

TECHNOLOGY COMPENDIUM



सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India



CSIR-Central Leather Research Institute





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CLRI Technologies are Intellectual Property(IP) protected.
Efforts are made to secure appropriate Intellectual Property(IP)
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in respect of the new developments.

TECHNOLOGY COMPENDIUM



CSIR-Central Leather Research Institute
Adyar, Chennai - 600 020, India.

2026





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FOREWORD

CSIR-CLRI is a prominent source of technology for the leather industry since the inception of the Institute. When the industry moved from manufacturing vegetable tanned leathers to chrome tanned leathers, CSIR-CLRI provided the necessary technological support and assistance to the industry. Later, when there was a need for manufacture of leather auxiliaries, namely syntans and fatliquors, CSIR-CLRI had developed technologies of the manufacture of the leather auxiliaries and transferred it to the leather chemical industry. Many technologies connected to waste management and treatment were translated to the industry, and the same had succored the leather industry.

This document of Technology Compendium provides the outline of all the technologies that have been developed in the recent past and will fulfil the technology requirements of the industry. The Technology Compendium comprises the synopsis of technologies developed to contain chromium pollution, utilization of solid wastes, treatment of wastewater, solid waste and gaseous emissions control, preparation of health care products from co-products of slaughterhouse, manufacturing of leather auxiliaries and manufacturing of leathers from non-conventional sources of skins. These technologies are developed keeping in mind the current and future requirements of the industry. Many of these technologies not only provide solutions to environmental issues but also bring about significant financial returns. This compendium is prepared to provide the snapshot of these technologies to the potential user industry and will be updated periodically. I strongly believe that the Technology Compendium will provide the necessary information of the technologies to the prospective users to enable them to opt for them. I invite the industry to ponder over the document and use it to good advantage of fulfilling their technology requirements. The scientists of CSIR-CLRI are willing to provide the industry all the necessary support for the successful adoption of the technologies.



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About Leather, Leather Products & Footwear Industry

The Leather, Leather Products & Footwear industry occupies a prominent place in the Indian economy in view of its substantial export earnings, employment potential and growth. The sector is spread across the formal as well as informal sectors and produces a comprehensive range of products from raw hides to fashionable shoes. The industry consists of firms in all capacities, including small artisans to major global players. Specialized institutions have been setup to promote the overall growth and performance of the industry. There has been an increasing emphasis on the planned development of industry, which is aimed at optimum utilization of available raw materials for maximizing the returns, especially from exports.

The share of Cattle & Buffalo population of India is about 20% of world livestock population and whereas Goat & Sheep population is 11%. The Annual availability of finished leather is about 3 bn sq. ft. Export of leather and leather products from India is constantly witnessed increased trends over the years.



LIST OF TECHNOLOGIES LISTED IN TECHNOLOGY COMPENDIUM 2026

S.NO.	NAME OF THE TECHNOLOGY	CODE NO.	PAGE NO.
CATEGORY I - LEATHER PROCESSING TECHNOLOGIES			
1	BACTERIAL PROTEASE FOR UNHAIRING APPLICATION	LMT01	1
2	CHICKEN FEET LEATHER AND LEATHER PRODUCTS	LMT02	2
3	ELECTRO-OXIDATION BASED ZERO WASTEWATER DISCHARGE PROCESS	LMT03	3
4	LEATHERS AND PRODUCTS FROM FISH SKIN	LMT04	4
5	LIGHT WEIGHT AND COLD RESISTANT LEATHERS	LMT05	5
6	PROCESS FOR MAKING LEATHER FOR MUSICAL INSTRUMENT	LMT06	6
7	ULTRA-LOW WATER LIMING PROCESS	LMT07	7
8	WATERLESS CHROME TANNING TECHNOLOGY (WCTT)	LMT08	8
9	CLI-MATE: A UNIFIED DIGITAL PLATFORM FOR CARBON FOOTPRINT ASSESSMENT FOR LEATHER INDUSTRY (CLI) AND WASTE TREATMENT SYSTEMS (ETP/CETP)	LMT09	9
10	COMPACT PRODUCT FOR ONE-SHOT POST-TANNING PROCESS	LMT10	10
CATEGORY II - LEATHER CHEMICALS			
11	CHROME -MELAMINE SYNTAN	LCT01	11
12	CHROMIUM FREE TANNING GEL	LCT02	12
13	COLD CRACK RESISTANCE FATLIQUOR FOR LEATHER PROCESSING	LCT03	13
14	EMULSIFIER FOR W/O AND O/W EMULSION	LCT04	14
15	IONIC POLYURETHANE- SILICA CONJUGATES	LCT05	15
16	LIGNIN BASED RE-TANNING AGENT	LCT06	16
17	NATURAL OIL-BASED POLYURETHANE DISPERSION	LCT07	17
18	ECO-FRIENDLY FLAME RETARDANT POST-TANNING AGENT	LCT08	18
19	PHASE CHANGE MATERIAL BASED RETANNING	LCT09	19
20	POLYURETHANE FOAM FOR FOOTWEAR SOLES	LCT10	20
21	FLUOROCHEMICAL- FREE WATER BASED FATLIQUOR WITH ANTI FOGGING PROPERTY	LCT11	21
22	PROTEIN- BASED SYNTHETIC TANNING AGENT	LCT12	22
23	A HIGH SOFTENING FATLIQUOR WITH LOW FOG VALUE FOR ENHANCED LEATHER PROPERTIES	LCT13	23
24	ENVIRONMENT-FRIENDLY AND NON-TOXIC FLAME RETARDANT FOR LEATHER AND A PROCESS FOR THE PREPARATION THEREOF	LCT14	24
CATEGORY III - WASTE MANAGEMENT TECHNOLOGIES			
25	BIOGAS GENERATION FROM ORGANIC WASTES	TWM01	28
26	CO-DIGESTION OF TANNERY SOLID WASTE FOR BIOENERGY GENERATION	TWM02	29
27	IMMOBILIZED OXIDATION REACTORS (IOR) FOR WASTEWATER TREATMENT	TWM03	30
28	INTEGRATED SOLAR DRYING AND PYROLYSIS PROCESS	TWM04	31
29	ORGANIC SUPPLEMENT FROM ANIMAL HAIR WASTE	TWM05	32
30	SEQUENTIAL OXIC-ANOXIC BIO REACTOR (SOABR) FOR WASTEWATER TREATMENT	TWM06	33
31	RECOVERY OF STRUVITE FROM TANNERY WASTEWATER AND ITS APPLICATION AS SOIL CONDITIONER	TWM07	34
CATEGORY IV - WASTE TO WEALTH			
32	ACTIVATED CARBON FOR MAKING SOLES FROM FLESHING WASTE	WTW01	38
33	BASIC CHROMIUM SULPHATE USING CHROME SHAVING WASTE AS REDUCTANT	WTW02	39
34	COLLAGEN PEPTIDE FROM FISH SKIN	WTW03	40
35	KERATIN HYDROLYSATE FROM FEATHER	WTW04	41
36	REGENERATED LEATHER FROM TANNERY SOLID WASTE	WTW05	42
37	A SUSTAINABLE PROCESS FOR THE VALORIZATION OF SPENT PICKLING ACID BY RECOVERING IRON AND CHLORIDE AS VALUE-ADDED CHEMICALS	WTW06	43
38	ECO-BENIGN (NANO) COMPOSITE SHEET MATERIAL WITH LEATHER & TEXTILE WASTE FIBRES FOR APPLICATIONS INCLUDING PACKAGING	WTW07	44

S.NO.	NAME OF THE TECHNOLOGY	CODE NO.	PAGE NO.
CATEGORY V - LEATHER LIKE MATERIAL			
39	PLANTBASED LEATHER LIKE MATERIAL	LLM01	48
40	PSEUDO-CORIUM : LEATHER LIKE MATERIAL	LLM02	49
VI – LEATHER PRODUCTS INCLUDING DEVICE			
41	ANKLE FOOT ORTHOSIS FOR PLANTAR PRESSURE OFFLOADING THE DIABETIC FOOT ULCER	LPR01	52
42	BIO-MECHATRONIC ORTHOTIC DEVICE WITH VIRTUAL INTELLIGENCE FOR CHILDREN WITH CEREBRAL PALSY	LPR02	53
43	EXTREME COLD WEATHER PROTECTION GLOVES	LPR03	54
44	PALM LEAF CRAFT	LPR04	55
45	SMART FOOTWEAR FOR PERSONS WITH DIABETES TO PREVENT FOOT DEFORMITIES AND DIABETIC FOOT ULCER	LPR05	56
46	AN INDIGENOUS FATIGUE RESISTANCE TESTING DEVICE FOR FOOTWEAR INSOLES REINFORCED WITH STEEL SHANK	LPR06	57
47	PAPU SHOE LAST AND A METHOD FOR MAKING THE SAME	LPR07	58



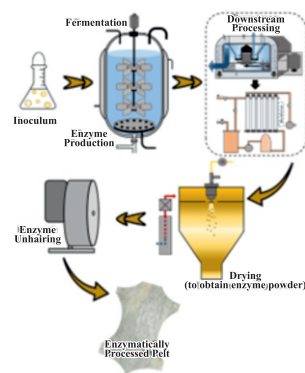
I - LEATHER PROCESSING TECHNOLOGIES

BACTERIAL PROTEASE FOR UNHAIRING APPLICATION

Technology Outline

A process for the production of bacterial protease enzyme for industrial application.

Worldwide, unhairing of animal skins/hides is achieved by conventional chemical-based method using lime and sodium sulfide. The usage of these chemicals leads to the generation of wastewater with pulped or solubilized hair, which corresponds to higher chemical oxygen demand (COD) and total dissolved solids (TDS) in the waste stream. In addition, possible release of toxic H₂S gas and obnoxious odour are other problems associated with the conventional unhairing process. As an alternative, enzymatic unhairing process has been developed. Being a hair saving process, there is reduction in the COD and TDS in the wastewater. Moreover, the process will be the first of its kind for sodium sulfide free-enzyme only unhairing process for a cleaner method of leather processing and eco-friendly for the tanners.



Salient Features / Highlights / Advantages

- Enzymatic unhairing of skins and hides eliminates the use of ~2-3% sodium sulfide/sulphydrate, thereby reducing the possible generation of toxicity.
- The process reduces the pollution load in wastewater and in-turn eliminates the need for sophisticated end-of-pipe treatment system with development of value-added by-products from recovered hair.
- It contemplates to provide the scope for introducing this product as a “Make in India” product in global leather market, thereby increasing the foreign exchange and Indian economy.



Commercialization Status / Techno – Economics

- This technology is ready for commercialization

Major Raw Materials to be utilized

- The raw materials include the bacterial strain, media components, salts, stabilizing agents which are indigenously available.

Validation Level

- TRL 3

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation would be provided upon licensing of this technology.



CHICKEN FEET LEATHER AND LEATHER PRODUCTS



Technology Outline

Chicken feet skin has been identified and screened as potential raw materials for the leather industry to make exotic leather and products. The raw material is a by-product of poultry and is cost effective. CSIR-CLRI has developed technology to process leathers from chicken feet skins with required properties, and consequently to panels and products from chicken feet leathers.



Salient Features / Highlights / Advantages

- Processing does not involve use of sodium sulphide and there is no sludge formation during beam house process.
- Processing does not involve any machinery operations except processing drums and there is no solid waste generation.
- Requires only mild finishing so as not to mask the natural exotic grain pattern.
- Panel and product making requires only small cutting & stitching machines and the technology can be easily adopted by artisans.
- Cost effectiveness, availability and exotic pattern similar to that of baby alligator with good strength properties are the uniqueness of the product.
- The technology has more societal benefits and would create opportunities for fresh entrepreneurs to start small scale leather / leather product industries and would also lead to make wealth from waste and to rural industrialization. The artisan clusters producing small leather goods and small leather toys can also be benefited.



Commercialization Status / Techno – Economics

- This technology has been already commercialized. Process is compatible with regular commercial process set-up (no special equipment/machinery required)
- Cost Workout - (This estimation is only for understanding purpose and actual figures may vary depend upon the requirement):
- From 1 kg of chicken feet skin, approximately 2 sq. ft of leather panel can be produced (varies depending on the weight of the chicken feet skin).
- Time required for production: Leather processing takes 7 working days (irrespective of the weight); Panel making takes 2 days (clicking, pasting on lining material, and stitching the individual pieces).
- Cost: Approx. Rs. 100 to 150 per sq. ft. Chicken feet leather panel (max)

Major Raw Materials to be utilized

- Chicken feet skins (by – product of Poultry)

Validation Level

- TRL 4, Validation at Pilot scale

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation



ELECTRO-OXIDATION BASED ZERO WASTEWATER DISCHARGE PROCESS

Technology Outline

The waste streams from different unit processes are segregated and gross solids are removed through screening. The sectional streams are then subjected to electro-oxidation for removing the organic pollutants using specially developed electrodes. Treated wastewater, which is free from organic pollutants, can be reused in the leather manufacturing to achieve zero wastewater discharge. The residual chemicals present in the treated wastewater in many waste streams are reutilized in the process.



Salient Features / Highlights / Advantages

- No wastewater Discharge; No sludge from treatment;
- No emission from hazardous gases; Less space requirement; Simple to operate;
- Reduction in Water input; Reduction in chemical offer;

Commercialization Status / Techno – Economics

- This technology has been already commercialized, For a unit manufacturing Leather from 2 tons of raw hide / skin; Optimum investment – Rs. 24 lakh/ton of raw hide; Approximate payback period / Return on Investment is about 3 years.

Major Raw Materials to be utilized

- Raw materials required for preparation of the equipment are available indigenously.

Validation Level

- TRL 4. The technology has been standardized on a pilot scale. The technology is also suitable for textile and slaughterhouse wastewater.

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



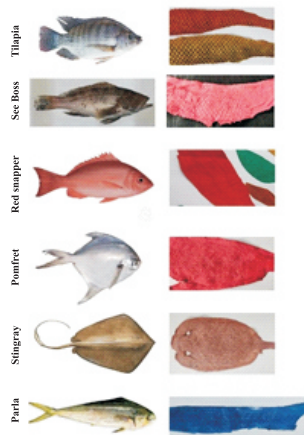
LEATHERS AND PRODUCTS FROM FISH SKIN

Technology Outline

The process of converting fish skins in to leather majorly differs from the existing technology in the beam house stage, choice of metal free tanning agents, choice of chemicals used in post tanning and finishing processes. Fish leathers are stitched after clicking process and leather mats /panels are made either seamor seamless. Panels are finished by applying top coating. Panel development uniqueness would be applicable for mass production.

Salient Features / Highlights / Advantages

- Optimized process technology for converting different types of fish skins in to leather
- The surface morphology/character of the fish skins are retained providing an exotic look to the final leathers
- The strength properties of the fish leathers are on par with those of the conventional ovine leathers
- The leathers developed from fish skins can be converted in to smaller leather goods such as wallets, belts, watch straps and shoes



Commercialization Status / Techno – Economics

- This technology is ready for commercialization

Major Raw Materials to be utilized

- Fish skins are available from the fish processing industry in India

Validation Level

- TRL 4

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation would be provided upon licensing of this technology



LIGHT WEIGHT AND COLD RESISTANT LEATHERS

Technology Outline

Gloves and clothing are essential for civilians and defence personnel deployed in high-altitude regions such as the Siachen Glacier and other icy environments. A standardized leather-making process has been developed with judicious selection of fatliquors, retanning and tanning agents, along with precise control of process parameters. The resulting leather exhibits cold resistance in the range of -30 to -10°C and a lightweight character of 450 ± 100 GSM, suitable for prolonged wear. The technology has high potential for immediate deployment in the leather and leather products sector for items such as gloves and cold-weather garments. Estimated requirement is 40,000–50,000 gloves per year for Siachen alone, with an equal number at base locations, presently met through imports; additional demand exists for civilian cold-weather applications.



Salient Features / Highlights / Advantages

- Optimized process recipe using commercially available chemicals to produce lightweight, cold-resistant glove leathers.
- Easy to adopt in existing glove/garment leather manufacturing lines without major capital modification.
- Resultant leathers provide cold resistance up to -30°C and maintain lightweight characteristics (450 ± 100 GSM).
- Process validated at CSIR-CLRI pilot tannery with a 50 kg batch, demonstrating reproducibility and scalability.
- Leathers conform to all physical and chemical norms prescribed for glove and garment leathers.
- Leathers have been successfully converted into gloves, and the finished products have been characterized for performance.

Commercialization Status / Techno – Economics

- Technology is ready for commercialization and has already been transferred to an industrial client manufacturing glove leather.

Major Raw Materials to be utilized

- Wet blue goat or sheep skins, along with commercial fatliquors, synthetic tanning agents and dyes.

Validation Level

- TRL 4

Handholding support

- Training, on-site/off-site demonstration, detailed technology documentation, troubleshooting assistance and support for technology implementation



A PROCESS FOR MAKING LEATHER FOR MUSICAL INSTRUMENTS

Technology Outline

- Leather-based percussion instruments have long served as vital conduits of cultural expression and emotional resonance within Indian society
- Far beyond their acoustic function, these instruments embody the emotional and symbolic dimensions of our heritage
- Despite their enduring cultural significance, such instruments have received limited attention within the domains of scientific research and technological innovation
- In response to this gap, the CSIR-CLRI has developed a process technology for the manufacturing of leather tailored to musical instruments and rigorously tested for mechanical and acoustic characteristics

*Traditional
Instruments*



Modified

Salient Features / Highlights / Advantages

- Accelerated process for making leather for musical instruments
- The desirable acoustic characteristics of the leather can be fine-tuned through an appropriate process
- Improvement and enhancement of organoleptic & aesthetic appeal
- Developed leather retains good sound & tonal quality
- Improved antifungal properties
- The technology is simple and suitable for the tannery manufacturer as well as the artisanal community

Commercialization Status / Techno – Economics

- This technology is ready for commercialization. Economically viable, with no need for any specialized machinery and infrastructure

Major Raw Materials to be utilized

- Indigenous low-cost raw materials

Validation Level

- TRL 6

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



ULTRA-LOW WATER LIMING PROCESS

Technology Outline

Conventionally, tanners employ about 300–400% water during the liming process, leading to very high effluent volumes. The resulting waste water contains eco-sensitive chemicals and significantly contributes to the overall pollution load from tanneries. There is a pressing need for innovative liming processes that can substantially reduce water usage without compromising leather quality. This technology employs an ultra-low quantity of water during liming, using a concentration-gradient-based approach to ensure effective chemical diffusion. Reduced water usage, combined with lower chemical offers, leads to a significant reduction in pollution load in liming wastewater. The process results in reduced wastewater discharge and facilitates conservation of water for other industrial uses.



Validation at commercial scale



Salient Features / Highlights / Advantages

- Use of ultra-low water during pre-tanning (liming) has been optimized for practical implementation in tanneries.
- The Ultra-Low Water Liming (ULWL) process has been fine-tuned at pilot scale and validated at commercial scale in a working tannery.
- Water consumption is reduced by about 75% compared to conventional liming.
- Reductions in key pollution parameters are achieved: COD by 19%, TDS by 15%, alkalinity by 20%, and sulphide by 88%.
- A net saving of about Rs 1500 is realized for processing 1 ton of hides through reduced water and chemical inputs.

Commercialization Status / Techno – Economics

- The technology is ready for commercialization and suitable for adoption in existing liming operations. The process offers a significant reduction in water and chemical usage, making it both technically and economically feasible.

Major Raw Materials to be utilized

- Applicable to all raw hides and skins, using conventional commercial chemicals such as lime and sulphide.

Validation Level

- TRL 4, with pilot and commercial-scale validation completed.

Handholding support

- CSIR-CLRI can provide training, on-site/off-site demonstration, detailed technology documentation, troubleshooting support, and assistance for technology implementation.



WATERLESS CHROME TANNING TECHNOLOGY (WCTT)



Technology Outline

The use of water during conventional chrome tanning is considered essential for achieving uniform diffusion, distribution and hydrolysis of chromium within the hide or skin matrix. Waterless Chrome Tanning Technology (WCTT) eliminates the use of added water, salt, sulphuric acid and basification salts during the chrome tanning stage, relying instead on the inherent moisture of the pelt. There is a growing need for a dedicated product/system that enables chrome tanning without water input, facilitating wider industrial adoption and large-scale application of this cleaner process.



Salient Features / Highlights / Advantages

- Complete elimination of common salt and sulphuric acid from the chrome tanning stage.
- Complete elimination of inorganic/mineral acids and basification salts in the tanning step.
- Significant reduction in Total Dissolved Solids (TDS) in wastewater streams associated with tanning.
- No discharge of chrome-containing wastewater from the chrome tanning operation, as the process operates without added water.
- Wet-blue leathers are comparable in physical and organoleptic properties to conventionally chrome-tanned leathers, with similar shrinkage temperature and performance.



Commercialization Status / Techno – Economics

- Licensed to more than 185 clients across India and to at least one overseas client (Egypt), reflecting strong industry acceptance.
- Techno-economics: Suitable for small and medium tanneries; existing units can adopt the technology without additional capital investment, with an approximate payback period / ROI of about 12 months driven by savings in water, chemicals and processing time.

Major Raw Materials to be utilized

- Existing raw materials and chrome tanning agents used in tanneries can be employed; no special new drum or equipment is required.

Validation Level

- TRL 8
- Product and process developed and validated at pilot scale, with commercial-level validation on goat skins and cow hides carried out in a tannery at Ranipet and other clusters.

Handholding support

- CSIR-CLRI provides training, on-site demonstration, detailed technology documents, troubleshooting assistance and support for technology implementation.



CLI-MATE: A UNIFIED DIGITAL PLATFORM FOR CARBON FOOTPRINT ASSESSMENT FOR LEATHER INDUSTRY (CLI) AND WASTE TREATMENT SYSTEMS (ETP/CETP)

Technology Outline

CLI-MATE is a sector-specific carbon footprint assessment platform developed by CSIR-CLRI for leather manufacturing and related waste treatment systems.

It enables leather manufacturing units, CETPs/ETPs, and allied industries to estimate process-wise carbon emissions and identify emission hotspots.

CLI-Mate provides a clear pathway toward low-carbon, sustainable, and future-ready leather manufacturing.



Salient Features / Highlights / Advantages

- **CLI-Mate:** Quantifies process-level carbon emissions across leather manufacturing operations
- **CLI-Mate :** Integrates raw materials, chemicals, energy, water, wastewater, solid waste, ETP/CETP, and carbon credit modules
- **CLI-Mate :** Converts routine tannery data into CO₂e-based carbon footprint outputs and actionable insights.
- **CLI-Mate :** Process-wise carbon footprint, hotspot identification and reduction potential.

Commercialization Status / Techno – Economics

- Ready for commercial utilization through Subscription model.

Validation Level

- TRL 4

Handholding support

- The licensing package includes login-based access to the software, user/process manual, demonstration, and technical support as required.



COMPACT PRODUCT FOR ONE-SHOT POST-TANNING PROCESS

Technology Outline

Compactone is a single-application standalone (“one-shot”) post-tanning system that integrates retanning and fatliquoring with optional dyeing into a single processing step. It is built on bio-polymer–polymeric–lubricating system, which penetrate the leather matrix uniformly and exhaust efficiently. By consolidating three conventional post-tanning operations into one bath, the technology shortens the process cycle, reduces chemical usage, inventory, processing time, and substantially lowers the pollution load of the discharged effluent, while imparting improved fullness, softness and overall quality to the finished leather.



Product form: brownish-white, water-soluble anionic liquid at pH 5-5.5, size of 200–350 nm.

Salient Features / Highlights / Advantages

- One-shot post-tanning – simultaneous retanning, fatliquoring and dyeing in a single bath
- ~25% reduction in chemical consumption compared with the conventional control process
- ~35% reduction in Pollution load (COD and TDS).
- Improves leather quality, fullness and softness
- Compatible with existing tannery and chemical manufacturers infrastructure.



COMPACT ONE

Commercialization Status / Techno – Economics

Validation level : ■ TRL-4

- Available for licensing and technology transfer to tanneries and leather-chemical manufacturers.

Major Raw Materials to be utilized

- Monomers, fatliquors, biopolymers

Validation Level

- TRL 4

Handholding support

- CSIR-CLRI can provide training, on-site/off-site demonstration, detailed technology documentation, troubleshooting support and assistance for technology implementation.





II - LEATHER CHEMICALS



CHROME-MELAMINE SYNTAN

Technology Outline

- Leather chemicals manufacturers are facing stringent restriction on the use of toxic substances and their presence in final product
- Syntans are products of addition and condensation polymerization
- Significant drawbacks associated with condensation product is the use of formaldehyde as a cross-linker, which is proven carcinogen
- The presence of free formaldehyde in leather and leather products, even at low ppm is becoming a huge cause of concern for leather manufactures
- Re-chroming is carried out to ensure uniform Cr_2O_3 content in the leathers procured from different sources
- Chrome-syntan (chromium and phenol or its derivatives-formaldehyde condensate product) is widely used for rechroming
- The use of formaldehyde condensate based mineral syntan in leather processing is not environmentally benign
- Melamine-formaldehyde condensate is used for preferential filling
- Combination of formaldehyde free melamine condensate and chromium melamine based syntans not available
- Keeping in mind the strictures on presence of free formaldehyde and the advantages that a melamine based product in association with chromium, could offer, this product – Chromium-Melamine Syntan (CrMS) has been developed



Salient Features / Highlights / Advantages

- Zero formaldehyde
- Eco-friendly with no possibility of Cr(VI)
- Selective filling and grain tightening effect on loose area and belly region
- Provides fine grain with soft handle
- Increase in thickness without affecting area yield
- Good dye levelling, excellent buff ability with natural sheen
- Produces uniform milling pattern
- Overall quality enhancement and better cutting value

Commercialization Status / Techno – Economics

- This technology has been already commercialized.
- Licensed to one client.
- Optimum investment – for syntan manufacturers, the equipment available can be used for the preparation of this syntan also; Approximate payback period / ROI – Cost of the syntan will be on par with the commercial chrome syntans.

Major Raw Materials to be utilized

- Melamine, Organic acid, Basic Chromium Sulphate, Glyoxal.

Validation Level

- TRL 6

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



CHROMIUM-FREE TANNING GEL

Technology Outline

- Globally, chromium-based tanning system is widely practiced (85-90%)
- Increase in demand for chromium-free tanning systems due to the drawbacks associated with chromium-tanning
- The present chromium-free tanning systems are not widely practiced due to high tanning cost ($> ₹ 15.0/\text{Sq.ft}$) and lack of versatility
- The present technology adopts soft-chemistry principles to synthesize the tanning agent at room temperature in an open vessel without using any temperature/ pressure-controlled reactors, which enables the tanners to produce their tanning agent in the respective tanning houses



Salient Features / Highlights / Advantages

- Nature of the Product: Gel
- Active Ingredients: Non-chrome inorganic polymers
- Application pH range: 3.0-6.5
- Leather Shrinkage Temperature: $80 \pm 2^\circ\text{C}$
- Predictable and consistent results
- Tanned leather is brighter and good grip for shaving
- Improved dye intensity with reduced dye offer/suitable for making all articles
- Tanned leather can be stored for a longer duration without any coloration
- Zero hazardous chemicals
- No risk for Cr(VI) formation
- Energy and resource-efficient system

Commercialization Status / Techno – Economics

- This technology is ready for commercialization
- The product can be prepared in ambient conditions, and no need for sophisticated equipment/reactors. Further, it can be prepared at tanning houses and subsequently used in leather manufacturing

Major Raw Materials to be utilized

- Indigenous low-cost raw materials

Validation Level

- TRL 4

Handholding support

- Handholding support: Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation



COLD CRACK RESISTANCE FATLIQUOR FOR LEATHER PROCESSING

CryoFlex C²R : Development of Cold Crack Resistant Fatliquor for Extreme Low-Temperature Leather Applications

Technology Outline

CryoFlex C²R is a specialty cold crack resistant fatliquor technology developed by CSIR-CLRI for leather applications requiring performance under extreme low-temperature conditions. The technology enables leather to retain flexibility, softness, and mechanical integrity at temperatures as low as -40 °C. It is an indigenously developed formulation designed to address the lack of specialty fatliquors suitable for extremely cold regions and automotive leather applications.



Salient Features / Highlights / Advantages

- Maintains leather flexibility and softness up to -40 °C
- Prevents cold crack formation and surface stiffness
- Withstands continuous bending and flexing without surface damage
- Ensures deep fiber lubrication and enhanced durability
- Compatible with all common fatliquors
- Eco-friendly, non-toxic, and cost-effective formulation
- Fully indigenous technology supporting AtmaNirbhar Bharat

Applications

- Automotive leather (car seats, steering wheels, interiors)
- Garments and upholstery leather
- Footwear upper leather
- Defense and high-altitude leather applications (Siachen, Kargil, mountainous regions).

Commercialization Status / Techno – Economics

- The technology has been demonstrated at laboratory, pilot, and bulk-scale levels. CryoFlex C²R is more cost-effective than imported specialty fatliquors, making it suitable for industrial adoption.
- Patent filing is in progress. Product pamphlet, safety data sheet, and technical documentation have been prepared for technology transfer.

Major Raw Materials to be utilized

- Water, Oil, Surfactants, Emulsifiers, Polymer.

Validation Level

- TRL 4

Handholding support

- CSIR-CLRI provides technical support for scale-up, application optimization, performance validation, and commercialization.



EMULSIFIER FOR W/O AND O/W EMULSION

Technology Outline

The Emulsifier pertains the dual-use for industrial applications. More precisely, the Emulsifier is mixed micelles that can produce both water-in-oil (W/O) and oil-in-water (O/W) emulsions with improved pH and thermal stability. This emulsifier has various applications in emulsion-based chemical industries and the leather chemicals industry, particularly in the production of fatliquors, which are crucial for adding flexibility and softness during the leather manufacturing process.



Salient Features / Highlights / Advantages

- **Dual Use:** The Emulsifier is suitable for preparing both water-in-oil (W/O) and oil-in-water (O/W) emulsions, providing versatility in its application.
- **Stability:** Emulsions formed from the emulsifier are stable over a wide range of pH (4 – 9) and temperature (20 – 60 °C) conditions, making it suitable for use in various industries.
- **Balanced Properties:** Emulsions formed from the Emulsifier have balanced properties, including pH, average particle size, zeta potential, contact angle, density, kinematic viscosity, and relative viscosity, which is beneficial in various industries.
- **Narrow Droplet Size Distribution:** Emulsions formed from the Emulsifier have a narrow droplet size distribution, which is desirable in many applications, such as drug delivery.
- **Effective Dissolution of Active Ingredients:** The Emulsifier allows for the effective dissolution of active ingredients with sustained release, making it useful in pharmaceutical and cosmetic applications.
- **Suitable for Fatliquoring Applications:** Emulsions formed from the Emulsifier are suitable for fatliquoring applications.



Commercialization Status / Techno – Economics

- The product is ready for commercialization.
- The product has various applications in emulsion-based chemical industries and the leather chemicals industry.

Validation Level

- TRL 3

Handholding support

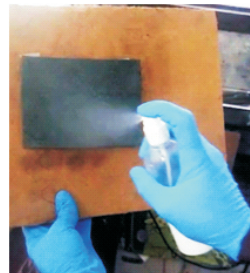
- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation would be provided upon licensing of this technology.



IONIC POLYURETHANE-SILICA CONJUGATES FOR WATER-BASED, HYDROPHOBIC, NON-STICKY, TRANSPARENT LOW GLOSS COATING ON LEATHER

Technology Outline

A sprayable coating formulation designed to protect leather surfaces from dirt, water, oil, and common staining agents (tea/coffee). The technology provides a transparent, low-gloss protective barrier that maintains the natural appearance of leather while enhancing its resistance to contaminants.



Salient Features / Highlights / Advantages

- Sprayable from spray-bottle (consumer product)/spray gun (industrial scale)
- Hydrophobic, transparent, low-gloss, durable coating on leather
- Easy cleaning of coated surface

Commercialization Status / Techno – Economics

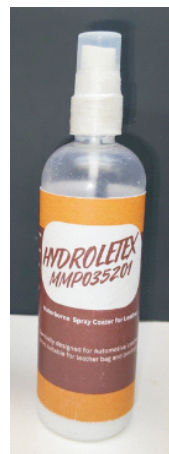
- The product is ready for commercialization.

Major Raw Materials to be utilized

- Diisocyanate, diol, silica nanomaterials, acetone, amines, dimethyl propionic acid

Validation Level

- TRL 4



LIGNIN BASED RETANNING AGENT



Technology Outline

Effluent from the paper and pulp industry (black liquor) predominantly contains large amounts of polyphenols such as lignin and fragmented lignin. The leather industry consumes large quantities of synthetic phenol-formaldehyde resins as retanning agents to improve homogeneity and organoleptic properties of leather. Free formaldehyde in leather is a major concern due to its carcinogenic nature; hence, the development of a formaldehyde free phenolic retanning agent is an emerging requirement. In this technology, waste liquor (black liquor) collected from the paper and pulp industry is chemically modified and used as a formaldehyde free retanning agent in leather manufacture.



Salient Features / Highlights / Advantages

- Utilizes paper and pulp industry black liquor as a sustainable raw material for leather retanning, converting an effluent stream into a value added product.
- The developed product is free from formaldehyde, addressing regulatory and health concerns associated with conventional phenolic syntans.
- Imparts an excellent soft handle, silky touch and wet feel to leather, with good body and resilience.
- Produces smooth, fine grain with good break and level dyeing characteristics on finished leather.
- Compatible with all common retanning auxiliaries including synthetic tanning agents, vegetable tannins and fatliquors, allowing easy incorporation into existing recipes.

Commercialization Status / Techno – Economics

- The technology is ready for commercialization and suitable for adoption by leather chemical manufacturers and tanneries, Approximate payback period / ROI is around 12 months, driven by replacement of costly phenolic raw materials and valorization of low cost industrial waste.

Major Raw Materials to be utilized

- Black liquor from paper and pulp mills and appropriate acids/chemicals for modification.

Validation Level

- TRL 3, Laboratory and pilotscale trials have been carried out to optimize formulation and application performance.

Handholding support

- Training, demonstration, detailed technology documentation, troubleshooting and technology implementation support can be provided.



NATURAL OIL BASED POLYURETHANE DISPERSION

Technology Outline

Bio-based Polyurethane Dispersion (PUD) for Sustainable Leather Finishing

A third-generation, castor-oil-derived anionic polyurethane dispersion, developed as a solvent-free, eco-friendly finishing binder for leather applications. The technology delivers soft handle, excellent flexibility, strong adhesion, and durability while reducing dependence on petrochemical-based binders.

Salient Features / Highlights / Advantages

- **Bio-based & Sustainable**
 - Renewable feedstock: castor oil; solvent-free, water-borne system
- **High Performance Finishing Binder**
 - Soft, clear, tough film formation
 - Excellent flex & crease resistance
 - Very good fastness
 - Good wet rub, light, water & perspiration resistance
 - Superior adhesion
- **Process & Application Friendly**
 - Compatible with conventional leather finishing auxiliaries
 - Suitable for full grain & corrected grain leathers



Commercialization Status / Techno – Economics

- Technology validated at pilot scale level and TRL evaluation completed. Technology is ready for industrial application.

Major Raw Materials to be utilized

- Castor oil (renewable polyol source)
- Di-/poly-isocyanates
- Internal emulsifier (for anionic charge)
- Neutralizing agents
- Water (dispersion medium)

Validation Level

- TRL 3
- Upscaled to 5 kg by CSIR-IICT
- Leather finishing trials on multiple substrates
- Performance evaluation as per ISO / SATRA standards
- Comparative benchmarking with commercial PU binders

Handholding support

- CSIR-CLRI and CSIR-IICT Support Includes:
 - Technology Transfer & Licensing
 - Pilot-scale production guidance
 - Customized finishing formulations
 - Application support for shoe uppers, garments, upholstery
 - Performance testing & certification support



ECO-FRIENDLY FLAME RETARDANT POST-TANNING AGENT

Technology Outline

The technology involves an eco-friendly flame-retardant (FR) product, a process for preparing the FR product, and a process for applying the FR product to produce flame-retardant leather.

The FR product primarily finds application in the leather and product industries for producing flame-retardant leather for use in upholstery, safety gloves, shoes, and apparel.

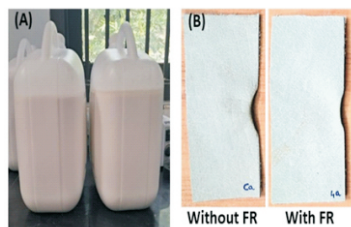


Figure 1. (A) The FR product, and (B) the leather samples after the Horizontal Flammability Tests.

Salient Features / Highlights / Advantages

- Environment-friendly and non-toxic
- Prepared from indigenous chemicals, hence low-cost compared to commercially available flame retardants
- Required dose 8-12% with respect to the weight of the leather
- Needs no process modification and is suited for all types of raw materials and leathers
- Application of the product to leather reduces the burning rate (flammability degree) by 30-40%

Commercialization Status / Techno – Economics

- This technology is ready for commercialization.
- Total cost Rs 180/Kg; Cost of Chemicals: Rs 150/Kg; Overhead cost (20%): Rs 30/Kg (Includes stirred tank reactor with heating facility for 40-45 °C, electricity charges, and miscellaneous cost.
- Cost of commercial FR (imported): Rs.2100/-

Major Raw Materials to be utilized

- An aqueous dispersion of inorganic hydroxide with dispersing agent(s)

Validation Level

- TRL 4

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation would be provided upon licensing of this technology.

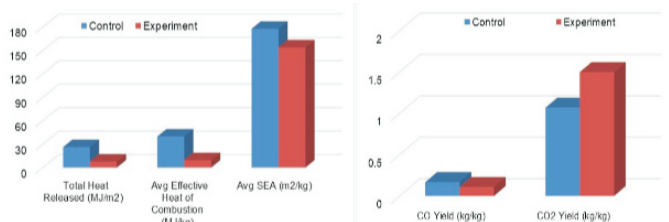


Figure 2. Cone calorimeter results showing reduction in THR, average effective heat of combustion, average SEA, and CO yield; and an enhanced CO₂ yield, favoring enhanced flame retardancy of the leathers treated with the FR product (experiment) compared to those made without the product (control).



PHASE CHANGE MATERIAL- BASED RETANNING SYSTEM FOR ENHANCED COLD INSULATION IN LEATHER

Technology Outline

- A multifunctional syntan with built-in thermoregulation for extreme cold climatic conditions.
- Formaldehyde-free resin with encapsulated Phase Change Material.



Salient Features / Highlights / Advantages

- Efficient cold insulation at extreme sub-zero temperatures
- Selective filling in loose area and belly region
- Enhanced Stability: Ensures no leakage or phase separation during thermal transitions

Commercialization Status / Techno – Economics

- Technology validated at pilot scale level and TRL evaluation completed.
- Technology is ready for industrial application.

Major Raw Materials to be utilized

- Melamine, PCM, surfactants

Validation Level

- TRL 4
- Upscaled to 15 kg in pilot plant
- Post tanning trials on multiple substrates carried out
- Performance evaluation for cold insulation done

Handholding support

- Technology Transfer & Licensing
- Pilot-scale production guidance
- Application support for shoe uppers, garments, upholstery
- Performance testing & certification support



POLYURETHANE FOAM FOR FOOTWEAR SOLES

Technology Outline

The technology involves the use of an environment-friendly nanofiller cum blowing agent in making polyurethane (PU) foam (free/molded). The preparation of molded PU soles using the nanofiller cum blowing agents has been optimized using industrial-scale reaction injection molding (RIM) and pouring machines. Technology to prepare PU soles for footwear based on biodegradable polyol and environment-friendly nanofiller, as well as commercial polyol/isocyanate systems and the nanofiller, by direct reaction injection molding process, has been developed. The technology also has potential application in making other footwear components such as midsole and in-sock.



PUNC-0 PUNC-1 PUNC-2

Salient Features / Highlights / Advantages

1. The nanofiller cum blowing agent used in making the PU-composite sole is
 - Environment-friendly, halogen-free, cost-effective and compatible with the commercial polyol systems used in making footwear soles
 - Increased PU foam formation because the nanofiller acts as a chemical blowing agent. Use of 1-3% of the nanofiller leads to a 20-40% increase in foam volume.
 - Increased foam formation leads to a reduction in raw-material requirement and hence the cost
2. The developed PU-nanofiller composite shoe soles show improved flexibility, improved cell stability, and a reduction in bulk density. High flexibility makes the sole suitable for applications where repeated flexing is required (outsole, midsole and in-sock).
3. Production of the PU-nanofiller composite soles needs no modification in the existing PU sole/footwear-making machinery (reaction injection molding/pouring machine)



Complete footwear fabricated using the injection molded PU-nanofiller composite sole

Commercialization Status / Techno – Economics

- This technology is ready for commercialization

Major Raw Materials to be utilized

- Nanofiller (Indigenous synthetic clay-like material), along with the general raw materials required for PU foam production such as Industrial polyol blend and Industrial isocyanate

Validation Level

- TRL 4

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Assistance, Technology Implementation



FLUOROCHEMICAL-FREE WATER BASED FATLIQUOR WITH ANTI FOGGING PROPERTY

Technology Outline

The leather industry, particularly the automotive upholstery sector, faces a persistent and unresolved challenge of fogging, caused by the release of volatile condensable materials (VOC/FOG) from conventional fatliquors, retanning agents, and finishing chemicals. To address this, a novel process has been developed for preparing a fluorochemical-free, water-based oil-in-water fatliquor that imparts intrinsic antifogging properties to leather when applied during the post-tanning/fatliquoring stage.



Salient Features / Highlights / Advantages

- Fluoro chemical (PFOS)-Free Water based Fatliquor with Antifogging Property
- Fog Mass less than 5 mg when applied as a single fatliquor
- Indigenous production aids Import substitution
- Improves consumer safety and comfort through durable antifogging properties in vehicle interiors, furniture, and aviation upholstery
- Economically Viable and Environmentally sustainable

Commercialization Status / Techno – Economics

- Techno-economics worked out.
- Ready for commercialization

Major Raw Materials to be utilized

- Silicone oil, PEG, DOSS, Sulphuric Acid

Validation Level

- TRL 4, Technology validated in laboratory environment

Handholding support

- Technology Demonstration and Training



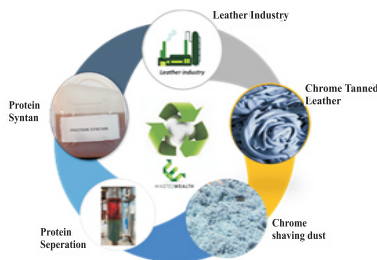
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PROTEIN-BASED SYNTHETIC TANNING AGENT

Technology Outline

Safe and environmentally friendly separation of collagen hydrolysate from chrome shaving waste is carried out through controlled alkali treatment, enabling recovery of chromium-free protein. The purified collagen hydrolysate is subsequently modified with suitable polymers via simple polymerisation to obtain a protein-based polymeric syntan. The developed syntan is designed for use in post-tanning as a filling and retanning agent for upper and lining leathers, improving body and handle. Crust leathers processed with the syntan show tight, fine grain, enhanced fullness and uniform dye uptake, making them suitable for quality footwear and garment leathers.



Salient Features / Highlights / Advantages

- Enables value-added utilisation of chrome shaving– derived collagen, thereby improving overall solid waste management in the leather sector.
- Protein-based syntan can partly or fully replace acrylic resins and conventional protein fillers in post-tanning formulations, reducing dependence on petrochemical-based materials.
- Fully compatible with conventional post-tanning chemicals such as synthetic tanning agents, vegetable tannins and fatliquors, allowing drop-in integration into existing recipes.
- Leathers processed with this syntan exhibit improved softness, round handle, better dye penetration and levelness, and more uniform grain break.
- Application of the product leads to up to about 50% reduction in TDS load in the effluent stream compared to conventional formulations, contributing to cleaner production.



Protein Syntan and Crust leather

Commercialization Status / Techno – Economics

- The technology has already been commercialized with selected industry partners in the leather and leather-chemical sectors. The syntan has been evaluated in the CSIR-CLRI pilot tannery and in commercial tanneries, confirming its technical performance, process compatibility and economic viability in regular production.

Major Raw Materials to be utilized

- Chrome shaving waste

Validation Level

- TRL 3

Handholding support

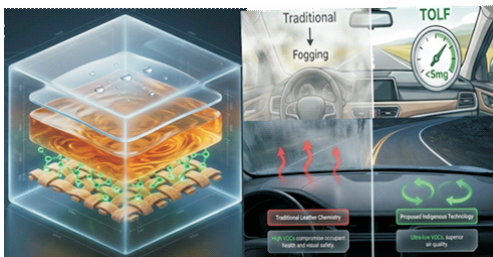
- CSIR-CLRI can provide training, on-site/off-site demonstration, detailed technology documentation, troubleshooting support, and assistance for technology implementation.



A HIGH SOFTENING FATLIQUOR WITH LOW FOG VALUE FOR ENHANCED LEATHER PROPERTIES

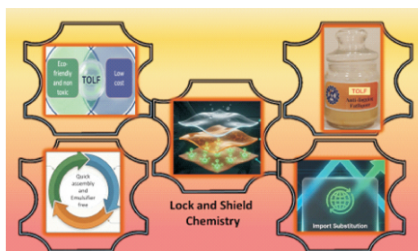
Technology Outline

A Trans-esterified Oil- Based Low Fog Fatliquor (TOLF) is a combination of low fog performance and high softening eco-friendly approach delivered through a low-cost, nontoxic, and emulsifier-free indigenous formulation. It can be customizable with other valuable properties like fragrance, antifungal, and waterproofness.



Salient Features / Highlights / Advantages

- Fog value less than 5 mg: Exceeds the most rigorous automotive industry standards for Volatile Organic Compounds and windshield fogging.
- Emulsifier-free: Eliminates the use of surfactant, resulting in a cleaner production.
- High softening: Engineered for deep, highly stable penetration into the leather matrix.



Process Efficiency

- Quick Assembly: TOLF provides a unique Formulation for rapid integration into existing production lines, maximizing the throughput and reducing processing time.
- Low Cost: Highly competitive pricing.
- Indigenous Production: Locally sourced and manufactured, ensuring a resilient, fast, and reliable chain. Sustainable Safety.
- Non-Toxic: It provides a non-toxic and sustainable alternative to the traditional fat liquoring process.
- Eco-friendly: Ensure safety for the environment and the final end user.

Commercialization Status / Techno – Economics

- This Technology is ready for commercialization.

Major Raw Materials to be utilized

- Bio-based Fatty acid Ester, Bio-Emulsifier, and Biocompatible Occlusive Agent.

Validation Level

- TRL 3

Handholding support

- Training Demonstration, Technology document, Assistance, and Technology implementation.





ENVIRONMENT-FRIENDLY AND NON-TOXIC FLAME RETARDANT FOR LEATHER AND A PROCESS FOR THE PREPARATION THEREOF

Technology Outline

The technology involves a flame-retardant (FR) product, a process for preparing the FR product, and a process for applying the FR product to make flame-retardant white leather.

The formulation is primarily used in the leather processing industry to produce fire- and flame-retardant white leather. It may also be used for making industrial safety leather apparel.

Salient Features / Highlights / Advantages

Salient Features / Highlights / Advantages

The product is

- Non-toxic and environment-friendly
- Made with common chemicals, hence cost-effective compared to imported chemicals
- Required dose 10-12% with respect to the weight of the leather
- Needs no modification in the conventional post-tanning process

Exposing the product-treated leather to fire

- Reduce the flammability degree (enhanced flame-retardancy) by 20-25%
- Reduce pre-post ignition smoke production
- Delay the time of peak heat release rate and hence provide more escape time during a fire accident.

Commercialization Status / Techno – Economics

- **Status of commercialization:** This technology is ready for commercialization

Major Raw Materials to be utilized

- An aqueous dispersion of inorganic hydroxide with dispersing agent(s)

Validation Level

- TRL-4

Handholding support

- Training, Demonstration, Technology Document, Troubleshooting, Assistance, Technology Implementation

Techno-Economics:

- Total cost Rs 125/Kg
- Cost of Chemicals: Rs 90/Kg
- Overhead cost (40%): Rs 11/Kg (Including energy, manpower, and miscellaneous costs)

Cost of commercial FR (imported): Rs. 2100/-



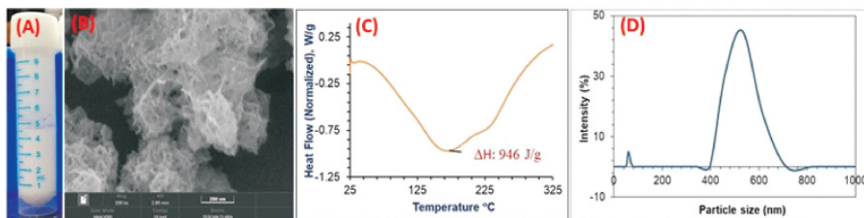
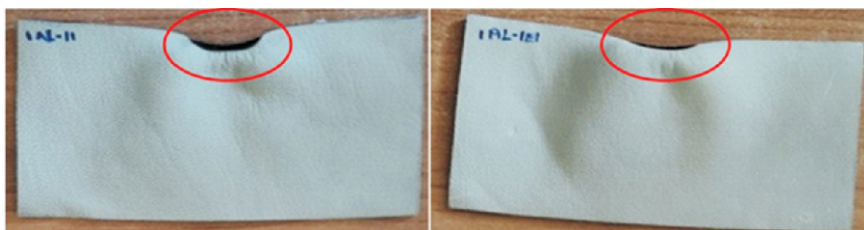


Figure 1. Figure (a) The FR product, (b) SEM Micrograph, (c) DSC Thermogram, and (d) Particle size distribution of the formulation.



Leather without the FR product

Leather treated with the FR product

Figure 2. Photographic images of the leather samples after the Horizontal flammability tests





III – WASTE MANAGEMENT TECHNOLOGIES

BIOGAS GENERATION FROM ORGANIC WASTES

Technology Outline

India's contribution to food waste - 68.8 million tonnes annually, i.e 7% of the global total. One of the most inevitable waste generated on a daily basis is from the kitchen i.e., leftover food, vegetable peels and fruit peels. Also, food wastage is a global problem. It is reported that, almost one third of the food produced is being wasted. Most of the organic waste generated in the country is either being dumped into landfills or sent to piggeries. With this technology, food waste from canteen and the vegetable/ fruit peels from the kitchen can be used for the generation of bio-energy under circular economy concept.



Salient Features / Highlights / Advantages

- This technology is meant for cafeterias, hotels and canteens for the management of organic fraction of their waste
- Generated biogas can be used for cooking purpose directly or used for electrical energy generation.
- The digestate can be used as organic manure
- Co-digestion studies indicated that biogas yield observed was 0.7 to 0.9 m³/kg of VS destructed
- Technology has been transferred and implemented at B. S. Abdur Rahman Crescent Institute of Science and Technology, Vandalur, Chennai with the capacity of the Plant 500 kg/day

Commercialization Status / Techno – Economics

- This technology is ready for commercialization.
- Elimination of groundwater pollution and odour problems associated due to disposal of solid waste generated from the food industry
- Biogas Generation and use of Digestate as manure

Major Raw Materials to be utilized

- Leftover Food Waste, Vegetable Peels and Fruit Peels

Validation Level

- TRL 6

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



CO-DIGESTION OF TANNERY SOLID WASTES FOR BIOENERGY GENERATION

Technology Outline

Today tanneries in India face the twin problem of managing process solid waste i.e fleshing, a process solid waste and effluent treatment plant sludge. Fleshing pose serious environmental threat and reuse potential is scarce. Likewise, the treatment of effluent treatment plant's Waste Activated Sludge (WAS) in a sludge digester demands huge investment cost. Keeping these two specific needs, technology has been developed for co-digestion of these two substrates i.e



fleshing a process solid waste in combination with Waste Activated Sludge (WAS) for biogas generation. A pilot scale demonstration plant of capacity 750 kg/day on wet weight basis has been implemented at Calcutta Leather Complex (CLC), Kolkata.

Salient Features / Highlights / Advantages

- Protection of environment i.e air, water and soil from contamination due to dumping of waste
- Disposal problem of fleshing and WAS in tannery sector can be minimized
- Odour and groundwater pollution problems can be minimized
- Bioenergy generation from tannery solid waste
- Minimization of carbon release into environment and thereby reduction in carbon foot print
- Generated Bioenergy can be used for operation of the plant
- Improves the aesthetic value in and around leather complexes

Commercialization Status / Techno – Economics

- The technology commercialization is under process.
- Elimination of ground water pollution and odor problems associated due to the disposal of solid wastes generated from the tanning industry.
- Bioenergy generation and use of digestate as soil conditioner.

Major Raw Materials to be utilized

- Fleshings, Waste Activated Sludge.

Validation Level

- TRL 6
- Pilot scale Plant is being implemented in Calcutta Leather Complex (CLC), Kolkata – Capacity of pilot plant is 750 kg per day on wet weight basis.
- The technology has been demonstrated to tanners.

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



IMMOBILIZED OXIDATION REACTORS (IOR) FOR WASTEWATER TREATMENT

Technology Outline

The technology has four components each of them either comprised of bacteria immobilized nanoporous carbon/ iron impregnated nanoporous carbon/ enzyme immobilized nanoporous carbon. Each component has ability to generate hydroxyl radical for the oxidation of organics in wastewater. The nanoporous activated carbon generates hydroxyl radicals from molecular oxygen by the carbon matrix at the outer pore surface area. The organics in wastewater are fragmented by immobilized matrices. The fragmented organics are oxidized by the hydroxyl radicals generated at the outerpore surface area of the nanoporous activated carbon matrix.



Salient Features / Highlights / Advantages

- Low Footprint requirement; No odour emission; Minimum sludge production compared to conventional technology; The technology can be integrated with membrane separation.
- **IPR Details:** Indian Patent Nos. 197246, 253584, 309251 (PCT application no. PCT/IN2013/000069), 410974.



Commercialization Status / Techno – Economics

- This technology has been already commercialized.
- Licensed to 15 clients (Both in India and in overseas).
- Cost of the reactor depends upon the material chosen: Tentative cost for the civil construction for RCC reactor – INR 15,000/m³ to 18,000/m³
- Tentative cost for the Plumbing – INR 5000/m³ to 7000/m³

Major Raw Materials to be utilized

- Carbon based catalysts

Validation Level

- TRL 6
- Implemented in many industries in India and abroad including leather, textile, pharmaceutical, chemical, pesticide manufacturing industries, automobile industry, Sea food Processing industries and Dye intermediate manufacturing industries. It is also implemented for municipal wastewater treatment.

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



INTEGRATED SOLAR DRYING AND PYROLYSIS PROCESS

Technology Outline

In urban areas, along with Municipal Solid waste, a considerable amount of fibrous waste, such as banana peduncle, tender coconut, sugarcane bagasse, etc., are generated, which needs special treatment for disposal. Hence, a combined technology of solar drying and pyrolysis has been demonstrated at the pilot level for the treatment of these wastes with the recovery of biochar and thermal energy. Similarly, the sewage sludge generated from STPs could also be solar-dried and pyrolyzed with this high-calorific fibrous waste to biochar and thermal energy which also addresses the objectives of the SDGs and National missions.



Salient Features / Highlights / Advantages

- This process requires less energy as the solar energy is used for drying and thermal energy is used for maintaining the temperature.
- Biochar production reduces carbon emission and can also be used as soil conditioner and fertilizer.
- Thermal energy can be harvested in the form of hot water and can be used for floor heating of solar dryer or any other suitable heating applications.



Commercialization Status / Techno – Economics

Status of commercialization

- Pilot study has been completed and is ready for commercialization

Major Raw Materials to be utilized

- Fibrous waste alone and or in combination with other biowaste

Validation Level

- TRL 4

Handholding support

- Technical support with training and demonstration can be provided for the stakeholders like municipalities, corporations and waste handlers/operators.

Techno-Economics

- Minimizes environmental impacts like groundwater contamination, odor and GHG emissions caused by waste disposal in dumps or landfills. Waste generators need to bear the minimal energy and operational costs for this technology



ORGANIC SUPPLEMENT FROM ANIMAL HAIR WASTE

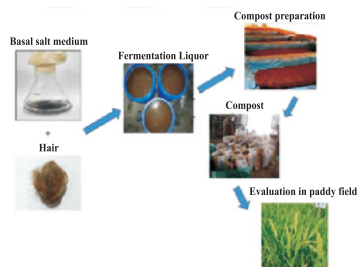
Technology Outline

About 50-70 kg of hair is produced from one ton of raw hides during pretanning operations. A process has been developed for preparation of compost using the solid waste, hair. A suitable bacterial species has been identified for the degradation of hair waste followed by manufacturing of compost using keratin hydrolysate (product of hair degradation). The whole process could be completed within a time span of 9-10 days. The process provides technological solutions to address the issue of solid waste on one hand and provide scope for financial returns on the other.



Salient Features / Highlights / Advantages

- The compost is organic in nature
- The supplementation of compost enhances the yield of paddy crop
- Preparation of compost provides technological solution to the disposal of solid waste, hair



Commercialization Status / Techno – Economics

- This technology is ready for commercialization.

Major Raw Materials to be utilized

- Mineral salts that are locally available in the market will be utilized for degradation of hair. Compositing materials like dry leaves, soil and saw dust.

Validation Level

- TRL 4
- 1 kg to 500 kg level.

Handholding support

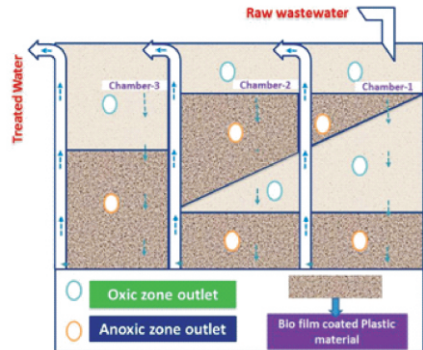
- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



SEQUENTIAL OXIC-ANOXIC BIOREACTOR (SOABR) FOR WASTEWATER TREATMENT

Technology Outline

Problem in using conventional technologies to remove high load of suspended solids resulted in the usage of chemicals and generation of high amount of primary chemical sludge. SOABR reactor can able to simultaneously remove colloidal and suspended particles with very minimum sludge production. The reactor comprises of sequential oxic and anoxic zones. The oxic zone removes the suspended particles by interception method, and the anoxic zone digests the solids scavenged by the oxic zone.



Graphical representation of the process flow chart of SOABR

Salient Features / Highlights / Advantages

- Low foot print requirement, Low electrical energy consumption, Low operation cost, No generation of primary chemical sludge.

Commercialization Status / Techno – Economics

- The technology is ready for commercialization.
- Cost of the reactor depends upon the material chosen: Tentative cost for the civil construction for RCC reactor – INR 15,000/m³ to 18,000/m³ Tentative cost for the Plumbing – INR 5000/m³ to 7000/m³

Major Raw Materials to be utilized

- For reactor construction – RCC/FRP materials required

Validation Level

- TRL 4
- Successful completion of bench scale studies for 4 L (Post tanning wastewater), 12 L (Post tanning wastewater) and 18 L (Sewage) was completed for a continuous run of 5, 7 and 9 months respectively.

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



RECOVERY OF STRUVITE FROM TANNERY WASTEWATER AND ITS APPLICATION AS SOIL CONDITIONER

Technology Outline

Struvite (Magnesium Ammonium Phosphate) has been developed from tannery wastewater. Struvite has been evaluated for its composition and used as soil conditioner for plant growth studies. The process has been patented by CSIR-CLRI and will fulfil the SDG goals of: SDG 9: Industry, Innovation and Infrastructure; SDG 12: Responsible Consumption and Production; SDG-13 Climatic action and aligned with National mission of Wealth from Waste.



Salient Features / Highlights / Advantages

- Utilizes nutrient-rich waste streams from tannery sector and promotes circular resource utilization by converting waste streams into value added product. Struvite (Magnesium Ammonium Phosphate) acts as soil conditioner
- An exemplary circularity model for the Tannery and Agricultural sectors



Commercialization Status / Techno – Economics

- Dissemination programme has been organized with Tanners and CETP management

Major Raw Materials to be utilized

- Wastewater streams from tannery sector

Validation Level

- TRL 6

Handholding support

- Dissemination, Training





IV – WASTE TO WEALTH

ACTIVATED CARBON FOR MAKING SOLES FROM FLESHING WASTE

Technology Outline

Developed activated carbon from fleshing waste, which can be used as filler for making rubber soles



Salient Features / Highlights / Advantages

Benefits for Tannery

- Avoid the disposal of fleshing waste into landfill
- Tanner can gain revenue from fleshing waste
- Reduce the environmental pollution load

Benefits for Rubber Industry

- Avoid the use of carcinogenic filler carbon black
- Prepare the carbon black free black rubber sole
- No imprint on carpet
- Good vulcanized rubber

Commercialization Status / Techno – Economics

- This technology is ready for commercialization / ATMANIRBHARTHA

Major Raw Materials to be utilized

- Fleshing waste, rubber compounding materials

Validation Level

- TRL 4
- Activated carbon developed at 25 kgs level and made 12 pairs of soles using this activated carbon.

Handholding support

- Demonstration, Technology Document, Technology Implementation



BASIC CHROMIUM SULPHATE USING CHROME SHAVING WASTE AS REDUCTANT



Technology Outline

Globally, about 0.8 million tons of chrome shaving waste are generated annually, resulting in the accumulation of chrome-bearing solid waste in large quantities. The presence of chromium in this protein-rich waste hinders its direct use in other applications and classifies it as a hazardous material. Conventional disposal through incineration or landfilling can lead to leaching of chromium into soil and water, posing environmental and health risks. There is an urgent need for technologies that enable efficient recycling and reuse of chrome-containing solid waste in line with circular economy principles. Accordingly, a sustainable technology has been developed for utilizing chrome shaving waste as a reducing agent in the manufacture of basic chromium sulphate (BCS), enabling internal recycling of chromium within the tanning value chain.



Salient Features / Highlights / Advantages

- The BCS produced using chrome shaving waste meets all quality requirements as per relevant BIS specifications.
- The product offers better masking and imparts a more pleasant blue shade in tanned leather compared to conventional BCS.
- Improved chrome exhaustion during tanning and more uniform chromium distribution in wet-blue leather are achieved.
- Presence of hydrolyzed protein in the prepared BCS enhances leather fullness and body.
- The process is economically feasible, with product cost comparable to commercial BCS grades.
- Chrome shavings are completely utilized as a reducing agent, minimizing residual solid waste.
- The technology eliminates the chrome shaving solid-waste disposal problem and strongly supports a waste-to-wealth, circular economy approach in tanneries.



Application trials

Commercialization Status / Techno – Economics

- The technology has already been commercialized and deployed with industrial partners.

Major Raw Materials to be utilized

- Chrome shaving waste

Validation Level

- TRL 3
- The process has been upscaled to a 50 kg production level at the CSIR-CLRI pilot plant facility.

Handholding support

- CSIR-CLRI can provide training, demonstration, detailed technology documentation, troubleshooting support, and assistance for technology implementation at industrial scale.



COLLAGEN PEPTIDE FROM FISH SKIN

Technology Outline

The process technology comprises of five steps namely (a) alkaline pre-treatment, (b) lipase pre-treatment, (c) hydrolysis, (d) concentration and (e) spray drying. The uniqueness of the present process is the alkaline pre-treatment with low concentration of alkali that favours enhanced yield of the collagen peptide (around 29.0%).



Salient Features / Highlights / Advantages

- High yield of product
- It is a sustainable solution for utilizing fish skin wastes from the fish processing industry.
- This technology is not associated with generation of wastewater or solid waste i.e., Zero Discharge Process.
- This technology not only provides a fool-proof solution to an environmental problem but enables the industry to secure significant financial returns.



Commercialization Status / Techno – Economics

- This technology is ready for commercialization.

Major Raw Materials to be utilized

- Fish skin & all other raw materials are Indigenous.

Validation Level

- TRL 3

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.



KERATIN HYDROLYSATE FROM FEATHER



Technology Outline

The poultry processing industry generates large quantities of feather as wastes, and needs to be disposed safely. Chicken feathers contain around 91% protein as keratin which could be degraded by keratinases and the resulting hydrolysate finds application as raw materials in many industries.

Hydrolysis of feather is accomplished through (a) physical methods involving high temperature and pressure, (b) chemical methods using alkalis and (c) biochemical methods using microbial strain or enzymes.

Biochemical method of hydrolysis is environment friendly, cost-effective and does not require any downstream processing. The keratinase could degrade various keratinous substrates efficiently and could be used in various industries including leather, poultry and cosmetics.

Preparation of keratin hydrolysate



Salient Features / Highlights / Advantages

- Developed process could provide sustainable solution to the disposal of feather wastes.
- The process is cost-effective and considered as a zero-waste discharge process.
- The keratin powder product could be used in various industries including agriculture, poultry and cosmetics.
- Import substitution (ATMANIRBHARTA)
- Exemplary model for circular economy as it provides scope for financial returns from the wastes of poultry industry

Commercialization Status / Techno – Economics

- This technology is ready for commercialization

Major Raw Materials to be utilized

- The raw materials include the bacterial strain, media components, salts and keratin wastes, which are indigenously available.

Validation Level

- TRL 3 for enzymatic process and 4 for chemical-based process

Handholding support

- Demonstration, Training, Technology Document, DPR preparation for setting up production plant facilities, Technology standardization at commercial scale upon licensing of this technology.



REGENERATED LEATHER FROM TANNERY SOLID WASTE



Technology Outline

The solid waste such as chrome shavings, or chrome-free shaving waste, or ground crust or finished leather trimming waste, or buffing dust is thermos-chemically (alkaline) hydrolyzed, followed by enzyme (protease) treatment optionally. The composition for calendaring is prepared mixing the hydrolyzed solid wastes with cross-linkers, acrylic syntan, dye and synthetic fatliquor and plasticizer. Calendaring using the composition prepared is done over a coat of synthetic film formed on a release paper. Finally, reinforcement with synthetic or natural fabric is done by pasting the fabric over the film, to make the Regenerated Leather Geno-Corium.



Salient Features / Highlights / Advantages

- It is a sustainable solution for utilizing solid wastes from the leather industry and the used/discarded leather products as well.
- This novel process of making regenerated leather not only provides a solution to an environmental problem but enables the industry to secure significant financial returns.
- Geno-corium leather is suitable for all the applications as that of leather. Suitable for manufacturing of shoes, life-style products and garments.
- Tested for physical properties & found to meet the requirements.
- This process technology is not associated with generation of wastewater or solid waste.

Commercialization Status / Techno – Economics

- This technology has been commercialized. Capital investment for production unit: about Rs. 96 lakhs for production of 50 m² per day; Break Even Point (BEP): Approx. 20 months;
- Licensed to Tata International Ltd., Dewas for commercial production

Major Raw Materials to be utilized

- Buffing waste, shaving dust, crust trimmings, finished trimmings. All other raw materials are Indigenous

Validation Level

- TRL 6
- Validated at commercial scale

Handholding support

- Technology licensing and transfer, Complete technology documentation, Training and on-site, demonstration, Industrial implementation support, Process optimisation and troubleshooting



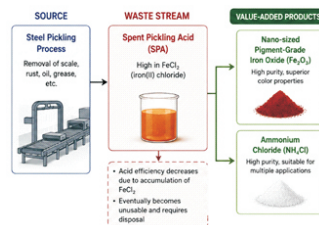
A SUSTAINABLE PROCESS FOR THE VALORIZATION OF SPENT PICKLING ACID BY RECOVERING IRON AND CHLORIDE AS VALUE-ADDED CHEMICALS

Technology Outline

Spent Pickling Acid (SPA) is a major waste stream generated in steel industries during the removal of scale, rust, oil, and grease. It gradually loses efficiency due to the accumulation of iron(II) chloride, which reduces the acid's efficiency and becomes a waste stream.

CSIR–CLRI has developed a sustainable process for the complete recovery of valuable inorganic constituents from SPA. The technology converts dissolved iron into nano-sized, pigment-grade iron oxide and recovers chloride as ammonium chloride, both of which are commercially valuable products.

The process ensures complete utilization of inorganic content, supports circular economy principles, and generates no secondary waste.



Salient Features / Highlights / Advantages

- Complete recovery of iron and chloride from spent pickling acid.
- Production of nano-sized, pigment-grade iron oxide with superior color properties.
- Recovery of chloride as commercially valuable ammonium chloride.
- Zero secondary waste generation; treated water suitable for reuse or safe discharge.
- An environmentally sustainable process supporting resource recovery and the circular economy.
- Simple, robust, and scalable for industrial implementation.
- Converts hazardous waste into value-added products.



Commercialization Status / Techno – Economics

- Industrially scalable technology with zero-waste operation.
- Reduces waste disposal costs and environmental impact.
- Suitable for integration with existing steel pickling facilities.

Major Raw Materials to be utilized

- SPA, Hydrogen peroxide/Ozone, Ammonia, Water

Validation Level

- Laboratory Scale (10 l) ; TRL 04

Handholding support

- Technical support for process scale-up and implementation, Assistance in pilot trials, process optimization, Training, SOP, and troubleshooting support.



ECO-BENIGN (NANO) COMPOSITE SHEET MATERIAL WITH LEATHER & TEXTILE WASTE FIBRES FOR APPLICATIONS INCLUDING PACKAGING

Technology Outline

- Out of 1000 kg of raw hide, nearly 745 kg is generated as solid wastes in leather processing.
- The use of leather waste fibres such as buffing dust or shavings waste as a resource, as quantum of Leather and Leather products materials essentially require significant amount of Eco-benign packaging material.
- Utilization and safe disposal of Leather waste fibres as value added sustainable packaging material for Leather and Footwear packaging as circular economy approach.
- Confinement of leather waste fibres by converting them in to useful products such as (Nano) composites.
- Utilizes all Eco-benign Biodegradable materials.
- Multifunctional Packaging material such as Bio-degradable nature, Water Proof, Anti-Microbial & Strength.



Salient Features / Highlights / Advantages

- Composite prepared using Eco-benign buffing dust provided Tensile strength: 478.6 kg/cm² as per IS-13360 (1996) (min. 200 kg/cm²) and IS 2508 (2024).
- Biodegradable Compostable Carry bags/ other Products.
- Barrier Properties: Water Vapor Permeability, Water Proof ability.
- Antimicrobial property.
- Chemicals and Solvent resistance property.
- Avoidance of Non-Biodegradable materials and polymers & VOC causing Solvents.



Commercialization Status / Techno – Economics

- Lab to Pilot level development.
- Cost – Comparable with conventional packaging.

Major Raw Materials to be utilized

- Eco-benign Polymers; Leather Buffing dust/ Shavings; Eco-benign materials.

Validation Level

- TRL-4.

Handholding support

- Will be Provided.



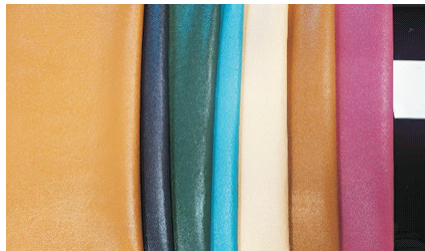


V – LEATHER LIKE MATERIAL

PLANT BASED LEATHER LIKE MATERIAL

Technology Outline

- CSIR–Central Leather Research Institute (CSIR CLRI) has successfully developed a novel leather-like material from plant straw waste, offering a sustainable and innovative solution
 - Made from agricultural waste
 - Eco-friendly and sustainable
- Suitable for lifestyle product development



Salient Features / Highlights / Advantages

- Follows a Zero Liquid & Solid Discharge production concept
- Requires minimal water usage
- Results in a low-cost, sustainable material
- Easily degradable and non-hazardous to the environment
- The prepared flexible sheet material can be used in textile, leather, packaging and other life style product industries



Commercialization Status / Techno – Economics

- This technology is ready for commercialization.
 - Technology Transferred - 4+ Clients
 - Break-even period - Less than Two years

Major Raw Materials to be utilized

- The raw materials include the bacterial strain, media components, salts, stabilizing agents which are indigenously available.

Validation Level

- TRL 6

Handholding support

- Training
- Demonstration
- Technology documentation
- Troubleshooting
- Technology implementation support



PSEUDO-CORIUM : LEATHER LIKE MATERIAL

Technology Outline

Pseudo-Corium is an innovative, plant-based composite material developed as a sustainable alternative to conventional leather. The technology valorises agricultural residues such as wheat straw and rice straw to produce a high-performance, biodegradable leather-like material suitable for footwear, lifestyle products, upholstery, and fashion applications.

The technology aligns strongly with circular economy, green manufacturing, and climate-positive material innovation, making it particularly attractive to start-ups, sustainable brands, and material innovators.

Pseudo-Corium is manufactured using a bio-composite formulation comprising:

- Natural plant-based polymers
- Crystalline Nanocellulose (CNC) derived from botanical cellulose (obtained from fermentation of wheat straw or rice straw)
- Bio-based cross-linkers and plasticisers
- Natural textile reinforcements (cotton, linen, rayon, etc.)

The formulation yields flexible sheets with leather-like texture, strength, and durability, suitable for multiple consumer applications.



Salient Features / Highlights / Advantages

- Fully plant-based and biodegradable
- Converts agricultural waste into value-added material
- Fully plant-based and biodegradable
- Converts agricultural waste into value-added material
- No wastewater or hazardous solid-waste generation
- Contributes to reduction of stubble-burning-related air pollution
- REACH-compliant material system
- Tested for physical and mechanical properties
- Suitable for footwear, fashion, lifestyle, and upholstery applications
- Customizable thickness, finish, and reinforcement
- Simple and scalable manufacturing process
- Indigenous raw materials ensure supply-chain security
- Competitive techno-economics compared to synthetic alternatives



Commercialization Status / Techno – Economics

- Technology standardised at pilot and commercial scale, Technology licensed to one large-scale industry and two start-ups for commercial production, Capital investment for production unit: about Rs. 80 lakhs for production of 50m² per day; Break Even Point (BEP): Approx. 18 months.

Major Raw Materials to be utilized

- Wheat straw and rice straw, agricultural waste

Validation Level

- TRL 5
- Validated for consistent quality and scalability

Handholding support

- Technology licensing and transfer, Complete technology documentation, Training and on-site, demonstration, Industrial implementation support, Process optimisation and troubleshooting





VI – LEATHER PRODUCTS INCLUDING DEVICE

A NOVEL ANKLE FOOT ORTHOSIS AND AN OFFLOADING DEVICE FOR PERSONS WITH DIABETIC FOOT ULCER

Technology Outline

- Ankle Foot Orthosis (AFO) is an off-the-shelf offloading device designed for people with Diabetic Foot Ulcer (DFU), using indigenous materials and technology for foot and ankle offloading.
- Diabetes affects over 100 million Indians, with DFU impacting 25% of patients and having a high recurrence rate. AFO is specifically designed to offload the plantar pressure, correct gait, and improve posture.



Salient Features / Highlights / Advantages

- Standardized posterior and anterior shell dimensions, along with a newly designed midsole and insole, ensure uniform plantar pressure distribution and offloading the force from affected foot.
- AFO is made using anatomically efficient and indigenous materials and methods.



Commercialization Status / Techno – Economics

- This technology is ready for commercialization.
- Orthotic device manufacturing can be undertaken by small and medium-scale industries. Assistive device manufacturing industries can generate significant revenue. The off-the-shelf AFO technology is simple and cost-effective

Major Raw Materials to be utilized

- Thermoplastic materials, upper and sole materials which are normally used for footwear fabrication

Validation Level

- TRL 4

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Assistance, Technology Implementation.



BIO-MECHATRONIC ORTHOTIC DEVICE WITH VIRTUAL INTELLIGENCE FOR CHILDREN WITH CEREBRAL PALSY

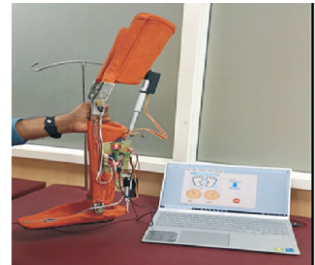
Technology Outline

- Cerebral Palsy (CP) affects muscle tone and occurs in approximately 2.1 out of 1000 live child births. Without timely rehabilitation, it can lead to permanent deformities and locomotor disability.
- In India, CP children use standard Knee Ankle Foot Orthosis (KAFO) and walkers, but these devices do not significantly improve their Gross Motor Function (GMF).
- To address this issue, a Bio-Mechatronic Orthotic Device with Virtual Intelligence (BioMOD) has been developed to enhance walking ability and GMF in children with CP.



Salient Features / Highlights / Advantages

- The device enables precise and regulated movement of knee and ankle joints, aiding in effective motor rehabilitation.
- BioMOD consists of two parts: a mass-producible component (sensor, actuator, control unit, power source) and a customized exoskeleton (standard KAFO) and software.
- End-users include physiotherapists, parents of affected children, and rehabilitation centers.
- The technology can be transferred to orthotic device and smart footwear manufacturers



Commercialization Status / Techno – Economics

- This technology is yet to be ready for commercialization.
- The orthotic device manufacturing can be done by medium scale industries.
- The device manufacturing industries can generate revenue.

Major Raw Materials to be utilized

- Thermoplastic materials, metal frames, sockets for orthoses, upper and sole materials for footwear, wearable sensors, actuators, PCBs, and batteries for power.

Validation Level

- TRL 3

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Assistance, Technology Implementation.



EXTREME COLD WEATHER PROTECTION GLOVES

Technology Outline

- Developed gloves that can be used in extreme cold weather conditions viz., -50°C



Salient Features / Highlights / Advantages

- Developed processing technology for Light weight leathers matching all the property requirements
- Designed interventions to have higher percentage of leather in gloves to enable better cold insulation and better grip
- All properties on par with global benchmark gloves with one third the price of the imported gloves

Commercialization Status / Techno – Economics

- This technology has been licensed and is ready for multiple commercialization. ATMANIRBHARTHA

Major Raw Materials to be utilized

- Leather and technical textile materials

Validation Level

- Gloves have passed Indian Army User trials
- TRL 3

Handholding support

- Demonstration, Technology Document, Technology Implementation



LEATHER AND PALM CRAFT COMBINATION PRODUCTS

Technology Outline

Palm leaf has been identified as potential raw materials for the traditional craft sector. The raw material is obtained from the palm tree and has been traditionally used the product making. CSIR-CLRI has developed technology to design and develop products in combination palm leaf with leather for the craft sector.



Salient Features / Highlights / Advantages

- The raw material is abundant available in India as well as globally.
- The craft is sustainable and the material is bio-degradable.
- Very less infrastructure and investment are required.
- Low investment for raw materials of craft.
- Traditional artisans are very skillful and a range of products in combination with leather can be developed.

Commercialization Status / Techno – Economics

- A range of product has been developed and ready for commercialization
- Out of the estimated 8.59 crores of Palmyrah in India, about 5.10 crores of Palmyrah are in Tamil Nadu.
- Tamil Nadu- potential centre for the growth and development of Palm Products Industry - attract foreign exchange by way of export of Palm Products.
- Based on the design and the products usage the costing can be arrived.

Major Raw Materials to be utilized

- Palm Leaves panels and Leather

Validation Level

- Developed in lab scale.

Handholding support

- Training, Demonstration, Technology Document, Trouble Shooting, Technology Implementation.

Advantages:

- Developing Fashion Goods from Traditional knowledge of Palm Leaf craft from Tamilnadu.
- Abundant availability of Palm leaves in Tamilnadu.
- Empowerment of women workers across Tamilnadu in Palm Crafts.
- The craft is Sustainable.
- The Material is Bio-Degradable

Highlights:

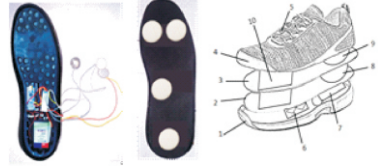
- Design intervention to the Palm Leaf Craft industry.
- Development of New-age fashion products from Palm Leaves and leather combination.
- Improve livelihood and socio-economic conditions of Palm Leaf craft artisans.



SMART FOOTWEAR FOR PERSONS WITH DIABETES TO PREVENT FOOT DEFORMITIES AND DIABETIC FOOT ULCER

Technology Outline

The CLRI technology on smart footwear relates to an assistive technology system specifically designed to manage and treat peripheral neuropathy through the application of high-frequency ultrasonic stimulation. The technology provides an assistive device that comprises multiple piezoelectric sensors and a battery-powered microcontroller circuit capable of generating programmable ultrasound signals within the therapeutic frequency range for peripheral nerve modulation and repair.



Salient Features / Highlights / Advantages

- The assistive device is biomechanically engineered and placed in a closed smart shoe.
- The number and positioning of the embedded ultrasonic transducers are customizable based on the user's foot dimensions and neuropathy severity, enabling personalized therapy and outcome.
- The system operates through a mobile application where the intensity, duration, and frequency of US waves based on each patient's neuropathy score can be set by the end users.
- The device is fully portable and suitable for regular ambulatory use.



Commercialization Status / Techno – Economics

The technology is yet to be ready for commercialization. Smart footwear manufacturing can be undertaken by small and medium-scale industries after the technology validation with patients with peripheral neuropathy which is currently on-going. Assistive/ medical device manufacturing industries can generate significant revenue.

Major Raw Materials to be utilized

- Upper and sole materials for footwear, wearable sensors, PCBs, and batteries for power.

Validation Level

- The technology is evaluated with the preliminary clinical response and patient acceptability and now it is at the TRL 3.

Handholding support

- CLRI can provide the handholding support after the patients wear trials for making production ready products and mass production for commercialization.



AN INDIGENOUS FATIGUE RESISTANCE TESTING DEVICE FOR FOOTWEAR INSOLES REINFORCED WITH STEEL SHANK

Technology Outline

An **indigenously developed fatigue resistance testing device** engineered to evaluate footwear insoles reinforced with steel shanks under **controlled in simulated walking conditions**. Unlike conventional methods that predominantly assess the steel shank as an isolated component, this technology evaluates the **insole–shank as an integrated functional assembly**, reflecting its actual configuration within footwear. Since the shank functions in conjunction with the reinforced insole during repeated walking-induced flexure, the device enables **realistic and repeatable assessment of assembly-level fatigue performance and durability**, supporting early identification of potential structural performance issues before incorporation into finished footwear.



Salient Features / Highlights / Advantages

Test the Insole–Shank Assembly the Way It Functions in Footwear

- **Integrated Assembly Testing:** Evaluates the steel shank together with the footwear insole rather than as an isolated component.
- **Simulated Walking Conditions:** Generates repetitive cyclic flexing representative of walking-related footwear deformation.
- **Product Development Support:** Enables comparison of different insole, shank and reinforcement configurations during footwear development.
- **Quality Evaluation:** Supports identification of fatigue-related deformation or failure before product commercialization.
- **Compact Mechanical Architecture:** Designed for laboratory and industrial footwear-component evaluation.

“This technology will evaluate the durability of the insole–shank assembly before it becomes a performance issue in the finished footwear”

Commercialization Status / Techno – Economics

Technology Status :

- Prototype developed and laboratory validated; available for demonstration and further industry-oriented validation.

IP Status: ■ Patent Application No. 202211012415

Target Users: ■ Footwear manufacturers, Insole manufacturers, Footwear testing laboratories, Quality-control laboratories, R&D institutions and Testing-equipment manufacturers

Major Raw Materials to be utilized: Validation level:

- Major components are indigenously/ commercially available.
- TRL 3. This technology can be demonstrated in lab scale.

Handholding support:

- Training, Demonstration, Technology Document, Trouble Shooting, Technical assistance, Technology Implementation would be provided by CSIR – CLRI.



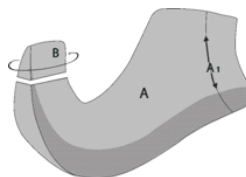
PAPU SHOE LAST AND A METHOD FOR MAKING THE SAME

Technology Outline

HDPE shoe last combining conventional last-making for Part A with thermo-vacuum forming for the scoop (Part B).

Salient Features / Highlights / Advantages

- Faster to Make: Shoes are made much quicker than by hand.
- Perfect Fit: Consistent sizing for comfortable wear.
- Traditional Look: Keeps the authentic Papu shoe design.
- More Comfortable: Improved support for all-day wear.
- Easier to Find: More shoes available for everyone.
- Skills Live On: Supports Ladakhi artisans and their craft.
- Lasting Quality: Ensures every shoe is made to the same high standard.



Commercialization Status / Techno – Economics

The Papu Shoe Last technology is presently at TRL-3 and has been developed and demonstrated at laboratory/prototype level. A functional two-part shoe last has been developed using conventional last-making and thermo-vacuum forming techniques to address the intricate geometry of traditional Papu footwear. The technology has potential for commercialization through standardization and modernization of Papu footwear manufacturing. Further product validation, optimization, field trials, pilot-scale manufacturing and techno-economic assessment are required to establish production cost, manufacturing cycle time, durability and market viability. Commercialization may be pursued through technology transfer/licensing to footwear manufacturers, artisans, MSMEs and enterprises involved in traditional/cultural footwear.

Major Raw Materials to be utilized

- HDPE (High Density PolyEthylene)

Validation Level

- TRL 3

Handholding support

Handholding support is required for further optimization and validation of the Papu Shoe Last, development of standardized size ranges, pilot-scale fabrication, field trials with traditional Papu footwear manufacturers/artisans, footwear prototype development, performance and durability evaluation, process standardization, techno-economic assessment, and scale-up. Support is also required for industry interaction, identification of suitable manufacturing partners/MSMEs, technology transfer/licensing, IPR facilitation, product branding and market development.



Our Industry Partners / Stakeholders



I. AGENCIES CONNECTED WITH LEATHER INDUSTRY

- a. Ambur Economic Development Organisation (AEDO)
- b. Central Pollution Control Board (CPCB)
- c. Chennai Environmental Management Company of Tanners (CEMCoT)
- d. Confederation of Indian Industry (CII)
- e. Council for Leather Exports (CLE)
- f. CSIR-Central Salt & Marine Chemical Research Institute (CSIR-CSMCRI)
- g. Director General of Foreign Trade (DGFT)
- h. Director of Industries and Commerce SIDCO Corporate Office Building (DICSCOB)
- i. ECGC Limited (Formerly Export Credit Guarantee Corporation of India Ltd)
- j. Export Inspection Agency (EIA)
- k. Federation of Indian Chambers of Commerce & Industry (FICCI)
- l. Federation of Indian Export Organisations (FIEO)
- m. India Trade Promotion Organisation (ITPO)
- n. Indian Leather Industry Foundation (ILIF)
- o. Indo-American Chamber of Commerce (IACC)
- p. Indo-Australian Chamber of Commerce (IACC)
- q. Indo-German Chamber of Commerce (IGCC)
- r. Indo-Italian Chamber of Commerce & Industry (IICCI)
- s. Indo-Japan Chamber of Commerce & Industry (IJCCI)
- t. Tamil Nadu Pollution Control Board (TNPCB)

II. COMMON EFFLUENT TREATMENT PLANTS IN TAMIL NADU

- a. Ambur Tannery Effluent Treatment Co.Ltd. MaligaiThope Sector
- b. Ambur Tannery Effluent Treatment Co.Ltd. Thuthipet Sector
- c. Madhavaram Leather Manufactures Facility P. Ltd
- d. Pallavaram Tanners Industrial Effluent Treatment Co.Ltd
- e. Perundurai Leather Industries Eco-Security (P) Ltd
- f. Ranipet SIDCO Finished Leather Effluent Treatment Co.Ltd
- g. Ranipet Tannery Effluent Treatment Co.Ltd
- h. SIPCOT & SIDCO Phase II Entrepreneur Finished Leather Effluent Treatment Co.P.Ltd.
- i. Talco Dindigul Tanners Enviro Control System Pvt. Ltd
- j. Talco Pernambut Tannery Effluent Treatment Co.Ltd. Bakkalapalli Sector
- k. Vanitec Limited - Valayampet Sector
- l. Visharam Tanners Enviro Control Systems P.Ltd

III. LIST OF REGIONAL TANNERS ASSOCIATIONS

- a. Erode Small Tanners Association
- b. Erode Tannery Owners Association
- c. The Ambur Tanners Association
- d. The Dindigul Tanners Association
- e. The Pallavaram Tanners Association
- f. The South India Tanners and Dealers Association
- g. The Tanners Association
- h. The Trichy Tanners Association
- i. The Vaniyambadi Tanners Association
- j. Madhavaram Tanners Association

IV. OTHER TRADE ASSOCIATIONS SERVING THE LEATHER INDUSTRY

- a. All India Skin and Hide Tanners and Merchants Association (AISHTMA)
- b. Indian Finished Leather Manufacturers and Exporters Association (IFLMEA)
- c. Indian Shoe Federation (ISF)
- d. Leather Chemicals Manufacturers Association (LCMA)
- e. Indian Leather Products Association (IIPA)
- f. Tamil Nadu Leather Tanners Exporters & Importers Association (TNLTEIA)
- g. Calcutta Leather Complex Tanners Association (CLCTA)
- h. South India Shoe Manufacturers Association (SISMA)
- i. Footwear Design & Development Institute (FDDI)
- j. Indian Footwear Components Manufacturers Association (IFCMA)



Special Concession for Indian Start-ups, Women Entrepreneurs and CSIR-CLRI Alumni Entrepreneurs in R&D/Technology

CSIR-Central Leather Research Institute, the most empowered R&D Organization in the leather world, has been extending all necessary intellectual intervention, novel knowledge products, erudite expertise, and vibrant techno-enablement, for the benefit of the user industry to ensure sustained growth and development of the leather sector.

As a part of its SSR (Scientific Social Responsibility) initiative, the Institute now offers special discounts in the area of Sponsored/Collaborative R&D and Technology Licensing Fee, for the Indian Start-ups, CSIR-CLRI Alumni Startup/Entrepreneurs and Women Startup/entrepreneurs, as a vibrant motivational measure, under the following categories:

Category	Particulars	Fee Concession
A	Start-up	10%
B	Startup/ Entrepreneur + Woman	15%
C	Startup/ Entrepreneur + CSIR-CLRI Alumnus	15%
D	Startup/ Entrepreneur + Woman + CSIR-CLRI Alumnus	20%

CSIR-CLRI welcomes corporates to invest CSR funds in R&D of institute

For Enquiry



CLRI.KPMU.TC.V09.2026
email : kpm�.clri@csir.res.in