The Central Leather Research Institute, founded in 1948 has emerged to be the largest research institute in the world. The Institute is the most powerful among all the R&D centres in leather with the potential to undertake long term research as well as short term developmental projects and consultancy services. Since inception, CLRI has been playing a direct role in education and training in leather and related technologies. CLRI is also the National Apex body and a clearing house for modern technologies for the leather sector. The institute has a highly efficient 639 scientific, technical and administrative staff, and imparts training to more than 452 personnel, with an annual budget of Rs 746.9 lakhs and an extra budgetary resource input of Rs 730.0 lakhs during 1994-95. The Institute has been an active partner in the trinity of academy-research-industry in the leather sector and enjoys vibrant linkages with the Indian leather industry. The services of CLRI to the industry include sponsored research, industrial consultancies, testing and certification, training, industrial planning, extension of R&D outcome, information exchange and technology counselling. The Institute is on the threshold of playing an International role in the leather sector.

The Institute and its affiliates

The Institute and its affiliates
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(July 1994 - June 1997)

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निदेशक की रिपोर्ट

चिकित्सा दृष्टिकोणों से देखा जाय तो 1994-95 का यह वर्ष केंद्रीय चर्म अनुसंधान संस्थान (केच.अस.) के लिए अलग महत्वपूर्ण रहा है। भारतीय चर्म क्षेत्र के सुदृढ़ विकास हेतु भारत सरकार के चर्म प्रौद्योगिकी मिशन का समारोह सीएसआईआर/केच.अस के इतिहास में एक अद्वितीय उपलब्धि है। भारत सरकार ने पहली बार राष्ट्रीय प्रौद्योगिकी मिशन के महत्वपूर्ण जिम्मेदार सीएसआईआर को और मिशन के कार्यनिवास की जिम्मेदार केंद्रीय चर्म अनुसंधान संस्थान को सौंपी है। भारतीय चर्म उद्योग के विकसित की तथा संगठित क्षेत्रों के बीच उत्पाद प्रौद्योगिकी की दास को महसूस के लिए यह कार्यक्रम विशेष रूप से बनाया गया है। जनवरी से मार्च 1995 की अवधि में देश के 7 राज्यों में लगभग 30 से अधिक कार्यक्रमों की शुरुआत की गई है।

केच.अस ने पर्यावरणानुकूल प्रौद्योगिकियों को वाणिज्यिक स्तर पर कार्यरत किया है और नीति/स्थल सरकार एवं युविद्यों की अन्तरराष्ट्रीय सहयोग से 5 परियोजनाओं का सकल संस्थान हो पाया है। उक्त कार्यक्रमों के अंतर्गत आंतरिक प्रौद्योगिकी तथा प्रौद्योगिकी के अंत में विस्तृत प्रयोग प्रौद्योगिकी भी शामिल है। कुछ क्षेत्र स्थलों में क्रम विस्तार की बहराइच पत्तियों का निरूपण भी किया गया है। वर्ष 1994-95 के दौरान केच.अस ने यूरोपीय का राष्ट्रीय चर्म विकास कार्यक्रम के अंतर्गत कई महत्वपूर्ण परियोजनाओं को पूरा किया है। साथ ही, चर्म उत्पाद के कुछ महत्वपूर्ण क्षेत्रों में नया कार्यक्रमों को शुरु किया है। इसमें भारतीय चर्म इकाइयों, चर्म उत्पादों का राष्ट्रीय स्तर पर सर्वेक्षण तथा पालन नौ वर्षों में भूमिगत सर्वेक्षण का सर्वेक्षण आदि भी शामिल है। राष्ट्रीय चर्म विकास कार्यक्रम के तत्वावधान में भारतीय स्टेट बैंक की वित्तीय सहायता से पथ-प्रदर्शक का कार्य करते हुए केच.अस ने राष्ट्रीय स्तर पर चर्मशोधनालय के आधुनिकीकरण पर एक विस्तृत रिपोर्ट तैयार की है। आगामी वर्षों में भारतीय चर्मशोधनालयों के आधुनिकीकरण के किरायाकलापों में यह रिपोर्ट एक उत्तमक एवं कार्य करेगी।

चर्म क्षेत्र के महत्वपूर्ण पहलू तथा संबंधित विज्ञान क्षेत्रों में केच.अस के गूढ़ अनुसंधान की उपलब्धियों, राष्ट्रीय एवं अंतरराष्ट्रीय पत्रिकाओं में, 125 प्रकाशनों के रूप में अपना महत्वपूर्ण स्तर प्राप्त कर चुकी है। इसके अतिरिक्त 2 वैज्ञानिकों को वैज्ञानिक अकादमी में पैंटोण, 4 वैज्ञानिकों को राष्ट्रीय पुरस्कार प्रदान किया गया है और 13 वैज्ञानिकों ने डाक्टरल/पोस्ट डाक्टरल अनुसंधान कार्यक्रम सम्पूर्ण कर लिया है।

केच.अस ने जर्मनी में आयोजित विश्व की IULTCS कॉंग्रेस में स्वीकार कार्यक्रम प्रस्तुत किए। उक्त कॉंग्रेस में जिन्हीं भी देश से, एक ही प्रमुखालय से शायद ही इलंगे अधिक प्रकाशन प्रस्तुत हुए होंगे। संस्थान के अनुसंधान कार्यों में बहु व्यापक एवं होस्ट अवस्था
एनएमआर सेवास्थली, भवनी क्षेत्र और कोल्हापुर राउंड बंधन, चर्म शोधन में गतिकी एवं परिवार प्रक्रिया का प्रतिरूप, 
पुद्दंगी की जीवनशैली, बहुप्रमाण एवं संबंधित अनुभवों का 
संस्मरण, जैव व्यवस्थाओं में प्रोत्साहन द्वारा प्रस्तुत असमानितताएं, 
संबंधित धारावाहिक रसायन शाखा एवं धारावाहिक शोधन से संबंधित 
संचालनक ग्रंथावलीता आदि पर भी अध्ययन कार्य हुए हैं।

केंद्रीय ने पहली बार, अंतरराष्ट्रीय सर्क पर सुविचार 'साला' (ब्रिटेन) की प्राप्ति का अंतगत चमड़े एवं पुद्दंगी हेतु 
अंतरराष्ट्रीय सर्क की परीक्षण प्रक्रियाशाला स्थापित की है। अब संस्थान 
में चर्म एवं चर्म उपाद अवकाशों के जटिल परीक्षण कार्य करने के लिए 
पूर्ण सुविधाएं उपलब्ध हैं।

वर्ष 1994-95 के दौरान केंद्रीय के मानव संसाधन विभाग के 
ब्रिटानीकारों में महत्वपूर्ण परिवर्तन हुए हैं। इसके अतिक्रिया संस्थान 
में चर्म एवं चर्म उपाद सांस्कृतिक किया जाने वाले 
प्रशिक्षण एवं परीक्षण कार्यक्रमों में 40 प्रतिशत वृद्धि हुई है। विज्ञान 
विभाग और सांस्कृतिक संस्थान (फिल्म) के सहयोग से अब विज्ञान 
में व्यावसायिक उपाधि का समारोह किया गया है। श्रेय संचालन, 
व्यवसाय, तथा प्रख्यात एवं निर्गम के प्रावधान इसकी कुछ अनींकनी 
विशेषताएं हैं।

राष्ट्रीय एवं अंतरराष्ट्रीय सहायता से केंद्रीय के अहमदाबाद 
और कानपुर में विभिन्न संस्थान केंद्रों में नई सुविधाएं उपलब्ध हैं। 
कानपुर विभिन्न संस्थान केंद्र में विभिन्न बैंक के सुलभ उद्योग कार्यक्रम के 
अंतर्गत नए विभिन्न उपकरण खरीदी जा रहे हैं। इससे कान 
तथा स्थानीय चर्मशोधनों को आधुनिक परिसंह तकनीकों को 
सुविधा प्राप्त करने का एक अच्छा मौका मिले गए।

वर्ष 1994-95 की अवधि में केंद्रीय के अन्य विभागों में हुई 
प्रभावशाली वृद्धि अद्वित सहायता रही है। राजकीय वर्ष में, अब 
अन्य विभागों से, 117 प्रस्ताव राशि मिली। भारतीय निजी 
वैदिक रसवस्थ एवं संस्थान तथा ओडीकारक ऐरेजेंसियां से प्राप्त विभाग 
सहायता ने संस्थान के अन्य विभागों के बजट की वृद्धि में 
अपना महत्त्वपूर्ण योगदान प्रदान किया है। केंद्रीय चर्म अनुसंधान 
संस्थान आज वर्ष 1995-96 के उजवल भविष्य की ओर देख रहा 
है।

- डा. के.बी. राघवन
The year 1994-95 has been significant for CLRI from several perspectives. The launching of the Leather Technology Mission of the Government of India for Sustainable Development of the Indian leather sector is a landmark event in the annals of CLRI/CSIR. The Government of India for the first time assigned the nodal responsibility of a National Technology Mission to the CSIR and the implementation task to CLRI. This programme has been designed to bridge the technological gap between the decentralized and organised sectors of the Indian leather industry. More than 30 programmes have been initiated during January and March 1995 in seven states in the country.

The implementation of eco-friendly technologies on a commercial scale by the CLRI has received a major thrust with the successful commissioning of five projects with international assistance from the UNIDO and the Government of The Netherlands. They cover in-process and end-of-the-pipe pollution control technologies. Better chrome management strategies have been demonstrated in a field location. During 1994-95, the CLRI completed several important projects under the National Leather Development Programme (NLDP) of the UNDP and simultaneously launched new programmes in critical areas in the leather product sector. They include ISO 9000 implementation in Indian leather units, nationwide survey on leather products and a survey of groundwater pollution in the Palar river basin areas. In a pathbreaking programme funded by the State Bank of India under the aegis of the NLDP, the CLRI has prepared a comprehensive report conceiving a national programme on tannery modernisation. The report is expected to catalyse the modernisation activities of the Indian tanneries in the coming years.

The basic research achievements in the frontier areas of leather and allied sciences are reflected in the form of 128 publications in prestigious national and international journals, fellowship of scientific academies to two scientists, four national awards and the completion of thirteen doctoral/post-doctoral research programmes. The CLRI contributed the largest number of publications from a single laboratory in any country at the World Congress of IULTCS held recently in Germany. Further, knowledge in multiple,
quantum and solid state NMR spectroscopy, dimensional stability and cross-linking of collagen, modelling of kinetic and transport processes in leather making, biomechanics of footwear, self-assembly of polypeptides and related molecules, chromium-induced abnormalities in biosystems, and structure activity relations of relevance to transition metal chemistry and mineral tanning has now been added.

The CLRI for the first time, established an international-class testing laboratory for leather and footwear with accreditation from the internationally acclaimed SATRA (UK). The Institute is now fully equipped to undertake complex testing assignments in leather and leather product sectors.

The year 1994-95 has brought in significant changes in the HRD activities of the CLRI. The Institute’s capacity for in-campus training and education in leather and leather product technologies has gone up by 40% as compared to the previous year. A Master of Vocational Science degree programme has been formally launched in collaboration with BITS (Pilani). It is unique in its structure, credit accumulation and exit and entry provisions.

The Extension Centres of the CLRI at Ahmedabad and Kanpur have been strengthened with new facilities through national and international funding. These centres are ready to receive new tanning equipment being procured under the World Bank soft loan programme. This will provide immense opportunities for the local small-scale tanners to employ modern finishing techniques.

The extra budgetary resources of CLRI have registered an impressive growth profile during 1994-95 with EBR totalling to 117% of revenue expenditure. The external cash flows from Indian private and public sector organisations and grants from international agencies strengthened the extra budgetary resource base. The Institute looks forward to a more challenging 1995-96.

Dr. K.V. Raghavan
TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

Leather is a unique commodity that links grassroot villages of developing countries with the fashion world of the west. The sustainable growth of the leather industry is closely linked with the ability of the Indian leather sector to respond quickly to global technological challenges. Development with environmental safeguards calls for innovations in technology. The CLRI has launched several trendsetting new initiatives during 1994-95.

Launching of Leather Technology Mission (LTM)

A technology mission on leather has been launched by the Government of India. This is the first of the technology missions being implemented directly by a Science department and the CSIR. The Institute has been entrusted with the responsibility to co-ordinate a technology-driven development through this Leather Technology Mission.

The Mission was inaugurated by Shri Bhuvanesh Chaturvedi, Union Minister of State for Science & Technology and Vice-President, CSIR on January 12, 1995 at the NPL Auditorium, New Delhi.

The total outlay of the Leather Technology Mission is Rs.22.00 crores; out of which Rs.10 crores have been sourced from the agencies. The total duration of the programme is four years.

Objectives of the Mission
* To augment the availability of quality hides and skins
* To evolve a technology grid for a balanced development
Resource Augmentation

Organization Models

Leather Technology Mission

HRD

Prototype Development

Cleaner Technologies

Technology Upgradation
of the Indian leather sector
* To provide extension services to rural and small-scale industries in the adoption of cleaner technology and upgradation techniques
* To initiate a campaign for quality and standardisation in the Indian leather sector
* To enable harmonious blending of traditional and new skills through innovative training and HRD programmes
* To evolve and implement technology delivery systems most suited for the Indian leather industry
* To study and identify the most suitable organisational structure(s) to integrate the development of rural, semi-urban and urban sectors in leather
* To catalyse the revival and the growth rate of 25% p.a. and the Indian share of 10% in the global leather trade.

The Leather Technology Mission complements the National Leather Development Programme and focusses attention on leather processing while the NLDP stresses on leather product sectors.

Projects taken up for implementation (1994-96)

Technology Extension
* Fallen animal carcass utilisation
  - Upgradation of carcass recovery centres in Tamil Nadu, West Bengal and Madhya Pradesh
* Animal health care vis-a-vis skin defect minimisation (Andhra Pradesh)
* Chrome Management (2 projects; Uttar Pradesh)
* Ammonia-free and cleaner wet operations (2 projects; Uttar Pradesh)
* Chrome recovery and reuse (Karnataka)

Plant Equipment Engineering
* Bicycle operated tanning drums (Gujarat, Madhya Pradesh and Uttar Pradesh)
* Project reports
  - Leather complex (Madhya Pradesh)
- Vegetable tannins/downstream products (Madhya Pradesh)
- UASB to CETP (Tamil Nadu)
- Animal byproduct complex (All India)
- CET project report (Tamil Nadu)

Human Resource Development
* Modernization campaigns (All India)
* New training centres / programmes (Tamil Nadu, Gujarat and Punjab)
* Worker's manuals (All India)
  Neighbourhood development for women household units (Karnataka)
* Nationwide survey on leather products (All India)

Information and Organisation
* Awareness workshops (Andhra Pradesh)
* Mass communication aids (West Bengal, Uttar Pradesh, Punjab, Maharashtra and Gujarat)
* Information system-footwear (All India)

Development Efforts
* RO test rig
* Ecolabelling

Ecofriendly leather processing: CLRI-Indian tanneries show the way
Seven projects in cleaner leather processing have been successfully commissioned during 1994-95 on a commercial scale in Indian tanneries. In these, the CLRI provided the complete range of technology packages. Financial support from the UNIDO, Governments of Switzerland and The Netherlands helped demonstrations at commercial sites.

Modernisation of the biggest beam house
Traditionally, practices in beam houses are associated with not-so-clean work environment, process inefficiencies, longer process time and a number of related disadvantages.

Through recourses to emerging techniques, the beam house
in M A Khizar Hussain & Sons has been totally modernised with engineering support from CLRI. The larger modern beam house in India established at K H & Sons at Ranipet has many special features.

The MAKHS - CLRI collaboration covered the following:

* Replacement of pits with large size paddles equipped with automatic material discharge facility
* Lime slurry system to minimise dust problems in liming operations
* Green fleshing to achieve shorter liming period
* Control instruments for pH and addition of water, chemicals and lime slurry
* Efficient waste water drain system
* Semi-automatic equipments for material handling
* Chemical tank farm for tanning section
* Basic design engineering package

The overall benefits include 40% reduction in process time, 2% chemical savings, quality consistency, smooth material movement and enhanced inplant ecology and operational efficiency. In recognition of this remarkable achievement, the MAKHS received the AISHTMA Platinum Jubilee National Technology Award (1994).

**Ammonia Free Processing**

Under the UNIDO programme supported by the Swiss Government, a full-scale demonstration unit has been set up for ammonia free and cleaner wet tanning operations.
The following process modifications have been adopted:

Reduction of ammonia, chromium and COD/BOD loads in the waste waters through in-process control measures and cleaner processing options; better water management through input control and float recycles; improvement and consistency of leather quality and better inplant ecology.

The following process modifications have been adopted:

Carbon di-oxide deliming; high exhaustion chrome tannage; rechroming with high performance syntans; pH control and float recycling; microprocessor controlled water and chemical dosing systems; improved drainage and waste water segregation system.

These modernisation and ecofriendly concepts can be extended to small production systems at affordable costs has now been demonstrated on a commercial scale for the first time in India.

**Two Chrome Recovery Plants commissioned**

Encouraged by the success at the Kanpur tanneries, the CLRI provided process knowhow, design engineering and technical support for the establishment of chrome recovery plants at M/s Arafat Tanners, Pallavaram with UNIDO-SWISS assistance and at M/s Jayabharat Tanners, Ambur with Dutch assistance.

For the first time a centralized chrome recovery system has been established at the Pallavaram tannery cluster with
M/s Arafat Tanneries taking the managing role and the Pallavaram Tanners Industrial Effluent Treatment Company providing the umbrella support. Technically, 60-70% of the processing capacity is utilised by the host tannery and the rest shared by the other tanners. The plant can recover 100-120 tonnes of basic chromium sulphate annually. The total investment and the annual operating costs are of the order of Rs.16 lakhs and 8 lakhs respectively. The annual net saving is of the order of Rs.9 lakhs with a payback period of less than two years.

Another successfully running chrome recovery plant at M/s Jayabharat Tanners, Ambur based on a modified process, is endowed with several advantages viz., 10% chemical savings, less toxic load in the waste water stream after chrome recovery, improved settling process in the precipitator and better consistency in basicity of recovered chrome. The plant is designed to process 8000 litres of chrome liquor per shift. The total investment is of the order of Rs.12 lakhs with the host tannery sharing 25% cost.

CLRI's contribution to chrome recovery and reuse in Indian tanneries received recognition, bagging the AISHTMA Platinum Jubilee National Environment Award (1994).

Two Simple Ecofriendly Options adopted

CLRI had successfully commissioned a mechanical desalting facility at M/s General Leathers and a less sulphide liming process at M/s Harty Leathers in the Pallavaram tannery cluster. These measures enable minimizing ground water pollution. The projects have been financed through the UNIDO-SWISS programmes with
tanneries sharing 20-25% of the investment. Extension to other regions is planned after assessment of technoeconomics in the social context of Indian tanneries.

**New Breakthrough in Chrome Management**

A secure solution to a severe problem viz. disposal of chrome containing sludges has been developed. A tripartite collaboration between CLRI, the Regional Research Laboratory, Trivandrum and the TNO Institute of Applied Physics in Eindhoven, The Netherlands has resulted in a breakthrough with the development of a process for chrome sludge utilisation for coloured wire cut brick manufacture. Technical scale trials with a batch size of 5000 bricks were made in a mechanised brick unit of M/s Raja Tiles, Trichur, Kerala. The unique feature of the technology is in the rendering of chromium in the resulting bricks non-leachable. It is proposed to encourage both existing and new mechanised brick units in various states to adopt this cost effective technology through the CLRI-TNO Dissemination and Leather Technology Mission programmes.

In-process enhancement of chrome uptake is one of the best options of long term chrome management. Two commercially attractive closed loop processes have been developed and field tested in commercial tanneries. The process based on ethanolamine pretreatment was developed through a collaboration of CLRI, TNO and the BLC (UK). The CLRI process based on Alutan-BCS employs indigenous chemicals and technology. A net cost saving of Rs. 2000.00 per tonne of bovine leathers and exhaustion levels exceeding 98% have been demonstrated.
Common Effluent Treatment Gains Momentum

The concept of Common Effluent Treatment (CET) plants is widely practised in the Indian leather sector. A large 2.8 MLD CET plant has been established at Pallavaram to serve 100 tanneries at a cost of Rs 8.00 crores. The CLRI participated in the technical collaboration with the UNIDO/TNPCB in setting up the plant.

CLRI has provided the knowhow and the design engineering for the setting up of the Bangalore CETP promoted by the Leather Industries Development Corporation of Karnataka (LIDKAR) and the local tanners association. The project serves 14 small scale tanneries and is endowed with a processing capacity of 1.25 MLD. The capital investment is about Rs.1.8 million.

Direct Closed Loop Chrome Recycle through Electrodialysis

CLRI had demonstrated in 1994 the feasibility of selective separation of neutral salts from heavy metal ions in spent chrome tanning solutions through electrodialysis. A closed pickle-tan loop with potentials for electrolyte balance and reduction of neutral salt discharge has been developed.

Combating Groundwater Pollution in Palar River Basin - the CLRI led Multi-institutional Project

The North Arcot-Ambedkar District of Tamil Nadu, the venue for over 500 tanneries, has about 75% of the state's tanning capacity. The sustainability of the leather industry in this region greatly depends on its environmental
compatibility. The Tamil Nadu Pollution Control Board (TNPCB) and the State and Central groundwater authorities in association with the CLRI and the National Geophysical Research Institute (NGRI) at Hyderabad have formed a consortium to combat groundwater pollution of the Palar river basin hosting the above tanneries.

Phase-I of the programme involved a first-level pollution assessment based on the data available with the TWAD, PWD and PCB of Tamil Nadu and the Central Groundwater Boards. The NGRI team has assessed the size of the affected areas using a mathematical model. The future scenario under controlled and uncontrolled pollution situations has been projected. The NLDP funded the studies.

The CLRI led consortium suggested the following options for Phase-II studies:

i. Microlevel assessment studies involving deeper groundwater data and more extensive soil parameters

ii. Soil remediation measures

iii. Overground water treatment based on membrane technology

Institutional linkages are being finalized for Phase-II studies.

Animal Health Care and Meat Handling Systems - Pilot Project with Canadian Collaboration

The project has aimed at providing triple benefits viz., higher returns to animal breeders, hygienic meat to consumers and quality skins to the leather industry. A pilot programme has been launched at the village of Chennur in Nellore district of Andhra Pradesh. A rural meat production centre with an optimised meat handling system is being established in collaboration with the Breeder's Cooperative Society.

About 450 livestock farmers from 24 villages are expected to benefit. The project is financially supported by the IDRC (Canada) and the Leather Technology Mission.
Tradition bound practices have been audited for their sustainability in the current industrial climate of the global leather sector. A technology driven development grid with recourse to modernisation has formed the focal theme of developmental activities at the CLRI in recent years. Some major achievements have been made in 1994-95.

CLRI Evolves a National Programme for Tannery Modernisation

Under the aegis of the National Leather Development Programme (NLDP) of the Government of India and UNDP, CLRI prepared a project report on tannery modernisation. Enhancing quality, productivity and sustainability through technology upgradation has been the objective of the project. The International Banking Division of the State Bank of India has funded the project.

A three level modernisation approach to meet the diverse technological requirements of small, medium and large scale Indian tanneries has been evolved. Replacement of sub-optimal and traditional techniques, upgradation of machinery, improvement of inplant ecology, environmental pollution abatement have been suggested. The report sensitizes the national and international financial institutions on costs/benefit of modernisation needs of Indian tanning sector.

State-of-Art Facilities at CLRI Pilot Tannery

Through international and national funding, state-of-the-art facilities have been added to the pilot tannery during 1994-95.
* Split leather finishing covering direct coating, transfer foil and lamination facilities
* Computer aided colour matching facility for dyed leathers
* Product development laboratory
* Electrodialysis

**Multiproduct Leather Processing Made Easy with Computer Assisted Scheduling and Sequencing**

A software package to minimise idle time, costs of production and inventory has been developed for M/s Namasthe Leathers, Vaniyambadi. The company produces 34 products using 38 process equipments. The computer-assisted decision tree is the first of its kind in an Indian tannery. This is an user-friendly software which provides Gantt Chart, the ability to identify bottleneck areas and optimum job sequencing.

**“Try Now and Pay Later” Scheme for Popularisation of Fashion Buffalo Leathers**

A new scheme of collaboration with the tanners has been evolved to develop process technology for fashion leather from buffalo hides. Nubuck, oil pull-up, shoe suede, milled and shrunken grain, upholstery and split finish leather have been developed and displayed at Paris and Hong Kong International Leather Fairs in 1994.

**ISO 9000 for Indian Tanneries - Pilot Project Launched**

The implementation of ISO 9000 norms in leather sector poses special challenges. Under the aegis of the NLDP, a new 18 month pilot programme to adopt ISO 9000 norms in
the leather sector has been launched. A joint effort of IRQS-CLRI-industry has been initiated. A quality management system for tanning sector is being developed.

Upgradation of Harness Leather Technology - British Leather Confederation (BLC) - CLRI Collaboration

Harness leather, produced mostly in some tanneries in Kanpur, fail to match international norms. Through an NLDP supported project, the BLC - CLRI combine is evolving suitable processes for the utilisation of Indian buffalo hides in harness leather manufacture with active support from Kanpur tanners.

CLRI Consultancy Services Gaining Popularity

1994-95 witnessed 40% growth rate in consultancy assignments in the tanning sector. They cover a wide range of technical services including troubleshooting, product development, quality management, process restandardisation, computer applications and modernisation. The Institute handled 50 projects. Its Regional Centres at Calcutta, Kanpur, Ahmedabad and Jalandhar actively participated in the programmes.

RESEARCH DEVELOPMENTS

CLRI Tops in Research Presentations at the IULTCS World Congress

The CLRI made visible impact in the XXII IULTCS World Congress during 15-20 May 1995. Nearly 20% of the scientific presentations at the congress was from the Institute, the largest by any one institute in the world. Two technical lectures and one scientific presentation from the CLRI related programmes stole the show at Germany, where representatives of 26 countries participated.

The presentation by the Institute covered a wide range of subjects viz. chromium chemistry and management, UASB, method for tannery waste water treatment, computer assisted leather processing, polymer synthesis and applications, reactive fatliquors, animal feed from byproducts, enzyme application in leather and treatment of phenolic wastes.
Basic Research Areas

Basic research studies in leather and allied science areas fall under the following titles:

i. Modelling of Transport Processes in Leather Making

A new mathematical model to the diffusion and transport of tanning solutions into a hide matrix has been developed facilitating a more quantitative understanding of underlying factors in tanning.

ii. Ultrasonic techniques for the objective assessment of leather

A new test and evaluation method for assessment of leather, based on ultra-sound is being developed. A direct 1:1 correlation of the tensile strength measured using currently employed destructive techniques with the ultrasound velocities in leather has been established. Significant differences of ultrasound velocities in defective regions of leather have been demonstrated providing means to assess leather.

iii. NMR Imaging of Leather Processing

Novel NMR techniques have been developed which enable high contracts in liquid imaging with sub-micron level spatial resolution. An experimental technique to froze liquid ingressions into leather lattices has been developed and applied to seek a further understanding of diffusion phenomenon in leather.

Unique Experimental UASB Facility Commissioned

A bench scale Upflow Anaerobic Sludge Blanket (UASB) bioreactor has been commissioned at the environmental engineering department. The facility is equipped with automatic data logging and online process parameter measurement accessories. Process and kinetic parameters on anaerobic waste water treatment are being collected with a view to exploit UASB systems for treating tannery waste waters without mixing with domestic sewage.
Developmental Efforts: For Leather Chemical Sector

The need for innovations in chemical inputs to afford value addition to leather is recognised by the Indian Leather Industry. As a result of a brainstorming session with the Leather Chemical Manufacturers Association in 1992, the Institute identified priority areas of R&D in leather chemicals. A three year work plan was drawn. During the years 1992-95, as many as 33 technologies for different chemicals and auxiliaries for use in the leather sector were developed. Among them 25 were delivered to the industry during 1993-95. Some of these technologies reaching stages of commercialisation during 1994-95 are listed below.

Blended Vegetable Tannin Extracts: Through Modern Processes

A microprocessor based extraction procedure with increased efficiency of leaching (from concentration ~ 60 to >90%) in reduced time (from 16 days to 16 hrs) had been developed and standardized at a pilot plant scale under a sponsored project (Rallis India). The blends selected by the company have been based on babul-wattle and myroob and this facilitated more complete utilisation of indigenous resources. During 1994-95, a new blend based on cashew-myroob-wattle has been developed under industry sponsored program.

Sponsorship agreement has also been signed for a blended vegetable tannin extract with indigenous tanning materials.
New Analytical Techniques: For Banned Arylamines

The German ban order on 22 arylamines placed the Indian leather and textile industries under stress. The Institute has developed a 2-tier analytical approach involving three different techniques. A reductive degradation procedure for the liberation of amines from azo dyes has been standardised. Spectrophotometric technique to detect the presence of arylamines listed in the German ban order has been standardised. HPLC and GC-MS based techniques have also been standardised as the second tier analytical method to enable quantitative assays as well as the identification of specific banned arylamine in the dye.

A demonstration of the three techniques was made to the industry and more than 900 samples have been analysed and reported. The techniques developed and standardised to ppm level detection limits enable the Indian leather sector to meet the challenges of the German ban order.

Search for Excellence in Basic Research in Chemical Sciences

The themes of basic research in the division have pertained to the development of new synthetic methods and synthesis of new organic and inorganic molecules, technologies for probing molecular assemblies and assessment of the role of the metal ion in molecular assemblies, synthesis of new polymers and investigations on polymer blends and interpenetrating networks of polymeric systems.

The utility of microwaves for chemical activation of molecules has been demonstrated in a chosen series of organic reactions. New heterocyclic molecules and Mannich bases have been synthesized using known routes and some of these compounds have attracted attention.

Further, understanding of issues in mechanistic chemistry of chromium(III), stabilization of Cr(V), molecular basis to chrome tanning and rationale for near zero waste mineral tanning has been obtained. A case for chromium induced structural changes and protein assemblies in insulin and collagen has been made. The first experimental evidence for chromium(III) induced apoptosis and the need to take
with the molecular structure of Cr(III) species rather than the oxidation state received arguments has been provided.

New techniques for the characterisation of micellar systems and investigating interfacial phenomena have been developed and a micelle forming macromonomer has been investigated with a view to develop a polymer with new properties. A synthetic methodology based on the generation of long chain diradicals as a means to prepare polymers has been developed and morphological and phase transitions in a number of liquid crystalline polymers investigated. Phase compositions of select polymer blends and alloys have been characterised and new polymers with special application potentials in leather sector developed.

Strategic Planning of R & D in Leather Chemical Sector 1995-98

A brainstorming session with the Leather Chemical Manufacturer’s Association has been held at the CLRI in April 1995 and R&D targets focused. Near, mid and long term targets have been identified in consultation with the industry. New efforts for the development of chemicals/ processes for buffalo and goat based leathers as well as ecofriendly technologies have been initiated. A new research and development effort for cost effective alternative dyes to those affected by the German ban order has been launched. A laboratory for microanalysis of ecosenstive chemicals with proactive capabilities is being established. There have been many strategic developments in the R&D support to leather chemical sector.
Orthopaedic Implants from Collagen

Investigations have been carried out on calcium apatite powder mixed with 1% solutions of gelatin, chitosan and collagen and calcined at 800°C. Rod-shaped calcium phosphate resulted. Chitosan-apatite paste gave the most uniform rods of good porosity. The calcined samples were characterized by FT-IR and X-ray diffraction. The apatite rods, loaded with an antibiotic like Gentamicin sulphate, are intended to be used for drug delivery at sites of orthopaedic implants for the prevention of osteomyelitis.

NATCO sponsors microspheres development for oral vaccine delivery system

CLRI has entered into an R&D sponsorship agreement with M/s NATCO Pharma Ltd., Hyderabad for the development of slow release delivery system for oral vaccines. This is the first time that the CLRI expertise in this area is being commercially exploited.

The technical scope of the project includes the development of biodegradable microspheres for the controlled oral delivery of vaccines; preparation of biodegradable gelatin/chitosan/alginate microspheres for vaccines; entrapment of vaccines such as tetanus toxoid and diphtheria toxoid in the gelatin microspheres and their characterization; enteric coating of the microspheres containing the vaccines using synthetic or natural polymers to make them resistant to gastric acidity; studies on the in vitro release profiles of entrapped vaccines; in vivo studies of vaccine delivery systems in rat models; scale up of the microsphere preparation technique and clinical evaluation of the vaccine delivery systems.

M/s Subbaraju & Co., Madras sponsors Maxiblock Development

Industry sponsored development of Maxiblock, an osteoinductive material used in Maxillofacial and orthopaedic surgery, has been launched.

Basic Research Developments

Multiple Quantum and Solid State NMR Spectroscopy

Investigations were performed on multiple quantum NMR spectroscopy involving spin-1 nuclei and/or spin-1 mimics.
It was established that one-spin double quantum coherence in such systems exhibits multiple structure with resolution enhancement ranging from 4 to 6.67, offering a unique possibility to measure unresolved couplings. Further, a novel scheme was developed to separate one-spin and two-spin double quantum coherences in such systems, based on their quadrature phase relationship under preparation and reconversion.

Work carried out on solid state NMR in a host lab resulted in the development of a novel experiment for investigation of quadrupolar nuclei; this results in resolution of double quantum chemical shifts and their sitewise correlation with quadrupolar couplings.

**Dimensional Stability and Crosslinking of Collagen**

Investigations have been carried out on the dimensional stability of collagen and evidence has been obtained for the role played by electrostatic forces and hydrogen bonds in the stabilization of fibrils. Bi-exponential stress relaxation behavior of RTT has been observed.

Work was carried out on cross-linking of collagen by formaldehyde, glutaraldehyde and dimethyl suberimidate. The nature of cross-links differs: GTA can form polymeric structures, while FMA does not. Treatment with DMS stabilizes the material considerably, but does not alter the negative staining pattern of collagen fibrils, unlike the case of GTA.

**DBT Sponsored Projects make progress**

The following projects have been sponsored by DBT:

i) Fallen animal carcass utilisation

ii) Animal feeds/byproducts

iii) Collagen based wound dressing materials

iv) Lipase enzyme applications in leather processing.

Potent isolates have been screened for developing an industrially viable lipase enzyme process technology. Standardisation of nutritional factors for the lipase product has also been undertaken.
Studies on biocompatibility, anti-genecity of biomaterials and their efficacy as a substrate for cell migration have been carried out.

Studies on cyanobacteria growth in the waste waters of animal byproduct recovery plant are being carried out in collaboration with the Madurai Kamaraj University.
CLRI Launches Nationwide Survey on Leather Products

A nationwide survey of Indian Leather Product sector has been launched by Dr S K Joshi, DG, CSIR on 24th Aug 1994 to generate a reliable database. The survey addresses the status, problems and potentials of both export and decentralised sectors of the leather product industry. The project is cosponsored by the industry, financial institutions, the CSIR and Government agencies under the aegis of the NLDP.

The project is expected to provide the first reliable database on the leather products industry which will be completed in 1995-96. The collection of primary data is being done.

CLRI's Shoe Design and Development Centre reaches out to the Industry

The footwear department, rechristened as Shoe Design and Development Centre (SDDC) to provide flexibility in its function, is being developed as a profit centre. The significant developments in 1994-95 are:

Participation in MODEUROP for International Fashion Colour Forecasting

A scientist of the SDDC joined the two member Indian team and participated for the first time in the MODEUROP Congress held in Germany in September 1994 to forecast fashion colours for the autumn/winter 1995-96. Two Indian leathers were selected by the committee for inclusion in the colour card. This event marks the beginning of Indian participation in international fashion forecasting in the leather sector.

Shoe Testing Laboratory receives SATRA (UK) Accreditation

Under the aegis of the NLDP, international class shoe testing facilities were formally commissioned at the SDDC on 31 January 1995 by Mr Sydney Palmer, Deputy High Commissioner of UK at Madras in the gracious presence of Dr R E Whittaker, Chief Executive, Shoe and Allied Trades Research Association (SATRA) of UK. More than 70 tests
conducted by this laboratory are accredited by the SATRA. The laboratory was set up with a USD 0.5 million funding from the UNDP and Rs.5 million counterpart funding from the CLRI/CSIR.

The major achievements of 1994-95 are:

a) Establishing a world class laboratory for conducting more than 160 tests for leather, footwear and components as well as safety shoes

b) Expertise building for calibration of testing instruments

c) Introduction of Quality Assurance Scheme (QAS) jointly with SATRA

d) Gaining SATRA accreditation for 72 tests

e) Development of norms and protocols for inhouse quality control, QAS for export shoes and calibration of inhouse test equipment in industry

More than 150 clients have availed of the testing services during Oct'94-Mar’95 with an average of 100 samples tested every month.

**Shoe Sole and Mould Design - SDDC offers Unique Expertise**

Unit soles needed for shoes for the export market are mostly sourced by India from overseas suppliers. In recent times, indigenisation of unit sole production is attempted.

Capability for the design of mould for shoe soles has been built. Notable steps taken during 1994-95 are: split mission of the UNIDO expert to India for providing specialized training to the CLRI personnel, advanced training of two CLRI scientists in Hungary, prototype mould fabrication
through the CLRI-CIPET bilateral collaboration, procurement of AutoCAD R 12 and AUTODESK Software/Hardware, creation of Shoe Sole Library and generation of computer database on sole designs and technical specifications of injection moulding machines.

A detailed project report for setting up a shoe sole mould design and production centre (1500 moulds/year) in the private sector has been prepared. The SDDC offers unmatched specialized services in mould design. Their services have already been utilised by M/s Farida Shoes, Ambur.

**Shoe Fashion Studio Proving Popular**

The CLRI studio has become synonymous with shoe fashion forecasting and styling. It offers design services enabling range building thus helping the industry in international competition. The Shoe Designers Club, started in 1994 has gained new members: professional designers, leading shoe exporters. The club in its monthly meetings discusses new design trends and material/ component co-ordination.
1994. A fashion studio with a resource room, information desk and sample product making facilities has been launched. The CLAD will function as a profit centre.

RESEARCH DEVELOPMENTS

Biomechanical and Ergonomic Studies

Scientific designs and development methodologies for orthopaedic and speciality footwear received emphasis. A technique has been developed for the design of special footwear suitable for calcaneal spur and flat feet.

The GAIT Analysis Laboratory strives to define quantitative parameters for assessing shoe component. The in-shoe temperature is being assessed as an indicative parameter for shoe comfort. Slip resistance of different soles is being studied.

Jute and Silk as Shoe Materials

Jute has been evaluated as a leather supplement for upper applications. Jute based shoes have been designed, fabricated and test evaluated. User trials are in progress.

Joint Research Programmes with the FDDI

An inter-institutional programme with the Footwear Design and Development Institute, New Delhi covering short and long term projects has been launched. This program includes testing of heel performance.

Heel Design and Performance

Employing a finite element model software package, the design and shape of different heels have been designed and performance evaluated.
Adhesion Test Protocols

Test protocols covering substrate preparation, material choice and adhesive application operations have been prepared taking into account international criteria. Problems associated with the application of TPR and other elastomers have received particular attention.

Hydrolysis of PU

The hydrolytic stability of different PU soles in the presence of water at high pressure and temperature and under the influence of alkali or acid hydrolysis is being studied.

Other Studies under CLRI-FDDI Co-operation

They cover:

i. Development of Indian standards for construction materials for steel toe cap and toe puff/stiffener

ii. Specialized software development for machinery maintenance, cutting norms, fashion trends and production costing

iii. Heat resistant neoprene adhesives

iv. Reaction injection moulding technology for PU soles
HUMAN RESOURCE DEVELOPMENT
Significant Growth in HRD Activities

Significant growth in the HRD activities of CLRI was registered in 1994-95. The NLDP and the Leather Technology Mission provided the necessary support for initiating new activities and concepts. The financial sustainability and horizontal transfer of training expertise have received the greatest attention.

CLRI-AFPIC (France) Programme on Pattern Design Launched

A new modular certificate programme (6 months duration) on pattern design was launched in footwear, leather garments and leather goods in December 1994. The training programme covers conceptual and engineering design principles, pattern engineering and sample product preparation. Four faculty members from CLRI have undergone advanced training in AFPIC, France. About 60 students are trained annually in pattern designing.

Junior Diploma in Leather Product Engineering

A one year junior diploma programme with a syllabi out of the CLRI-AFPIC modular training programmes has been launched. This programme is a first step towards providing trained personnel as shop floor supervisors for footwear, leather goods and the garment sector. 36 students are trained under this category annually.

CLRI-BITS Launch Vocational Degree Programme in Footwear Technology

The two institutions signed a Memorandum Of Understanding to launch a Master of Vocational Sciences
Programme in Footwear Technology. The unique features of this programme are
a) Modular Structure
b) Multiple entry and exit facilities
c) Credit Accumulation
d) Integration of Junior and Senior diploma courses into the module

The first batch of 12 students have been admitted into the course. This is the first degree programme in Footwear Technology in the country. The four year course curriculum consists of 42 modules covering mathematics, subjects in physics and chemical sciences, engineering, technology, humanities and management.

CLRI Adopts Industry Managed Training Units
The Vaniyambadi Tanners Association (VTA) sought CLRI’s accreditation and technical support for establishing a training facility for leather garments construction at Vaniyambadi. This is to provide training to the local youth seeking employment in the leather garment units. The NLDP came forward to partially finance the cost of equipment. The centre started functioning in December 1994 with a two module certificate programme. The annual intake of trainees is 48. CLRI inputs include curriculum and syllabus formulation, training of trainers, technical supervision during the entire training period and holding examinations.

CLRI Offers Assistance to Rural Training Units for Women
As a special gesture to enhance the employment potential of rural women, CLRI has offered special technical assistance to a leather goods training unit at Kundrakudi and a tanning training facility at Kallupatti in Tamil Nadu. Both facilities are managed by non-governmental voluntary agencies. Partial financial support is provided through the NLDP and CSIR Action Programme for rural women.

Short Term Training Programmes for Women Entrepreneurs under the CSIR Action Programme
The regional centres of the CLRI at Ahmedabad, Jalandhar and Calcutta organised 4 week training programmes in
leather goods fabrication for 60 women entrepreneurs with support from the CSIR Action Programme.

CLRI achieves a Quantum Jump in its Training Capacity

In order to meet the growing need for human resource and expertise, a number of skill and knowledge based HRD programmes have been launched. Quantum increase in the number of specialised HRD programmes and the number of people trained has been registered.

Promotion of industry or voluntary agencies sponsored training units is one of the policy decisions taken by the Institute in 1994-95 to strengthen the HRD base of the Indian leather industry. In this model, the management of the training centre will be with the industry and the Institute provides the knowledge base. This arrangement strengthens the Institute-industry links further. A number of new training sub-centres will be established with industry participation during 1995-96. A growth rate of 40% was achieved in the trainee intake of various programmes during 1994-95.
Extension activities of the Institute have registered a significant growth during the last two years. With many projects leading commercialisation during 1994-95, the Regional Centres for Extension and Development in Ahmedabad, Bombay, Calcutta, Jalandhar and Kanpur have expanded their activities.

Ahmedabad

The CLRI Rajkot Centre has been shifted to Ahmedabad at Plot No.5013, GIDC Industrial Estate, Phase-IV, Vatva, Ahmedabad-382445. Land and building for the Centre in the new location has been provided by the Government of Gujarat.

The Centre is equipped for training programmes in the area of leather goods and has conducted a training programme for 15 rural women on leather goods under the CSIR Action Plan and in leather processing for ten candidates sponsored by the Gujarat State Leather Development Corporation.

Leather processing machines worth Rs.30 lakhs are being added to the Centre under the World Bank programme.

A number of leather chemicals such as dyes, syntans, wetting agents and binders manufactured by local industries have been tested and evaluated. Data on foot measurement has been collected.

Practical demonstrations on bag tanning, vegetable tanning, hair-on tanning, chrome tanning and finishing of different leathers were made. Demonstration-cum-training programmes sponsored by the DST, Government of Rajasthan have been conducted at Tanner’s colony, Palai.

Bombay

The Bombay centre has been shifted to a new and better location in the premises of the Government Institute of Leather Technology, Bandra. The Centre has been carrying out mostly PCP testing and finished leather certification. Due to popular demand from the industry in the region, a complete facility for training in leather goods is being established in the new premises with a grant of US$ 50000.00 from the NLD P.
Calcutta

The Calcutta centre expanded its training activity further during 1994-95. Due to an active collaboration with the Indian Leather Products Association (ILPA) the modular training programme along the ALFA-AFIPC model scaled new dimensions. A one year diploma course in leather goods has been introduced this year and the training has received wide industrial acceptability. About 35-40 students are to be trained annually.

The Centre conducted training programmes in leather goods for fifteen rural and destitute women under the CSIR Action Plan.

A project on enzymatic hydrolysis on tannery waste has been awarded by the Department of Science & Technology, Government of West Bengal.

Processes for hair-on tanning, chamois leather manufacturing and other speciality leather have been demonstrated and assistance to rural tanners in setting up of wet blue manufacturing units have been provided.

The Centre has been involved in data collection for foot measurement survey in the region.

The direct involvement of the centre in R&D has been supported by the DST, West Bengal through granting a project on enzymatic hydrolysis of tanning wastes as well as enzyme based dehairing system.

The Centre is actively involved in PCP testing and leather certification and has undertaken job work on leather using tannery and leather goods machines.

The Centre has taken a lead role in establishing a training centre at RRL-Jorhat under LTM.

Jalandhar

A training programme for fifteen rural women has been conducted under Action Plan of CSIR.

State-of-the-art facility in the area of leather garment training is being established at the Centre.

The Centre has taken up advisory consultancy programme for M/s Domino Leather Ltd., Chandigarh, for setting up a tannery and footwear unit.
The Centre is actively involved in finished leather certification, job work on leather using tannery machines and in foot measurement survey.

**Kanpur**

The Centre at Kanpur has been shifted to its new premises at 407/377A, Jajmau, Kanpur. Due to the goodwill generated by the Centre the Government of Uttar Pradesh has allotted land for construction of a permanent centre at Jajmau, Kanpur.

The Centre has taken the lead role in absorbing the high exhaustion chrome tanning technology from the base unit and disseminating it among the tanners in the region. In the implementation of high exhaustion chrome tanning in the chosen tanneries at Kanpur, the Centre has taken an active role and worked in tandem with the R&D of the base unit.

The newly established CAD Centre for footwear has commenced to function and is rendering a number of services to the local industry.

A saddle-cum-bridle training-cum-work centre is being established at the centre with UNDP assistance. Machines worth Rs. 1.20 crores are being commissioned at the Centre for support to leather processing industry through a soft loan from the World Bank. Due to the initiatives taken, the Kanpur Centre will soon be equipped with state-of-the-art facilities for a range of services to be rendered to the tanneries in the region.

The Centre has been actively involved in the implementation of ISO 9000 in the Zam Zam Tannery, collection of data for foot measurement survey, finished leather assessment, tannery effluent analysis and executive training programmes in leather processing.
**BUDGET AT A GLANCE**

(Rupees in lakhs)

**BUDGET HEAD**

A. Recurring

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<td>Contingencies P4</td>
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<td>Chemical &amp; Apparatus P7</td>
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**TOTAL RECURRING (A)** 623.606

B. Capital

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<td>Furniture &amp; Fittings P5(9)</td>
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**TOTAL CAPITAL (B)** 123.203

**GRAND TOTAL (A+B)** 746.809
### EXTRA BUDGETARY RESOURCES
(Rupees in lakhs)

#### I EXTERNAL CASH FLOW (ECF)

- Job Work & Testing: 34.90
- Training: 40.00
- Grant in aid (National & International): 31.00
- Sponsored Research: 35.40
- Consultancy Programmes: 137.00

**TOTAL**: 279.00

% Contribution from private sector: 80.00

#### II LARGE INTERNATIONAL PROJECTS

- UNDP: 144.00
- TNO: 103.00
- UNIDO AND OTHER SOURCES: 204.00

**TOTAL**: 451.00

**GRAND TOTAL (I + II)**: 730.00

CSIR Revenue Budget: 624.00

E BR as % Revenue Expenditure: 117
STAFF POSITION

Group IV (Scientific) 127
Group III (Technical) 118
Group II (Technical) 128
Group I (Technical) 113
Administrative 109
Group D (Non Technical) 44

POST DOCTORAL AND STUDENT STRENGTH

1. Post Doctoral Fellows 19
   (Research Associates,
    Pool Officers Quickline)
2. Doctoral Students 42
3. Master in Technology 24
4. Bachelor in Technology 132
5. Master in Vocational Sciences 12
6. P.G Diploma 19
7. Diploma 47
8. Certificate 157
PAPERS PUBLISHED IN INTERNATIONAL JOURNALS

ALAMELU S, PANDURANGA RAO K

ALDER RW, SIVARAMI REDDY B
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Behaviour of lyotropic liquid crystalline compound at air-water interface *Colloids and Surfaces*, vol. 83A, 1994, 303-307

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GEETHA BASKAR, MANDAL AB
Self-diffusion studies on methoxy polyethylene glycol macromonomer micelles by using cyclic voltammetry and fourier transform pulsed gradient spin echo NMR techniques. *Langmuir*, vol. 11, 1995, 1464-1467

HARIDAS KR, GANGA RADHAKRISHNAN
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JAYAKUMAR R, GANESH JEEVAN R, MANDAL AB, MANOHARAN PT

JAYAKUMAR R, JAYANTHY C, GOMATHY L

JOHN COLLINS, MAHESH GN, GANGA RADHAKRISHNAN, ARUNA DHATHATHREYAN
Effect of spreading solvents on polymeric monolayers. *Colloids and Surfaces*, vol. 95A, 1995, 293-297

JYOTI K RAO, VIJAYA RAMESH D, PANDURANGA RAO K
Controlled release systems for proteins based on gelatin microspheres. *Journal of Biomaterial Science Polymer Edition*, vol. 6, 1994, 391-398

JYOTI K RAO, VIJAYA RAMESH D, PANDURANGA RAO K
Implantable controlled delivery systems for proteins based on collagen-p HEMA hydrogels. *Biomaterials*, vol. 15, 1994, 363-369

MANDAL AB, JAYAKUMAR R

MATHANGIRAMAKRISHNAN, PRATHIBA V, MARY BABU, SREEDHAR RAO K, GUPTA FD

MURALIDHARAN D, SUNDARA RAO VS

NACHAIAPPAN CHOCKALINGAM, SURENDRAM M, DAS BN

NACHAIAPPAN CHOCKALINGAM
Restoring Foot Function by Insole Correction. *Schuh Technik*, no. 7/8, 1994, 369-370
NAGARAJAN S, SRINIVASAN KSV
Block copolymerisation initiated by Ce(IV)-poly(ethyleneglycol) redox system: Kinetics and characterisation.
European Polymer Journal, vol 30, 1994, 113

NAGARAJAN S, SUDHAKAR S, SRINIVASAN KSV
Block copolymerisation initiated by Mn(III)-poly(ethylene glycol) redox system: General features and kinetics.
Colloid and Polymer Science, vol 272, 1994, 777

NAGARAJAN S, SRINIVASAN KSV,
VENKATA RAO K
Kinetic and mechanistic studies on the oxidation of poly(ethylene glycol) by ceric sulphate in sulphuric acid medium. Polymer Journal, vol 26, 1994, 851

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NATCHIMUTHU M, GANGA RADHAKRISHNAN,
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Vulcanisation characteristics and mechanical properties of nitrile rubber filled with short leather fibres.
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SURIANARAYANAN M, RAGHAVAN KV

PURUSHOTHAM H, KOSHY A, SUNDARA RAO VS,
LATHA P, GURUMURTHY MN, RAGHAVAN KV

RADHAKRISHNAN N, LAKSHMINARAYANA Y,
UMA DEVI, SRINIVASAN KSV
Studies on graft copolymerisation of acrylonitrile on to sodium alginate. Journal of Macromolecular Science - Pure and Applied Chemistry, vol A31, suppl 5, 1994, 381

RAMA RAJARAM, BALACHANDRAN UNNI NAIR,
RAMASAMI T

RAMARAJ B, GANGA RADHAKRISHNAN
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RAMESH CV, JAYAKUMAR R,
PUVANAKRISHNAN R

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SADULLAS
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_Leder Informant_, 1995, 159-162

SANJEEVI R, SOMANATHAN N
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_Journal of Materials Science_, vol 29, 1994, 3553-3558

SHANTHA KL, UDAYA BALA,
PANDURANGA RAO K
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_European Polymer Journal_, vol 31, 1995, 377-382

SOMANATHAN N, SANJEEVI R

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RANGASAMI T, POORNESWARI S, KHANNA JK

SUBBA RAO S

SUGUMAR N, PONNUSWAMY MN, JAYAKUMAR R

THACHARODI D, PANDURANGA RAO K
Development and in-vitro evaluation of chitosan based transdermal delivery systems for the controlled delivery of propranolol hydrochloride. _Biomaterials_, Vol 16, 1995, 145-146
PAPERS PRESENTED IN INTERNATIONAL CONFERENCES

Total papers presented at Conferences: 11

1. International Symposium on Agricultural and Food Processing Wastes, Chicago
2. SPSJ International Polymer Conference (5th), Osaka (2 papers)
3. International Conference on Biomedical Engineering (8th), Singapore (2 papers)
4. World Congress of Biomechanics (2nd), Amsterdam (2 papers)
5. International Symposium on Computing Methods in Biomechanics and Biomedical Engineering (2nd), Swansea
6. Materials Research Society Spring Meeting, San Francisco
7. Biomaterials and Tissue Engineering Workshop, Japan
8. International Symposium on Biomechanics in Sport (12th) Budapest

CHAPTERS IN MONOGRAPHS PUBLISHED ABROAD

ARUMUGAM V, SOMANATHAN N, NARESH MD, SANJEEVI R

PARASHAR DC, RAMASAMI T, MAHASEWARASWAMY, BALACHANDRAN UNNI NAIR

PUBLICATIONS STATISTICS

Total Output: 347

Journal articles: 128

* International Journal: 58
* Indian Journal: 70

Papers presented at Conferences, Symposia and Seminars: 198

* International Conferences: 10
* International Conferences held in India: 30
* National Conferences: 158

Monographs and Chapters in Monographs: 21

Monographs: 2
Chapters:
* Foreign: 2
* Indian: 17
AWARDS & HONOURS

1. Dr K V Raghavan, had been elected as a Fellow of the Indian National Academy of Engineering, New Delhi from Mar 1995.

2. Dr T Ramasami, had been conferred with the Voice Silver Jubilee award for his contributions to the Leather Industry Research.

3. Dr T Ramasami, had been elected as Fellow of the Indian Leather Technology Association.

4. Dr A B Mandal, had been selected for the Rev. Fr. Dr. L. M. Yeddanapally Memorial Award for the year 1993 by the Indian Chemical Society, Calcutta for his outstanding contribution in Physical Chemistry.

5. Dr A B Mandal, received the Tamil Nadu Scientists Award given by the Tamil Nadu State Council for Science and Technology for the year 1994-95 for his work on Colloids and Surface Science in Chemical Science.

6. Dr A B Mandal, had been elected as a Fellow of the Indian Academy of Sciences, Bangalore on 3rd January '95.

7. AISHTMA PLATINUM JUBILEE Environmental Award (1994) to CLRI and its associates and appreciation of CLRI's role in Technology Award (1994).
SEMINARS

MAY '94
1 Prof T J Tilak Viegas, Director General, Centre for Science Research and Development, Brussels, Belgium. *International cooperation in Science with special reference between European commission and developing countries.*

JUNE '94
2 Prof S Ramnath, Yselta Independent School District, Texas, USA. *Collision of celestial bodies.*
3 Prof T Veeraraghavan, Dept of Civil Engineering, University of Regina, Canada. *Recent advances in Civil Engineering.*

JULY '94
4 Mr Tony Passman. *Overview of Leather Industry in New Zealand.*
5 Dr M S Rajagopalan, Kentucky Biosafety Consultant, Kentucky, USA. *Occupational Safety and Health.*
6 Dr R Krishnan, University of Kentucky, USA. *Isolation of Nucleotide Binding Sites in Proteins and Enzymes - Application of Photoaffinity Labelling.*

SEPTEMBER '94
7 Dr Akira Ishihama, Professor, National Institute of Genetics, Mishinh, Japan. *Molecular Anatomy of Gene Technology of Influenza Virus.*
8 Dr J Peter Bentley, Professor, Oregon Health Services University, Oregon, USA. *Biologically benign crosslinking for collagen in wound healing.*
9 Prof V T Nachmias, University of Philadelphia, Philadelphia, USA. *Inhibition of actin polymerization by thymosin B4.*

OCTOBER '94
10 Prof John Cullum, Dean, University of Kaiserslautern, Germany. *The linear chromosome of streptomyces: Consequence for genetic instability and variability.*

NOVEMBER '94
11 Dr S D Varma, Professor, University of Maryland, USA. *Cataract formation and its prevention.*

DECEMBER '94
12 Dr Timothy Charles Gallagher, Professor, University of Bristol, Bristol. *Recent developments in Electrophile mediated cyclisation reactions.*
13 Dr A Veyrieres, Director of Research, University of Orleans, France. *From glycols to 2-amino sugar C-glycosides: new approaches.*

JANUARY '95
14 Dr R Dhamodharan, Cornell University Ithaca, USA. *Synthesis and Absorption of functionalised polystyrene.*

FEBRUARY '95
15 Dr Mangala Suderkrishnan, Queens University, Kingston, Canada. *Theory of Radiofrequency process in nuclear quadrupole resonance spectroscopy.*
16 Prof K Weighardt, Max Planck Institute fur strahlenchemie, Germany. *Hemerythrin and catalase Functional Model Chemistry.*

MARCH '95
17 Dr R Natarajan, University of Maryland, USA. *Process optimisation of amylase production in recombinant B subtilis using immobilization system.*
Structures of Major Polynuclear Species of Chromium (III) Complexes Present in BCS

Dimer (Main tanning species)

Trimer (Important tanning species)

Tetramer (Low affinity species
Main constituent of spent tanning solution)

Transmission Electron Micrographs of Dimer or Trimer treated RTT Collagen Demonstrating Molecule Specific Morphological Changes

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<th>Dimer</th>
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