing critical challenges in drying produce, especially during high humidity conditions. This system employs controlled temperatures and uniform air distribution to dehydrate food and agricultural products while retaining their functional properties, micronutrients, and flavors. It is particularly valuable for processing heat-sensitive exotic spices, fruits, vegetables, and flowers, ensuring efficient drying even under adverse climatic conditions. By providing a reliable drying solution during challenging weather, this technology plays a crucial role in preventing post-harvest losses and improving the shelf life of agricultural products. The Dehumidification Drier not only preserves the quality and nutritional value of produce but also enhances its suitability for both local markets and export.

Salient Features, Highlights, And Advantages

- **Quality Preservation:** Retains functional properties, micronutrients, and flavors of produce through controlled temperature and uniform air distribution.
- **All-Weather Functionality:** Enables effective drying even during high humidity conditions, addressing challenges posed by adverse weather.
- **Versatile Application:** Suitable for a wide range of products, including heat-sensitive exotic spices, fruits, vegetables, and flowers.
- **Market-Ready Solution:** With a TRL of 9, the technology is fully commercialized and ready for widespread implementation in the food and agriculture industry.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 2 clients
- Major raw materials to be utlilized: Fresh ginger flakes, fruits, vegetables etc.
- Validation level: TRL 9
- Handholding support: Eng. consultancy for project implementation and training.

DEHYDRATION OF FRUITS AND FRUIT PRESERVATION IN HONEY

Technology Outline

This technique is designed to maintain the quality of ripe fruits during storage through novel drying methods that achieve optimal water activity. The process involves partially osmotically dehydrating fruits in honey, followed by gentle dehydration, resulting in a product free from additives. The end product can remain shelf-stable for one year at room temperature without added preservatives when vacuum-packaged in standalone polyethylene bags. This method preserves the fresh and natural flavors of the fruits while extending their shelf life. The dehydrated fruits can be enjoyed as healthy snacks, incorporated into desserts, or used as ingredients in various preparations, offering versatility and convenience to consumers.

Salient Features, Highlights, And Advantages

- **Natural Preservation:** Utilizes honey for osmotic dehydration, eliminating the need for artificial preservatives.
- **Extended Shelf Life:** Enables fruits to remain stable for up to one year at room temperature when properly packaged.
- **Flavor Retention:** Preserves the natural taste and nutritional value of fruits through gentle dehydration processes.
- **Versatile End Product:** Produces dehydrated fruits suitable for snacking, desserts, and various culinary applications.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 1 client
- Major raw materials to be utlilized: Regionally grown fruits and vegetables
- Validation level: TRL 8
- Handholding support: Technical guidance, selection and installation of machinery
- Techno-Economics :RoI as per MoU

READY TO COOK DEHYDRATED VEGETABLES/VEGETABLE MIXES

Technology Outline

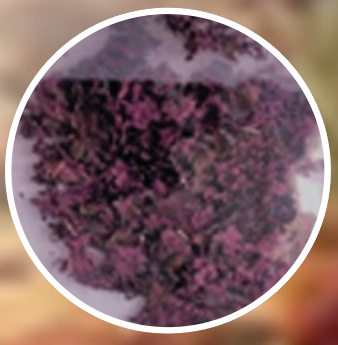
This technology focuses on preserving vegetables during peak harvest periods to ensure year-round availability. The process involves dehydrating various vegetables and creating vegetable mixes that can be easily rehydrated for cooking. These ready-to-cook products can be quickly prepared by soaking in hot water for 2-3 minutes. This innovation extends the shelf life of perishable vegetables, reduces post-harvest losses, and helps stabilize prices by managing excess production more effectively. The technology ensures a consistent supply of quality vegetables throughout the year, benefiting both consumers and the agricultural economy.

Salient Features, Highlights, And Advantages

- **Extended Shelf Life:** Preserves vegetables in a safe, processed condition for long-term storage and use.
- **Quick Rehydration:** Allows for easy preparation by soaking in hot water for just 2-3 minutes.
- **Versatile Applications:** Suitable for various culinary uses as standalone ingredients or in mixed vegetable products.
- **Economic Benefits:** Helps manage excess production and stabilize vegetable prices throughout the year.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 6 clients
- Major raw materials to be utlilized: Vegetables/spices
- Validation level: TRL 6
- Handholding support: Technical guidance, selection and installation of machinery
- Techno-Economics: RoI as per the terms and conditions of MoU



FRESH GINGER PROCESSING TECHNOLOGY

Technology Outline

This innovative technology extracts 30% more ginger oil from fresh ginger while preserving all aroma constituents that impart its fresh flavor. It is commercially viable for processing fresh spices into essential oils and spice powders, offering 20% savings in both labor and energy. The process is particularly suited for the climatic conditions of North Eastern States and ensures high-quality products with fresh aroma and better yield. By processing fresh ginger immediately after harvesting, the technology guarantees a superior product while creating employment opportunities for rural populations and generating income for farmers. Additionally, the environmentally friendly nature of the process, which avoids toxic chemicals, makes it a sustainable option for spice processing.

Salient Features, Highlights, And Advantages

- **Enhanced Extraction Efficiency:** Extracts 30% more ginger oil while preserving all fresh aroma constituents.
- **Economic Benefits:** Offers 20% savings in labor and energy, creating employment and income opportunities.
- **Quality Assurance:** Ensures high-quality products with fresh aroma and better yield through immediate processing.
- **Environmental Sustainability:** Utilizes an eco-friendly process without toxic chemicals, promoting sustainable spice processing.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 7 clients
- Major raw materials to be utlilized : Fresh ginger
- Validation level: TRL 8
- Handholding support: Tech transfer, project implementation in turnkey/consultancy basis

RED PALM OLEIN (RPO) BASED SOFT GEL VITAMIN-A SUPPLEMENT

Technology Outline

This innovative technology harnesses the nutrient-rich properties of Red Palm Olein (RPO), an edible grade oil abundant in β-carotenoids, to create effective Vitamin-A supplements in soft gel form. The primary aim of this development is to combat Vitamin-A deficiency, a significant health concern, particularly in rural communities. By utilizing RPO, the technology provides a natural and accessible source of Vitamin-A, which is crucial for maintaining good vision, supporting immune function, and ensuring overall health. The soft gel format makes it easy for individuals of all ages to consume, addressing the widespread nutritional deficiency in a practical and user-friendly manner. This approach not only offers a solution to a critical health issue but also promotes the use of natural, plant-based sources for essential nutrients.

Salient Features, Highlights, And Advantages

- **Nutrient-Rich Composition:** High content of β-carotene, tocopherol, and tocotrienols, offering not just Vitamin-A but also additional antioxidant benefits for overall health.
- **Natural and Safe Formulation:** Natural composition ensures safety for consumption and effectiveness in improving Vitamin-A levels, making it suitable for long-term use.
- **User-Friendly Delivery:** Easy-to-ingest soft gel format allows for convenient integration into daily diets, enhancing compliance and regular intake.
- **Targeted Nutritional Solution:** Practical approach to addressing widespread Vitamin-A deficiency, especially beneficial for rural communities with limited access to diverse nutrient sources.

Commercialization Status

- Status of commercialization: Not yet commercialized
- No. of Licenses: Licensed to 4 clients
- Major raw materials to be utlilized: Red palm oil
- Validation level: TRL 9
- Handholding support: Technical support
- Techno-Economics: As per MoU

REFINING OF RICE BRAN OIL

Technology Outline

The refining of rice bran oil presents a transformative approach to oil production, offering numerous health benefits such as enhanced skin health and improved immune system function. This method yields a high-quality, physically refined rice bran oil that retains its micronutrient richness while ensuring safety and purity for edible use. The resulting oil is rich in tocopherols, tocotrienols, and oryzanol, known for their antioxidant properties and contributions to overall well-being. As a versatile and health-enhancing edible oil, it caters to consumers seeking nutritious and high-quality options for their dietary needs, providing a healthier alternative to conventional oils.

Salient Features, Highlights, And Advantages

- **Health-Enhancing Properties:** Offers benefits such as improved skin health and immune system function.
- **Nutrient Retention:** Preserves micronutrients like tocopherols, tocotrienols, and oryzanol during refining.
- **Versatile Application:** Suitable for various culinary uses while providing health benefits.
- **Superior Quality:** Ensures safety and purity for edible use while maintaining nutritional value.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 5 clients
- Major raw materials to be utlilized: Crude rice bran oil
- Validation level: TRL 9
- Handholding support: Technical support for the process implementation and plant commissioning

SWING TECHNOLOGY FOR SPICE OIL AND OLEORESIN EXTRACTION

Technology Outline

Swing Technology revolutionizes the extraction of spice oil and oleoresin, offering a 40% increase in yield while drastically reducing processing time to just four hours. This innovative method ensures superior flavor quality, making it highly attractive for producers aiming to maximize efficiency and product quality in the competitive spice market. The technology is adept at producing high-aroma essential oils ideal for value-added products and can extract oleoresin and essential oil from both fresh and dry spices. By adopting swing technology, spice manufacturers can enhance their product offerings with superior quality oils and oleoresins, meeting the growing demand for premium spice extracts in the food and fragrance industries.

Salient Features, Highlights, And Advantages

- **Enhanced Yield and Efficiency:** Offers a 40% increase in yield with processing time reduced to just four hours.
- **Versatile Extraction:** Capable of extracting oleoresin and essential oil from both fresh and dry spices.
- **Superior Product Quality:** Ensures high-aroma essential oils and superior flavor quality in extracts.
- **Market Competitiveness:** Enables manufacturers to meet growing demand for premium spice extracts in various industries.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 1 client
- Major raw materials to be utlilized: Fresh/dry spices, chilli, turmeric, ginger etc
- Validation level: TRL 8
- Handholding support: Technology transfer

FRUIT ROLLS

Technology Outline

Fruit roll-up also known as fruit leather, is a type of confectionery made from fruit puree that has been dried into a thin, flexible sheet. To overcome the inherent defects of conventional drying methods and relate it to fruit roll-up drying, we have used Refrigeration Adsorption Dehumidified Dryer (RADD) customized in our institute and this fruit roll-up drying offers several advantages over conventional methods; by implementing the specific formulation and innovative drying technology, manufacturers can produce high-quality fruit roll-ups that meet consumer expectations for flavor, nutrition, and safety.

Salient Features, Highlights, And Advantages

- Nutritional Retention: due to low-temperature drying.
- Energy Efficiency: Reduced energy consumption compared to traditional drying methods, leading to lower production costs.
- Safety: Minimized risk of aflatoxin contamination through controlled drying conditions, ensuring a safer product.
- Convenience: Lightweight, portable, and easy to store, making it an ideal snack for on-the-go consumption.
- Flavor Preservation
- 100% Natural Ingredients
- Versatile Use
- Customizable Flavors
- Shelf-Stable

Commercialization Status

- Validation level: TRL 6, Technology validation at relevant environment

PLANT BASED BUTTER

Technology Outline

This innovative process creates plant-based butter from a semi-solid system formulated using plant-based food hydrocolloids. The resulting product replicates the sensory and textural characteristics of commercially available dairy butter. This butter substitute is crafted to closely match the taste, texture, and melting properties of traditional dairy butter. Consequently, it meets the rising demand for vegan and lactose-free alternatives by providing a viable option without sacrificing culinary quality. This innovation offers a sustainable and healthier alternative, expanding the range of food products available to consumers. The plant-based butter formulation aligns with the growing trend of plant-based diets and presents a fresh approach to addressing the limitations of traditional dairy butter.

Salient Features, Highlights, And Advantages

- Semi-solid based system developed using plant based food hydrocolloids
- The product promotes healthier choices, featuring zero trans-fat content, reduced fat levels, and an enhanced dietary fiber profile, in comparison to the commercial product
- Suitable for partial and complete replacement of diary based butter and to consume as table top spread as well for bakery application

Commercialization Status

- Status of commercialization: Not yet commercialized
- Major Raw materials: Plant based polysaccharides, vegetable oil
- Handholding support: Technical guidance, Training
- Validation level: TRL 5

PLANT-BASED MEAT ANALOGS

Technology Outline

Plant-based meat analogs represent an innovative alternative to traditional animal-based products, addressing concerns about the environmental impact and sustainability of industrialized animal farming. This technology utilizes a wide range of plant proteins to create high-moisture extrudates with moisture content up to 60%, mimicking different types of animal meat structures through an anisotropic fibrous texture. The process is designed to be industrially scalable and employs indigenous machinery, making it a viable option for commercial production. The prototype product has been demonstrated at pilot scale and evaluated, indicating its readiness for scale-up and commercialization. This innovative approach to meat alternatives aligns with UN panel suggestions for plant-based products as potential substitutes for animal-derived meat and dairy products.

Salient Features, Highlights, And Advantages

- **Sustainable Food Production:** The technology offers a low carbon footprint food product, contributing to more sustainable food systems and improved animal welfare.
- **Texture and Versatility:** The process creates plant-based meat analogs with textures similar to various animal meats, expanding the range of alternatives available to consumers.
- **Simplified Manufacturing:** The improved and simple process, coupled with limited additives and indigenous machinery, makes this technology accessible and efficient for implementation.
- **Health and Safety Benefits:** By reducing reliance on animal-based products, this technology has the potential to decrease zoonotic and food-borne diseases associated with traditional meat production.

Commercialization Status

- Status of commercialization: Ready for commercialization
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Plant protein, Starches and Fat
- Validation level: Pilot scale level
- Handholding support: Technology, Technical Consultancy

VEGAN BLOCK STYLES CHEESES

Technology Outline

Development of vegan block-style cheeses involves creating plant-based cheese alternatives that mimic the texture, flavor, and melting properties of traditional dairy cheeses. This vegan cheese is typically free from dairy, gluten, and preservatives, appealing to health-conscious consumers and those with dietary restrictions. The final product is sliced, grated, or cubed, ready for various culinary applications, from sandwiches to pizzas, and is designed to offer a satisfying, dairy-free alternative without sacrificing taste or texture. We have developed, Feta, Mozzarella and Cheddar style vegan cheeses. Feta is used in salads, Mozzarella on pizza and Cheddar in Nacho dips and sauces.

Salient Features, Highlights, And Advantages

- 100% vegan
- Dairy free (Lactose & casein)
- Gluten free
- Non-GMO

Commercialization Status

- Validation level: TRL 6
- Status of commercialization: Not yet commercialized.

Vegan Cheddar style cheese

Vegan Mozzarella style cheese

Cubes of Feta

PREBIOTIC AND SYNBIOTIC VEGAN MILK TEA PREMIX

Technology Outline

The Prebiotic and synbiotic vegan milk tea premix technology involves creating an instant beverage powder that combines the benefits of prebiotics, synbiotics (a combination of probiotics and prebiotics), and a vegan milk base. This premix offers a convenient, nutritious alternative to traditional milk tea with added functional benefits for gut health, resulting in a shelf-stable, dairy-free product that can be instantly reconstituted with hot water, appealing to vegan and lactose-intolerant consumers.

Salient Features, Highlights, And Advantages

- 100% vegan
- Dairy free (Lactose & casein)
- Synbiotics
- Trans fat free
- Gluten free
- Preservative free
- Non-GMO
- Rich in polyphenol
- Instant product: convenient to use
- Shelf-Stable

Commercialization Status

- Validation level: TRL 6
- Status of commercialization: Not yet commercialized.

TECHNOLOGY FOR PRODUCTION OF FORTIFIED RICE KERNELS (FRK) PREMIX

Technology Outline

The addition of micronutrients in their free form can lead to degradation during processing and storage. To counteract this, the micronutrients are encapsulated using the freeze-drying approach, which prevents micronutrient loss. The encapsulated premix, containing iron, vitamin B12, and folic acid, can be blended into the ingredient mixture during the preparation of fortified rice kernels (FRK). This approach significantly improves nutrient retention efficiency and preserves the physicochemical properties of the FRK. The technology can be commercialized globally, as it improves the nutritional content and consumer acceptability of FRK.

Salient Features, Highlights, And Advantages

- **Scalable and sustainable raw materials:** Utilized food-grade rice starch
- **Cost-effective and scalable:** Economically viable process that can meet growing market demands.
- **Improved and enhanced stability:** Encapsulation protects micronutrients such as iron, folic acid, and vitamin B12 from degradation caused by light, heat, moisture, and oxygen, ensuring they remain effective for longer periods.

Commercialization Status

- Status of commercialization: Ready for commercialization
- Major raw materials to be utlilized: Broken rice, starch and nutrients
- Validation level: TRL 4 at pilot scale
- Handholding support: Technology and technical consultancy

ENHANCEMENT OF CREMA RETENTION AND FOAM STABILITY OF INSTANT COFFEE

Technology Outline

This technology offers high crema retention and foam stability in instant coffee. Incorporation of gas in the coffee particles enhances the crema retention in hot coffee. At high temperatures also, the coffee foam retains for a long time through this process. It is possible to apply this technology on a commercial scale globally which improves the coffee market and consumer acceptability.

Salient Features, Highlights, And Advantages

- **No external foam agents or surfactants:** The crema of instant coffee has improved without the addition of any external surfactants
- **Cost-effective and scalable:** Economically viable process that can meet growing market demands.
- **Less labor intensive process:** The process requires very less labor to achieve the desirable texture and crema.

Commercialization Status

- Status of commercialization: Ready for commercialization
- Major raw materials to be utlilized: Instant coffee
- Validation level: TRL 7
- Handholding support: Technology and technical consultancy

ENHANCEMENT OF NUTRITIONAL AND PHYSICOCHEMICAL PROPERTIES OF FORTIFIED RICE KERNELS (FRK)

Technology Outline

The technology for the production of improved FRK offers the seamless blending of FRK with natural rice; the FRK must have physicochemical, sensory, and cooking on par with natural FRK, which is seldom found in market-available FRK. Incorporating encapsulated premix in the rice enhances the nutritional and physicochemical properties. It is possible to apply this technology commercially globally, improving fortified rice and consumer acceptability.

Salient Features, Highlights, And Advantages

- **Sustainable raw materials:** Utilized broken rice by-products, reducing waste and creating value-added food products from unused, broken rice.
- **Cost-effective and scalable:** Economically viable process that can meet growing market demands.
- **Improved nutritional value:** Fortified rice contains vital nutrients such as iron, folic acid, and vitamin B12 that may be lacking in regular diets.

Commercialization Status

- Status of commercialization: Ready for commercialization
- Major raw materials to be utlilized: Broken rice and premix
- Validation level: TRL 4 at pilot scale
- Handholding support: Technology and technical consultancy

LEATHER SUBSTITUTES FROM AGRO WASTES

Technology Outline

This innovative process produces vegan leather from agricultural by-products like rice straw, wheat straw, cactus, mango peels, banana stem, pineapple leaf, and vetiver grass. The resulting material mimics conventional leather's appearance and functionality while addressing environmental concerns associated with both animal-derived and synthetic leathers. This eco-friendly alternative can be applied across multiple industries, including fashion, footwear, automotive, and accessories. By harnessing readily available agricultural waste, the technology reduces environmental impact and creates value from underutilized resources. The cost-effective and scalable process offers a viable solution for meeting the growing demand for sustainable materials in the global leather market.

Salient Features, Highlights, And Advantages

- **Sustainable Raw Materials:** Utilizes abundant agricultural by-products, reducing waste and creating value from discarded resources.
- **Eco-friendly alternative:** Addresses environmental concerns of both animal leather and synthetic leather.
- **Versatile applications:** Usable in fashion, footwear, automotive, and accessories industries.
- Cost-effective and scalable: Economically viable process that can meet growing market demands.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 10 clients
- Major raw materials to be utlilized: Technology knowhow available for various raw materials across India
- Validation level: TRL 9-10
- Support Provided: Technical support is provided for setting up the plant.

BIODEGRADABLE TABLEWARE

Technology Outline

In response to the growing environmental crisis caused by single-use plastics, innovative technologies have been developed to produce biodegradable Tableware and cutlery from agricultural wastes such as rice straw, coconut shells, and sugarcane bagasse. This development addresses the urgent need for sustainable alternatives to plastic, which has been a major contributor to pollution, contaminating oceans, clogging waterways, and harming wildlife. The biodegradable products, including plates, bowls, spoons, and cups, are not only environmentally friendly but also safe for hot and cold foods and microwave-friendly. Their adoption could significantly reduce plastic waste in high-traffic areas like railway stations, airports, and food courts Moreover, these products support a circular economy by converting into nutrient-rich animal feed after use Addressing both plastic pollution and agricultural waste management, this innovation is well-positioned to make a substantial impact in promoting sustainable development and resource efficiency, offering a practical solution to reduce our environmental footprint.

Salient Features, Highlights, and Advantages

- **Sustainable Raw Materials:** Utilizes agricultural wastes like rice straw, Wheat bran, peanut shell, and sugarcane bagasse.
- **Versatile and Practical:** Produces a range of products including plates, bowls, spoons, and cups that are safe for hot and cold foods and microwave-friendly.
- **Circular Economy Support:** Converts into nutrient-rich animal feed after use, promoting a closed-loop system and resource efficiency.
- **High Implementation Readiness:** With a TRL of 9, the technology is well-developed and ready for widespread adoption and commercialization.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 20 clients
- Major raw materials to be utlilized: Technology knowhow available for various agro-based raw materials across India
- Validation level: TRL 9-10
- Support Provided: Technical Support is provided for setting up the plant.

CLEAN BIOPROCESS FOR WHITE PEPPER PRODUCTION

Technology Outline

CSIR-NIIST has developed and commercialized a process for the production of white pepper from black pepper/green pepper. The technology involves removing the seed coat using microbial enzymatic action, achieved through an accelerated controlled anaerobic digestion (anaerobic leach bed) in a specially designed reactor using a natural consortium of microbes. This innovative technology offers a sustainable and efficient method for producing high-quality white pepper. As an added benefit, the process generates methane gas and organic fertilizer as valuable by-products. This technology improves product quality and contributes positively to the economic and environmental aspects of spice production, enabling efficient bulk production of superior white pepper.

Salient Features, Highlights, And Advantages

- **Enzymatic Decomposition:** Utilizes enzymes to naturally remove the outer skin of black pepper, preserving its valuable ingredients.
- **Eco-Friendly Process:** This avoids toxic chemicals and reduces pollution, making it a sustainable alternative to traditional methods.
- **By-Product Generation:** Produces useful by-products like methane gas and organic fertilizer, enhancing overall process efficiency.
- **Quality Preservation:** Maintains the essential oils and aroma of the pepper, ensuring a high-quality end product.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to more than 30 clients
- Major raw materials to be utlilized: Black pepper
- Validation level: TRL 9
- Handholding support: Support will be provided for technology transfer, implementation and commissioning of the plant

EXOPOLYSACCHARIDES FOR FOOD GRADE APPLICATION

Technology Outline

Exopolysaccharides (EPS) are emerging as a game-changing natural compound in the food industry, particularly for enhancing the quality of dairy products. Produced by probiotic bacteria, these beneficial polysaccharides offer multiple applications, significantly improving the texture, stability, and overall quality of dairy items. Beyond their immediate effects on product quality, EPS provide long-term health benefits, exhibiting prebiotic properties and demonstrating immunomodulatory functions that contribute to better gut health. The integration of EPS in dairy production leads to the creation of functional foods and enables probiotic fortification, addressing the growing consumer demand for health-promoting products. By improving texture and rheology, EPS prevent issues like syneresis and enhance the functional properties of dairy products. This results in more stable products with longer shelf lives, combining improved quality with significant health benefits for consumers.

Salient Features, Highlights, And Advantages

- **Natural Quality Enhancement:** Improves texture, stability, and overall quality of dairy products using natural compounds produced by probiotic bacteria.
- **Health-Promoting Properties:** Exhibits prebiotic and immunomodulatory functions, contributing to better gut health and overall well-being of consumers.
- **Functional Food Creation:** Enables the production of probiotic-fortified dairy products, meeting the growing demand for health-enhancing foods. Can be a good food additive
- **Extended Shelf Life:** Prevents syneresis and enhances product stability, leading to longer-lasting dairy products with maintained quality.

Commercialization Status

- Status of commercialization: Lab scale technology developed and ready for Industrial partnership for scale up
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Synthetic medium
- Validation level: TRL 4
- Handholding support: Knowhow and SOP to produce and purify EPS from lactobacilli

LIGNOCELLULOSE HYDROLYZING ENZYME COCKTAIL(S) FOR BIOREFINERY APPLICATIONS

Technology Outline

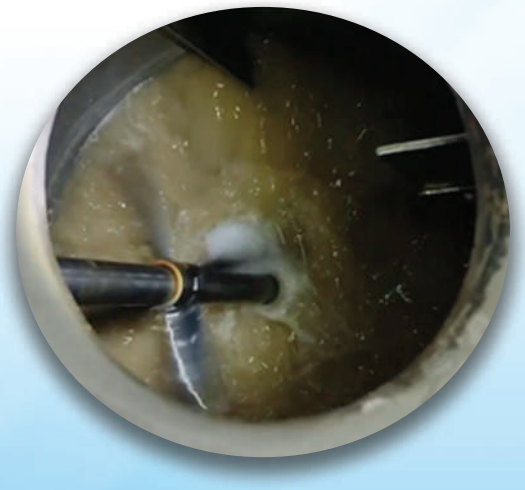
ndia's reliance on imported crude oil and its commitment to reducing greenhouse gas emissions are driving the push for ethanol blending in gasoline, targeting 20% by 2025. To meet and exceed this target, ignocellulosic biomass must be utilized for ethanol production, requiring efficient and affordable enzymes to convert biomass into fermentable sugars. An indigenously developed enzyme cocktail, combining cellulase and beta-glucosidase, delivers performance on par with the best global alternatives. The solid-state fermentation process used for enzyme production is cost-effective and has been successfully tested at a pilot scale, making it viable for biomass biorefineries.

Salient Features, Highlights, And Advantages

- **High Hydrolysis Efficiency:** Achieves over 80% efficiency in breaking down pretreated rice straw and sugarcane bagasse.
- **Cost-Effective Process:** Uses solid-state fermentation, reducing CAPEX and achieving a mare concentrated product.
- **Adaptability:** Enzyme cocktail can be customized for different types of lignocellulosic biomass in biorefineries.

Commercialization Status

- Status of commercialization: Not yet commercialized
- Major raw materials to be utlilized: Agro-residues, Wheat. Bran, Cellulose
- Validation level: TRL 6
- Handholding support: Technical consultancy, Handholding till production, and training



PROCESS FOR PRODUCTION OF BETA GLUCOSIDASE (BGL) AND ORGANISM THEREFORE

Technology Outline

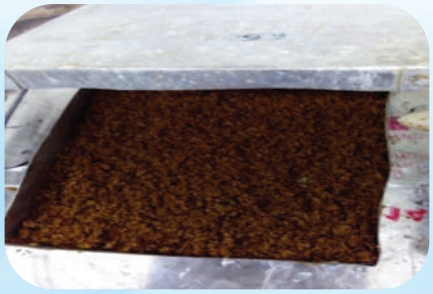
This technology focuses on a novel organism and process for the production of Beta Glucosidase (BGL), a crucial enzyme in the cocktail used for lignocellulosic biomass hydrolysis. As the rate limiting enzyme in cellulolysis, BGL plays a vital role in liberating glucose from lignocellulose, making it essential for bioethanol production from biomass. By enhancing the hydrolysis efficiency of acid cellulase by up to 30%, the addition of this enzyme significantly improves the conversion of biomass to fermentable sugars. Improving the efficiency of cellulases not only makes the production of bioethanol more economically viable, but also enhances the sustainability of biofuel production. The technology offers a promising solution for the bioenergy sector, potentially reducing the cost and increasing the accessibility of bioethanol as a renewable energy source.

Salient Features, Highlights, And Advantages

- **Enhanced Enzyme Production:** A unique organism and cost effective process for efficient Beta Glucosidase production.
- **Improved Biomass Conversion:** Increases the efficiency of cellulose breakdown into glucose by up to 30%.
- **Cost Reduction:** Lowers the overall cost of biomass hydrolyzing enzymes in bioethanol production.
- **Improved Process Viability:** Enhances the economic viability and sustainability of bioethanol production processes.

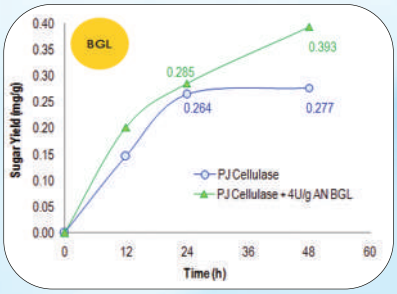
Commercialization Status

- Status of commercialization: commercialization in progress
- No. of Licenses: Licensed to 1 client
- Major raw materials to be utlilized: Wheat Bran, Cellulose
- Validation level: TRL 6
- Handholding support: Technical consultancy, Handholding till production, and training



Tray fermentation for enzyme production – growth of *Aspergillus carbonarius*

Biomass hydrolysis using NIIST enzyme cocktail



Improvement in hydrolytic efficiency with BGL addition to cellulase

SOLID-STATE FOOD-WASTE BIOGAS TECHNOLOGY

Technology Outline

Anaerobic digestion, or bio-methanation, of food waste is a recommended sustainable method for treating food waste. Conventional biogas plants have inherent limitations, including large footprints, freshwater consumption, low biogas yield, and foul-smelling discharge slurry that can lead to vector breeding. A novel solid-state bio-methanation system for food waste has been developed as an improved alternative to existing biogas plants, particularly suitable for corporations and municipal areas. This innovative technology addresses the limitations of conventional systems while providing an efficient solution for food waste management. The solid-state bio-methanation system offers numerous advantages, making it a promising option for various food waste-generating establishments.

Salient Features, Highlights, And Advantages

- **Compact and Versatile Design:** The system features a compact size, scalability to accommodate more food waste, and potential portability even for large units, making it suitable for diverse settings.
- **Efficient Resource Management:** This technology eliminates freshwater consumption, can process any type of food waste, and produces less slurry output that is highly stable and usable as manure.
- **Enhanced Biogas Production:** The system yields more biogas with higher methane content, approximately 200 liters per kilogram of food waste, surpassing conventional biogas plant performance.
- **Environmental and Health Benefits:** By eliminating vector problems and reducing odor issues, the solid-state bio-methanation system contributes to improved sanitation and public health in wastemanagement areas.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 3 clients
- Major raw materials to be utlilized: Fabricated unit, Microbial culture, Eletromechanical systems
- Validation level: TRL 9
- Handholding support: Training in design, operation & trouble shooting

JAIVAM, A BIO-MEDIUM FOR ACCELERATING AEROBIC COMPOSTING OF ORGANIC WASTE

Technology Outline

Aerobic composting is a widely accepted sustainable approach for managing organic waste, stabilizing it, controlling foul odors, and producing high-value organic manure. The process typically requires systems or devices that ensure sufficient aeration, and can be enhanced by using microbial cultures with high biodegradation activity. However, many commercially available inoculums lack proper study and testing for their activity, potential pathogenicity, and antimicrobial resistance. A new bio-medium called JAIVAM has been developed to accelerate the composting process, suitable for use in small-scale household composting units to large Organic Waste Converter (OWC) units. JAIVAM consists of a constituted bacterial consortium and an organic filler medium designed to speed up the composting process.

Salient Features, Highlights, And Advantages

- **Scientifically Validated Composition:** JAIVAM contains genetically identified bacterial consortium with proven hydrolytic activity against various organic components, ensuring a safe and effective composting process.
- **Versatile Application:** The bio-medium is suitable for use in a wide range of composting scenarios, from small household units to large-scale organic waste converters.
- **Enhanced Plant Growth Promotion:** The bacterial consortium includes strains with plant growth promotion activity, adding value to the final compost product.
- **Environmental and Health Benefits:** JAIVAM is a 100% organic medium that accelerates aerobic composting while eliminating odor and fly issues, contributing to improved sanitation and environmental quality.

Commercialization Status

- Status of commercialization: commercialization in process
- No. of Licenses: Licensed to 1 client
- Major raw materials to be utlilized: Bacterial culture and Filler material coco peat
- Validation level: TRL 9
- Handholding support: Training in making the formulation and its usage

HOUSEHOLD GREY WATER TREATMENT & REUSE SYSTEM

Technology Outline

Greywater accounts for approximately 80% of household wastewater, and it contains various contaminants, ncluding organics, nutrients, pharmaceutical residues, synthetic nanomaterials, micro-plastics, pathogens, and antimicrobial resistant genes. The common practice of directly disposing untreated greywater in soak pits contributes to poor water environments, public health issues, and socioeconomic problems. Scientific ntervention can treat greywater and recover reuse-quality water for various household applications, reducing freshwater consumption and protecting groundwater from contamination. Currently, the market acks technologies for treating and recovering reuse-quality water from greywater at household level. A novel, patent-protected, modular household greywater treatment and reuse system has been developed as a sustainable solution for managing greywater at individual houses, serving as a substitute for conventional soak pits.

Salient Features, Highlights, And Advantages

- **Innovative Design:** A modular, compact system replaces conventional soak pits and is suitable for individual houses in urban and rural areas, particularly in locations with high groundwater tables.
- **Nature-Based Technology:** The system employs a completely biological treatment process, utilizing innovative filter bed media, specific microbial cultures, and selective macrophytes.
- **Cost-Effective Solution:** Low capital and operational costs make the system an economically viable option for household greywater treatment and reuse.
- **Environmental Impact:** The technology recovers reuse-quality water from greywater, addressing critical water management issues and related public health and socioeconomic problems.

Commercialization Status

- Status of commercialization: Completed Pilot scale testing under field conditions
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Fabrication of the unit in PVC or FRP, Filter bed media, Plants, Bacterial inoculum, Plumbing works
- Validation level: TRL 6
- Handholding support: Training in design, operation & trouble shooting

MODULAR ONSITE WASTEWATER TREATMENT UNIT (NOWA)

Technology Outline

The disposal of untreated wastewater (>70%) is a major cause of water environment deterioration and associated public health and socioeconomic problems. Limited sewerage networks in most cities make it difficult for commercial establishments to treat and dispose of high-strength greywater and sewage. Existing onsite wastewater treatment systems have inherent limitations such as high costs, poor performance with high-strength greywater, space requirements, chemical consumption, and sludge disposal issues. A novel Onsite Wastewater Treatment and Resource Recovery unit (NOWA) has been developed to address these challenges. NOWA is a patent-protected, completely biological treatment system with integrated anaerobic and aerobic process modules, specially adapted microbial systems, and additional sludge handling and disinfection modules.

Salient Features, Highlights, And Advantages

- **Efficient Design:** NOWA features a modular and compact size with less footprint, allowing for easy retrofitting to existing conditions and adaptability to various settings.
- **Resource Recovery:** The system recovers 70-80% of COD in wastewater as biogas and produces reuse-quality water meeting discharge standards for different applications.
- **Cost-Effective Solution:** NOWA offers lower capital and operational costs compared to existing systems, while providing a completely biological treatment process without frequent sludge disposal issues.
- **Versatile Application:** The technology is well-suited for a wide range of establishments, including restaurants, hotels, catering units, bakeries, community halls, canteens, and agro-based MSMEs.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 5 clients
- Major raw materials to be utlilized: Fabricated unit, Filter bed, Bacterial culture, electromechanical units, pumps and control panel
- Validation level: TRL 9
- Handholding support: Training in design, operation & trouble shooting

BFBR - A HIGH-RATE ANAEROBIC REACTOR FOR COMPLEX WASTEWATER TREATMENT

Technology Outline

The Buoyant Filter Bioreactor (BFBR) is a high-rate anaerobic bioreactor developed at CSIR-NIIST (U.S. Patent 6592751) for the efficient treatment of high-strength, complex wastewater. This advanced technology has proven effective in treating wastewater from a range of industries, including ice cream factories, rice mills, fishmeal production units, and desiccated coconut units, etc. Apart from the wastewater treatment, the process generates biogas and can be used as fuel in the industry. BFBR based effluent treatment plant has been successfully customized and widely deployed both in India and internationally.

Salient Features, Highlights, And Advantages

- **High-Strength Wastewater Treatment:** Specifically engineered to manage complex wastewater with a high ratio of suspended COD to total COD.
- **Narrow Gap Lamella Separator:** Lamella separator designed for efficient separation of poorly settling solids. Effectively retains floating fats and scum, which are then remixed for complete degradation.
- **Automatic Gas-Driven Backwash:** Employs an automatic gas-driven backwash system for the lamella settler, enhancing operational efficiency.
- **Rapid Start-Up:** Facilitates rapid start-up without the need for flocculants or granular sludge, reducing initial operational time and costs.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 2 clients
- Major raw materials to be utlilized: High-Strength and complex wastewater treatment
- Validation level: TRL9
- Handholding support: Technical Consultancy and Training

BIOFILTER - TECHNOLOGY FOR INDUSTRIAL ODOUR CONTROL

Technology Outline

Biofilter technology (Patented Technology: US6696284) offers a sustainable solution for controlling industrial odour, particularly in industries such as shrimp feed plants, fish meal plants, and composting facilities. It employs specially designed biofilter media that provides essential moisture, supports microbial growth, and acts as a neutralizing agent for odorous gases. The media's unique characteristics include low pressure drop, high water holding capacity, and efficient mass transfer of contaminants from air to microbes. This environmentally friendly technology promotes green practices with its long-lasting effectiveness, addressing industrial odour issues comprehensively while aligning with sustainable practices.

Salient Features, Highlights, And Advantages

- **Sustainable Odour Control:** Provides an environmentally friendly solution for industrial odour management.
- **Efficient Microbial Support:** Specially designed media promotes microbial growth and optimal moisture levels.
- **Energy-Efficient Design:** Low pressure drop in the biofilter media reduces overall energy consumption.
- **Versatile Industrial Application:** Suitable for various industries (i.e., Fish meal plants, Bone mill, Gelatin factory, Rendering plants, Petrochemical, Pharmaceutical, Spray painting, STPs/ETPs, solid waste treatment sites, etc.) enhancing environmental stewardship and operational efficiency.

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 2 clients
- Major raw materials to be utlilized: Low-cost eco-friendly packing material
- Validation level: TRL 9
- Handholding support: Technical Consultancy and Training

BIOREMEDIATION TECHNOLOGY FOR PERCHLORATE

Technology Outline

Perchlorate is a thyroid-disrupting toxic oxyanion (ClO_4^-) known to cause hypothyroidism in humans and adverse effects on growth and metamorphosis in various animal models. Perchlorate salts are primarily used in strategic sectors, space R&D, and industries such as cracker and matchbox manufacturing units. The current WHO permissible limit for perchlorate in drinking water is 70 µg/L, with several US states limiting its permissible level to <20 µg/L. A novel technology (US patent 11,390, 547 B2) has been developed for treating perchlorate-contaminated water, soil, and other matrices. The proprietary bacterial system used in this technology completely reduce perchlorate into non-toxic oxygen and chloride under defined conditions in an engineered treatment system.

Salient Features, Highlights, And Advantages

- **Versatile Application:** The technology can treat perchlorate-contaminated water, including groundwater and wash water from perchlorate bulk handling sites, as well as contaminated soil and other matrices.
- **Field-Tested Performance:** The water treatment technology has been successfully scaled up and tested in the field, producing 2000 L of drinking water daily from a previously abandoned, perchlorate-contaminated community well.
- **Efficient Soil Remediation:** A two-stage process for decontaminating perchlorate-contaminated soil has been developed, offering a more economical solution that can be completed in a few days compared to existing technologies.
- **Environmentally Safe and Cost-Effective:** The indigenous bioprocess ensures environmental safety and public health while providing a cost-effective solution for perchlorate remediation, with water treatment costs <10 paise per liter.

Commercialization Status

- Status of commercialization: Demonstrated at field
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Custom fabricated treatment unit, bacterial culture, electromechanical units
- Validation level: TRL 4
- Handholding support: Training in design, operation & trouble shooting

CARDANOL POLYOL MODIFIED POLY URETHANE DISPERSIONS (PUDS)

Technology Outline

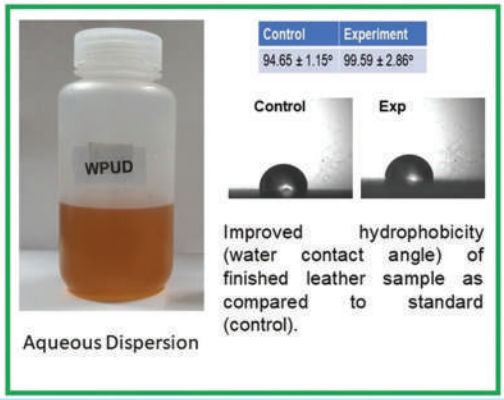
Cardanol Polyol Modified Polyurethane Dispersions (PUDs) represent an innovative and sustainable technology in the field of aqueous polyurethane dispersions. By incorporating cardanol polyol, the dispersions show superior properties as compared to petrochemical polyols, including enhanced light fastness, adhesion, and hydrophobicity. This eco-friendly alternative not only adds value to agricultural resources but also provides improved mechanical and corrosion resistance properties, making it suitable for a wide range of applications, from coatings to medical devices. The use of cardanol, derived from cashew nut shell liquid, demonstrates a significant step towards utilizing renewable resources in polymer chemistry. Furthermore, these PUDs showcase the potential for developing high-performance materials that meet both industrial requirements and environmental sustainability goals, paving the way for future advancements in green chemistry and materials science.

Salient Features, Highlights, And Advantages

- **Sustainable Solution:** Cardanol Polyol Modified PUDs offer a green alternative to conventional polyurethane products, promoting environmental sustainability.
- **Superior Properties:** These dispersions exhibit enhanced light fastness, adhesion, and hydrophobicity compared to traditional polyol-based polyurethanes.
- **Versatile Applications:** The technology is applicable in various fields, including leather coatings, hygiene coatings, adhesives, sealants, elastomers, and medical devices.
- **Improved Performance:** Cardanol Polyol Modified PUDs provide better formulation flexibility, stronger adhesion, water resistance, and enhanced hydrolytic stability.

Commercialization Status

- Status of commercialization: Not yet commercialized
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: commercially available materials
- Validation level: TRL 4
- Handholding support: Technology development and validation



CASHEW NUT SHELL LIQUID (CNSL) AND DERIVATIVES: A BIO-REFINERY

Technology Outline

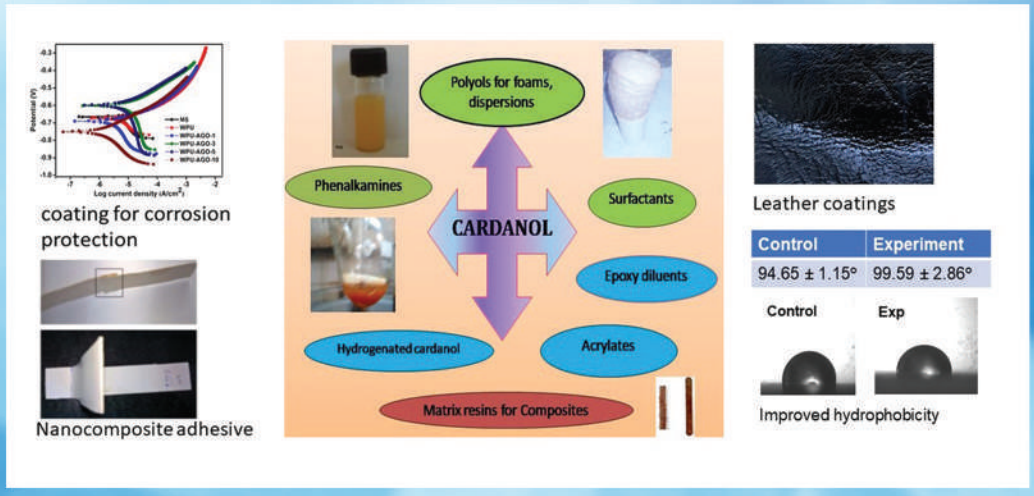
Cashew Nut Shell Liquid (CNSL) is a versatile by-product of the cashew industry, offering a cost-effective source of unsaturated phenols for various industrial applications. Through distillation, CNSL produces cardanol, which serves as a foundation for developing custom polymers. Adopting a biorefinery approach, CNSL can be transformed into multiple valuable products, adding significant value to this agricultural by-product. CNSL finds applications in polymer-based industries, including the production of friction linings, paints, varnishes, and various types of resins. Products made from CNSL offer superior water resistance and mechanical properties while being environmentally friendly due to their biobased nature.

Salient Features, Highlights, And Advantages

- **Versatile Industrial Applications:** Used in producing friction linings, paints, varnishes, and various types of resins.
- **Biorefinery Potential:** Can be transformed into multiple valuable products through a biorefinery approach.
- **Enhanced Product Properties:** Offers superior water resistance and mechanical properties in final products.
- **Eco-friendly Alternative:** Provides a biobased, environmentally friendly option for various industrial applications.

Commercialization Status

- Status of commercialization: Not yet commercialized
- Major raw materials to be utlilized: biobased
- Validation level: lab level



COMPOSTABLE, HYDROPHOBIC AND MOISTURE RESISTANT PLANT OIL-BASED BIO-RESIN

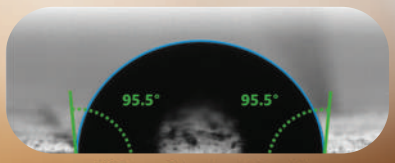
Technology Outline

This innovative plant oil-based bio-resin offers an eco-friendly and biodegradable alternative to non-biodegradable plastic liners in the packaging industry. It can be applied to various substrates including paper, biopolymer, and cellulosic materials, creating compostable barrier packaging products such as bags, pouch, plates, and takeaway containers. The resulting bio-coated products are environmentally friendly, non-toxic, and microwave-friendly. They provide significant advantages, including hydrophobicity, oleophobicity and icephobicity, along with an 80% reduction in water vapor transmission rate (WVTR) and improved shelf life. The moisture-resistant and oil-resistant properties of the bioresin make it suitable for packaging fatty foods and beverages at both hot and cold temperatures. It is repulpable whereby recycling of the substrate can be achieved, and is also compostable with nil release of toxic components into the soil, ensuring environmentally safe disposal.

Salient Features, Highlights, And Advantages

- **Eco-Friendly Composition:** Derived from plant oil, offering a biodegradable and compostable alternative to traditional plastic liners.
- **Versatile Application:** Can be applied to various substrates, creating a wide range of compostable packaging products suitable for different uses.
- **Enhanced Performance:** Provides significant improvement in moisture barrier, oil barrier and shelf life compared to traditional alternatives.
- **Regulatory Compliance:** Meets USFDA 176.160 and EU 10/2011 migration standards, ensuring safety for food packaging applications.
- **Circular economy:** Compostable as per ISO 17088:2021 and repulpable with 80-90% recovery.

Bioresin



Water Contact Angle

Commercialization Status

- Status of commercialization: commercialized
- No. of Licenses: Licensed to 3 clients
- Major raw materials to be utlilized: Vegetable oil
- Validation level: TRL 9
- Handholding support: Technical consultancy and Training

Coated paper roll

Packaging pouch

ECO-FRIENDLY COIR-BASED GEOCOMPOSITE MULCH SHEETS

Technology Outline

Coir-based geocomposite mulch sheet with desired porosity is an innovative agricultural solution made using coir (coconut husk fiber) and bio-based binder. They offer as an environmentally sustainable substitute for synthetic plastic mulch sheets in mitigating carbon footprints. These sheets promote soil health and productivity of crops while contributing to waste management and reducing plastic pollution. Their biodegradability and ability to release fertilizer/water judiciously make them ideal for agricultural applications. The coir-based sheets could effectively retain soil moisture, regulate soil temperature, suppress weed growth and, promoting better plant growth. Their environmental sustainability makes them a desirable choice for farmers seeking to implement advanced organic agriculture practices.

Salient Features, Highlights, And Advantages

- **Sustainable Material:** Repurposes waste coir into useful agricultural products, promoting circular economy principles
- **Soil Health Enhancement:** Improves soil conditions by retaining moisture, regulating temperature, and suppressing weed growth
- **Wide-range of Applications:** Drip irrigation, slow-release fertilizer/water, geo-separation layer, filter component, drainage purpose, root-barrier applications etc.
- **Biodegradable Option:** Provides an environmentally friendly mulch solution that naturally decomposes over time

Commercialization Status

- Status of commercialization: Ready-to-transfer technology
- No. of Licenses: Not yet licensed
- Validation level: TRL 6 (Prototype produced at industrial facility)
- Handholding support: DPR and technical consultancy to setting up the production unit

INJECTION MOLDABLE, BIODEGRADABLE COIR COMPOSITE PELLETS (ICO PELLETS)

Technology Outline

CSIR-NIIST developed a cost-effective and scalable technology to produce biodegradable coir pellets that involve simple unit operations utilizing agricultural byproducts like coir (coconut husk or mesocarp). The injection moldable, biodegradable coir composite pellet (iCo Pellet) is an innovative material made from coir blended with biodegradable polymer. These pellets can be injection, compression or extrusion molded into a wide variety of shapes and products, making them a promising alternative to non-biodegradable plastics. These pellets are sustainable, versatile, non-hazardous, durable and compostable. Some of the potential applications are garden products, office stationery, construction materials, packaging materials, healthcare products etc. This technology addresses the environmental concerns associated with micro/nano plastic pollution and the critical need for sustainable solution while offering a scalable, affordable option across multiple sectors.

Salient Features, Highlights, And Advantages

- **Sustainable Raw Materials:** Utilizes agricultural byproducts (e.g. coir), low-cost biopolymer and additives
- **Versatile Manufacturing:** Ready-to-use pellets compatible with injection, compression or extrusion molding processes, allowing for diverse product shapes and applications
- **USP:** Non-toxic, non-hazardous, biodegradable, high mechanical properties, water-repellent, no coating required, no effluents generated, etc.
- **Wide-range of Applications:** Suitable for use in various industries, including building materials, agriculture products, packaging, consumer goods and automotive
- **Market Growth Potential:** Poised for significant expansion due to increasing demand for sustainable materials and eco-friendly alternatives

Commercialization Status

- Status of commercialization: Ready-to-transfer technology
- No. of Licenses: Not yet licensed
- Validation level: TRL 6 (Prototype produced at industrial facility)
- Handholding support: DPR and technical consultancy to setting up the unit

WEATHER RESISTANT COIR GEOTEXTILE

Technology Outline

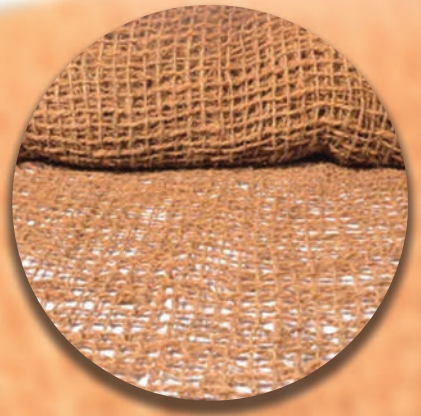
Weather-resistant coir geotextile is an innovative solution for preventing soil erosion while maintaining soil fertility. This environmentally friendly material leverages the natural durability of coir fibers, enhancing their resistance to weather conditions. It can be effectively used in various civil engineering applications, including road construction and the protection of sea and river shores. The treatment process to achieve weather resistance adds only 10% to the total cost of the geotextile, making it an economical choice for large-scale soil erosion prevention projects. This material provides a sustainable and efficient method to preserve the integrity of natural and man-made landscapes.

Salient Features, Highlights, And Advantages

- **Enhanced Durability:** Improves the natural strength of coir fibers to withstand various weather conditions.
- **Versatile Applications:** Suitable for road construction, sea erosion control, and riverbank protection.
- **Cost-Effective Solution:** Offers long-term performance with minimal additional cost for weather-resistant treatment.
- **Eco-Friendly Approach:** Provides a sustainable alternative to synthetic materials for soil stabilization and erosion control.

Commercialization Status

- Status of commercialization: Not yet commercialized
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Coir Fibre
- Validation level: TRL 6
- Handholding support: Technical Consultancy



WOOD SUBSTITUTES FROM COIR

Technology Outline

The Wood Substitutes technology presents an innovative approach to enhancing the utilization of coir, a regionally abundant resource, by creating high-quality alternatives to traditional wood products. This process involves impregnating coir with both thermoplastic and thermoset polymers, followed by compression molding, achieving a remarkable process efficiency of over 90%. The resulting product not only offers superior quality compared to standard plywood but also boasts enhanced properties such as fire resistance, termite resistance, and resistance to both cold and boiling water. By using approximately 50% coir as raw material, this technology aligns perfectly with the 'Make-in-India' initiative and has the potential to revolutionize MSMEs in the coir sector, promoting self-reliance under the 'Atmanirbhar Bharat' scheme. Although the technology is licensed, it currently awaits commercialization, presenting an excellent opportunity for businesses to invest in and promote a sustainable and high-quality alternative to traditional wood products.

Salient Features, Highlights, And Advantages

- **Enhanced Material Properties:** Superior quality compared to standard plywood, including exceptional fire resistance, termite resistance, and water resistance (both cold and boiling).
- **Durability and Functionality:** Demonstrates good screw-holding capacity, ensuring long-lasting and reliable performance in various applications.
- **Sustainable Resource Utilization:** Promotes self-reliance and adds significant value to coir, a locally available resource, aligning with national initiatives for economic growth.
- **Efficient Manufacturing Process:** High process efficiency of over 90%, making it suitable for commercialization by MSMEs and contributing to industrial growth and job creation.

Commercialization Status

- Status of commercialization: Not yet commercialized
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Coir, Polyethylene or any other polymer depending on the end product
- Validation level: TRL 5
- Handholding support: Technical consultation will be provided.

DEEP RED EMITTING PHOSPHORS FOR INDOOR PLANT CULTIVATION

Technology Outline

CSIR-NIIST developed a highly efficient blue light excitable deep red-emitting phosphors by utilizing a scalable route perfect for indoor plant cultivations since its emission and excitation spectra match well with the absorption of important plant pigments such as various phytochromes and chlorophylls, which are mainly responsible for plant growth.

Salient Features, Highlights, And Advantages

- The phosphor showed higher blue absorption. Under the blue light, it shows high red emission efficiency.
- Hence this phosphor is perfect for making blue LED-based deep red emitting lighting systems, which are very cost-effective due to the utilization of blue LEDs rather than UV LEDs.
- The phosphor does not use any rare earth materials and is synthesized via a scalable route. Hence the product has a lower cost compared to the commercialized red samples.

Commercialization Status

- Status of commercialization: Under process
- Major raw materials to be utlilized: Non-toxic, Oxides
- Validation level: TRL 5
- Support Provided: Industrial development & consultancy

DUAL EMITTING PHOSPHOR FOR SECURITY APPLICATION

Technology Outline

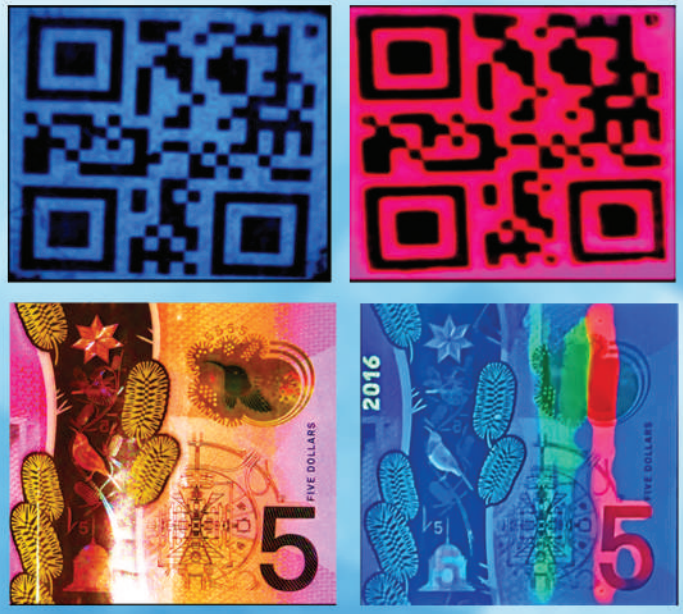
CSIR-NIIST uniquely developed dual colour emitting inorganic phosphors for specialized applications. In the daylight conditions, these phosphors do not emit any noticeable light. Under UV lights of different wavelengths, the phosphors show different emission colours. The developed security inks using these phosphors produced various writings on different surfaces, including currency notes and QR codes. The above technique can prevent fraud and duplication of logos, currency notes and documents.

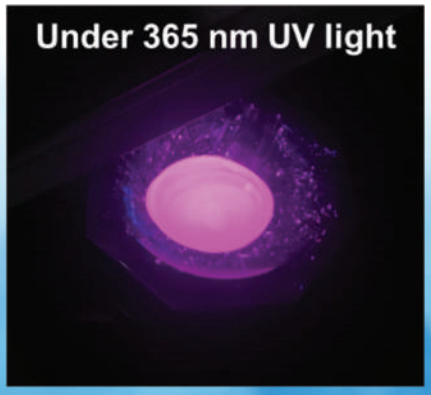
Salient Features, Highlights, And Advantages

- CSIR-NIIST developed inorganic phosphor emits blue and red colour at various UV lights
- This technology of dual emitting inorganic phosphors under various UV lights could provide additional protection to crucial products to secure their originality.
- Since the phosphor emission and lifetime are highly stable, hence these are perfect for anti-counterfeiting applications, particularly in various currencies and codes.

Commercialization Status

- Status of commercialization: Under process
- Major raw materials to be utlilized: Non-toxic, Oxides
- Validation level: TRL 5
- Support Provided: Industrial development & consultancy





FLUORESCENT PIGMENTS FOR SECURITY PRINTING

Technology Outline

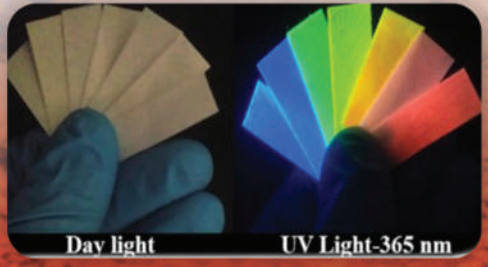
Fluorescent pigments for security printing are advanced materials designed to combat counterfeiting in currencies, documents, pharmaceutical products, and consumer goods. These pigments appear white or off-white under normal daylight but emit brilliant colors (blue, green, yellow, orange, red, etc. when exposed to ultraviolet (UV) light. This technology provides an invisible yet highly effective anti-counterfeiting measure that is difficult to replicate. The technology involves the development of novel fluorescent molecules and their conversion into pigments with specific optical properties. These materials can be incorporated into security features through random distribution (as fibers) or by printing (as ink formulations).

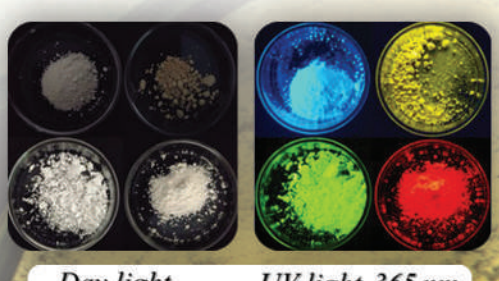
Salient Features, Highlights, And Advantages

- **Invisible under normal light:** Provides covert security without altering the appearance of the protected item.
- **Brilliant fluorescence:** Emits vivid colors under UV light, making verification easy and reliable.
- **Multiple color options:** Available in various colors (blue, green, yellow, orange, red) for diverse applications.
- **High fluorescence quantum yield:** >70% efficiency in light emission.
- **Chemical and environmental resistance:** Maintains properties when exposed to various chemicals and environmental conditions.
- **Non-toxic and environmentally friendly:** Safe for use in various applications, including currency and consumer goods.
- **Scalable production:** One-pot synthesis process allows for industrial-scale manufacturing.
- **Customizable:** Can be tailored to meet specific requirements of different industries and applications.
- **Compliant with international standards:** Meets or exceeds global benchmarks for security printing materials.

Commercialization Status

- Status of commercialization: Partially commercialized
- No. of Licenses: Licensed to 1 client
- Major raw materials to be utlilized: Organic chemicals
- Validation level: Technology Readiness Level 6 (TRL6) - Prototype demonstration in a relevant environment
- Handholding support:
  - Technical know-how transfer
  - Assistance in scaling up production
  - Quality control guidelines
  - Application support for various security printing techniques





INFRARED REFLECTIVE BLUE PIGMENT

Technology Outline

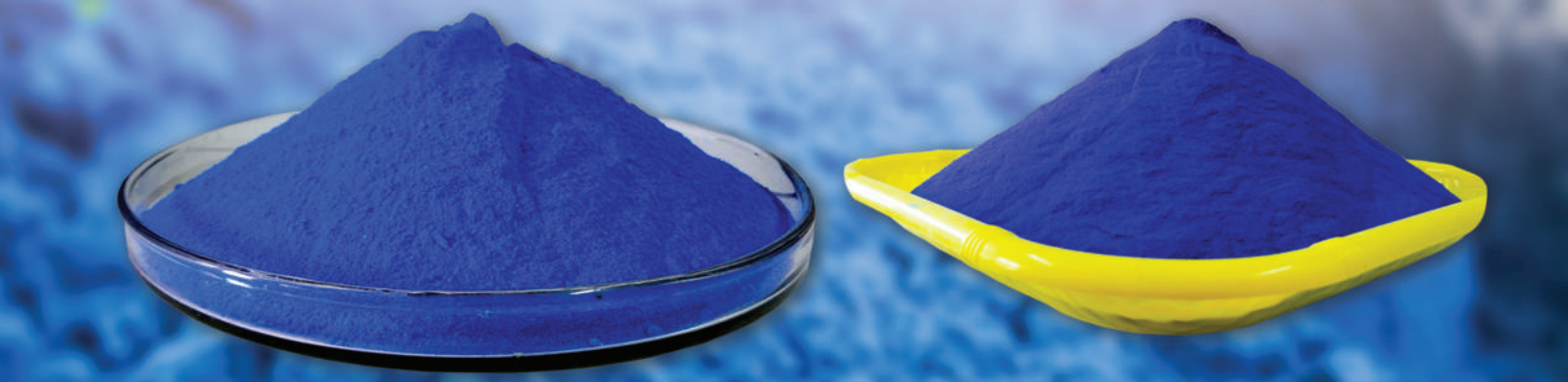
The Infrared Reflective, inorganic pigments is a ground-breaking advancement for the paint and pigment industry, designed to enhance energy-saving applications. Crafted from rare earth silicate using a straightforward calcination process, this pigment offers a vibrant blue colour and superior reflectance properties. It is non-toxic, making it safe for building concrete surface, metal / polymer roofing materials and plastics applications. With an impressive infrared reflectance of over 70%, surfaces coated with this pigment remain cooler, leading to significant energy savings in temperature regulation. The pigment also boasts a high color index, ensuring a deep and consistent blue hue, making it ideal for both decorative and functional coatings.

Salient Features, Highlights, And Advantages

- **Energy Efficiency:** Provides high infrared reflectance, reducing heat absorption and lowering cooling costs.
- **Vibrant Aesthetics:** Offers a deep blue color with a high color index, suitable for decorative applications.
- **Eco-friendly Composition:** Utilizes non-toxic materials, ensuring safety in various applications.
- **Versatile Usage:** Applicable in both functional and decorative coatings across different industries.

Commercialization Status

- Status of commercialization: Process Know-How demonstrated to User Industries
- No. of Licenses: Not yet licensed
- Major raw materials to be utlilized: Inorganic oxides and additives
- Validation level: TRL 6
- Handholding support: Process Know-How transfer and Manufacturing Plant installation.



STRAIN-FREE AND THERMALLY STABLE HIGH POWER PC-WHITE LEDS

Technology Outline

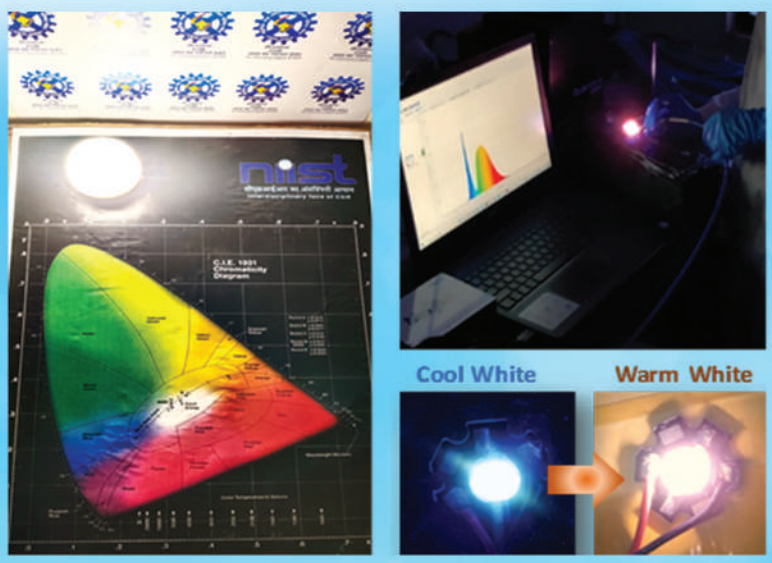
Current pc-white LEDs made with InGaN blue-LEDs and Y3Al5O12: Ce3+ (YAG: Ce) phosphor's luminescence suffer from low colour rendering (CRI) ~ 70%, and high colour temperature (CCT) > 5000 K because of the lack of red light, and due to the leakage of blue light, which is unhealthy. Also, lighting colour properties fluctuate with currents. In addition, the present pc-LEDs have low thermal stability at higher operating temperatures. The CSIR-NIIST has established prototypes of rigid and flexible white LEDs with the developed broadband yellow emitting phosphor that have specific features as follows.

Salient Features, Highlights, And Advantages

- The white LEDs fabricated using NIIST-developed phosphors have superior colour qualities than the commercial white LEDs based on YAG: Ce.
- The developed phosphors produced strain-free warm white light with appreciable CRI (~ 80%) and lower CCT (~3500 K).
- The developed phosphors showed higher thermal stability compared to commercial YAG: Ce.
- The developed white LEDs are thermally stable and more suitable for eco-friendly general lighting.

Commercialization Status

- Status of commercialization: Under process
- Major raw materials to be utlilized: Non-toxic, Oxides
- Validation level: TRL 5
- Support Provided: Industrial development & consultancy



ULTRA BRIGHT INORGANIC PHOSPHORS FOR FORENSIC FINGER PRINT DETECTION

Technology Outline

NIIST developed phosphor nanoparticles have special fluorescent properties that make them compatible with fingerprint residues. Ultrafine phosphor particles synthesized via a scalable route are efficiently glowing under UV lights. The particle sizes are matched well with the finger ridges and valleys. These nanoparticles are perfect for certain security and forensic applications.

Salient Features, Highlights, And Advantages

- Submicron particles with intense red and green glow under the UV light are obtained.
- A rapid and optimized microwave-assisted route has been adopted for synthesis.
- These promising phosphors exhibited excellent visualization regardless of the background interference and limit the risk of duplication and are highly reliable.
- Highly suitable for the visualization of latent fingerprints on various substrates.

Commercialization Status

- Status of commercialization: Under process
- Major raw materials to be utlilized: Non-toxic, Oxides
- Validation level: TRL 5
- Support Provided: Industrial development & consultancy

MANUFACTURING BUILDING BRICKS FROM FOUNDRY SILICA SAND

Technology Outline

Waste to Wealth is a program identified by CSIR, Government of India under the theme Industrial Solids Waste Management. Manufacturing building bricks from foundry silica sand is an innovative technology developed in NIIST for the complete utilization of foundry mould silica sand. This technology utilizes over 55% foundry silica sand to produce a wide range of construction products through cost-effective compression moulding technique. The process technology involved mixing of sand with required raw materials and compressed into bricks, and blocks. The technology produced durable compressed bricks with the density of 1.8 to 2.1 kg/cm3, water absorption 15 to 18% and the strength of > 5 MPa.

Salient Features, Highlights, And Advantages

- **Sustainable solution:** The process uses industrial waste material and produces no CO2 emissions, as it does not involve firing.
- **Cost-effective:** Minimal cement usage and simple compression molding significantly reduce material and production costs.
- **High-performance products:** The resulting bricks have high compressive and wet strength, ensuring durability in various building applications.
- **Versatility:** The technology enables the production of a wide range of construction products, including bricks, blocks, and panels.

Commercialization Status

- Status of commercialization: Process know-how transferred
- No. of Licenses: Licensed to 2 clients
- Major raw materials to be utlilized: Fine silica sand from Foundry, Gravel, Lime and Additive
- Validation level: TRL 6
- Handholding support: Brick manufacturing plant installation and commissioning

PRINTED FABRIC HEATERS INTEGRATED SMART-APPARELS

Technology Outline

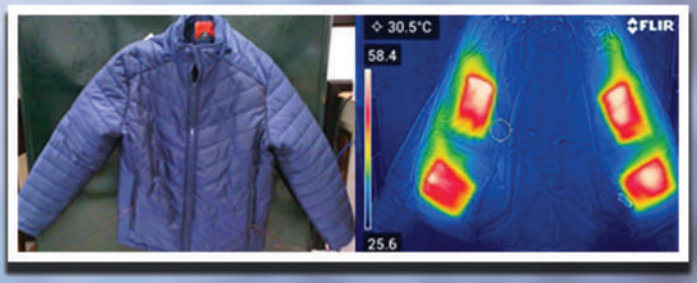
CSIR-NIIST has developed advanced smart apparel with thermoregulation capabilities using printed electronics technology, designed for the next generation of intelligent clothing. By depositing conductive materials in ink form onto flexible substrates, we have created printed heaters that deliver efficient heating while consuming minimal electrical energy. These heaters offer a lightweight and flexible alternative to conventional coil heaters and can be seamlessly integrated into various wearable applications, such as heated insoles, gloves, and jackets. Our innovation focuses on three primary types of heated apparel: insoles, gloves, and jackets. The heated gloves are produced by incorporating fabric heater into commercially available gloves, customized to meet specific warmth requirements. Similarly, the heated insoles are developed by combining a printed heater with a standard polyurethane base and fusible interfacing fabric, ensuring comfort and functionality equivalent to traditional insoles. In extremely cold climates, where conventional jackets struggle to provide sufficient warmth, our heated jacket offers a highly effective solution. These jackets are equipped with integrated fabric heaters that regulate body temperature based on user preferences, eliminating the need for rigid components and enhancing comfort. The result is a versatile, energy-efficient line of smart clothing that not only improves user experience but also meets the demands of those working in harsh conditions. These smart apparels are well suited for defence personnel operating in cold desert environments.

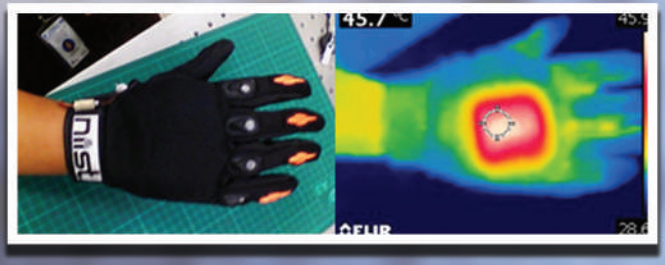
Salient Features, Highlights, And Advantages

- Exceptionally lightweight and gentle on the skin
- Rugged and reliable energy-efficient heaters integrated into fabrics
- User desired temperatures can be set (RT to 60 °C)
- Precise temperature delivery using interface electronics
- Flexible design with no rigid electronic components
- Washable and breathable design over fabrics
- Low energy consumption
  (Glove: 3 W for attaining 50 °C)
  (Insole: 3.5 W for attaining 50 °C)
  (Jacket: 14 W for attaining 50 °C)
- Can be powered with rechargeable battery pack (9V), power bank etc.

Commercialization Status

- Status of commercialization: Not yet commercialized
- Potential clients:
  - Textile Industries
  - Leather Industries
  - Strategic Agencies (DRDO, Armed Forces)
- Validation level: TRL 5



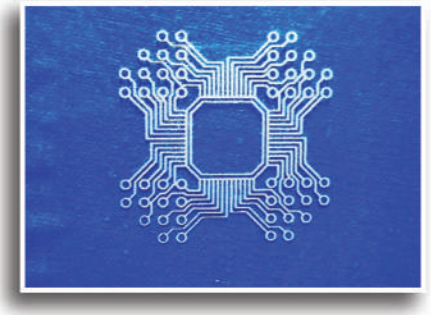


SCREEN PRINTABLE CONDUCTIVE INKS

Technology Outline

The conductive inks are mainly used to create flexible and portable electronic devices, through screen printing. The readily available technologies include silver, gold, copper, nickel, aluminium and carbon nanotubes. These conductive inks are mainly used in the following applications.

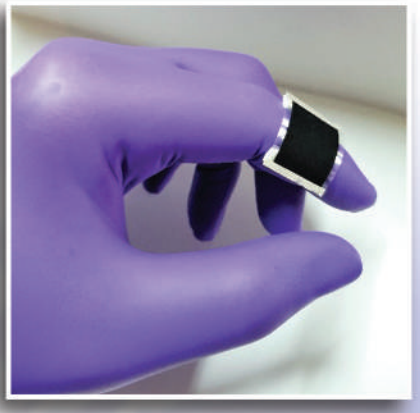
- Textile wearables used in health monitoring systems
- Printed heaters for car seats and thermotherapy
- Hybrid electronic multilayer modules
- RFID antennas for asset monitoring and mobile health assessment
- Metallization of silicon solar cells
- Printed keyboards for portable electronics
- Conductive traces for touch screen sensors used in mobile phones
- Conductive coating for EMI shielding



Salient Features, Highlights, And Advantages

Specifications

- Electrical conductivity: >104 S/m for conductive inks/pastes
- Viscosity: 10-50 Pa.s
- Cure Temperature: 100-200oC
- Substrate: Paper, fabric, plastic or ceramic

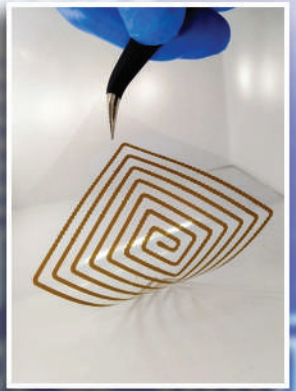


Standards

- Adhesion: ISO 2409 (no material removed)
- Viscosity: Shear thinning (non-Newtonian)
- Conductivity: Positive temperature coefficient (PTC) of resistance

Commercialization Status

- Status of commercialization: Not yet commercialized
- Potential clients: PCB manufacturers, RFID makers, solar cell manufacturers, printed electronic industries, strategic sectors (ISRO/DRDO)
- Validation level: TRL 5-6



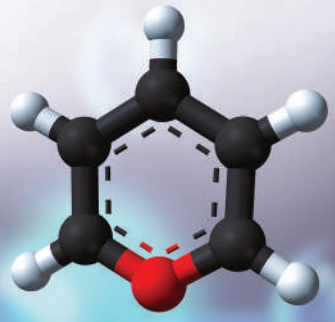
INDUSTRIALLY VIABLE INDIGENOUS PROCESS FOR CATALOGUED SPECIALTY CHEMICAL PYRYLIUM IONS AND NOVEL VARIANTS

Technology Outline

Pyrylium ions demonstrate widespread applications; from valuable synthons to photoredox catalysis, fluorescent probes, photosensitizers, Q-switchers, laser dyes, organic luminophores and solar cells. The main limitations of the existing methods are low yields, tedious separation process and only symmetrical pyrylium ions can be synthesized in a single-step reaction. To address these issues, at CSIR-NIIST, we have developed a simplified, one-pot direct synthesis process for the production of symmetrical and unsymmetrical pyrylium ions. The process explores indigenously available key starting materials with reaction parameters suitable for industrial-scale applications. The notable invention in the process is to produce a diverse library of novel variants of pyrylium ions via the one-pot process. This technology presents significant market potential both domestically and globally, offering Indian industries the opportunity to produce speciality chemicals indigenously.

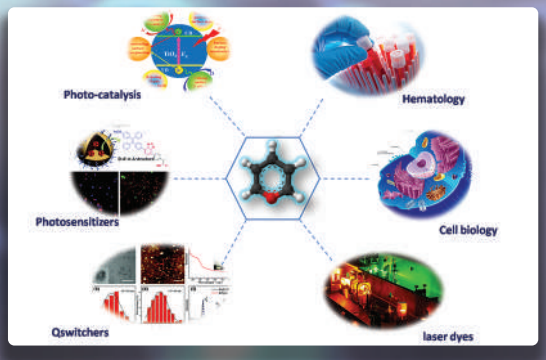
Salient Features, Highlights, And Advantages

- Cost-effective one-pot scale-up process for the production of catalogued pyrylium ions.
- Cost-effective one-pot scale-up process for the production of a newly designed library of novel variants of pyrylium ions.
- Indigenous process technology to facilitate the Indian market requirement.
- Large library of pyrylium ions which can open new avenues in specialty chemicals viz. phtoredox catalysis, fluorescent imaging, cell biology, solar cell processing etc.



Commercialization Status

- Status of commercialization: Multiple patents granted
- No. of Licenses: In progress
- Major raw materials to be utlilized: Indigenously available in India
- Validation level: TRL 7
- Handholding support: Technical Consultancy



HERBAL INHALER FORMULATION

Technology Outline

The novel patented water-soluble steam inhalation drop contains a blend of active essential oils from Eucalyptus globulus, Ocimum sanctum and other medicinal plants that are recommended by AYUSH for their extensive antimicrobial, antitussive, antispasmodic, anti-allergic and anti-inflammatory property which are backed up by scientific proof for their sustained action. The product mimics the existing conventional steam inhalation liquids but are made water soluble through formulation techniques which significantly reduce the burning sensation to nose and eyes during steam inhalation therapy. The medicinal herb ingredients help to reduce respiratory symptoms; and water solubility allows them to be released slowly along with steam providing long term effects without irritation and preventing dose dumping.

Salient Features, Highlights, And Advantages

- Controlled or slow release of active ingredients
- Safe and effective steam inhalation therapy up to 30 minutes
- The novel formulation can hold the active ingredients up to 72 hours, if kept open

Commercialization Status

- Status of commercialization: Not yet commercialized
- Major raw materials to be utlilized: Volatile essential oil ingredients from medicinal plants
- Validation level: TRL 4
- Handholding support: Technical Consultancy


E. globulus


M. piperita


O. sanctum


C. citratus

TECHNOLOGY FOR EARLY CANCER DIAGNOSIS EMPLOYING RAMAN SPECTROSCOPY AND ARTIFICIAL INTELLIGENCE

Technology Outline

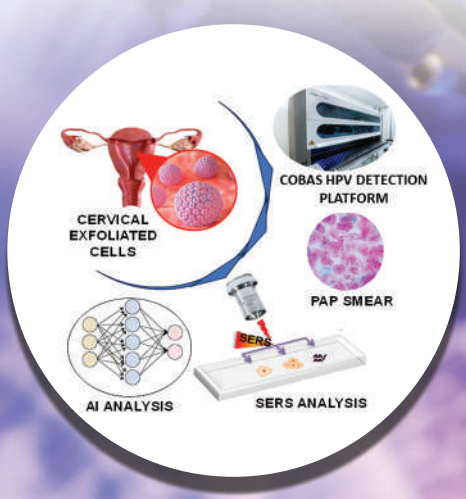
Raman spectroscopy combined with artificial intelligence offers a groundbreaking approach to early cancer diagnosis. This technology analyzes surface-enhanced Raman Scattering (SERS) of plasma metabolite profiles or exfoliated cells, which change with cancer progression. Artificial Intelligence (AI) -based classification of these SERS fingerprints enables sensitive and non-invasive cancer detection and staging. The method's non-invasive nature and minimal sample preparation requirements make it highly practical for clinical diagnosis. This innovative approach can potentially revolutionize cancer management by promoting earlier and more precise treatment interventions. Importantly, the technology can detect asymptomatic cancers, potentially leading to improved survival rates through early intervention. Additionally, its cost-effectiveness and ability to provide digital pathology findings make it a promising tool for widespread implementation in various healthcare settings, including resource-limited areas.

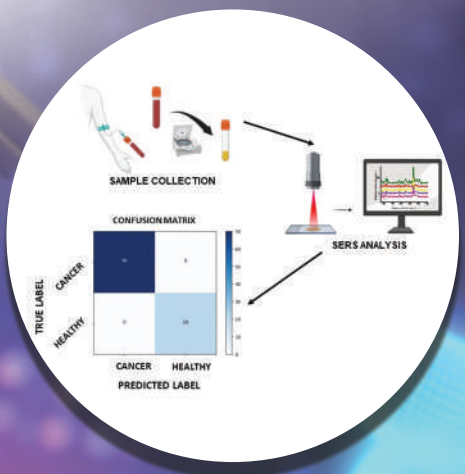
Salient Features, Highlights, And Advantages

- **Non-invasive diagnosis Description:** The technology uses Raman spectroscopy on easily obtainable samples, eliminating the need for invasive biopsies.
- **AI-powered analysis Description:** Artificial intelligence algorithms classify SERS fingerprints, enabling accurate and efficient cancer detection and staging.
- **Versatility in cancer types Description:** The method can be applied to various cancer types, including breast, cervical, lung, and larynx cancer, and those detectable through blood plasma samples.
- **Real-time results Description:** The technology provides immediate analytical reports, facilitating quick diagnosis and treatment decisions.

Commercialization Status

- Status of commercialization: Not yet commercialized
- Validation level: TRL 5
- Handholding support: Technology implementation and Training





ALUMINIUM AUTO COMPONENTS

Technology Outline

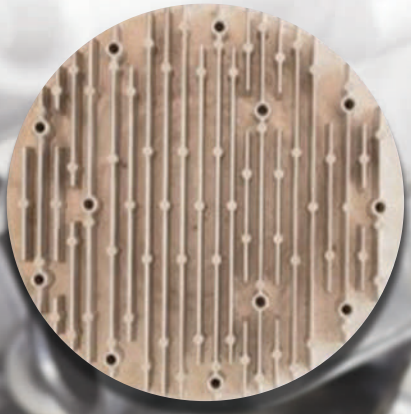
This technology focuses on producing near net shape high-strength aluminium alloys and products using squeeze casting technology for automotive and strategic applications. The process excels in creating components such as suspension knuckles, control arms, and hub components for various vehicles, including hybrid electric ones. Different aluminium alloys are used for specific applications: modified Al-Si-Mg (A356) for high-strength structural components, Al-Si-Cu (A319) for suspension and functional automotive parts, and a high-temperature Al-Si-Cu-Ni-Mg alloy for engine and transmission components. The technology offers advantages such as producing high-integrity, porous-free components with high strength, lightweight properties, and high thermal conductivity.

Salient Features, Highlights, And Advantages

- **Diverse Alloy Applications:** Utilizes various aluminum alloys tailored for specific automotive and strategic components.
- **Squeeze Casting Technology:** Enables the production of high-integrity, porous-free components with superior properties.
- **Lightweight Solutions:** Creates high-strength, lightweight engineering components ideal for improving vehicle efficiency.
- **Versatile Component Production:** Facilitates the manufacturing of a wide range of auto parts, from suspension components to engine parts.

Commercialization Status

- Status of commercialization: Product delivered to user industry
- Major raw materials to be utlilized: Aluminium Alloy
- Validation level: TRL7, System prototype demonstration in operational environment
- Handholding support: Technology Implementation and Training



Aluminum alloy Squeeze Cast Scroll Compressor Plates

Aluminum alloy canon ball component

ENVIRONMENTAL FRIENDLY PROCESS FOR HIGH GRADE SYNTHETIC RUTILE PRODUCTION

Technology Outline

CSIR-NIIST has developed an environmentally friendly process for producing high-grade synthetic rutile from ow-grade ilmenite, a natural mineral used globally for making pigment-grade TiO2 and titanium metal. This nnovative technology features superior pollution control measures and advanced processing techniques, esulting in high-quality synthetic rutile. Successfully demonstrated in collaboration with two private industries, he process has handled approximately 700 metric tons of ilmenite, yielding 570 metric tons of metallized lmenite and 130 metric tons of synthetic rutile. The process conditions are tailored to ensure compatibility with various grades of Indian ilmenite, making it adaptable for widespread application in titanium dioxide production. This technology presents significant market potential both domestically and globally, offering ndian industries the opportunity to upgrade ilmenite to contain over 90% TiO2, thus meeting increasing domestic demand and enhancing the mineral's value substantially.

Salient Features, Highlights, And Advantages

- **Eco-friendly Mineral Processing:** Utilizes environmentally conscious techniques to upgrade low-grade ilmenite to high-grade synthetic rutile.
- **Versatile Application:** Adapts to various grades of Indian ilmenite, ensuring widespread applicability in the industry.
- **Significant Value Addition:** Substantially increases the market value of ilmenite by enhancing its TiO2 content.
- **Market Opportunity:** Addresses the growing domestic and global demand for high-grade titanium dioxide materials.

Commercialization Status

- Status of commercialization: Pilot scale testing has been carried out (600MT of ilmenite processed and 275MT of Synthetic rutile (93% - TiO2) produced)
- No. of Licenses: Licensed to 3 clients
- Major raw materials to be utlilized: Ilmenite (FeTiO3)-, Coal, Titania Slag
- Validation level: TRL 5
- Handholding support: Technical consultancy and Training

FUNCTIONALLY GRADED ALUMINIUM ALLOY AND COMPOSITE PRODUCTS AND PROCESS TECHNOLOGY

Technology Outline

This technology involves using Functional Grade Material (FGM) concepts to design and create lightweight aluminium composite components for automotive applications. These components offer improved mechanical and wear properties at specific locations within the material. The technology has been successfully used to fabricate various automotive parts such as brake rotor discs, cylinder liners, gear housings, and piston rings. The main advantages include enhanced durability and performance of these parts due to their improved mechanical properties. Additionally, the use of lightweight materials contributes to overall vehicle efficiency and fuel savings, opening up new possibilities for creating more efficient and reliable automotive components.

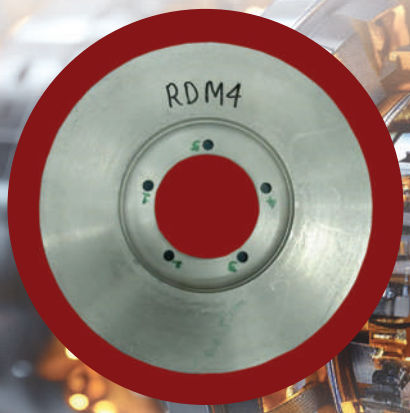
Salient Features, Highlights, And Advantages

- **Tailored Performance:** Enables the creation of components with specific mechanical properties at precise locations.
- **Lightweight Design:** Utilizes aluminium composites to reduce overall vehicle weight, improving fuel efficiency.
- **Versatile Applications:** Successfully applied to various automotive components, enhancing their durability and performance.
- **Innovative Manufacturing:** Employs FGM concepts to create advanced materials with superior

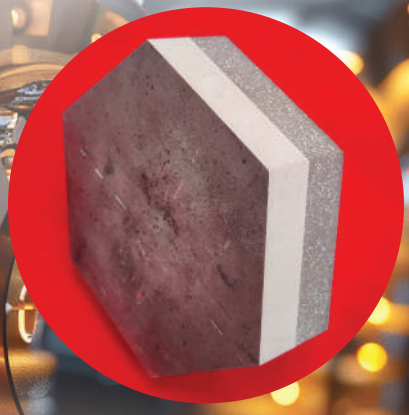
Commercialization Status

- Status of commercialization: Product delivered to user industry
- Major raw materials to be utlilized: Aluminium Alloy and Composite
- Validation level: TRL7, System prototype demonstration in operational environment
- Handholding support: Technology Implementation and Training

Al FGM Cylinder liner



Al FGM Brake Rotor Disc



Al-SiC FGM Armour Plate

INDOOR LIGHT HARVESTERS

Technology Outline

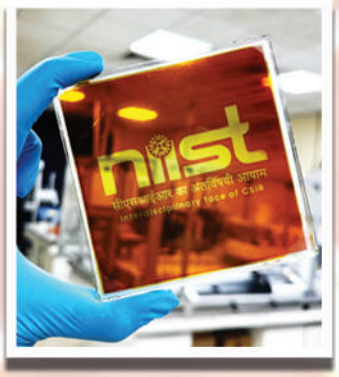
ndoor/Ambient Light Harvesters for Self-powered IoTs are third-generation molecular light-harvesting devices ɔased on Dye-sensitized solar cells (DSCs) technology. These harvesters are designed to capture and recycle ɑll types of light, including indoor and outdoor sources, to power self-sufficient devices. DSCs have proven to be the most efficient technology for harvesting energy from indoor and ambient lighting, with efficiencies reaching ɹp to 40%. This technology addresses the limitations of conventional solar technologies, which are often too ɔulky, rigid, or inefficient for use in remote or indoor locations under artificial lighting. The market for indoor ɔhotovoltaics is projected to reach $850 million by the end of 2024, highlighting the growing demand for this nnovative solution.

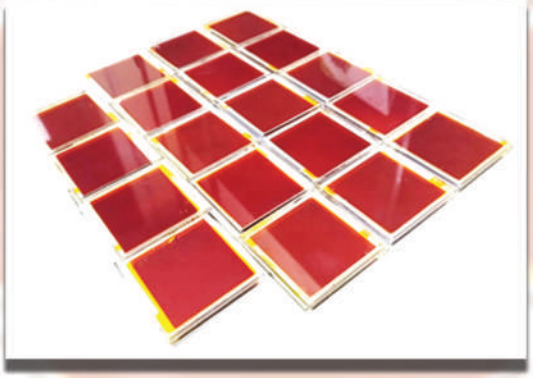
Salient Features, Highlights, And Advantages

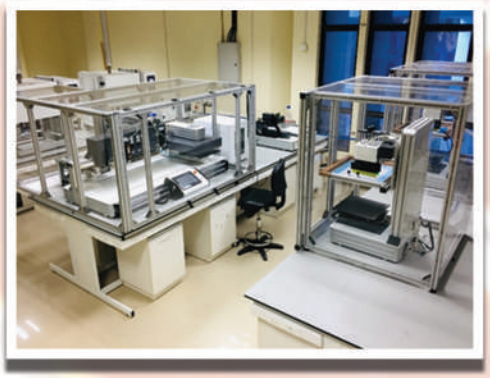
- **Eco-friendly alternative:** Reduces pollution caused by disposable batteries, potentially saving millions of square kilometers of land and water from contamination.
- **Versatile and efficient:** Capable of harvesting energy from various light sources, including artificial indoor lighting, with efficiencies exceeding 40%.
- **Cost-effective production:** Utilizes easily sourced materials and supports indigenous manufacturing, leading to reduced production costs and import substitution.
- **Sustainable lifecycle:** Offers improved recyclability compared to batteries, contributing to a greener and more sustainable living environment.

Commercialization Status

- Status of commercialization: Fabrication equipment design commercialized
- No. of Licenses: Licensed to 1 client
- Validation Level: Field trials in progress
- Raw Materials: Indigenous and custom made
- Support Provided: For setting up the production facility for these indoor solar cells







NANO GENERATORS FOR SELF-POWERED ELECTRONICS

Technology Outline

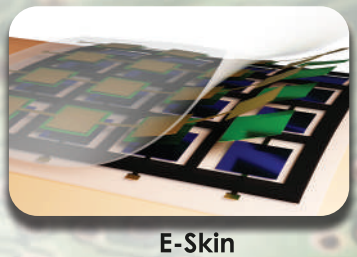
Harvesting kinetic energy from surroundings is utmost important in the era of internet of things (IoT) and AI enabled sensor networks, as the energy demand is rising day by day. Piezoelectric (PENG) and Triboelectric Nanogenerators (TENG) are key players in this arena of green energy scavengers as they convert discrete mechanical vibrations into useful electricity for powering personal gadgets and self-powered sensors. TENG is a mechanical energy harvesting device, which converts discrete, high entropy and low frequency mechanical energy from surroundings into electricity by conjunction of contact electrification and electrostatic induction while PENG generates electricity via the dislocation of dipoles under an external mechanical impact. CSIR-NIIST is one of the leading institutions in the country in the area of nanogenerators, which has rich expertise in engineering high-performance flexible and wearable piezo-tribo nanogenerators for efficient kinetic energy harvesting from ambient environment and self-powered sensing applications.

Salient Features, Highlights, And Advantages

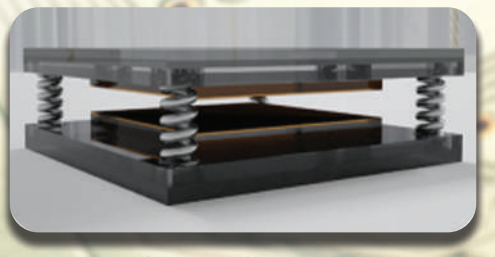
- Generate ample electrical energy, with a peak maximum voltage of 4.3 kV, current of 45 µA and power density of 20.2 w/m^2 respectively.
- Self-powered sensors that realise tactile perception, structural health monitoring, noise pollution detection, obstacle mapping and navigation is developed.
- Facile, flexible, and stable form factors and environmental benign materials selection for practical implementations of devices..
- Lead-free piezoelectric materials, printable ink formulations and electrospun nanofiber mats are developed for PENG

Commercialization Status

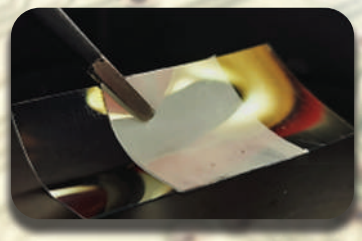
- Status of commercialization: Not yet commercialized
- Potential clients:
  - Tyres Manufacturing Companies
  - Shoe Manufacturing Companies
  - Biomedical Companies
  - Clean energy Firms
  - Structural Health Monitoring Companies
  - Strategic sector agencies (ISRO/DRDO)
- Validation level: TRL 5



E-Skin



Spring Assisted TENG



PENG

EVEN SOLAR SHARING AGRIVOLTAICS

Technology Outline

Agrivoltaics (AV) is an innovative approach that combines agricultural production with photovoltaic power generation on the same land, aligning with India's goal to double farmers' income. CSIR-NIIST has developed the Even Solar Sharing (ESS) AV technology, currently at TRL 5, which offers solutions for shade-intolerant plants and features tunable ray spreading and spectral conversion. The ESS-AV system provides precision solar radiation control, reducing evapotranspiration and thermal stress on crops while increasing electricity generation through expanded PV coverage. Its versatility allows for converting existing PV plants into AV plants, integrating PV with greenhouses, and implementing Building Integrated Agrivoltaics (BIAV) as a multifunctional roofing solution. With a market potential of 3,156 GW agrivoltaics installation in India alone, ESS-AV technology contributes to precision carbon-neutral farming and aligns with multiple Sustainable Development Goals and national initiatives.

Salient Features, Highlights, And Advantages

- **Dual-Use Technology:** Enables simultaneous crop production and solar energy generation on the same land, optimizing land utilization.
- **Adaptive Light Management:** Provides tunable ray spreading and spectral conversion for optimal crop-specific light conditions and increased energy yield.
- **Crop Stress Reduction:** Offers precision solar radiation control to minimize evapotranspiration and thermal stress on crops and farmland.
- **Versatile Integration:** Supports conversion of existing PV plants, greenhouse integration, and Building Integrated Agrivoltaics applications.
- **Sustainable Impact:** Contributes to precision carbon-neutral farming while aligning with national and global sustainability goals.

Commercialization Status

- Status of commercialization: Not yet commercialized
- Validation Level: TRL 6
- Support Provided: Technology, and plant design guidelines

Doing business with NIIST

Empower Your Innovations with NIIST: Your Partner in R&D Advancement

1. **Sponsored and Collaborative Projects**
   for innovative and breakthrough R&D
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   to maximize efficiency and improves quality
3. **Turn-Key Projects**
   from concept to completion delivering comprehensive solutions
4. **Advisory Consultancy**
   offers strategic insights and direction for R&D endeavours
5. **Technical Consultancy**
   that addresses the unique needs and propelling the projects towards success
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   ensuring seamless operations and process improvements
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   to drive eco-friendly decisions and meet regulatory requirements
8. **Contract Manufacturing and Pilot Plant Services**
   that embody efficiency, precision, and innovation
9. **Testing and Analytical Services**
   Precision matters! guaranteed quality and integrity
10. **Skill Development Programs and Human Resource Development**
    fostering a workforce equipped for the challenges of tomorrow
11. **Incubation Services**
    to turn the visionary concepts into reality

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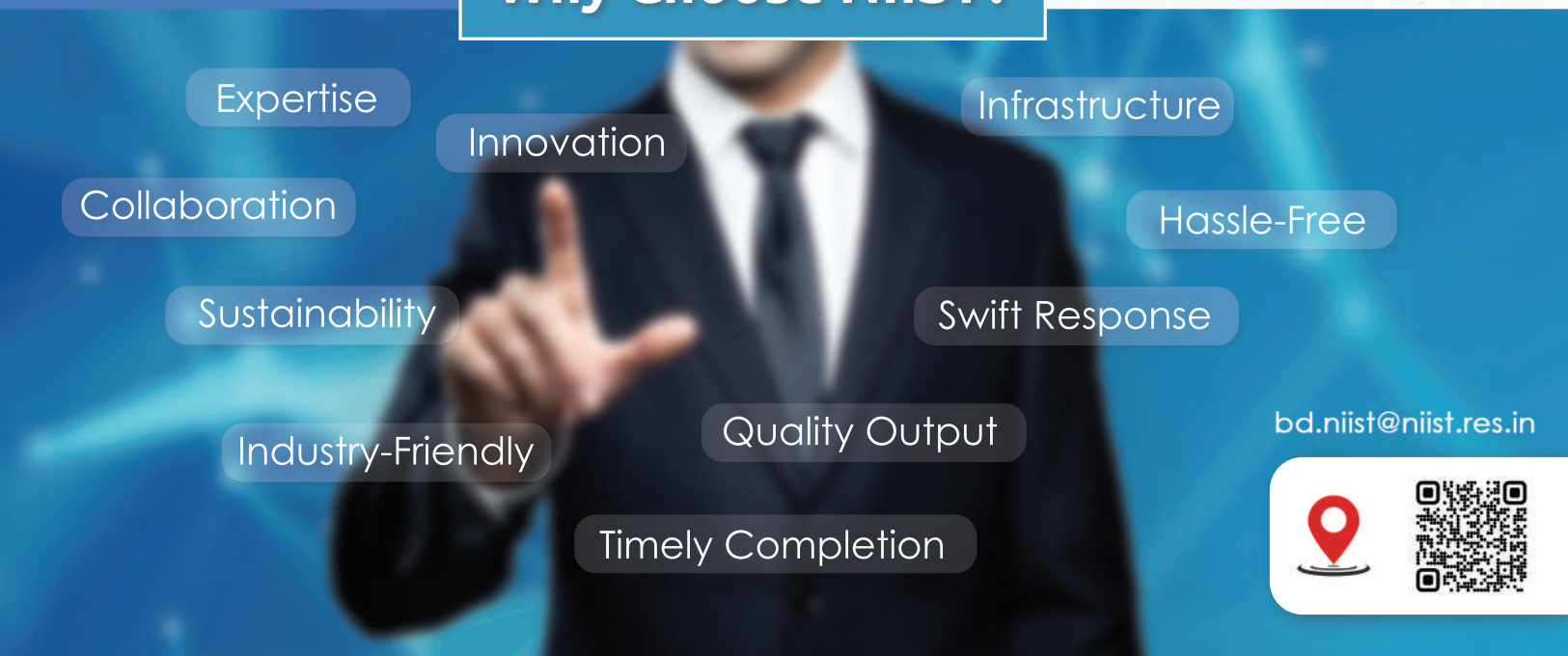
We Welcome CSR Funds

for R&D, Solution Implementation and Infrastructure Projects (SDGs)

Why Choose NIIST?



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