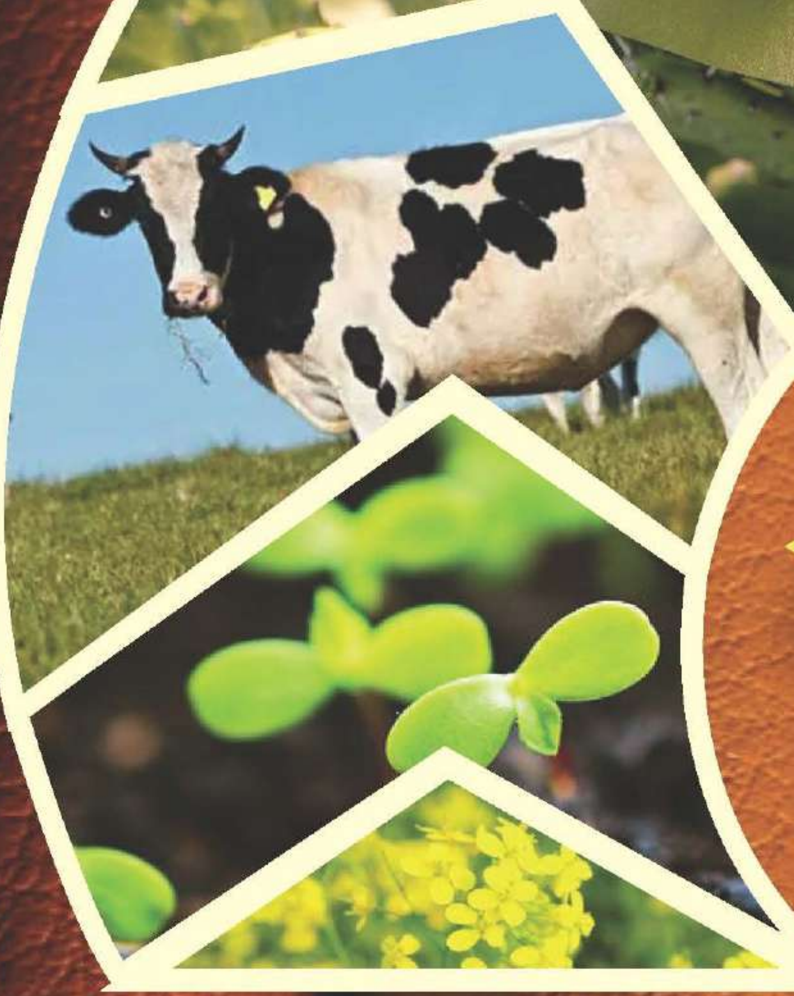
ILTA
Since 1950

JILTA

Journal of Indian Leather Technologists' Association

VOLUME : LXXIII   No. 07   JULY' 2023



JILTA 2023 2024

Rgtn. No. KOL RMS/074/2022-24
Regd. No. ISSN 0019-5738
RNI No. 2839/57
Date of Publication: 6th

₹ 50.00

Synopsis of Objectives

- An Association with over 550 members from India and abroad working since last 72 years for the growth and development of Leather and its allied industries.
- Organize seminars, symposiums, workshops in order to share information, knowledge & latest development and interactions for the benefit of all concerned.
- Organize Human Resource Development programmes on regular basis.
- Publish for over 72 years, a technical monthly journal namely "Journal of Indian Leather Technologists' Association" (JILTA), widely circulated through out the World.
- Publish books for the benefit of the students at various levels of study, for the Research Scholar and the Industry.
- Work as interface between Industry and the Government.
- Assist Planning Commission, various Government Institutions, Ministry and autonomous bodies to formulate appropriate policies for the growth of the Industry.
- Assist small and tiny leather goods manufacturers in marketing their products by organizing LEXPOs in Kolkata and different parts of India.

ILTA
Since 1950

Indian Leather Technologists' Association
[A Member Society of International Union of Leather Technologists' and Chemists Societies]

'Sanjoy Bhavan', 3rdFloor, 44, Shanti Pally, Kolkata- 700 107, WB, India
Phone : 91-33-2441-3429 / 3459 WhatsApp +91 94325 53949
E-mail : admin@iltaonleather.org; mailtoilta@rediffmail.com
Website : www.iltaonleather.org

ILTA
Since 1950

JOURNAL OF INDIAN LEATHER TECHNOLOGISTS' ASSOCIATION (JILTA)

JULY, 2023 VOL.: LXXIII NO.: 07 RNI NO.: 2839/57 REGD.NO.: ISSN 0019-5738

Contents

Hony. Editor : Dr. Goutam Mukherjee

Communications to Editor through E-mail :

admin@iltaonleather.org; jiltaeditor@gmail.com

Cover Designed & Printed by :

M/s TAS Associate

11, Priya Nath Dey Lane, Kolkata - 700 036

Published & Printed by :

S. D. Set, on behalf of Indian Leather Technologists' Association

Published from :

Regd. Office : 'Sanjoy Bhavan', 3rd Floor,

44, Shanti Pally, Kasba, Kolkata - 700 107

Printed at :

M/s TAS Associate

11, Priya Nath Dey Lane, Kolkata - 700 036

Subscription :

Annual	Rs.(INR)	400.00
Foreign	$ (USD)	45.00
Single Copy	Rs.(INR)	50.00
Foreign	$ (USD)	4.00

All other business communications should be sent to :

Indian Leather Technologists' Association

'Sanjoy Bhavan', 3rd floor, 44, Shanti Pally

Kasba, Kolkata - 700 107, WB, India

Phone : 91-33-2441-3429
91-33-2441-3459

E-mail : admin@iltaonleather.org;
mailtoilta@rediffmail.com

Web site : www.iltaonleather.org

JOURNAL OF INDIAN LEATHER TECHNOLOGISTS' ASSOCIATION (JILTA)

Indian Leather Technologists' Association is a premier organisation of its kind in India was established in 1950 by Late Prof. B.M.Das. It is a Member Society of International Union of Leather Technologists & Chemists Societies (IULTCS).

The Journal of Indian Leather Technologists' Association (JILTA) is a monthly publication which encapsulates latest state of the art in processing technology of leather and its products, commerce and economics, research & development, news & views of the industry etc. It reaches to the Leather / Footwear Technologists and the decision makers all over the country and overseas.

Advertisement Tariff

Full Page / per month

Black & White	Rs. 5,000.00/-
Colour (full page)	Rs. 10,000.00/-
Colour Insert (One side) (Provided by the Advertisers)	Rs. 5,000.00/-

Full Page / per anum

Front inside (2nd Cover)	Rs. 96,000/-
3rd Cover	Rs. 84,000/-
Back Cover	Rs. 1,20,000/-

Mechanical Specification

Overall size	:	27 cm X 21 cm
Print area	:	25 cm X17 cm

Payment should be made by A/c. Payee Cheque to be drawn in favour of :

Indian Leather Technologists' Association
and Payable at **Kolkata**

Send your enquiries to :

Indian Leather Technologists' Association
'SANJOY BHAVAN'
3rd floor, 44, Shanti Pally, Kasba, Kolkata – 700 107
Phone : 91-33-24413429 / 91-33-24413459
E-mail : admin@iltaonleather.org / mailtoilta@rediffmail.com / iltaonleather1950@gmail.com
Website : www.iltaonleather.org

INDIAN LEATHER TECHNOLOGISTS' ASSOCIATION (ILTA)

(Member Society of International Union of Leather Technologists and Chemists Societies)

Executive Committee (2022-24)

Central Committee

President : Mr. Arnab Jha

Vice-Presidents : Mr. Asit Baran Kanungo
Mr. Pulok Majumdar
Dr. S. Rajamani

General Secretary : Mr. Susanta Mallick

Joint Secretaries : Mr. Bibhas Chandra Jana
Mr. Pradipta Konar

Treasurer : Mr. Kaushik Bhuiyan

Committee Members:

1. Mr. Alokesh Roy
2. Mr. Abhijit Das
3. Mr. Mihir Prasad Das
4. Mr. Udayaditya Pal
5. Mr. Jiban Dasgupta
6. Mr. Amit Kumar Mondal
7. Mr. Aniruddha De
8. Mr. Sudagar Lal (Secretary North/West Region)
9. Dr. R. Mohan (Secretary South Region)
10. Dr. K. J. Sreeram
11. Mr. Arijit Chakraborty

Ex-Officio Member : Dr. Goutam Mukherjee

Regional Committees

Southern Region :

President : Mr. N. R. Jagannathan

Vice-President : Dr. J. Raghava Rao

Secretary : Dr. R. Mohan

Treasurer : Dr. Swarna V Kanth

Committee Members :
Dr. N. Nishad Fathima
Dr. P. Thanikaivelan
Dr. Subhendu Chakrabarti
Dr. S. V. Srinivasan
Dr. J. Kanagaraj

Northern / Western Region :

President : Mr. Jai Prakash Saraswat

Vice-President : Mr. Rajeev Mehta

Secretary : Mr. Sudagar Lal

Treasurer : Mr. Jaswinder Singh Saini

Committee Members:
Mr. Kamal Sharma
Mr. Mohinder Lal
Mr. Rajveer Verma
Mr. Jagdish Gupta
Mr. Sakattar Lal

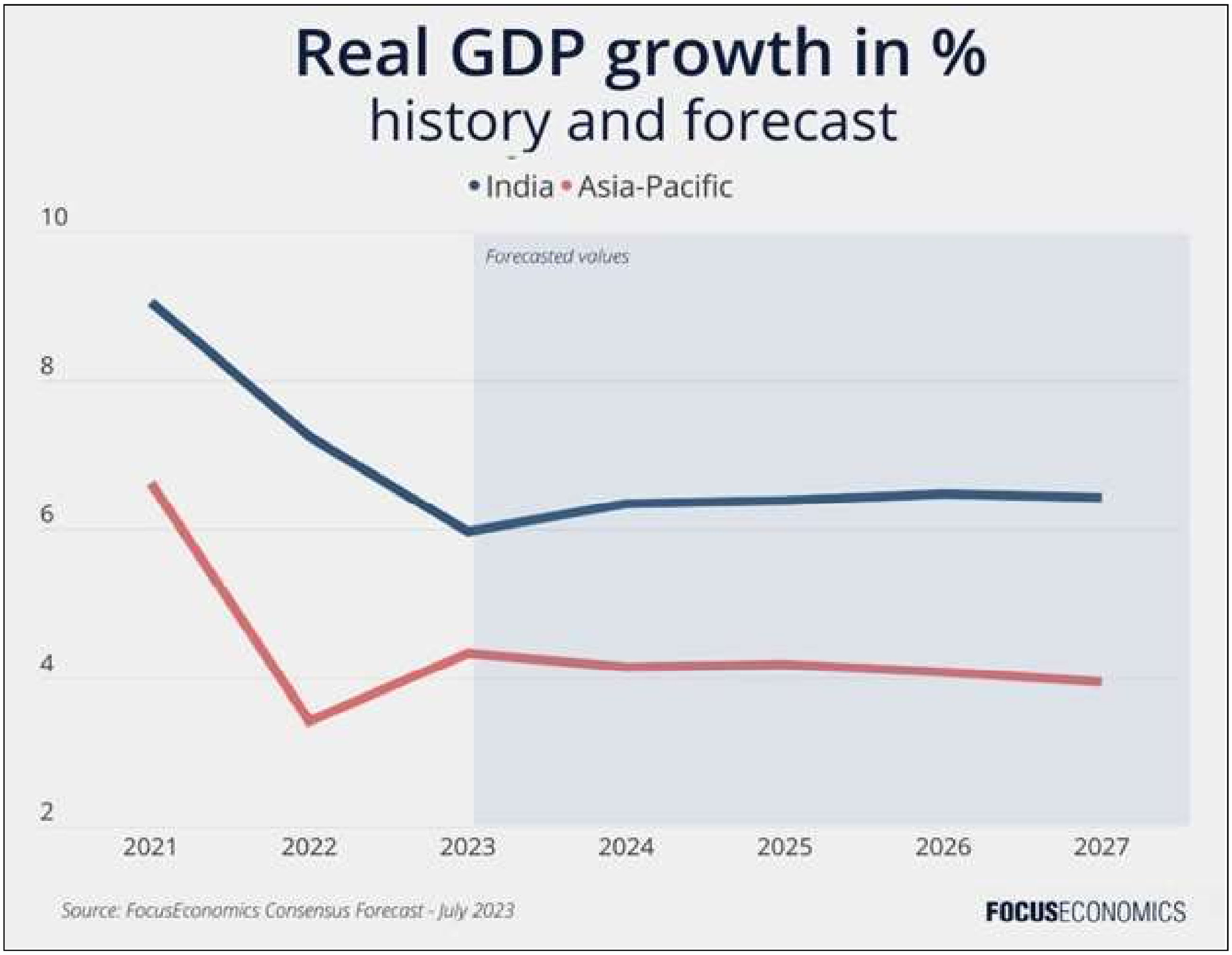
JOURNAL OF INDIAN LEATHER TECHNOLOGISTS' ASSOCIATION (JILTA)

EDITORIAL BOARD OF JILTA

Indian Economy showing up Promising Trend

By almost all accounts, India has had good few years. Since 2010, the country's GDP has doubled in nominal terms from USD 1.7 trillion to USD 3.4 trillion. Over the same period, real GDP growth has averaged 6.1%, one of the best rates in Asia. The stock market is up by around half from pre-pandemic levels, underpinned by increasing interest from overseas fund managers. Multinationals are investing in new manufacturing facilities in the country. Earlier this year, India overtook China as the world's most populous nation; the demographic gap between the two will widen going forward. And foreign dignitaries are rushing to boost ties with New Delhi: Prime Minister Modi, currently on an official state visit to the U.S., is only the third leader to whom President Biden has granted such a distinction. Economic conditions should remain rosy. The Consensus among our analysts is for India's economy to expand 6.3% each year on average from 2023 to 2027; in Asia, only Bangladesh is expected to record faster growth. By 2027, India is seen vying with Germany and Japan for the spot of the world's third-largest economy. Progress will be broad-based, with rapid advances seen in private consumption, fixed investment, government spending and exports. Domestic political stability, a business-friendly reform agenda, strong population growth and increased interest from foreign firms looking to diversify supply chains away from China will all underpin activity. That said, growth would be even faster if it weren't for shoddy infrastructure; according to India's transport minister, logistics costs represent 16% of GDP—double the figure of advanced economies. And while the country churns out 1.5 million engineering graduates annually, the education system as a whole is deficient; average years of schooling adjusted for learning are a mere 7.2, below other up-and-coming Asian nations such as Vietnam (11.0), Thailand (8.9) or Indonesia (8.0). Moreover, the government's "Make in India" push to boost manufacturing self-reliance could lead to an inefficient allocation of capital and relatively few new jobs.

An escalation of border clashes with China and territorial disputes with Pakistan are major geopolitical risks, despite their low probability of occurrence. But, huge recurring expenditure for the consolidation of a huge number of men and machinery is the occult blood in the Indian economy itself which is being met at the cost of the development of socio-economic status within the country. These are the ominous plans of China and Pakistan to push the Indian economy into the doldrums by staging proxy wars. But, such kind of hostile situation is helping the domestic defense industry gain sustainability rapidly and increasing its umbrella of export globally. Other big nations are recognizing and collaborating with the Indian defense industry with the utmost willingness. The world knows that India is going to be the face of global revolution and counter-face to ominous forces in the world. A strong Federal Government of India with a strong/belligerent foreign policy under a robust leader accepted by the world with warmth is the need of the coming days. Every Indian citizen should be aware of the resonance of the present Indian footstep in global affairs.



On the labor market, **analysts at the EIU** have expressed:

"India's working-age population is expected to exceed 1bn by the end of this decade. Although only limited direct employment will be generated by the manufacturing sectors, services included in the manufacturing ecosystem will be meaningful generators of employment. For example, the logistics industry has emerged as one of the top five employment-generating sectors in the country since 2020."

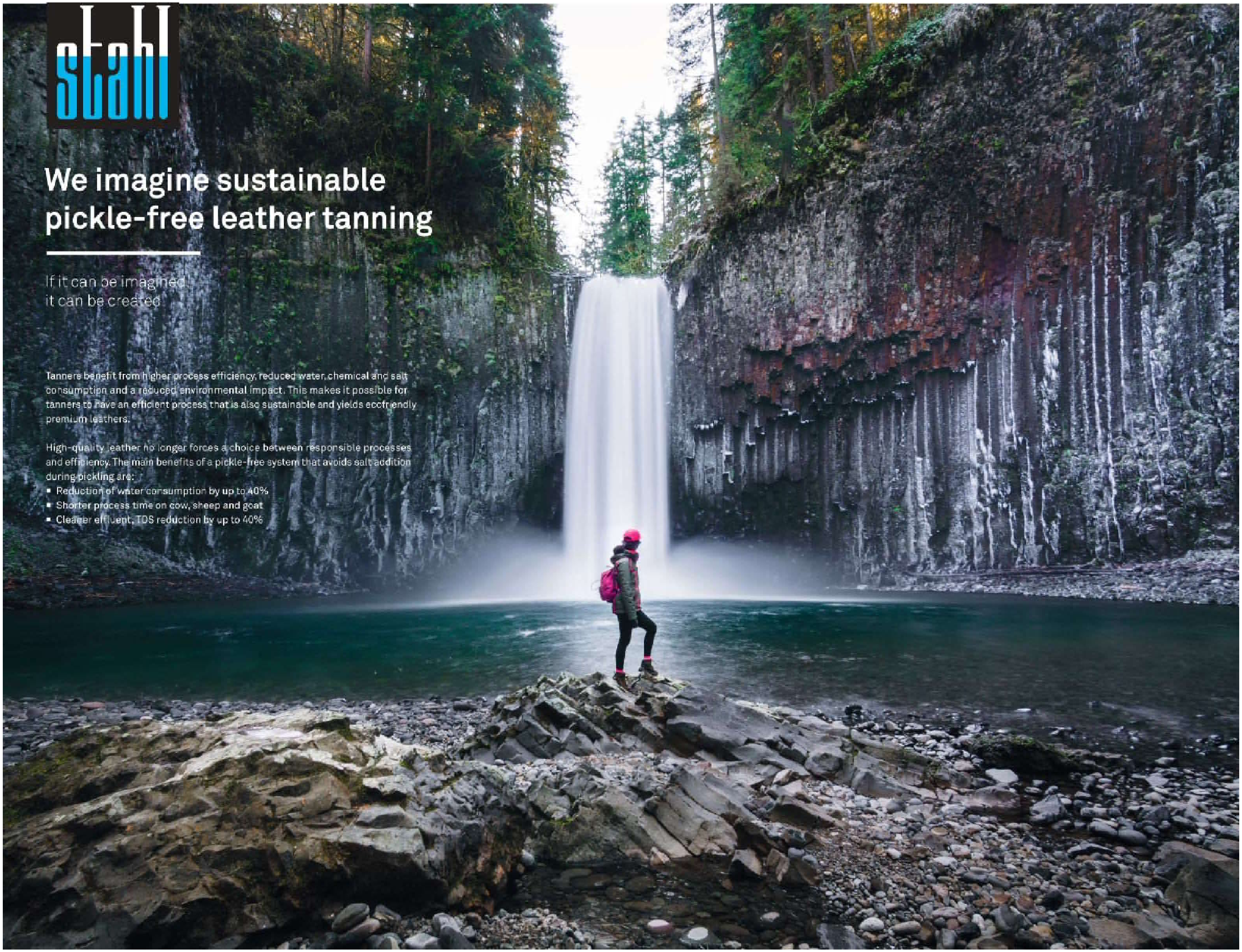
Dr. Goutam Mukherjee
Hony. Editor, JILTA

As an active proponent of responsible chemistry, Stahl has established the Stahl Campus® training institute in its Center of Excellence for sustainable leather technologies in Kanpur. With our Stahl Campus® Leather Modules, we can offer training and information, such as responsible chemistry and sustainability in leather production. We believe that in this way, we facilitate transparency that inevitably will lead to a better supply chain with responsible chemistry.

Our approach is modular, making it easy to tailor learning programs to specific needs. Stahl Campus® has at its core the drive to unlock human potential and make that new competitive advantage. By providing the possibility of sharing knowledge, we embrace our role in the dynamic leather and chemical industry. Stahl Campus® is a great opportunity to strengthen skills and capabilities in order to make working methods more efficient by sharing experiences and studying products and procedures.

If you're interested to receive more information on Stahl Campus®, please contact Prasanna Maduri **(Prasanna.maduri@stahl.com)**.

If it can be imagined, it can be created.


stahl
We imagine sustainable
pickle-free leather tanning
If it can be imagined
it can be created
Tanners benefit from higher process efficiency, reduced water, chemical and salt consumption and a reduced environmental impact. This makes it possible for tanners to have an efficient process that is also sustainable and yields ecofriendly premium leathers.
High-quality leather no longer forces a choice between responsible processes and efficiency. The main benefits of a pickle-free system that avoids salt addition during pickling are:
▪ Reduction of water consumption by up to 40%
▪ Shorter process time on cow, sheep and goat
▪ Cleaner effluent, TDS reduction by up to 40%

STAHL'S EMISSIONS REDUCTION TARGETS APPROVED BY THE SCIENCE BASED TARGETS INITIATIVE

Stahl, a leading provider of coating technologies, announces that its near-term greenhouse gas (GHG) emissions reduction targets have been validated by the Science Based Targets initiative (SBTi). Stahl is one of the few coatings companies to receive this validation. To date, 145 companies in the chemicals sector have submitted an emissions reduction target to the SBTi, of which 61 have had their targets validated.

Stahl's science-based targets, which reflect the company's commitment to the 2015 Paris Agreement goals, are:

- Stahl Holdings B.V. commits to reduce absolute scope 1 & 2 GHG emissions 42.0% by CY2030 from a CY2021 base year.

- Stahl Holdings B.V. commits to reduce absolute scope 3 GHG emissions 25.0% by CY2030 from a CY2021 base year.

The SBTi classifies emissions reduction targets according to two potential temperature pathways: 1) limiting global temperature rises to 1.5˚C above pre-industrial levels, and 2) limiting temperature rises to well below 2˚C. The SBTi has determined that Stahl's Scope 1 and 2 target is in line with a 1.5˚C trajectory, while Stahl's Scope 3 target has been validated in line with the well-below 2˚C pathway.

Maarten Heijbroek, CEO of Stahl: *"The validation of our Scope 1, 2, and 3 emissions reduction targets by the SBTi is an important milestone on our ESG journey as we strive to limit our contribution to global warming, in line with the Paris Agreement. Our targets are ambitious, and rightly so. Realizing our goal to help create a more responsible coatings value chain starts with being accountable for our own environmental impact, and taking concrete steps to reduce our emissions wherever possible."*

A clear strategy to reduce GHG emissions

Stahl's approach to realizing its near-term emissions reduction targets is outlined in the company'sflEnvironmental, Social, and Governance (ESG) Roadmap to 2030. This strategy defines the specific metrics against which progress on the company's ESG commitments will be measured.

Stahl's Scope 1 and 2 GHG emissions reduction targets, as submitted to the SBTi, cover emissions from all manufacturing sites where Stahl products are produced, as well as the company's largest non-manufacturing locations. Stahl aims to lower these emissions by reducing its overall energy consumption and increasing the use of renewable energy at its sites. To achieve this, the company plans to increase its self-generated electricity capacity (using solar power, for example) and continue investing in more energy-efficient equipment.

Stahl plans to reduce its Scope 3 upstream emissions primarily by replacing fossil-based raw materials in its products with renewable alternatives, such as bio-based and recycled-based feedstocks. In addition, the company plans to introduce more low-impact raw materials into its product design.

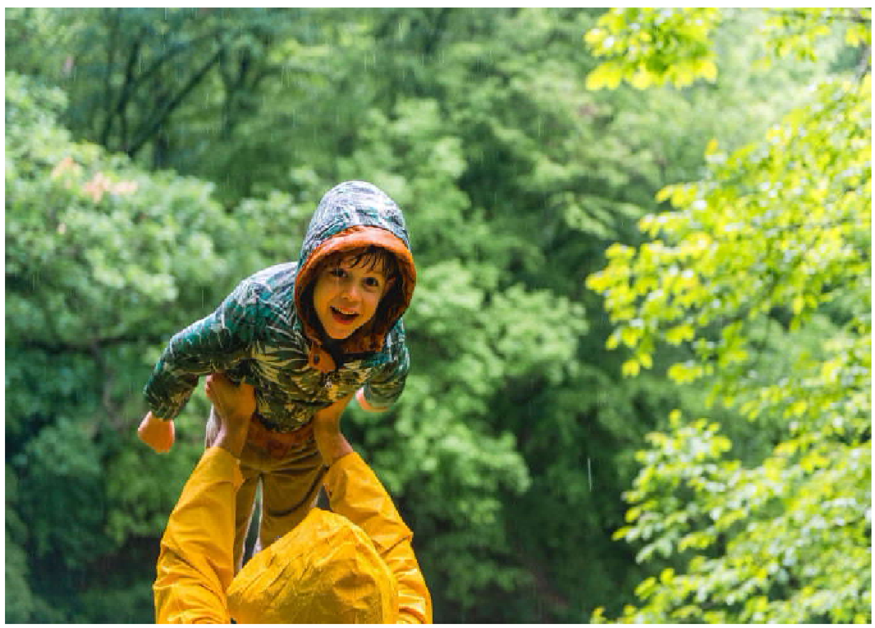
About the Science Based Targets initiative

The Science Based Targets initiative is a global body with the goal of enabling businesses to set ambitious emissions reduction targets in line with the latest climate science. It is focused on accelerating the efforts of companies worldwide to halve emissions before 2030 and achieve net-zero emissions before 2050. The initiative is a collaboration between the CDP, the United Nations Global Compact, World Resources Institute (WRI), and the World-Wide Fund for Nature (WWF).

More information about the steps Stahl is taking to realize its climate ambitions and broader ESG strategy can be found in the company's 2022 ESG Report, available online : ***https://esg2022.stahl.com/esg-report-2022/start.***

(Stahl News – 04/05/2023)

STAHL OUTLINES PROGRESS ON ENVIRONMENTAL, SOCIAL, GOVERNANCE AMBITIONS IN 2022 ESG REPORT



Stahl, a leading provider of coating technologies, has published its 2022 Environmental, Social, and Governance (ESG) Report. The report, which shares its title with Stahl's new purpose –Touching lives, for a better worldfl– details the company's recent progress against its mid-term ESG 2030 targets and broader ESG ambitions. The report is available to view as a/ fully digital version.

Stahl's 2022 ESG Report is the 10th edition of the publication, which aims to provide stakeholders with a clear understanding of the company's ESG strategy, goals, and activities. In 2022, Stahl took steps to strengthen its non-financial reporting, including preliminary efforts to address the requirements of/the/Corporate Sustainability Reporting Directive (CSRD), a forthcoming EU regulation. Stahl has established a project team to gain a better understanding of double materiality, governance elements, and other ESG disclosures related to the CSRD.

Demonstrable progress against Stahl's ESG targets

A key focus of the report is Stahl's ESG Roadmap to 2030,a list of ESG-related commitments and targets aligned with the UN Sustainable Development Goals (SDGs). % The roadmap uses metrics to track Stahl's progress against its targets, which are based on a set of clearly defined environmental,social, and governance topics.

These targets include reducing greenhouse gas (GHG) emissions. In 2022, the CO_2e intensity of Stahl's Scope 1 and Scope 2 GHG emissions fell by 3%. This followed a decrease of more than 30% in the company's Scope 1 and 2 emissions in absolute terms between 2015 and 2020. During the year, Stahl also submitted a new Scope 3 target to the Science Based Targets initiative (SBTi), with the aim of reducing its upstream emissions by at least 25% by 2030 (2021 baseline). Scope 3 GHG emissions cover all the additional indirect emissions that may occur in the value chain, including those associated with purchased raw materials, packaging, business travel, logistics and transportation, and dealing with end-of-life products. Stahl's Scope 3 emissions currently represent over 90% of its carbon footprint.

EcoVadis Platinum rating

In 2022, Stahl received an EcoVadis Platinum rating, placing it in the top 1% of companies assessed by the globally renowned EcoVadis sustainability rating platform. By achieving the highest possible rating, Stahl has surpassed its ESG Roadmap goal of achieving a Gold rating by 2023. Stahl's commitment to the EcoVadis process also extends to its supply chain. 83% of the company's raw material spend came from EcoVadis-rated suppliers, and Stahl aims to ensure that all EcoVadis-rated suppliers in its network achieve a minimum rating of 47/100 by 2030.

Safe and supportive work environment

Stahl's 2022 ESG report also details the company's efforts to support the physical and mental well-being of its employees, forming a core pillar of its ESG approach. For instance, Stahl's Roadmap to 2030 includes a target to have all Stahl manufacturing sites ISO 45001-certified1 by 2030 (59% of Stahl's products were produced at ISO 45001-certified sitesin 2022).

In addition, Stahl has taken steps to increase employee engagement and strengthen its diversity, equity, and inclusion (DEI) culture and vision. This has included defining and implementing local DEI plans in each of Stahl's legal entities worldwide and appointing local DEI committees for eachflentity. As part of this effort, Stahl is committed to improving gender equality and the representation of women throughout the organization. To this end, it has set a target to achieve 30-60% female representation across the company's Leadership Team, Extended Leadership Team, and heads of function.

Maarten Heijbroek, CEO of Stahl: "2022 was my first full year as CEO, and I am proud to say that it was a year of progress, as we continued to build momentum toward the goals set out in our ESG Roadmap to 2030. It was a year of significant milestones, including the announcement of our new Scope 3 greenhouse gas emissions target and our EcoVadis Platinum rating, to name a few. While we still have a long way to go to become the responsible organization we aspire to be, each year we touch more lives, as we work with our partners toflcreate a better world."

(Stahl News – 22/03/2023)

STAHL COMPLETES ACQUISITION OF ICP INDUSTRIAL SOLUTIONS GROUP

Stahl, a provider of coatings technologies headquartered in the Netherlands, has completed the acquisition of ICP Industrial Solutions Group (ISG), a leader in high-performance coatings for packaging and labeling applications. The acquisition reinforces Stahl's position as the global leader in the field of specialty coatings for flexible substrates.

ICP Industrial offers a comprehensive portfolio of high-performance coatings used primarily in packaging and labeling applications, notably in the food and pharmaceutical sectors. . ICP Industrial is primarily active in North America (close to 70% of sales), where it is a recognized technical leader. It also operates in Europe, under the "Hi-Tech Coatings" brand name.

In addition to enhancing Stahl's product offering and manufacturing capabilities, the acquisition stands to strengthen the company's environmental, social, and governance (ESG) leadership position. The integration of ICP Industrial coating technologies (water-based and energy-cured[1]) will enable Stahl to support customers in their transition to more sustainable packaging.

With ICP Industrial reporting sales of approximately USD 140 million in 2022, the acquisition will bring Stahl's annual sales beyond the EUR 1 billion mark, with an EBITDA margin above 20%.

Maarten Heijbroek, CEO of Stahl: ”*Completing this important strategic acquisition is an important milestone for our organization. Stahl and ICP Industrial's product focus and technologies are highly complementary, and the acquisition willflenhance our growth profile, diversify our target markets, and broaden our technology base. Moreover, integrating ICP Industrial's expertise and range of innovative low-impact solutions into our portfolio will add further value to our stakeholders as we work to create a more sustainable coatings value chain.”*

(Stahl News – 16/03/2023)

From the desk of General Secretary

73RD FOUNDATION DAY CELEBRATION OF ILTA

ILTA will celebrate its 73rd Foundation Day and organize Prof. B. M. Das Memorial Lecture as organized every year on 14th August' 2023.

Mr. Subhamoy Maitra, Professor, Applied Statistics Unit, Indian Statistical Institute, Kolkata has kindly consented to deliver the Prof. B. M. Das Memorial Lecture on this occasion.

Rest details of the event will be intimated in due course.

65TH ANNUAL GENERAL MEETING

The 65th Annual General Meeting is likely to be held any time of September' 2023. Audit of the accounts for the FY 2022 – 23 is going on and supposed to be completed by 1st week of July' 2023.

Details of the meeting will be intimated in due course.

SEMINARS & SYMPOSIUMS

ILTA is planning to organize few seminars and symposiums (Online / Offline) on Leather Science & Technology by coming months. Progress will be shared in due course.

14TH ASIA INTERNATIONAL CONFERENCE ON LEATHER SCIENCE & TECHNOLOGY (AICLST)

ILTA proposed to organize the 14th Asia International Conference on Leather Science & Technology (AICLST) in the year 2026 at Kolkata, India. Official confirmation has been received so far from IULTCS.

Planning and details of the program would be shared in due course.

(Susanta Mallick)
General Secretary

General Secretary and the Members of the Executive Committee are available to interact with members at 18.30 hrs, at our Registered Office on every Thursday

RECEIVING PRINTED COPY OF JILTA EVERY MONTH

We have started to post Printed copy of JILTA from April' 2022 to members and all concerned as it was before Covid period. Simultaneously we have been sending the e-copy of JILTA through email also to all the concerned receivers.

If you are not receiving JILTA by Post or through email, may please verify your Postal Address and/or Email Id with our office at the earliest.

PUBLISH YOUR TECHNICAL ARTICLE

Faculties, Research Scholars and students of various Leather Institutes may wish to publish their Research / Project papers in an Article form in this monthly technical journal, JILTA.

Interested author may sent their paper (in MS Word format) along with a PP Photograph and Contact details like Email, Mobile etc. to our email IDs : admin@iltaonleather.org / jiltaeditor@gmail.com

Members are requested to :-

a) Kindly inform us your '**E-Mail ID**', '**Mobile No**', '**Land Line No**', through E-Mail ID: admin@iltaonleather.org or over Telephone Nos. : 24413429 / 3459. This will help us to communicate you directly without help of any outsiders like Postal Department / Courier etc.
.

b) Kindly mention your **Membership No.** (If any) against your each and every communication, so that we can locate you easily in our record.

YOUTUBE CHANNEL & FACEBOOK PAGE OF ILTA

An official **YouTube Channel** namely **ILTA Online** and a **Face Book Page** namely **Indian Leather Technologists' Association** has been launched for sharing the activities of our Association since November' 2020 and July' 2021 respectively.

You may find all the Lives / Video recordings of different Seminar, Symposiums & Webinars on both of these social medias along with our website **www.iltaonleather.org** time to time.

You are requested to kindly do **Like** & **Subscribe** the YouTube Channel and **''Follow**' the FaceBook Page to get regular updates on the activities of our Association.

Solidaridad

With over 50 years of experience in developing sustainable solutions to make communities more resilient, Solidaridad has been working on many different issues, from supporting marginalized communities to fostering a more sustainable supply chain.

Solidaridad

switchasia
GRANTS PROGRAMME

Solidaridad

switchasia GRANTS PROGRAMME

EFFECTIVE WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT OF MSME TANNING COMPANIES IN KOLKATA LEATHER CLUSTER (BANTALA)

2022-2023

PROJECT PARTNERS IN ASIA

Pradipta Konar, Programme Manager-Leather(Kolkata): pradipta.konar@solidaridadnetwork.org

Solidaridad Regional Expertise Centre

158/5, Prince Anwar Shah Road, Kolkata-700045 | Contact: 033-40602211, +91-9830279866

Solidaridad

switchasia GRANTS PROGRAMME

The pursuit of accuracy is essential in order to attain maximum sustainability

In our journey towards green technology and sustainable development, implementing good **practices** in the leather industry is crucial. One such practice that holds significant benefits is the weighing of hides and skins. By accurately measuring the weight of these materials, we can optimize chemical usage, conserve water by minimizing wastage, and ensure precise measurements for the required water in each operation.

To take this practice to the next level, we are planning to introduce a platform weighing machine or floor scale weighing machine in one of our closest and most renowned tanneries.This machine will provide a reliable and standardized method of weighing hides and skins, ensuring accuracy and consistency in the production process.

By adopting this technology, we can achieve several advantages. Firstly, it enables us to optimize chemical usage by ensuring the right amount of chemicals is applied based on the weight of the hides and skins. This not only reduces chemical waste but also minimizes the environmental impact associated with excess chemical usage.

Secondly, accurate weighing facilitates water conservation by precisely measuring the required amount of water for each operation. This helps to minimize water wastage and promotes efficient water management practices in the tannery.

Furthermore, the introduction of a weighing machine promotes transparency and accountability in the industry. It allows for accurate record-keeping and data analysis, enabling tanneries to track and monitor their resource consumption, identify areas for improvement, and make informed decisions towards sustainability.

By implementing this practice in a renowned tannery, we aim to set an example for the industry and encourage other tanneries to adopt similar weighing practices. This will contribute to the overall improvement of sustainability in the leather sector, promoting responsible resource management and reducing the environmental footprint.

Through the integration of a platform weighing machine or floor scale weighing machine, we can enhance the accuracy, efficiency, and sustainability of the tanning process. It is a significant step towards achieving our goals of green technology and sustainable development in the leather industry.

Ensuring accurate weighing of hides and skins in the tanning process brings numerous benefits, both from a chemical usage perspective and overall process optimization. Here are some key points highlighting the advantages:

1. Precise Water Usage: By accurately measuring the weight of hides and skins during soaking, the correct amount of water can be added, reducing water wastage and promoting efficient water management.

2. Controlled Chemical Addition: Accurate weighing allows for the exact measurement of bactericides, surfactants/ emulsifiers, and soaking enzymes, ensuring the appropriate amount is added. This prevents the need for guesswork or excessive chemical usage, leading to improved process efficiency and reduced environmental impact.

3. Lime Liquor Optimization: By reducing the weight of calcium hydroxide (lime), the total suspended solids (TSS) and total dissolved solids (TDS) in the lime liquor can be minimized. This contributes to cleaner effluent and lower environmental pollution.

4. Precise Sodium Sulphide Usage: Weighing the exact amount of sodium sulphide for the dehairing process helps to reduce the sulphide content in the effluent. This decreases the formation of hydrogen sulphide gas (H_2S) and improves overall environmental and workplace safety.

5. Improved Chemical Cost Management: Accurate weighing ensures chemicals are used in the correct proportions, reducing chemical waste and ultimately lowering costs associated with chemical procurement.

6. Evaluation and Process Control: Weighing hides and skins after lime fleshing allows for the accurate measurement of weight increment, enabling better evaluation of the process. This helps in fine-tuning chemical usage and ensuring consistent quality in wet blue production.

From an indirect perspective, the benefits extend to various aspects of the tanning process:

1. Equipment Longevity: Using the actual weight of chemicals, hides, and water helps increase the lifespan of drums by carrying less weight than conventional methods.

2. Reduced Water Requirement: Accurate weighing and optimized chemical usage result in reduced water requirements, extending the lifespan of pumps and minimizing maintenance needs.

3. Decreased Carbon Footprint: By minimizing chemical waste, optimizing processes, and reducing water usage, the carbon footprint of the tannery operations can be significantly reduced.

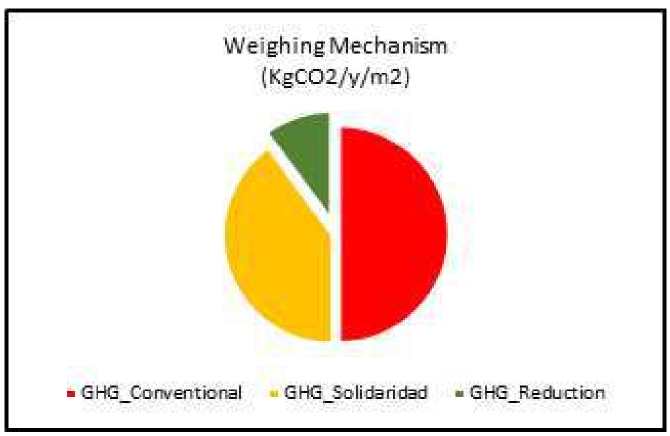
4. Efficient Solid Waste Management: With fewer chemicals being used, solid waste generated from the treatment plant becomes more manageable and easier to treat or recycle.

Overall, accurate weighing in the tanning process brings direct benefits in terms of chemical optimization, water conservation, and waste reduction. It also has indirect advantages such as improved equipment longevity, reduced environmental impact, and enhanced process control. By adopting precise weighing practices, tanneries can achieve greater sustainability, cost savings, and environmental responsibility.

Water footprint and carbon Footprint Analysis through Accurate weighing System:-

Water Footprint	Weighing Mechanism (Liters/100 pcs Hide)
WF_Conventional	22,500
WF_Solidaridad	12,500
WF_Difference	10,000

GHG Analysis	Weighing Mechanism (KgCO2e/y/m2)
GHG_Conventional	0.062833
GHG_Solidaridad	0.050192
GHG_Reduction	0.012641



IULTCS
INTERNATIONAL UNION OF LEATHER TECHNOLOGISTS AND CHEMISTS SOCIETIES

PROFESSOR JIANZHONG MA ANNOUNCED AS RECIPIENT OF THE IULTCS MERIT AWARD 2023

It is with great pleasure that IULTCS announces Prof Jianzhong Ma has been chosen as the winner of the prestigious IULTCS Merit Award for Excellence in the Leather Industry. The IULTCS was founded for the purpose of encouraging the technology, chemistry and science of leather on a worldwide basis. It is therefore appropriate that we recognise the achievements of those of stature in our industry who have contributed significantly to our global understanding of the leather industry and its by-products. The IULTCS Merit Award is given biennially by the IULTCS Executive to an individual, whose past or current endeavours have had an extraordinary impact on our industry and provide an example for others to follow. Prof Jianzhong Ma fits this profile perfectly.

Prof Jianzhong Ma has published more than 240 academic articles on prestigious international peer-reviewed journals, such as Advanced Functional Materials, Angewandte Chemie International Edition, Green Chemistry, Carbohydrate Polymers, etc. Seven of them were selected by ESI high citation papers. More than 100 National Invention patents and 7 international invention patents have been authorized. He has published 9 books including 2 monographs, among which “Chemistry of Leather Finishing Materials” has been rated as one of the national top-quality courses. To formulate and revise 7 National and Industrial Standards. Currently, Prof. Jianzhong Ma’s H-index (Reported by Web of Science) is 39 and total citation is more than 7056 times.

His extensive list of Practical Achievements is long and varied, with much of his time dedicated to the leather industry, helping to maintain sensible adjustments to testing methods as well as working on new technology for a better future for the leather industry worldwide. He is project leader of 973 pre-research Project of China, 863 Project of China, Key Project of the National Natural Science Foundation of China, General Project of the National Natural Science Foundation of China, National Key Research and Development Plan Project, and over 60 items of University-Enterprise Cooperation Research Projects.

Prof Jianzhong Ma has been actively involved with the development and industrialization of new leather tanning agents, retanning agents, finishing agents, fattening agents, and other chemicals, transferred to more than 40 enterprises at home and abroad. functional finishing agents such as cold resistant, hydrophobic and antifouling chemicals have been developed and put into practice. The achievement won the 2nd prize of national technological invention, as well as 2 types of 1st prize of provincial and ministerial technical invention.He has presided over the national teaching team, national quality courses, national planning textbooks and national experimental teaching demonstration centre etc. He has cultivated more than 100 graduate students, including entrepreneurial talent of the national "Thousand Talents Plan", young top-notch scholar of the "Ten Thousand Talents Plan", and young scholar of Yangtze River Scholars. A large number of outstanding engineering talents have been delivered to the industry. He won the 2nd prize of national teaching achievement.

Notable Conference and workshop presentations from Prof Jianzhong Ma for the leather industry have been:

1. Speaker of 14th National Leather Science and Technology Conference, Plenary presentation, China, 2022
2. Executive Chairman of the Organizing Committee of 11th Asia International Conference of Leather Science and Technology (AICLST), China, 2018
3. Speaker of XXXII Congress of the International Union of Leather Technologists and Chemists Societies (IULTCS), Oral presentation, Turkey, 2013
4. Speaker of XXXI Congress of the International Union of Leather Technologists and Chemists Societies (IULTCS), Oral presentation, Spain, 2011
5. Speaker of 5th Asian International Conference of Leather Science and Technology (AICLST), Oral presentation, Korea, 2002

The award ceremony will be made during the XXXVII IULTCS Congress in Chengdu, China. Please join us to congratulate Prof Ma for the IULTCS Merit Award.

(IULTCS Website)

IULTCS CONGRESS: DEADLINE EXTENSION FOR ABSTRACT SUBMISSIONS AND ACCEPTANCE NOTIFICATION

In response to the overwhelming interest and active engagement of participants, the International Union of Leather Technologists and Chemists Societies (IULTCS) has collaborated with the China Leather Industrial Association (CLIA) to facilitate an improved experience for all participants. As a result, the deadline for abstract submissions and acceptance notification has been extended tofl**July 15 and July 31**, respectively. It will grant prospective presenters additional time to refine their submissions and contribute to the exceptional scientific program.

The IULTCS Congress stands as a premier platform for researchers, academics, industry experts, and professionals to engage in fruitful discussions, explore innovative technologies, and foster collaborations that drive progress in the field of leather technology and chemistry. By extending these vital deadlines, IULTCS aims to promote an inclusive and dynamic environment, encouraging the submission of exceptional research work that showcases the forefront of leather-related advancements.

For further details, including submission guidelines and conference updates, please visit the official 2023 XXXVII IULTCS Congress website (www.iultcs2023.org). Stay tuned for more exciting announcements and prepare to be a part of this transformative event.

(Source : https://www.iultcs2023.org)

Photochromic Polyure - thane Footwear

Dibyendu Bikash Datta[1] Raksha Kothari[2]

[1] Associater Professor, Dept. of Fashion Management Studies

[2] Graduate Scholar, Dept. of Leather Design

National Institute of Fashion Technology, Kolkata

Abstract

Chromic materials undergo reversible colour changes in response to external stimuli. Photochromic colourants used in niche products change rapidly and reversibly from colourless to coloured when activated by UV light. As colour change is an effective way to convey important information, research into these materials has expanded. Many fashion products have used photochromic colour change technology. A changing colour product is both functional and trendy. In recent times, research on photochromic polyurethane has intensified, which could lead to commercially significant high-tech applications. This paper summarizes the chemistry, mechanism, and application of photochromic colourants on polyurethane and the evaluation procedure for performance. It also discusses other technical features, potential application areas, and challenges related to photochromic colours.

Keywords: Photochromism, polyurethane, colouration, functional, ultraviolet.

1.0 Introduction

A collaborative multidisciplinary approach to smart materials research is emerging at the intersection of science, technology, materials, and fashion. Future materials will need to be smart and functional. Technological advancements have changed people's expectations of polyurethane (PU) materials. The functional properties of PU materials have also become more important than their aesthetic, design, and fashion-related characteristics. In this context, functional PU-based products enhance company competitiveness. Photochromic PU materials, which change colour when exposed to external factors, can be used for fashionable and smart products (Figure 1).

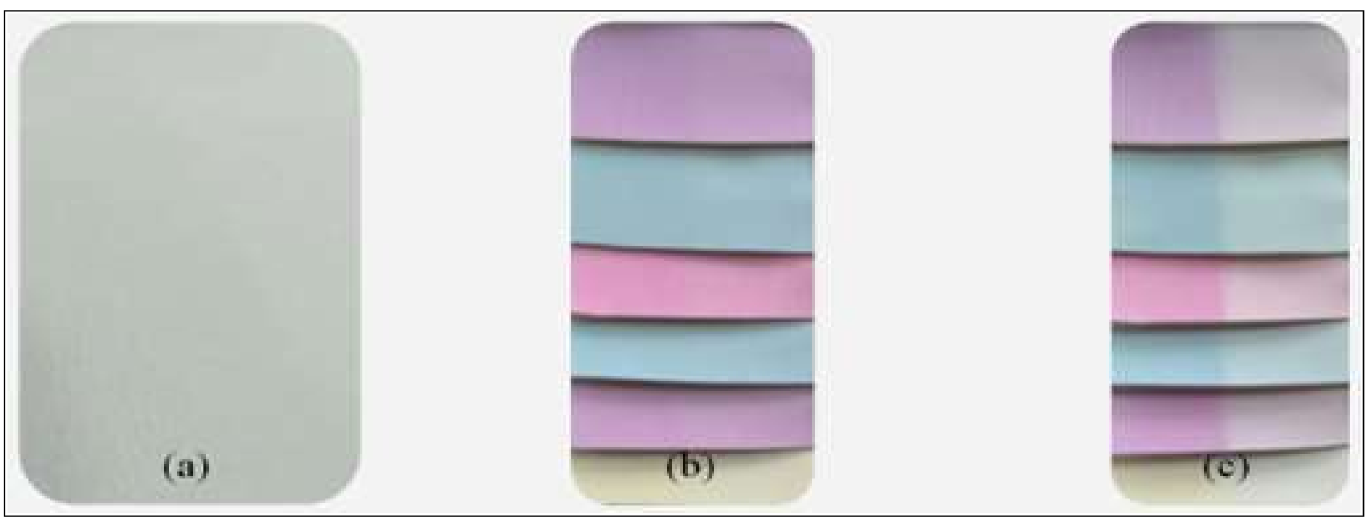


Figure 1 : (a) Polyurethane (b) Dyed polyurethane (c) Photochromic effect on polyurethane

Corresponding author E-mail : dbdatta@gmail.com

Traditionally, dyes are used primarily to colour textiles and non-textile materials. In the past, consumers purchased products for their aesthetic appeal. Consumers today have smart choices. Aesthetic properties alone could not attract them. Effective use of colourants can impact the entire value chain. Colourants enhance brand recognition, differentiation, and emotional connections. Ideally, the product should be smart and functional to attract consumers. Smart and functional dyes are considered the most affordable method of developing smart and functional materials. For the last few decades, researchers have searched for functional and smart aspects of dyes. Smart dyes detect their surroundings and adjust their chromogenic behaviour appropriately. Chromogenic materials change colour and are classified as chameleonic as they change colour reversibly in response to changes in environmental factors, and artificially created stimuli (Behera, 2021).

Polyurethane was first introduced by German Professor Dr Otto Bayer and his co-workers in the 1940s (Bayer, 1947) and has been applied in a very broad range of commercial and industrial fields due to its unique combination of unusual features including excellent mechanical strength, good abrasion resistance, corrosion resistance, low-temperature flexibility, toughness, processability, etc. The basic repetitive unit in PU is the urethane group (–NHCOO–), produced from the reaction between isocyanate (–NCO), polyols (–OH), and other additives (Trzebiatowska et al., 2018). Segmented PU is composed of two blocks: soft segment forms by macrodiol (polyether or polyester diol), and the hard segment composed of a diisocyanate and a low-molecular-weight chain extender or crosslinkers (Kojio et al., 2020).

In contrast to other common polymers such as polyethylene and polystyrene, PU is produced from a wide range of starting materials. This chemical variety produces PU with different chemical structures suitable for different applications. These include rigid and flexible foams, coatings, adhesives, insulation material, PU laminate and fibres like spandex (Trzebiatowska et al., 2018). The global polyurethane market will grow from $77.6 billion in 2022 to $88.34 billion in 2023 at a compound annual growth rate of 13.8% (Research and Markets, 2023).

PU leather, also known as faux leather, or synthetic leather, is a type of artificial leather made by applying PU to a fabric backing. PU coatings can be applied to various fabric materials, such as polyester, cotton, or nylon. This coating gives the fabric a leather-like appearance and texture. The PU layer is often stamped with a grain pattern to simulate the look of real leather and the feel of genuine leather while offering certain advantages and characteristics of its own. In general, PU leather is a popular choice for furniture upholstery, clothing, footwear, handbags, and automobile interiors. Its affordability, durability, and versatility make it a widely accessible alternative to genuine leather.

Over the last few years, PU has been applied in several areas because of its remarkable features, such as excellent mechanical strength, good abrasion resistance, toughness, low-temperature flexibility, etc. Among the major applications, PU is a prominent retanning agent and coating material in leather manufacturing. More specifically, PU can easily be tailor-made to meet specific demands. This structure-property relationship endows great potential for use in wider applications. With improvements in living standards, ordinary PU products cannot meet people's growing need for comfort, quality, and novelty. This has recently drawn enormous commercial and academic attention to the development of functional PU (Tian, 2020). Functional PU can show stimuli response to the environment or possess unique characteristics, like thermosensitivity, shape memory, self-healing, and photochromic.

Despite its advantages, it's important to note that PU leather has certain limitations. It may not have the same breathability and natural ageing characteristics as genuine leather. Additionally, the manufacturing process of PU leather involves the use of chemicals, and the disposal of such materials may have environmental implications.

In the 1989 movie, Back To The Future II, a pair of magic shoes that could emit light and self-lace was predicted to be developed in the future. After H" 20 years of development, Nike released the Air Mag Sneaker to turn this past fantasy into a reality (Standaert, 2022). The integration of high-tech and value-adding characteristics to design smart shoes, bags, and clothes has become a popular trend. Systems capable of responding to stimuli in a predictable and controllable fashion have attracted tremendous interest (Figure 2).

Developing a lightweight, flexible, foldable, and sustainable substrate for multi-stimuli responsive devices, especially wearable devices, remains both highly desirable and a challenge. Such substrates need to meet the performance requirements of multi-stimuli responsive devices and ideally exhibit good air and moisture permeability and wearing comfort. PU leather, due to its high durability, decent strength and elasticity, and superior softness and cushioning comfort, has been designed and used for bags, clothing, shoes, furniture, etc. (Sundar et al., 2006).

There is no question that real leather is better than PU leather. Most importantly, leather is a natural material and is made up of collagen fibres, which maintain the micro and nanostructures of animal skin (Maxwell, 2007). The special structural characteristics endow natural leather with good air and moisture permeability, which ensures a perfect affinity between leather and human skin. Therefore, leather is an ideal substrate candidate to design wearable devices (Jia et al., 2021). Real leather not only looks better, but it is also more durable. Real leather is also full of character and will age beautifully. PU leather, on the other hand, is not as durable and will crack and peel over time.

The main advantages of PU leather are lower cost, ease of maintenance, ability to have the leather look and feel of various types of animals. The biggest downside of PU leather is that it will not last as long as real leather, because it is not made from natural animal hide. Moreover, it will likely lack the vintage look that a lot of people like about leather.

There is no question that real leather is better than PU leather. Real leather looks better but is also more durable. Real leather is also full of character and ages beautifully. PU leather, on the other hand, is not as durable and cracks and peels over time.

Figure 2. : Air Mag "Back To The Future" Sneakers

Herein, we report on the use of photochromic PU for making footwear. The prepared footwear exhibited excellent photochromic performance and the technology is expected to find a wide range of application prospects in the field of chromic PU products.

2.0 Literature review

The word "chromo" comes from the Greek language and refers to a change in colour and, by extension, a change in physical characteristics. "Phoron" means bearer (Kuehni, 2012). A chromophore is usually a group of atoms that are having electron-withdrawing nature, possess unsaturation, and when present in conjugation imparts colour to the compound by absorption of visible light while transmitting wavelengths that are not absorbed (Jeong et al., 2019). This includes alterations at the molecular level, such as chemical bond breakage and molecular conformation changes. Most of the time, chromism is caused by changes inside the molecule, namely between electrons. This includes the π- or d- electron locations, implying that the phenomena are triggered by various stimuli capable of altering the electronic density of the molecule or material (Hassabo et al., 2022). Chromism has been studied since before the 1900s and the main applications are in the areas of photochromism, thermochromism and electrochromism such as paints, inks, tiles, eyeglasses, windows and many optical applications. Colourants that change, radiate, or erase colour as a result of external stimuli are called chromic colourants. Chromic colourants can create responsive or adaptive products.

2.1 Chromism classification

Many natural compounds have chromism and many artificial compounds with specific chromism have been synthesized to date. Based on the stimuli involved, chromism can be categorized in a variety of ways ((Hassabo et al., 2022) as mentioned in Table 1.

Table 1: Different types of chromism

Chromism type		External stimulus induced by
Photochromism	:	Sunlight or UV rays
Thermochromism	:	Changes in temperature
Electrochromism	:	Electrical stimulus
Solavtochromism	:	Solvent polarity
Lonochromism	:	Ions
Halochromism	:	Changes in ph value
Tribochromism	:	Mechanical friction
Piezochromism	:	Mechanical pressure
Mechanochromism	:	Mechanical deformation
Hygrochromism	:	The presence of moisture
Chemochromism	:	Specific chemical agents
Vapochromism	:	Vapours
Chronochromism	:	Time
Radiochromism	:	Ionizing radiation
Magnetochromism	:	A magnetic field
Biochromism	:	Biological sources
Carsolchromic	:	Electron beam
Crystallochromic	:	Crystal structure change of a colourant
Gasochromic	:	Gas
Aggregachromic	:	Dimerization/aggregation of chromophores

In the field of 'smart' materials, which sense and respond to external environmental conditions, chromism and its applications have substantial potential. With colour-changing clothing and fashion accessories, people could adjust the aesthetics of their fashion ensemble to suit their mood, style, etc., allowing them to be creative and expressive. Colour-responsive smart materials are generating intense interest among artists and designers because of their interaction, responsiveness, and ultimate functionality. Colour-changing technology offers unique and challenging design possibilities (Esther et al., 2014).

Recent research papers and patents have explored the chemistry and mechanisms of photochromic colourants. However, these colourants have not been extensively studied from a PU application perspective. In PU parlance, dye refers to colourants having an affinity for PU substrates; therefore, in this article, colourant refers to photochromic colours.

2.2 Photochromism

Photochromism is defined as a reversible transformation of a chemical species between two isomers having different absorption spectra induced in one or both directions by photoirradiation (Tian and Zhang, 2016). A photochromic material changes colour when irradiated with ultraviolet (UV) or visible light and then returns to its original colour when the light source is removed (Nigel Corns et al., 2009) as described in Figure 3.

This definition is very broad, covering the fully switchable appearance of colour, disappearance of colour, or alteration in hue. It could be argued that the definition is too general because it does not preclude labeling as photochromic those changes in absorption properties that cannot be observed unaided by the typical human eye. The definition does not exclude instances in which the changes in spectra are restricted entirely to within the UV or that switch from and back to the original colour very rapidly, such as on a sub-millisecond timescale. This article thus uses the term to signify a reversible change in the colour of a system that is visible to the naked human eye (Towns, 2021).

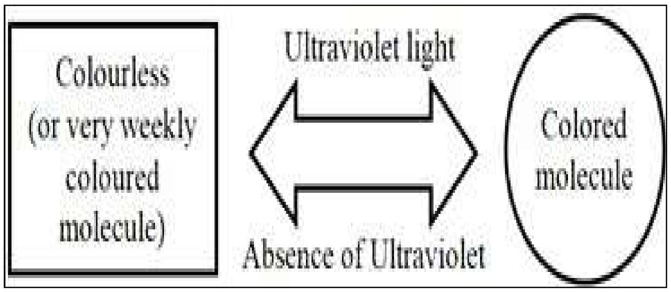


Figure 3 : The behaviour of commercially important photochromic colourants.

Photochromism is a reversible photochemical process during which a photochromic material temporarily changes its chemical structure and, consequently, also its electromagnetic waves absorption spectrum under the influence of irradiation involving UV rays (Bamfield, 2010). The reaction can be presented with the following equation (i) :

A (colourless) + $hv_1 \rightarrow$ B (coloured) …… equation (i)

The colourless photochromic material A does not absorb visible light. It can only be activated by high-energy photons (hv_1) from the near UV range of the electromagnetic spectrum. Due to the changes in the electron density, material B is capable of absorbing low-energy photons (hv_2) from the visible part of the electromagnetic spectrum, which results in colouration of the material B. The absorption spectrum of material A (in the absence of UV rays) is different from that of material B (in the presence of UV rays) (Figure 4).

A reverse reaction [equation (ii)] takes place when the excited molecule B absorbs visible light (hv_2) with a frequency near absorption maximum and returns to the non-excited colourless state A. This reaction is also called decolourization.

B (coloured) + $hv_2 \rightarrow$ A (colourless) …… equation (ii)

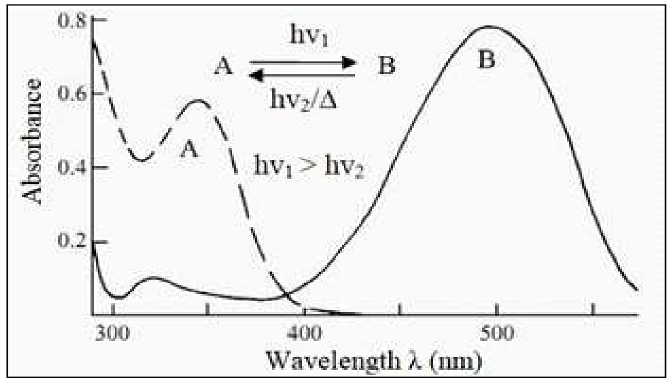


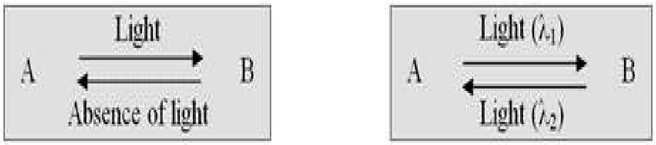
Figure 4 : Absorption spectra of photochromic compounds : spectrum A changes under UV rays (hv_1) into spectrum B. Reversible reaction occurs photochemically (hv_2) or thermally (Δ).

A reverse reaction in thermosensitive materials can be induced also by heat absorption. In the open air in the presence of UV rays and visible light, both reactions are going on based on the equation (i) is very quick, the equation (ii) is usually slower. Decolourization of a photochromic dye under the influence of UV rays is called negative photochromism.

At present, many inorganic and organic photochromic substances are known. Most inorganic substances, such as various metal oxides, alkaline earth metal sulphides, titanates, copper compounds, mercury compounds, certain minerals, transitional metal compounds and others, are not suitable for dyeing leather and textile materials. Organic photochromic dyes, on the other hand, are much more effective and environmentally friendly.

Photochromic colourants fall into one of two groups depending upon how they revert to the state they were in before photoactivation, i.e. whether the colour change is thermoreversible (T-type) or triggered photochemically (P-type) (Figure 5).

T-type photochromism **:** The property of returning to the original coloured state simply upon removing the stimulating radiation. This reversion is thermally driven, so maintenance of the colour change requires constant irradiation: as soon as the illumination is removed, the system starts to turn back to its original colour. The most important T-type organic photochromic compounds, which are sensitive to the thermal effects and the most common in the industry, include spiropyran, spirooxazine, naftopyran (chromenes) and azobenzenes.



T-type photochromism   P-type photochromism

Figure 5. : Classification of photochromic dyes based on thermal stability

P-type photochromism : Behavior in which a colour change is driven in the reverse direction only by photochemical means. Purely P-type colourants will remain indefinitely locked in one state once irradiated until they are flipped back to their original state by the light of the appropriate wavelengths. The most important P-type organic photochromic compounds include diarylethene and fulgide and are thermally stable.

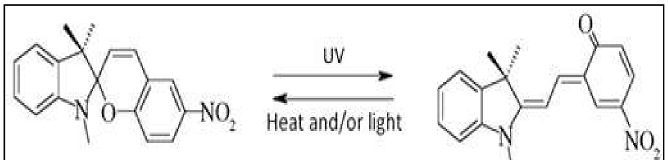
P-type photochromic colourants have received increasing attention over the past decade as a consequence of industry and academia seeking to make new applications based on photochromism a commercial reality. These technologies rely on controlled light-driven switching between molecular states (Gust et al., 2006), which is a mode of action that, by deûnition, is not possible with T-types. Consequently, there is great interest in ûnding optical equivalents to electronic components, such as switches and logic gates, based on P-type colourants (Matsuda and Irie, 2006).

Over the past 50 years, thousands of organic photochromic molecules have been synthesized, but only a few of them have been commercialized due to complex technical and commercial challenges faced in developing a marketable product. Not only the candidate molecule should be practical and economical to manufacture, but also various aspects of its photochromism have to be satisfactory. The best-known classes of photochromic dyes are spiropyran, spirooxazine, naphthopyran, diartyltenene, fulgide, and azobenzene.

Spiropyran

Photochromic spiropyran has been receiving considerable interest in recent years because it can be readily synthesized and photochromed to deep colours that bleach at useful rates.

The colourless form of the spiropyran can undergo a molecular rearrangement in which the pyran ring opens and generates a coloured photo merocyanine colourant, thus they show photo chromatic properties (Figure 6). The colour intensity of the system is dictated by a dynamic equilibrium between the open-ring and close-ring forms. Each species coexists, there being constant inter-conversion between the two forms at any given moment. Irradiation with UV light facilitates the ring-opening reaction, shifting the balance of the equilibrium so that the concentration of the photomerocyanine form increases, which is observed as an intensiûcation of colour. Removal of the light source has the opposite effect. The equilibrium moves towards the colourless pyran form of the colourant, which is seen as fading. As ring closure is driven thermally, a rise in temperature speeds up the decay of the photomerocyanine form to the pyran. The equilibrium shifts further away from the ring-opened side, leading to a perceived reduction in the intensity of colour. Consequently, the photochromic effect will be weaker at higher temperatures; the photochromism of spiropyran, therefore, shows temperature dependence (Nigel Corns et al., 2009).

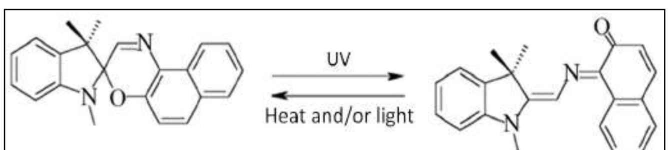


Closed-form   Open form (Merocyanine)

Figure 6. Photochromism of spiropyran to merocyanine

Spirooxazine

Spirooxazine colourants are similar to spiropyran in terms of their molecular structure and the mechanism behind their photochromism but exhibit lower orders of magnitude of fatigue (Durr and Bouas-Laurent, 2003). Like spironaphthopyran, spirooxazine changes from colourless or pale yellow to red, purple or blue when exposed to UV radiation (Figure 7). Photocolourability of all compounds is assured due to their large molar absorption coefficients, high reaction yields and relatively slow bleaching kinetics (Dawson, 2010). Spirooxazine shows slightly faster colour development and fades much more rapidly than the naphthopyran and the latter shows a residual colour after fading.



Closed-form   Open form (Merocyanine)

Figure 7. Photochromism of spirooxazine to merocyanine

Naphthopyran

Naphthopyran has been neglected for many years since it was discovered but has been much studied over the past two decades (Crano and Guglielmetti, 2002). Commercially, naphthopyran is the most important photochromic molecule class and is similar to the spiropyran and spiroxazine groups. Their photochromism depends on light-induced ring openings (Figure 8). However, due to their flexible colourant chemistry, many different types of functional groups can be introduced cost-effectively, which facilitates a more extensive colour gamut that spans across the visible spectrum from yellows through to oranges, reds, purples and blues. Like other known classes of photochromic colourants, commercial naphthopyran generally have good stability properties and their photochromism is less sensitive to temperature than spirooxazine (Mattila, 2006).

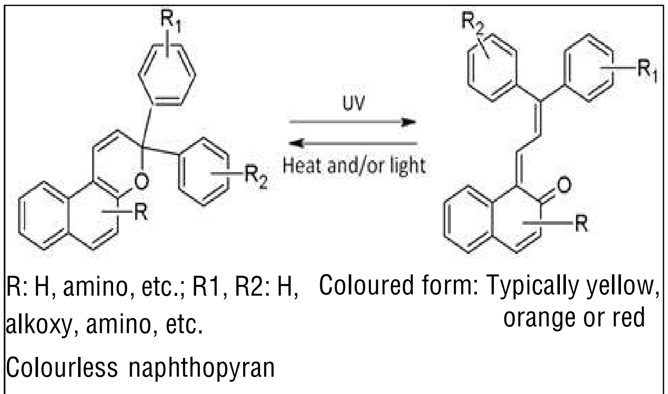


Figure 8. Photochromic compound (naphthopyran) and its photochromic reaction

Diarylethene

Photochromic diarylethene is particularly interesting because of its fatigue-resistant and thermally irreversible properties. The synthesis of the molecule studied here is the colourless single crystals of {1,2-bis [5'-methyl-2'-(2"-pyridyl thiazolyl] perfluorocyclopentene} (9a) turn dark red upon irradiation with 365 nm light. This colouration corresponds to the formation of the closed-ring isomer (9b) see Figure 9. The photoproduct is thermally stable; visible light irradiation induces the back reaction. Upon UV irradiation, absorption spectra of microcrystals present a broad absorption band in the visible region with a maximum of 550 nm. The absorption is highly polarized and the direction of maximum absorption coincides with the long axis of the colourless open-ring isomers (Colombier et al., 2005).

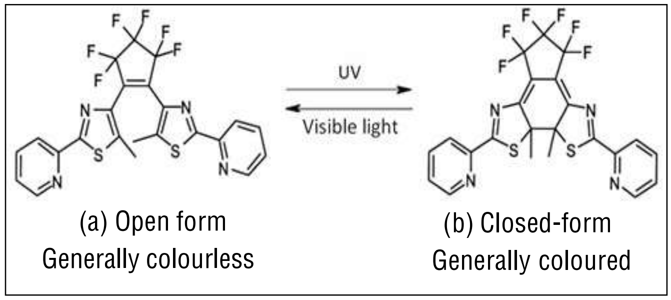


Figure 9. Photochromism of diarylethene

Fulgide

In organic chemistry, a fulgide is a class of photochromic compounds consisting of a bismethylene-succinic anhydride core with an aromatic group as a substituent. The highly conjugated system is a good chromophore. It can undergo reversible photoisomerization induced by UV light, converting between E and Z isomers, both being colourless compounds. Unlike the more-stable Z isomer, the E isomer can also undergo a photochemically-induced electrocyclic reaction, forming a new ring and becoming a distinctly coloured product called C form (Yokoyama, 2000). It is two-step Z–C isomerization that causes photochromic change starting from the stable uncyclized form (Figure 10).

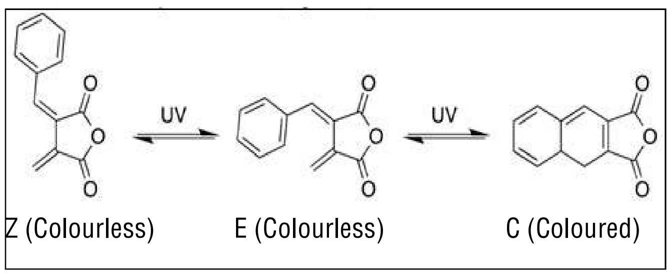
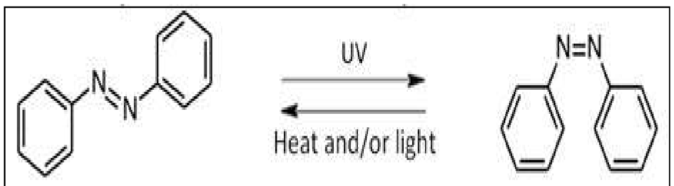


Figure 10. Photochromism of fulgide

Azobenzene

Azobenzene is a photoswitchable chemical compound composed of two phenyl rings linked by N=N double bond. It is the simplest example of an aryl azo compound. The term 'azobenzene' or simply 'azo' often refers to a wide class of similar compounds. These azo compounds are considered derivatives of diazene (diimide) (McNaught,1997) and are also referred to as 'diazenes'. Diazenes absorb light strongly and are common dyes (Patai, 1975). In azobenzene photoisomerization, the *trans* form converts to the *cis* form by UV wavelength of 300-400 nm (Figure 11). Visible illumination at > 400 nm converts the molecule back to the *trans* form. Alternately, the molecule will thermally relax to the stable *trans* form.



Trans-azobenzene *cis*-azobenzene

Figure 11. Photochromism of azobenzene

2.3. Application methods

Besides different printing and coating techniques, some other methods of application of photochromic microencapsulated compounds, such as spraying, impregnation (Kamata, 1995) and dyeing, can be used. Photochromic colourants can also be applied as a pigment. To use photochromic colourants as a pigment, it is dissolved in acetone and the solution is added dropwise into a binder and thickener formulation. This formulation is referred to as a printing paste of 0.05% wD w, representing the concentration of the colourant in the print paste. Then using a plain mesh print screen, printing is carried out, the printed sample is dried and cured at 140°C for 5 min in a hot air oven. For printing photochromic dyes on leather materials, the influence of the substrate on the visual effect of photochromic dyes should be taken into account. Light-coloured substrates are more adequate for photochromic dyes.

Surface coating with photochromic colourants is also possible. The leather substrate can be coated with different coating systems like PU, polyacrylate and a Sol-Gel system. As photochromic colourants are not soluble in water, they must be solved in the first step in small amounts of a solvent like acetone or methyl alcohol. The solved colourant is then mixed in the coating system and the coating formulation is applied to the leather. The colour effects depend on the leather, the coating material and the amount of the photochromic colourant. Good colour effects can be obtained by a small amount of photochromic colourant (<1%). The minimal amount depends on the dyestuff (Classen and Beringer, 2010).

Microcapsules fixed with polymer binders

Photochromic dyes are usually available as microcapsules in pulverized form. The shell of microcapsules acts as protection and improves the stability of dyes in particular, and extends their lifetime. Microencapsulation is the process by which an active substance, which represents the core of a microcapsule, is protected with a special wrapper or shell. Microcapsule is a tiny particle with a size of 1 to 1000 µm, which has a core composed of a photochromic system and a shell made of polymer material. Conventional microencapsulation processes can be mechanical (spray drying, centrifugation, co-extrusion etc.) or chemical (coacervation or interfacial polymerization). The chemical process is more suitable for photochromic dyes. To obtain satisfactory shelf-life and durability on leather interfacial polymerisation is nearly always used (Rijavec and Braèko, 2007).

Many different substances can be incorporated into microcapsules by using chemical processes. However, certain basic requirements must be fulfilled like the active substance should not be soluble in the carrying medium and should not react with the shell or exert some other influence on it, the active substance should be properly dispersed in the carrying medium and should be resistant to the changes of pH, temperature or other conditions required by the microencapsulation process.

Microcapsules can be used as conventional pigments and are applied on leather substrates by using polymer binders. The choice of binder is highly important for the quality and stability of dyes at use, particularly at washing. Mostly used are water-soluble polymer binders, (starch, modified starch, carboxymethyl-cellulose, polyvinyl alcohol, xanthates), synthetic latexes (such as styrene-butadiene copolymer, poly(vinyl acetate), polyacrylates with anionic or nonionic emulsifiers) and amino aldehyde resins (such as urea- and melamine-formaldehyde resins, dimethylolethylene-urea, dimethylolpropylene-urea and silicones) (Boh, 2003). For the application of microcapsules, a suspension, which, besides microcapsules and binder, contains also antifoaming and viscosity-controlling agents is prepared. The addition of PU latex improves the softness of the fabric handle, whereas the addition of melamine/formaldehyde resins produces a stiffer handle (Rijavec and Braèko, 2007).

Water-soluble photochromic dyes

The development of new water-soluble photochromic dyes represents an important move forward in the development of less expensive photochromic dyes for leather and textile materials. We speak about a series of spirooxazine-based photochromic dyes containing a sulphonate group, which imparts water solubility to dyes. These dyes are designed for dyeing protein substrates, such as fashionable leather shoes and accessories, silk apparel and furnishings. Under the influence of UV irradiation (maximum wavelength 370 nm), a dyed silk substrate (at the dye concentration of two per cent on the weight of fabric) exhibited a change in colour from its original natural pale yellowish to green. The colour changes are much more distinct immediately after dyeing when the fabric is still wet than after drying. The wash fastness and photostability of dyed silk fabrics are moderate (Shah et al., 2005).

2.4 Application areas for photochromic colourants

Photochromic colourants have a wide range of potential application areas for use in textiles and non-textile applications that change colour in response to light. Here are some examples:

Eyewear: Photochromic colourants are commonly used in eyeglass lenses, allowing them to darken in bright sunlight and lighten indoors or in low light conditions. This adaptive feature provides users with convenient and comfortable vision without the need for separate sunglasses.

Automotive: Photochromic colourants can be incorporated into automotive glass, such as windshields or sunroofs, to automatically adjust the tint level based on light intensity. This helps to reduce glare and improve driving visibility.

Architectural and smart windows: Photochromic colourants can be applied to windows and glass facades in buildings. By responding to sunlight, they can control the amount of light and heat entering the interior, contributing to energy efficiency and occupant comfort. Additionally, smart windows with photochromic properties can eliminate the need for blinds or curtains.

Textiles and apparel: Photochromic colourants can be used in textiles and fabrics to create interactive and dynamic designs. For example, they can be applied to clothing, accessories, or home textiles to create colour-changing effects in response to UV light exposure. UV-light sensitive curtain has been developed by the Swedish Interactive Institute using photochromic colourants sensitive to UV radiation. Various parts of the curtain are dynamically illuminated by a computer-controlled UV lamp, creating a dynamic textile pattern which is driven by a computer-controlled digitized pattern (Hallnäs et al., 2002). Photochromic colourants are now used in the development of camouflage patterns for military protective clothing. This pattern can change from one colour to another upon absorption of sunlight to mimic the surrounding environment (Chowdhury et al., 2014). Photochromic PU-coated textile products can be found in various forms, including bags, wallets, belts, shoes, and even furniture upholstery. When these items are exposed to sunlight or other UV sources, a transition from a lighter or neutral colour to a darker or more vibrant shade occurs.

Packaging and security: A photochromic colourant can be used in packaging materials, labels, or security features. These labels can provide an added layer of security by changing colour when exposed to specific light conditions.

Art and design: Photochromic colourants offer artists and designers unique opportunities for creating interactive and engaging artworks. By incorporating these materials into paintings, sculptures, or installations, artists can introduce dynamic and changing colour effects based on lighting conditions.

Educational tools and toys: Photochromic colourants can be used in educational tools, such as books or learning aids, to illustrate light-related concepts. They can also be integrated into toys or novelty items to provide unique visual or sensory experiences for children and adults.

Cosmetics and nail polishes: Photochromic colourants can be integrated into cosmetic products, including nail polishes and lipsticks. These materials can create colour-changing effects in response to light or temperature, offering unique and eye-catching aesthetics.

It is important to note that the application areas for photochromic colourants are not limited to the examples provided above. As the field of materials science progresses, new and innovative uses for photochromic colourants may continue to emerge, expanding their potential across various industries and creative domains.

(.......To be continued in next issue)

LEATHER CRAFTSMANSHIP: HONORING TRADITIONAL TECHNIQUES IN THE MODERN WORLD

Leather craftsmanship is an art form that has stood the test of time, weaving a tale of tradition, skill, and timeless elegance. From the earliest civilizations to today, leather artisans have honed their craft, passing down techniques and knowledge from one generation to the next.

In a world characterized by rapid technological advancements, leather craftsmanship remains an ode to the meticulous and labour-intensive process of creating exquisite leather goods. Delve into the realm of leather craftsmanship and explore the ways in which artisans honour traditional techniques in modern products, such as leather boots and wide leather belts, while navigating the challenges that come with it.

Preserving Perfection: Leather Craftsmanship in the Modern World

In today's fast-paced and technology-driven society, there is something captivating about the enduring art of leather craftsmanship. It stands as a testament to the human spirit, celebrating tradition and preserving age-old techniques passed down through generations. As we navigate the modern world, there is an increasing appreciation for the artisans who dedicate their lives to perfecting this time-honoured craft.

Leather, with its inherent strength, durability, and versatility, has been used for centuries to create functional and beautiful goods. From exquisite bags and accessories to finely crafted footwear and bespoke garments, leather items have an undeniable allure. However, it is the craftsmanship behind these creations that truly elevates them from mere objects to works of art.

The Evolution of Leather Craftsmanship: Traditional Techniques in a Contemporary Context

At the heart of leather craftsmanship lies a deep respect for tradition and a commitment to mastering the intricate techniques that have been refined over centuries. These techniques encompass every aspect of the craft, from the careful selection of high-quality hides to the precise cutting, stitching, and finishing processes. Each step requires meticulous attention to detail and a profound understanding of the material.

One of the most critical aspects of leather craftsmanship is the art of tanning, which transforms raw animal hides into supple, durable leather. Traditional tanning methods, such as vegetable tanning, rely on natural extracts from plants to treat the hides, resulting in a more organic and environmentally friendly process. This technique not only creates leather with exceptional longevity but also enhances its unique character, allowing it to develop a beautiful patina over time.

In an era of mass production and disposable fashion, leather craftsmen stand as guardians of quality and longevity. They embrace the belief that true luxury lies in meticulous handwork and attention to detail that can only be achieved through traditional methods. Each stitch, each cut, and each dyeing process is executed with precision, ensuring that every finished piece is an embodiment of excellence.

Balancing Tradition and Innovation in Leather Craftsmanship

While honouring tradition, leather craftsmen also find ways to adapt and embrace the opportunities presented by the modern world. They marry their time-honoured skills with contemporary design sensibilities, creating pieces that are both rooted in history and relevant to today's fashion landscape. Using traditional techniques and innovative approaches, they breathe new life into leatherwork, enabling it to flourish and evolve.

Additionally, leather craftsmen understand the importance of sustainability in the modern era. They seek out eco-friendly practices and materials, striving to reduce the environmental impact of their work.

From utilizing vegetable-tanned leathers to repurposing scraps for smaller accessories, these artisans demonstrate a commitment to responsible craftsmanship, ensuring that their creations leave a positive mark on the world.

The Timeless Appeal of Handmade Leather Goods

In a society that often favors speed and convenience, the enduring art of leather craftsmanship serves as a reminder of the value of slow, deliberate creation. It celebrates the patience, dedication, and mastery required to transform raw materials into precious objects. Each handcrafted piece tells a story, carrying with it the soul and spirit of its maker.

So, the next time you hold a beautifully crafted leather bag, slip into a pair of expertly handmade shoes, or run your fingers across the smooth surface of a finely tooled leather wallet, take a moment to appreciate the artisans behind these creations.

Leather artisans are the custodians of a tradition that connects us to our past and preserves the art of human ingenuity. In honoring traditional techniques in the modern world, they inspire us to cherish the timeless beauty of craftsmanship and to seek out the exceptional in an increasingly disposable culture.

Crafting Stories by Hand: Embrace the Artistry and Legacy of Leather Craftsmanship

In a world that often values quantity over quality, the enduring art of leather craftsmanship serves as a reminder of the inherent beauty and value of slow, deliberate creation. It is a celebration of human ingenuity and the power of skilled hands.

In the fast-paced nature of our lives, leather craftsmen inspire everyone to embrace the timeless beauty of craftsmanship and seek out the exceptional. So, honor the art of leather craftsmanship and embrace a deeper appreciation for the enduring beauty of handmade creations.

(qrius.com/ - 23/06/2023)

MANDATORY FOOTWEAR QUALITY STANDARDS TO COME INTO FORCE FROM JUL 1, CURB SUB-STANDARD IMPORTS: BIS DG

Large and medium-scale footwear manufacturers and all importers will have to follow the mandatory quality standards for 24 footwear and related products from July 1, aimed at curbing sub-standard imports from countries like China. For small-scale footwear makers, the deadline is January 1, 2024, while for the micro footwear industry, the mandatory quality standards will be applicable from July 1, 2024, Bureau of Indian Standards (BIS) Director General Pramod Kumar Tiwari told reporters here. "No further extension will be provided. This QCO will ensure domestic production of quality footwear and check sub-standard imports," he said.

The QCO for 24 footwear and related products were notified in October 2020 and thereafter extension was given thrice before making it mandatory for large and medium-scale industries from next month. The standards prescribe what kind of raw material like leather, PVC, and rubber to be used in manufacturing footwear besides norms on making soles and heels, among other parts of the footwear.

The standards prescribe what kind of raw material like leather, PVC, and rubber to be used in manufacturing footwear besides norms on making soles and heels, among other parts of the footwear. The 24 footwear products on which the quality standards will apply include rubber gum boots, PVC sandals, rubber hawai chappals, slippers, moulded plastic footwear, footwear used for municipal scavenging work; sports footwear, derby shoes and anti-riot shoes, moulded solid rubber soles and heels, among others.

With this, the total number of footwear products under the QCO (quality control order) stands at 27 out of 54. The Indian standards are aligned with the global standards. "The rest 27 and other footwear products will be brought under the QCO in the next six months. The work is underway," Tiwari said.

He also shared that the BIS has revised five standards on footwear specifications, and the industry has been given an additional time of six months till January 1, 2024, to comply with the QCOs. Test facilities have been created in 2 BIS labs, 2 Footwear Design and Development Institute (FDDI) Labs, Central Leather Research Institute and 11 private labs for testing footwear, he added. Apart from this, the BIS Director General said the mandatory compliance of quality standards for making 'protective clothing for firefighting' as well as 'geo-textiles related 19 products' will come into force from October this year.

Currently, 470 products are under the mandatory quality standard regime. BIS has shared another 600 products with ministries for consideration to bring them under the QCO, he added. The BIS also unveiled a "public call facility" through which one can share suggestions, queries or complaints regarding the BIS initiatives, schemes and other matters.

The facility will be active on all working days from 10-11 am. The entire conversation will be recorded. The BIS also launched an online exchange forum 'Manak Rath' on its website to enable users to get connected and share their views. Student members of standards clubs can participate in various activities and competitions and win exciting prizes.

(Economic Times – 20/06/2023)

MUSHROOM LEATHER: A SUSTAINABLE ALTERNATIVE TO ANIMAL LEATHER

In the age of growing environmental concerns and the search for sustainable alternatives to traditional materials, an unexpected contender has emerged: mushroom leather. As the name implies, this novel material is derived from fungi, offering a potential answer to the ethical and environmental issues surrounding animal leather.

This article delves into the world of mushroom leather, exploring its properties, production process, and potential impact on the future of sustainable fashion and beyond.

The Rise of Mushroom Leather

Mushroom leather, also known as mycelium leather, is a type of bio fabricated material that's derived from the root structure of mushrooms known as mycelium. As a natural resource, mycelium grows quickly, is renewable, and leaves a minimal environmental footprint, making it a promising alternative to traditional animal leather.

Producing Mushroom Leather

Creating mycelium-based leather involves an intriguing mix of biology and technology. The process begins with the careful selection and cultivation of mycelium. Once the fungi have been grown under controlled conditions, they form a mat of interconnected fibers, similar in structure to animal hide.

This mat is then harvested, treated, and processed to create a material that's remarkably similar to animal leather in terms of texture, appearance, and performance.

The entire process of growing and processing mycelium leather can be completed in a matter of weeks, significantly faster than raising animals for traditional leather.

Furthermore, the process requires far fewer resources, produces less waste, and does not involve harming animals, aligning with the principles of sustainable and ethical production.

Properties and Applications of Mushroom Leather

Mushroom leather offers properties akin to traditional leather, including durability, breathability, and flexibility. It can also be produced in various thicknesses and can be dyed, stitched, and otherwise manipulated like animal leather.

However, what sets mushroom leather apart is its environmental footprint. The production of mycelium leather emits fewer greenhouse gases, uses less water, and requires less land compared to animal leather. Additionally, as a plant-based product, it is biodegradable and compostable, thus reducing waste in landfills.

The potential applications of mushroom leather are broad and exciting. While it's primarily used in the fashion industry for shoes, bags, and clothing, its potential use extends to furniture, automotive interiors, and even construction materials.

The Rise of Mushroom Leather

Mushroom leather, also known as mycelium leather, is a type of biofabricated material that's derived from the root structure of mushrooms known as mycelium. As a natural resource, mycelium grows quickly, is renewable, and leaves a minimal environmental footprint, making it a promising alternative to traditional animal leather.

Producing Mushroom Leather

Creating mycelium-based leather involves an intriguing mix of biology and technology. The process begins with the careful selection and cultivation of mycelium. Once the fungi have been grown under controlled conditions, they form a mat of interconnected fibers, similar in structure to animal hide. This mat is then harvested, treated, and processed to create a material that's remarkably similar to animal leather in terms of texture, appearance, and performance.

The entire process of growing and processing mycelium leather can be completed in a matter of weeks, significantly faster than raising animals for traditional leather. Furthermore, the process requires far fewer resources, produces less waste, and does not involve harming animals, aligning with the principles of sustainable and ethical production.

Properties and Applications of Mushroom Leather

Mushroom leather offers properties akin to traditional leather, including durability, breathability, and flexibility. It can also be produced in various thicknesses and can be dyed, stitched, and otherwise manipulated like animal leather.

However, what sets mushroom leather apart is its environmental footprint. The production of mycelium leather emits fewer greenhouse gases, uses less water, and requires less land compared to animal leather. Additionally, as a plant-based product, it is biodegradable and compostable, thus reducing waste in landfills.

The potential applications of mushroom leather are broad and exciting. While it's primarily used in the fashion industry for shoes, bags, and clothing, its potential use extends to furniture, automotive interiors, and even construction materials.

(miragenews.com – 26/06/2023)

CALL TO ENSURE HEALTHCARE FOR BANGLADESH TANNERY WORKERS

Leaders of the Bangladesh Tanners' Association and Tannery Workers' Union have called for initiating necessary steps to ensure healthcare for tannery workers in the interest of the country's economy.

"Tannery owners should prioritise workers' health and tie up local medical centres to provide healthcare to the workers," said Md Sakhawat Ullah, general secretary of the Bangladesh Tanners' Association, while inaugurating a daylong health camp for tannery workers at the Tannery Industrial Estate in Hemayetpur of Savar on Friday.

The camp was organised by the Tannery Workers' Union (TWU), in collaboration with the Solidarity Centre-Bangladesh office, reads a press release.

Over 200 tannery workers received free medicine upon consulting the doctors at the camp. Medicine specialists and dermatologists also provided advice to the workers.

Addressing as the chief guest, Md Sakhawat Ullah also called for establishing a full-fledged hospital in the Tannery Industrial Estate to protect the health of tannery workers.

The BSCIC should set up a community clinic till the hospital is established there, he said. In addition to the health camps, safety awareness programmes like safety fairs should be organised regularly at the estate, added Sakhawat.

Salim Ahsan Khan, senior legal counselor of the Solidarity Centre-Bangladesh, who was present as special guest, said boards inscribed with awareness-raising messages on chemical risks should be installed at all factory premises.

Chairing the opening ceremony of the camp, Tannery Workers' Union (TWU) President Abul Kalam Azad said, "A full-fledged hospital in the tannery industrial estate is a crying need. Such health camps should be organised regularly in the interest of the workers."

General Secretary of the Bangladesh Tannery Workers' Union Abdul Maleque moderated the event.

(tbsnews.net – 27/06/2023)

MSMES GET TIME TO COMPLY WITH LEATHER QUALITY CONTROL RULES

The Union government on Wednesday decided to give six more months to small industries for complying with the mandatory quality standards order for leather products.

While the fresh deadline for companies with an annual turnover of ¹ 50 crore and investment of ¹ 10 crore will be 1January 2024, the deadline for the micro units with annual turnover less than ¹ 5 crore would be 1 July 2024. Notably, the small units were earlier out of the ambit of these orders.

Commerce and industry minister Piyush Goyal at a press briefing said that these orders would help in increasing production of quality footwear, exports and establishing Indian brands in the global markets. "We have decided that the QCOs will be implemented from 1 July. The order will come into force from 1 July. It was decided not to do any change in that. No extension will be given and everybody has agreed for that," he told reporters after holding a meeting with the participants of the industry.

"Most manufacturers have not even applied for a BIS license and this is unfortunate. The industry was aware of the QCO for more than two years," Goyal added. This comes after large footwear retailers asked the government to enforce quality norms for leather and non-leather footwear to be pushed back by months. The manufacturers and retailers said that they can only start selling eight to ten months from that date because there won't be enough certified stocks in the market.

The Federation of Indian Chambers of Commerce & Industry (FICCI), Retailers Association of India or RAI, PHD Chambers as well as Confederation of All India Traders (CAIT) had all written to the Department for Promotion of Industry and Internal Trade (DPIIT) seeking between eight to ten months of extension from the date the regulation kicks in for manufacturers.

On the leather and footwear sector, the government issued three mandatory quality orders on 27 October 2020. Out of these three, one on protective footwear was already implemented from January 2022 and the remaining would come into force from 1 July this year.

According to the 'Footwear Made from Leather and Other Materials (Quality Control) Order, 2022', which will come into force from 1 July, manufacturers have to modify their processes to comply with the new standards. This includes establishing testing laboratories, obtaining BIS licences, and adhering to the rules for issuing the ISI mark.

Goyal said that there is no mandatory rule for the industry to set up their own testing facilities and the BIS will set up with their fund across the country. The minister informed that five products like sports shoes, where the process of framing the QCO is ongoing, will have to implement those orders from 1 January 2024.

Some footwear which are not covered under any QCO, BIS and industry would work on those in the next 1-1.6 months. Regarding testing fees, it was decided to give 80% discounts to government-recognised start-ups and micro units, having less than Rs. 5 crore annual turnover.

(livemint.com – 14/06/2023)

GOVT WITH LEATHER INDUSTRY, RESOLVING ISSUES: MAHANA

In the overall leather export category of the fourth Central Regional Export Excellence Award ceremony, Super House Group won the first prize. The ceremony was held at KLC complex Banthar Unnao on Saturday. Rehman Industries Group and AFPL Global Private Ltd received the second and third prize in the same category, respectively.

The awards were given by chief guest, UP Legislative assembly speaker Satish Mahana, in the presence of several senior state government officials. Superhouse diretor Yusuf Amin received the award, along with three more awards in other categories.

There were 13 categories of leather and leather product export awards and the chief guest handed them to 54 leather & leather products export units of Kanpur. Three women entrepreneurs who received the award included Nargis Begum of RNZ Exports for saddlery & harness in the leather category. Shruti Takru of Lord Shiva International and Pooja Agarwal ASPEN Mfg Co received the non-leather category awards.

Mahana in his address expressed best wishes to all export award winners and industry members. He assured that state government is always stand behind the industry and extending close cooperation in establishment of mega leather cluster and resolving other issues.

Kanpur-Unnao Leather Cluster Development Company Ltd director Rakesh Suri welcomed the guests and stated the idea behind organising such event in this region is to help leather industry become stronger and grow at a faster pace through an all-inclusive eco system which will help in achieving the ambitious industry target of 47 billion dollars by 2030.

Additional chief secretary MSME & export promotion Amit Mohan Prasad inaugurated the event and officially launched first edition of CLAPSS 2023 with the statement that UP government would extend all support required for the growth of leather industry. He mentioned a scheme 'PLEDGA' and informed that UP government was organising UP Industrial Trade Show in Greater Noida Export Mart during 21st to 25 Sep. 2023, wherein about 400 overseas buyers will participate. So, all industry members should participate.

Chairman Mukhtarul Amin also welcomed the guests and appreciated the state government's support for the growth of this sector and congratulate award winners. CLE vice chairman R K Jalan welcoming the guest said that UP is playing vital role in export earnings and having substantial shares in India's total exports of leather and leather products. He emphasised that to invite more investment in non-leather footwear on the lines of Tamil Nadu so that desired growth could be achived. Javed Iqbal regional chairman CLE gave vote of thanks.

(Times of India – 11/06/2023)

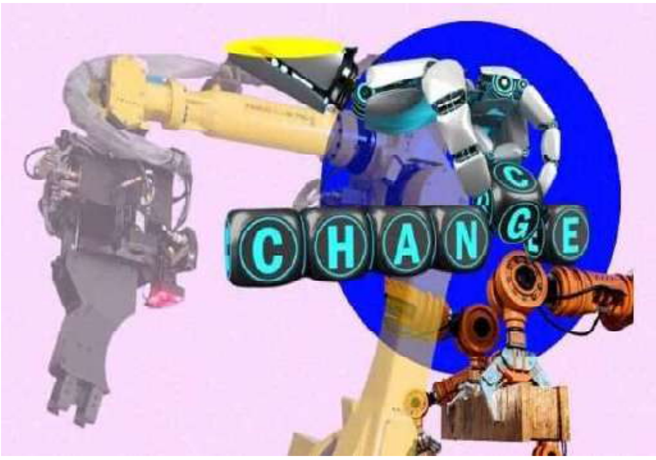
DPIIT GIVES MAHARASHTRA GO-AHEAD FOR MEGA LEATHER FOOTWEAR AND ACCESSORIES PARK

The Department for Promotion of Industry and Internal Trade has given the state of Maharashtra an in-principal approval to launch a Mega Leather Footwear and Accessories Cluster Park. The development will be located in Ratwad, Raigad district and will be designed to boost its leather industry.

DPIIT aims to develop the leather goods industry in India to boost employment opportunities, especially for women and young people. By choosing Maharashtra for its next major development project, DPIIT has confidence that the state can take a leading position in leather goods exports, ET Bureau reported. "Leather sector holds immense potential for empowering women and engaging the youth," read a release by DPIIT, TNN reported. "The establishment of the Mega Leather Footwear and Accessories Cluster Park in Raigad will mark a milestone in Maharashtra's economic growth trajectory. This ambitious project will unleash a tremendous employment opportunity, strengthen the leather sector ecosystem, and foster the state's overall economic prosperity."

(https://in.fashionnetwork.com - 16/06/2023)

INDUSTRY 4.0 IS THE ERA OF AUTOMATION THAT OFFERS NEW OPPORTUNITIES AND CHALLENGES FOR MSMES.



Businesses of all sizes, especially Micro, Small, and Medium Size Enterprises (MSME), are significantly impacted by the rise of automation. For MSMEs, automation can provide a variety of advantages, including better productivity, lower prices, and higher quality.

The COVID-19 epidemic has made it more urgent for MSMEs to implement automation and Industry 4.0 technologies to stay competitive. However, many MSMEs encounter difficulties implementing these technologies because of a lack of knowledge, a trained labor shortage, and expensive expenses.

Furthermore, MSMEs now have access to cutting-edge tools and capabilities previously only available to larger businesses thanks to automation technologies like robotics, artificial intelligence (AI), and the Internet of Things (IoT).

These technologies help MSMEs improve quality control, streamline their manufacturing processes, and gather real-time data for strategic decision-making. This evens the playing field and enables MSMEs to compete with larger businesses by providing reasonably priced premium goods and services.

When implementing automation, MSMEs must also overcome a few obstacles. The price of automation presents one of the main obstacles for MSMEs. Automation can require a substantial financial outlay; hence it might only be practical for some MSMEs. MSMEs also lack the technical know-how necessary to implement automation solutions and keep them running smoothly. Lack of knowledge of the advantages of automation is another issue facing MSMEs. Many MSMEs may be reluctant to adopt new technology because they are unaware of the potential advantages of automation.

Despite these obstacles, a number of MSMEs have been successful in making the transition to automation. These MSMEs have discovered strategies for overcoming obstacles and taking use of automation. MSMEs have adapted to automation in part through collaboration with tech companies. The correct automation solutions for MSMEs' needs can be found with the assistance of technology suppliers, who can also aid with implementation and maintenance.

MSMEs have also reacted to automation by spending money on training. MSMEs must make sure that their staff members are competent in using automation technologies. Finally, MSMEs must be mindful of any risks that automation could bring. Automation may result in job losses and present new compliance and data security challenges.

Here are some further ideas on how MSMEs might adjust to automation:

Automation will likely pick up speed in the upcoming years as its costs fall, and its advantages are better understood. MSMEs will be better able to compete in the future if they can successfully adapt to automation. Governments and business organizations can aid MSMEs in adopting automation by offering funding, training, and other resources.

(https://www.analyticsinsight.net – 03/07/2023)

Leather from Invasive Species

(Part-6)

Subrata Das, M.Tech (Leather Technology)

Freelance Leather Technologist & Consultant, Chennai

Green Iguana

Importing, trading, selling, purchasing and keeping exotic pets from distant lands, in outdoor pens, menageries, cages, gardens or simply indoors, has always been a favourite American pastime. A staggering array of arthropods, amphibians, reptiles, birds and mammals from all corners of the globe can be found with pet owners and 12740 pet stores and outlets, in the United States. (1)

Sadly, the inceptive infatuation and adoration of the dilettante pet owners evaporate, as their live acquisitions begin to grow in dimension and voracity, whereby it becomes obligatory upon them, to invest more time, focus, attention and expenses for the upkeep of their unique and strange "creature companions". Releasing them into the "wild" in a non-native ecosystem is the eventual benign option, most pet owners opt for. Although some of these exotica do not survive in the alien environment, some of those that do, establish stable breeding numbers, causing serious implications not only for their immediate habitat but also for the greater ecosystem. (2)

The first sighting of green iguanas was reported from Florida, as early as in 1966. The arboreal herbivores were alleged to have arrived into the Sunshine State as stowaways on cargo ships bringing consignment of fruits from South and Central America, promptly escaping into the wild, once the fruit crates were opened. Gradually, with the pet trade gaining momentum, more of these dewlapped creatures were imported and adopted by besotted individuals and families. Some of these "escape artists" managed to make off into freedom. Others were intentionally liberated. Many of the escapees and the manumitted, survived, acclimatized, multiplied, thrived, matured and developed the ability to adapt extraordinarily well to their new environment. (3)

The antediluvian countenanced saurian with its smorgasbord of anatomical coloration has always been spectacular pet material for hobbyists and beginners. The intelligent lizard, which can distinguish its owner both by sight and voice, has

Corresponding author E-mail : katasraj@rediffmail.com

been preferred by many enthusiasts for its easy demeanor, inexpensive maintenance, absence of odoriferous offence, housetraining amenability to newspaper and adaptability to an extensive medley of lifestyles and household ambience and setting with minimum of fuss.

Though undemanding of constant attention, iguanas dislike being picked up or handled recurrently. They are pets to be enjoyed visually, therapeutically, or emotionally, rather than through palpability, tactility or physicality.

Iguanas transmit, receive and exchange communication, with one another and with their handlers mainly through vocalization, visual communication and body language. Since they do not possess vocal chords, the reptiles, hiss, click, wheeze or breathe shallowly depending on the situation. Posturing, strutting, stylized walking, tongue and tail flicking constitute vocabulary through kinesics. Limpidly swaying dewlaps exude non –aggressive behavior while when flared, signify either aggression or defense. Splayed dorsal and nuchal crest represent intimidation and threat.

A study by the University of Georgia, in 2021 revealed an invasive population of 20,000 iguanas of three salient varieties – green, black spiny tail – and Mexican spiny tail iguanas.

Iguanas are endemic to Guatemala, Honduras, El Salvador, Nicaragua and Costa Rica, with their range spreading all the way from Venezuela to Paraguay on mainland South America. Apart from the green iguana, these include ten species of spiny-tailed iguanas. Many of the species are difficult to tell apart, particularly at the juvenile stage. Green iguanas resemble regular lizards. Based on their native geographical habitat and range, the crown contour, integumentary ordonnance, physical dimension and colour, patterning, vary from one individual to another.

Regardless of the umbrella term "green iguana", the tree - and shrub-dwelling poikilotherms come in a plethora of colours. The pet trade has been responsible for importing many non-indigenous species of green iguanas from El Salvador (bright to faded blue), Costa Rica (red), Mexico (orange), Caribbean islands (pink, black, lavender, green) and Puerto Rico (dark grey to brick red). (4)

Adult green iguanas are arguably the largest lizards in the Americas- usually 4 to 5 feet long, some specimens make it to 7 feet. The tail constitutes more than 50% of this length and is sometimes thrice the body length. Caudal autotomy capacitates iguanas to voluntarily shed a body part in response to attempted predation. The detached tail can carry on quivering and pulsating for half an hour or longer. Research has established that the self – amputated appendage enacts tortuous, complex movements, with sudden and abrupt vertical flips up to 3 cm. The pulsating and throbbing motion, consistently deflects the focus of the predator or hunter, enabling the scaled herbivore to escape.

Caudal autotomy occurs at the flat structural strata known as the fracture planes of the lacertilian's tail. In the event of tail autotomy incorporating the vertebra, the tail gets broken or snapped at a pronouncedly emasculated region of the reptilian appendage. Studies have revealed that these species accelerate the mechanism of autotomy by constricting muscle tissues around the fracture strata, which occur at pre-formed intervals along the lizard's tail. The flexion, tension and contraction of the muscles split the skin to ensure complete detachment of the tail.

The sinewy-legged and long-toed iguanas, endowed with lanceolated talons, are masterly climbers. With the second and third toe much longer than the others, they can easily grasp boughs and branches to ascend vegetation. The generalist herbivores are equally adept at swimming and burrowing and have been recorded running at a top speed of 21 miles per hour. (6) They can also hold their breath underwater for 10 hours, unmatched by any animal on the planet holding its breath underwater. (7)

The green species is different from the other iguanas as they have spikes that usually go down the spine to their tail area. Males weigh up to 9kgs and females up to 3 kgs. Green Iguanas have a dewlap, which is a flap of skin under their lower lip and jawline. They also have a sequence of long tensile and flexible spines running down their back, from the nape of the neck to the tip of the tail. Males have longer spikes and larger dewlaps and jowls than the female of the species.

Sexually maturing between the ages of 2 and 3, gravid females, usually in early February, lay clutches of up to 30 eggs in nests, made with wet sand and sundry vegetation, in burrows. After a period of 100-120 days, the eggs hatch in April or May, with the hatchlings hollowing their way out.

Today, the herbivorous lizards reproducing rapidly have established themselves throughout South and Central Florida. They arbitrarily feed on both widespread and endangered plants, usurp hollows and warrens of gopher tortoises and burrowing owls, inconvenience native wildlife populations, damage commercial and residential gardens and landscape vegetation and ravage golf courses.

In Florida, iguanas have become so abundant that they can be seen darting across highways and pavements, cavorting in canals and ponds, and moving up trees in residential backyards or basking on rooftops. Equally at home, afloat or submerged, in salt and freshwater, iguanas root intricate, interconnected tunnels with numerous exits and entrances. Such aggressive, subterranean activity can considerably deteriorate waterfronts, weaken the stability of trees, etiolate decks, patios and yards, undermine sidewalks, adversely affect roadways, undermine seawalls and levees, and interfere with the safety and stability of home structures.

Iguana have also caused serial power outages by snuggling into transformers in substations during winter, to stay warm. Most of them have been found to survive 69,000-volt charges from electric equipment with the mere sacrifice of a tail or in the worst-case scenario, a leg. Most Florida substations have installed iguana guards at US$ 17,000 each. These are fiberglass caps that cover transformer parts in the substation to which iguanas are attracted for warmth. (12)

Although the Sunshine State has since incentivized the culling of green iguanas for their skin and meat, the population of these fecund and prolific reptiles shows no signs of abating.

Invasive colonies of iguanas, colloquially called, gallina de palo ("bamboo chicken" or "chicken of the tree"), prosper vigorously in South Florida (including the Florida Keys), Rio Grande Valley of Texas, the US Virgin Islands and Hawaii. The lacertilians have, in similar fashion, satisfactorily established themselves on the island of Anguilla, Guadeloupe, Cayman Islands, Fiji, Taiwan, Thailand, Singapore and Ishigaki Island, south-west of Okinawa, assuming invasive status in the USA, Fiji and all over the Caribbean. Little Gasparilla barrier island in southwest Florida, alone is estimated to be home to more than 12,000 iguanas. (11)

In Central America, particularly in Nicaragua and Costa Rica, there is a history of using iguana skin for the manufacture of leather handicrafts, purses, wallets, shoes and belts that are sold in local markets. However, based on market surveys and trade data, it appears the use of iguanines for leather is currently not common. Some mounted specimens and a variety of curios made from iguanines make it to the markets, but there is no evidence of significant trade in leather products made from iguanines, especially when compared to the scale of trade in iguanas for food and pets. Local market hunting and the international pet trade are clearly the drivers of iguana and ctenosaur exploitation in Central America. (13)

The main function of the epidermal layer of iguanas is to protect its body from evaporation because the fur- and hairless arboreal dwellers, lack a thermostatic layer, and have to rely on outside sources, such as sunlight, for their heat supply. Since the characteristic ossified horny scales and plates are structures of the corium, not of the epidermis, after the removal of the epidermis, the characteristic horny structures remain, giving the attractive design of reptile leather.

Iguana skins, which make very attractive and durable leather products have not yet gained commercial traction in Florida and elsewhere in the United States, because of a number of factors. Owing to ignorance, callousness or faulty flaying, curing and preservation, the skins often reach the tanning facility in too bad a condition to tan. The usual ante- and post-mortem- defects which by a little attention, could be easily avoided are cuts, gouge marks, bad shape, scale slip and putrefaction. Damage due to delayed flaying or dragging over rough ground is also common. So is damage due to over- drying or overexposure to the sun, due to distortion and overextension, or to the action of beetles after the skins have been dried.

It is also imperative that the flaying of reptile skins is to be done immediately upon cull or slaughter, before decomposition, with consequent scale slip, can take place, at least within three hours after the death of the lacertian.

The catching and killing of iguanas is by humane methods, as in case of livestock animals. Spearing and battering reptiles to death with hammers, sticks and stones will certainly not secure a perfect skin. The preferred option is a headshot with a single bullet.

Smaller reptiles are sometimes caught and brought alive to be euthanized humanely with anesthetics. Formaldehyde injection is unsuitable because of its tanning effect, which hinders the removal of the epidermis in the tanning process. Electrocution of iguanas prior to flaying, adversely impacts the skin quality. (14)

Some of the companies making leather and mounted specimens from this invasive species including, handbags, jackets, belts, shoes and accessories are Gold Dogs, Seattle

(Iguana cowboy boots), Midwest Traders, Adelaide, South Australia (Iguana Lizard Skin Boots), Art Studio, Odessa, Ukraine (bags, briefcases, purses, diplomats, purses, wallets, purses, belts, cell phone cases, cases for tablets and spectacle cases) WildTech, Green Cove Springs, Florida (Bifold wallets) and Iguana Leathers & Co., Sachse, Texas (contemporary, minimalist and modern designs of leather accessories)

Mike Kimmell, who operates Martin County Trapping & Wildlife Rescue in Indian Town, a village in Martin County, Florida, has killed hundreds of iguanas over a decade uses all parts of the iguana. He regularly eats them and says they're delicious. All lizards are skinned and tanned, and the leather is used for making wallets, purses, even pistol holsters. Heads and claws of large lizards are made into trinkets for tourists.

Most green iguanas the iguana huntsman has shot were 2-4 feet in length and his biggest to date is a gargantuan 6-footer behemoth that tipped the scales in excess of 8 Kg. Kimmel shot that saurian in 2021 on a golf course and had it taxidermized. He uses the mounted lizard as a visual medium during environmental education sessions at fairs, hunting workshops and fairs. (15)

In February 2021, The Florida Fish and Wildlife Conservation Commission banned the import, breeding and possession of sixteen most harmful non-indigenous species, including the green iguana. Pet owners have been permitted to keep existing pets with a no-cost permit requiring conformance to the latest regulations, which deny authorization to replace the companion animal, upon its death. After June 2024, breeding of animals on the list for commercial sale will be prohibited. (16)

Although appreciable progress has been made to contain the "green goblins", more concerted effort needs to be made by iguana wranglers, hunters, leather businesses and restaurants to popularize iguana leather and meat to bring down their numbers to more manageable and satisfactory levels.

Reference

1. https://www.ibisworld.com/industry-statistics/number-of-businesses/pet-stores-united-states/
2. https://www.onegreenplanet.org/animalsandnature/what-happens-when-people-release-exotic-animals-into-the-wild/
3. https://animal-world.com/encyclo/reptiles/lizards_iguanid/GreenIguana.php
4. https://wildlifetroopers.com/why-are-iguanas-a-problem-in-florida/
5. https://www.thehindu.com/sci-tech/science/self-amputation-in-lizards/article32125428.ece
6. https://oddlycutepets.com/how-fast-can-an-iguana-run/
7. https://oddlycutepets.com/how-long-can-an-iguana-stay-underwater/
8. file:///D:/Data/Downloads/IguanaTrade2012.pdf
9. https://oddlycutepets.com/how-long-can-an-iguana-stay-underwater/
10. https://www.outdoorlife.com/conservation/florida-iguana-invasion/
11. https://en.wikipedia.org/wiki/Green _ iguana #Anatomy _and_morphologies
12. https://a-z-animals.com/blog/iguanas-in-florida-what-species-are-native-to-florida/?from=exit_intent
13. https://www.researchgate.net/publication/271443622_Survey_of_Status_Trade_and_Exploitation_of_Central_American_Iguanas
14. https://open.unido.org/api/documents/4685419/download/THE%20TANNING%20AND%20INDUSTRIAL%20PRODUCTION%20OF%20REPTILE%20LEATHER2020UNDER%20CONDITIONS%20ENCOUNTERED%0IN%20DEVELOPING%20COUNTRIES%20(02323d.en)
15. https://www.wideopenspaces.com/florida-iguana-hunter/
16. https://thehill.com/changing-america/sustainability/environment/544388-florida-bans-toilet-invading-iguanas-and-15-other/#:-:text =Florida%20bans%20toilet%2Dinvading%20iguanas%20and%2015%20other%20invasive%20species,-by%20Joseph%20 Guzman & text=The%20rule%20allows%20for%20current,the%20animal%20once%20it%20dies.

This article was originaly published in Vol.- 27 No.- 08 Aug' 1979 issue of JILTA.

Procter Memorial Lecture

Collagen—Nature's Framework in the Medical, Food and Leather Industries

A. J. BAILEY

Muscle and Collagen Research Group, University of Bristol, Langford, Bristol, England.

Summary

Over the past two decades 'collagen' has grown into a large family of genetically distinct molecules, and the characteristic triple helical structure has also been shown to be present in several non-collagenous proteins. Details of the structure are now so refined that the mutation of a single glycine by cystcine has been shown to lead to a lethal form of a brittle bone disease. The chemistry of the polymeisation of the collagen molecules is now well established, although the additional cross-link reactions with increasing age are less clear. Some of these later reactions are non-enzymatic involving glucose, and are found to be accelerated in diabetics. However, the fundamental structure of collagen as a stable triple helix precisely polymerised into mechanically strong fibres provides the leather industry with its basic commodity, the food indusry wih a gel forming protein and the meat industry with the determining factor in the texture of meat. The quality of gelatin gels depends on the ability of the triple helix to reform, the kinetics of which in turn depend partly on the nature and location of the cross-links. Similarly, the texture of meat is determined by the strength of the small proportion of denatured collagen in meat following cooking, which again depends on the thermally stable cross-links.

The biological diversity of collagenous structures and their varied functions in nature, as well as their role in the food and leather industries can now, to large extent be explained, a far cry from the data availallble to the earliest collagen chemist, Henry Procter.

Introduction

I consider it a singular honour to be invited to deliver the Procter Memorial Lecture, and doubly honoured to deliver it on the occasion of the Centennial of the founding of the Procter Department here in Leeds.

In setting up the first Department of Leather Industries Henry Procter, as a practical tanner, realised that technology could only advance the industry so far, and further improvements would come to a stop without a basic understanding of the chemistry of both the source material and of the tanning process. He therefore insisted that all his students acquired a good grounding in chemistry. It is interesting to read of the problems he had in setting up the department 100 years ago ie. financial restrictions; invitations to set up a similar school in the US; the general feeling among tanners that "scientific advice is well enough if 'gratis', but not worth

52

paying for", and that the setting up of a Professor of Leather gave scope for jest and some indignation in the more austere academic circles.[1] However, Henry Procter had the last laugh, the department became world famous and not only were sound principles applied to industry but his own fundamental research was sufficiently academic to gain his election to a Fellowship of The Royal Society.

In his attempt to understand the source material Procter undertook a detailed light microscopy study of the corium, and demonstrated the importance of fibre packing, and the organization of the fibre bundles in the subsequent properties of the leather. He noted that the white interlacing fibres of collagen in the dense dermis appeared to be of two types and that they were cemented together by an unknown component (now known to be proteoglycan). He also observed that 'splitting' occurred along the lines of organization of the bundlse and that tightness of the sheath determined the extent of 'opening up' of the structure. Oxhide was clearly very much more tightly bound than calf-hide.

Procter's other primary interest was in the swelling of the leather and particular attention was laid on gelatin as a model system. He recognized the amphoteric nature due to acid and basic groups, being aware of the contemporary work of Fisher on the amino acids. The high molecular weight of the 'colloidal solution' of gelatin made advances slow but Procter realised that on application of the Donnan equilibrium calculation, although verifying the predicted ion distribution, there appeared to be a constraint limiting swelling. Since the swelling was controlled by Hooke's Law he recognized that the classic response must be due to a network of cross-linkages binding smaller units. He estimated the molecular weight of these units at about 1000, and suggested that the cross-linking in the sold state ie. the collagen of the corium would be even greater.[2]

It is to these two perceptive insights of Professor Procter's in the early 1900s ie. (1) the apparently different types of collagen fibre in the organization of the skin, and (2) the cross-linking of the fibres to provide mechanical strength, that I should like to dedicate this Centennial lecture.

1) Types of Collagen in the Skin

Before discussing the organization of the collagen fibres in the skin it is worth while briefly reviewing the current state of knowledge on the structure of the collagen molecule and its organization in the fibre.

Structure of the Collagen Fibre

Not surprisingly the chemistry of collagen has moved on considerably since Henry Procter published his text-book on tanning in 1885 and his Principles of Leather Manufacture in 1903. However, it was some considerable time before any real advances were made, firstly the triple helical structure of the molecule was elucidated in the 1950s[3], and secondly the alignment of the molecules in the fibre was determined in the 1960s.[4] The chemistry of the inter-molecular cross-links subsequenly explained t he crucial mechanical properties of collagen in the 1970s.[5] During the 1980s there has been an explosion of interest and understanding of the genetically distinct types of collagen that are now beginning to explain its diverse biological structures, and hence their function.[6, 7, 8] These rapid advances in knowledge have primarily been due to the new techniques in molecular biology allowing the characterisation of the collagen genes. Indeed the nucleotide sequence of the gene can now be determined and translated to an amino acid sequence for a complete *x-chain* in a fraction of the time required to sequence the chain by the standard amino acid sequencing techniques. This ability to sequence the gene has now been applied to the identification of genetic mutaions that lead to heritable defects in the organization and function of the collagenous organs of he body. Examples of these defects will be discussed later.

Although Henry Procter could detect differences in the fibres at the light microscope level it was not until the 1940s with the advent of the electron microscope that one could observe the individual fibres. In cross-section they had a surprisingly uniform diameter, and possess a unique 67 nm axially periodicity. This periodicity was subsequently shown to be due to the quarter-stagger alignment of

53

the individual molecules in the fibre. The triple helical nature of the molecules was first determined by the X-ray diffraction of the fibres, but the length of the molecules was determined in the electron microscope by re-precipitating the molecules from solution with their ends in register. The molecular length was shown to be 4.4 times the length of the axial periodicity of 67 nm indicating a 25 nm end overlap of the molecules within the quarter-stagger alignment.

The basic structure of the collagen molecule is very simple. The primary sequence is a tripeptide repeat (Gly-X-Y)n where X is often proline. Glycine therefore occupies every third residue, and the proline twists the chain into a polyproline helix, rather than the more common α-helix of the globular proteins (Fig. 1). The small side chain of glycine, a simple hydrogen atom, allows

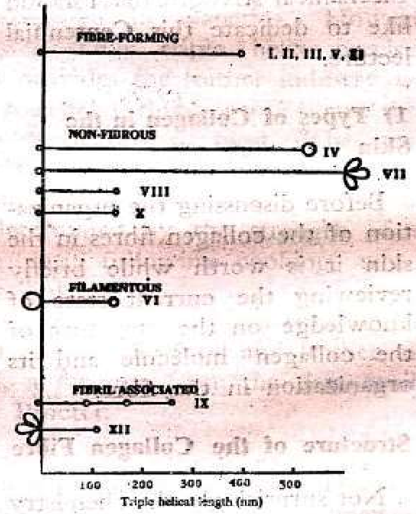
1. TRIPLET REPEAT
(GLY-X-Y) 100 400
2. TRIPLE HELIX

3. HYDROXYLATED PROLINE AND LYSINE

Figure 1. Definition of collagen. Three repeating tri-peptides each coiled in a left-handed polypropline helix interacting to form a right-handed super-triple helix and containing hydroxyproline and hydroxylysine.

these polyproline helices to pack in close contact and from a super-coiled triple helix. The triple helix is stabilised by a H-bond from the glycine to the peptide backbone of an adjacent chain. The larger polar and non-polar amino acid side chains face radially outwards from the cylindrical helix providing a charge profile along the molecule. It is this charge profile that spontaneously drives the self-assembly of the collagen molecules into the quarter-staggered alignment of the collagen fibre.[9]

Over the past decade several new collagens have been identified that do not form the classical banded fibres despite the presence of the typical triple helical structure.[8,7] The variety of different supramolecular aggregates assumed by these new collagens is achieved by variation in the properties of the collagen molecule (Fig. 2) for example.



Triple helical length (nm)

Figure 2. Molecular forms of collagen classified into 4 groups based on their supra-macromolecular structure in tissues.

(i) in the length of the triple helix,

(ii) the charge profile along the helix,

(iii) interruptions in the integrity of the triple helix,

(iv) the size and shape of the terminal globular domains,

(v) the cleavage or retention of the latter in the supra-macromolecular aggregate.

(vi) and variation in the post-translational modifications.

These modifications of the basic structure of the molecule lead to dramatic differences in the mode of their aggregation to form the supramolecular structures found in the different tissues (Table I). The identification of these structures and consequent differing functions has at last allowed the collagen chemist to begin to account for the biological diversity of collagenous tissues.

Their variation in structure makes the molecules difficult to classify. Some classifications have based on the genetic structure, other on the molecular weight, or the length of the triple helix, others on the fact that the triple helix is interrupted by non-helical domains. At the current stage of knowledge with more collagens to be characterised the most useful approach is probably to classify on the nature of aggregated structure. The 14 molecules identified to date can then be classified as ; (i) fibrous collagens (ii) non-fibrous collagens (iii) filamentous collagens and (iv) fibril associated collagens.

(i) Fibre Forming Collagens

The fibre forming collagens are types I, II, III, V and XI. Each possesses a 300 nm triple helix from which the N-and C-

54

globular domains have been partially removed prior to aggregation of the molecules in the quarterstagger. alignment (Fog. 3). These fibres act as the main framework of the mamma-

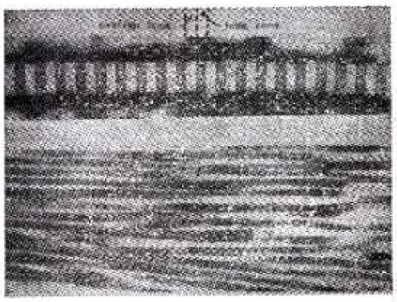


Figure 3. Fibrous collagens. (a) Molecular organization of the collagen molecules in the quarter-stagger end-overlap to produce the characteristic 67 nm banding of the collagen fibre (b) and the organization of the fibres in the dermis (c).

lian body. Type I is the major collagen of the skin and tendon, and of the hard calcified tissues, bone and dentine. Type III collagen always produces fine fibres and is widely distributed, but is present in high proportions in foetal skin and the vascular system, ie. generally where a more flexible tissue is required.

(ii) Non-fibrous collagens

(a) *Net-works.* Type V collagen possesses a long triple helix (400 nm) but lacks the charge profile to form quarter-staggered fibres, and in contrast to the fibrous collagens retains its terminal globular domains in the aggregated structure. The molecules interact in an anti-parallel fashion through their N-terminal regions with a small overlap of 80 nm to form tetramers.[10] The C-terminal globu-

TABLE I

Tissue Distribution of Collagen Types

Type	*Structure*	*Distribution*
I	Large banded fibrils	Widespread skin, tendon, bone
II	Small banded fibril	Cartilage, vitreous, IV disc
III	Small banded fibrils	Foetal skin, vascular system
IV	Non-fibrous network	Basement membrane, lens capsule, kidney glomeruli, capillaries
V	Small-banded fibrils	Widespread: skin, tendone, bone
VI	Filaments, 100 nm periodicity	Widespread: skin, tendon, cartilage
VII	Antiparallel dimers anchoring fibrils	Skin, placenia, cervix
VIII	Hexagonal lattice	Descemet's membrane
IX	Type II fibre associated	Cartilage, vitreeas
X	Hexagonal lattice	Mineralizing cartilage
XI	Fine fibrils? Copolymer with Type II?	Cartilage
XII	Type L fibre associated	Tenon

lar domains at the end of these extended arms of the tetramer then interact to form a network, or "chicken-wire" structure[11] (Fig. 4). This network forms the framework of basement membranes, for example the kidney glomeruli, dermal-epidermal junction and capillaries. The open sturcture is ideal for the

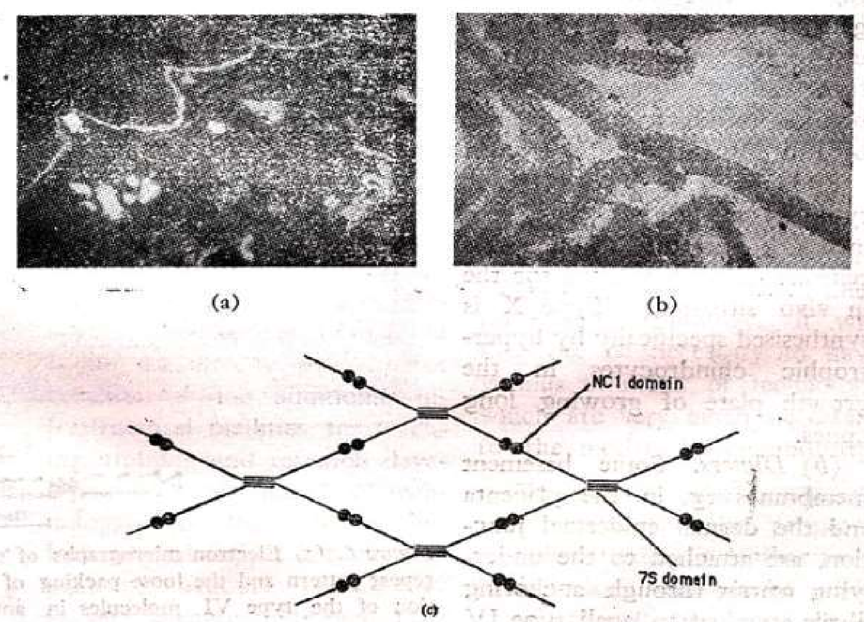


Figure 4. Non-fibrous collagen. (a) dermal-epidermal basement membrane stained with antibody to type IV collagen, (b) high resolution electron micrograph of glomerula basement membrane, (c) diagrammatic representation of the organzation of the type IV collagen molecules in the basement membrane.

55

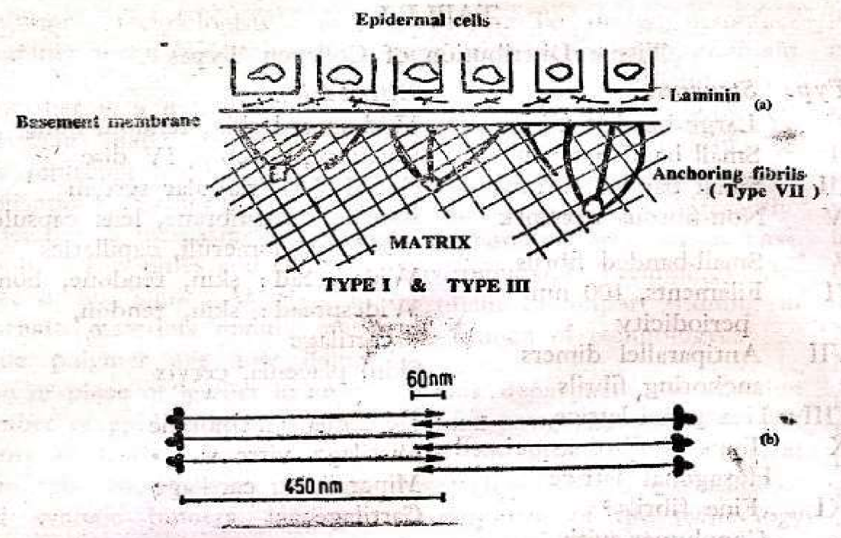


Figure 5. Non-fibrous dimeric collagens. (a) diagrammatic representation of anchoring fibrils attaching basement membrane to the underlying matrix. (b) molecular alignment of the type VII collagen molecules in anchoring fibrils.

incorporation of other component molecules ie. laminin, heparan sulphate, entactin and osteonectin, etc. It has been suggested that type VIII collagen molecules make up the unique hexagonal network structure of Descement's membrane[12, 13], which is synthesised by the corneal endothelial cells.

Preliminary studies in vitro on type X collagen also suggest a network structure,[14] bubt this remains to be confirmed for the in vivo situation. Type X is synthesised specifically by hypertrophic chindrocytes in the growth plate of growing long bones.

(*b*) *Dimers.* Some basement membranes eg. in the placenta and the dermal epidermal junction, are attached to the underlying matrix through anchoring fibrils attached to small type IV plaques in the matrix. These anchoring fibrils are made up of two type VII molecules end-overlapped in an anti-parallel fashion (Fig. 5).[15] The fibres are therefore only two molecules in length, but several combine laterally to form the fibre observed in the electron microscope.

(iii) Filamentous Collagens

Loosely packed fibrils with a repeating pattern of about 100 nm have been shown to be comprised of type VI collagen.[16] The molecules posses short triple helices, about 100 nm, but large globular regions at both the N and C-termini. The globular region of one of the three α-chains has a molecular weight about double that of the other two α-chains. Aggregation is complex, initially involving the extensive overlapping of two molecules in an anti-parallel manner, then two of these dimers aggregating to form a stable tetramer. The teramers subsequently aggregate longitudinally through their terminal globular domains to form long filamentous structures (Fig. 6).[17] Type VI fibres are widely distributed as a minor component of many different collagenous tissues, for example, cartilage, skin, tendon and bone, but

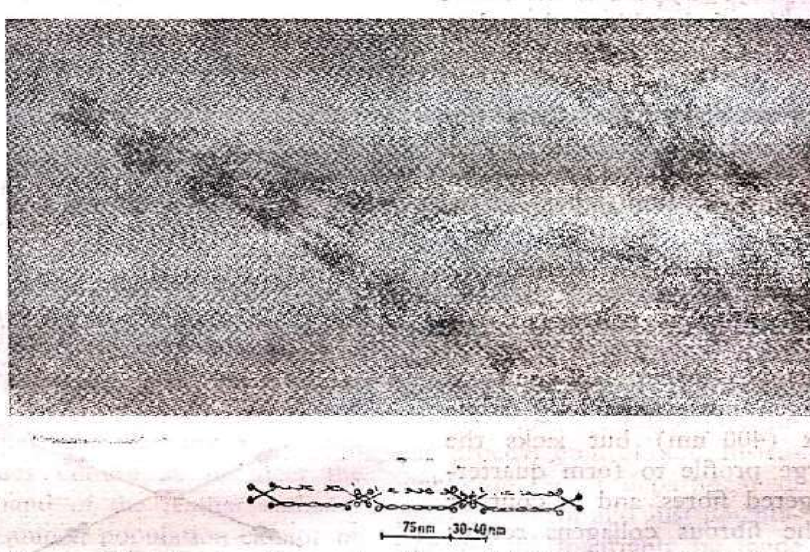


Figure 6. (a) Electron micrographs of type VI fibrils illustrating the 100nm repeat pattern and the loose packing of the fibrils (b) schematic representation of the type VI molecules in antiparalled array in the filamentous structure.

the function of these fibres has not been elucidated. It has been suggested that they may play a role in the spacing and alignment of other fibres in tissues, for example, the highly organized type I fibres in the cornea.

(iv) Fibril Associated Collagens

These collagens are found in association with the quarter-staggered fibres of other collagen types. This group includes the FACIT collagens i.e. the Fibril Associated Collagens with Interrupted Triple Helices. For example, type IX collagen has been shown to be attached to the surface of type II fibres[18] (Fig. 7), and type XII has been reported to be attached to type I fibres in some tissue.[19] The function of these collagens is not

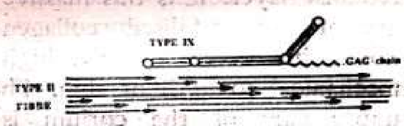


Figure 7. Fibril associated collagens. Arrangement of the type IX molecules on the surface of a type II fibre.

clear, but they could be involved in the regulation of fibre diameter, or they may be involved in the interaction of fibres with other components of the extracellular matrix. In this context it is interesting to note that type IX could be considered a proteoglycan since the a-2(IX) chain acts as a core protein for a chondroitin, or dermatan sulphate, side-chain.

Two further collagens, types XIV and XV have been identified by cDNA analysis and tentatively assigned to this group of collagens.[20]

The variety of supramacromolecular structures achieved by the family of collagen molecules is unequalled by any other protein.

Non-Collagenous Proteins

A number of other protein molecules contain short sections of the collagen triple helix but they are not classified as members of the collagen family as they do not form the supramacromolecular structures that act as the supporting framework of the extracelluar matrix. About six of these proteins have now been identified for example, the complement component Clq[21], acetyl cholinesterase.[22] Recently, collagen sequences have been identified in bacteria.[23]

Precision in the Organization of the Collagen Supramacro-molecular Aggregates

Genetic Defects in Collagen

The rules of organization of the collagen molecules into their various structures are extremely precise. This can be demonstrated by the dramatic effect of genetic defects on the structure and function of tissues. The collagen genes have been identified on a number of different chromosomes including the **genes for the αI(1) and α2(I) chains. The gene for the α-2** chain of type I collagen is extremely large, only 8% of its length being translated to the collagen amino acid sequence.[24] Many examples of gene defects have now been identified, from point mutations, to deletions, repetitions or even the loss of a complete gene.[25] The biosynthesis of collagen is a lengthy and complex process even after translation, when twelve different enzymes are involved in various post-translational modifications of the molecule.[26] These post-translational modifications are also critical in the formation of normal fibres. To illustrate these points I shalll consider three examples where the gene defect has been conclusively identified with a structural defect in the tissue of a particular inherited disorder.

(i) Point mutation

A particularly dramatic example is the point mutation of the glycine at residue 748 in the **helical region of the α-1 chain** of type I collagen to cysteine that occurs in the lethal form of Osteogenesis Imperfecta, or brittle bone disease.[27] The introduction of the bulky side chain of cysteine in the place of **glycine in the two α-1 chains** causes a deformation of the triple helix resulting in a kink in the molecule. *In vitro* attempts to form fibres from the molecules, synthesised in culture resulted in the formation of branched fibres, clearly resulting in an inability of the fibres to pack into the thick type I fibres necessary for the strength of bone. Conclusive support that this single mutation was capable of producing such a dramatic effect on the strength of the bone was elegantly demonstrated by the use of transgenic mice. These mice with engineered **α-I(I) collagen genes** with the specific glycine mutation showed a dominant lethal phenotype characteristic of the

57

human disease.[29] Surprisingly, as little as 10% mutant gene expression prevents normal bone formation (Fig. 8).

A number of other defects in type I collagen have been identified in different forms of osteogenesis imperfecta, but have not yet been definitely correlated with a structural change.[30]

(ii) Collagen type deficiency

Certain individuals lack type VII collagen, the anchoring fibrils which attach the basement membrane to the under-

aggregation of the molecules into the quarter-staggered fibre (Fig. 9). The cross-section of the fibres are star-shaped rather than circular, thus preventing the formation of a network of cross-links throughout the fibre to provide mechanical strength.[33] The dermis of cattle and sheep with this disease is extremely fragile, easily tearing under the slightest tension. A milder form of the defect exists in humans, and is one of the Ehlers-Danlos syndromes.[30]

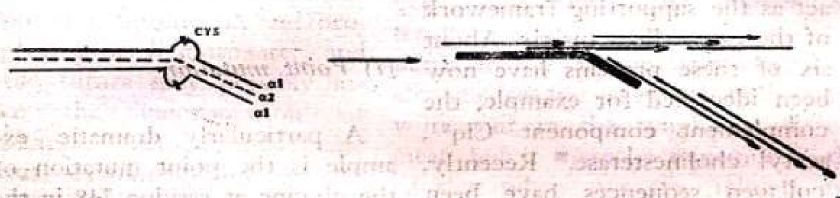


Figure 8. Cysteine side chains causing deformation of the triple helix, and subsequent branching during fibrilogenesis.

lying matrix.[31] This deficiency leads to extensive blistering of the skin as the epidermis lifts from the corium at the dermal-epidermal junction. This severe disease is known as dystrophic Epidermolysis Bullosa.

(iii) Post-translational defect

Another example of the precision required for the organization of the collagen molecule into a functioning fibrous tissue is a defect that results in fragile skin, known as dermatosparaxis.[32] Following secretion of the pro-collagen molecule the N- and C-terminal non-helical domains are sequentially cleaved by specific enzymes for each of these domains. The deficiency of the No-pro-collagen peptidase results in the retention of the N-terminal globular domains, which in turn sterically hinders normal

Collagen is not only important in the heritable disorders of connective tissues, but is also now becoming increasingly studied as an important compo-

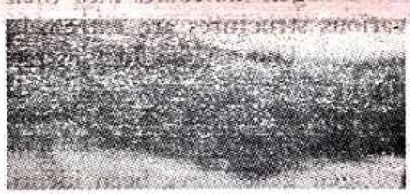


Figure 9. Transmission electron micrograph of a typically disorganized fibre isolated from the dermis of a dermatosparactic calf.

nent in the acquired connective tissue diseases. The major diseases being studied are osteoarthiritis, rheumatoid arthiritis, ostzoporosis, diabetes and fibrotic diseases.

Organization of the fibres in the dermis

Animal skin is the basis of leather, hence knowledge of its microstructure is essential for an understanding of the changes taking place during the tanning process. Henry Procter, as previously mentioned, described the skin as two distinct layers, the epidemis and the corium, the latter being composed of white interlacing collagen fibres cemented together by a substance removed during liming, now known to be dermatan sulphate.

The epidermis and any underlying subcutaneous tissue are removed during processing leaving the corium, which, due to the net-like appearance of the fibres, is also referred to as the reticular layer. It is this massive network of stabilised collagen fibres that determines the high mechanical strength of skin. The upper part of the corium is known as the grain layer and the structure of this layer determines the appearance of the leather. Procter noted that the corium contained discrete bundles whilst the upper grain layer was composed of tightly packed individual fibres. Further, he noted that the corium bundles appeared to be surrounded by a different type of much thinner fibre. He described these bundles as splitting longitudinally into finer fibres, and that the ability to 'open up' the structure depended on the tightness of the packing of these bundle sheaths. For example the packing was clearly much looser in calf skin than ox hide. The opening-up of the structuress is obviously important for the in-

58

gress of the tanning solutions and Procter attempted to follow the changes in structure produced by the processing conditions.

We can now think in terms of the genetic types of collagen distriuted in the dermis (Table II), their distribution in relation to fibre bundle packing, together with the differences in the intermolecular cross-linking of the individual fibres, and the interaction with the proteoglycans. During the development of the dermis there is a high proportion of type III collagen fibres, about 40%, but this decreases rapidly postnatally to about 15%.[34] The fine type III fibres are usually present in tissues that require flexibility as does the skin during growth, and indeed these fibres are replaced by larger and larger type I fibres as the animal grows. As growth slows at maturity the fibres possess a fairly uniform diameter throughout the reticular layer and maintain that diameter throughout life.

The boundary between the epidermis and the dermis has long been known to stain intensively with silver indicating a distinct component in the skin. The structure of this layer was later identified as a typical amorphous basement membrane consisting of of a lamina densa and a lamina rara. This structure is now known to be based on the open framework of type IV collagen aggregates, together with the major glycoproteins of basement membrane, laminin, fibronectin and heparan sulphate. As mentioned above the basement membrane is attached to the underlying matrix by anchoring fibrils to small type IV plaques in the matrix. These anchoring fibrils have been shown to be type VII collagen.[15] The network of banded collagen fibres immediately below the membrane have been shown to be mainly type III collagen fibres with some type I and type V. This distinct boundary between the epidermis and the reticular layer is fragile and is sensitive to chemical, enzymatic and mechanical treatment and is consequently lost with the epidermis on liming, leaving a surface of tightly packed individual type III fibres, known as the grain layer. The surface of the grain layer was described by Procter is being composed of fine elementary fibrils so densely packed that a structure could not be recognized.

When examined in the scanning electron microscope the fibres are seen to have a smooth surface, which together with the viscous inter-fibrillar proteoglycans allows ease of movement within the fibre weave. The difference between the grain layer and the corium can readily be appreciated in the electron microscope. In the centre of the corium the arrangement of the fibre bundles can be seen, each bundle being encircled by a sheath of fine fibrils. At high magnification in the transmission electron microscope when viewed in cross-section these thick fibres are seen to be made up of even finer fibres with a diameter of about 5 μm, and each fibril within the bundle having a diameter of about 0.08 μm (Fig. 10).

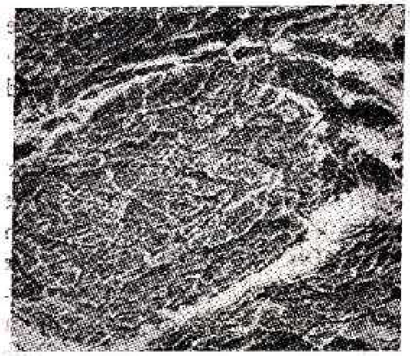
The grain layer also contains fibres in which the collagen molecules have retained their N-terminal propetide extensions, although the C-terminal propeptide has been completely

TABLE II

Collagen Types in Bovin Hides

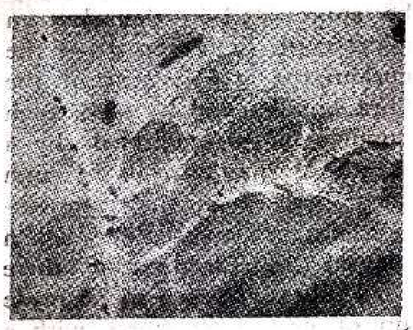
Region of Hide	*Collagen type*	*Fibre Type*
Grain layer	Type I	Fine banded fibrils
	Type III	Fine banded fibrils
	pro Type I/pro Type III	Microfibrils
Reticular layer	Type I	Thick banded fibres
	Type III	Fine banded fibres
	Type V	Fine banded fibres
	Type VI	Filamentous structure
Basement membrane (dermal-epidermal junction)	Type IV	Non-fibrius structure
	Type VII	Anchoring fibrils

59



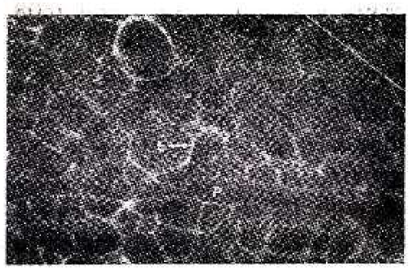
(a)

0.166 μm



(b)

2.2 μm



(c)

0.166 μm

Figure 10. Electrol micrographs of dermal collagen (a) scanning electron micrograph (mag × 1000) showing fine fibrils surrounding the bundles of larger collagen fibres. (b) transmission electron micrograph showing individual fibrils within each fibre. (c) transmission electron micrograph of a cross-section of dermis at high magnification (× 60000) showing the uniform size and circular cross-section of the fibrils. (Reproduced with permission from Haines, *JSLTC*, 1983, 68).

removed by the C-propetidase. These fibres are very small diameter but the presence of the N-propeptide can be established by immunofluorescence staining. Whether the fibres are inhibited from growing larger by the steric hindrance of the large propetides, or whether they are in a transition state before removal of the propeptides and and subsequent further growth is not yet clear. Certainly they do not continue to grow whilst retaining N-propeptide since this would result in the formation of star-shaped fibre cross-sections as seen in the dermatosparactic calf skin described earlier. The p-N-type I collagen is believed to be involved in growth of the fibril up to about 20-30 nm when the N-pro-preptide is cleaved thus allowing aggregation with other type I fibrils. On the other hand the p-N-type III collagen is retained throughout the growth of the fibril.[35] The effect of the liming process on these unusual fibrils does not appear to have been studied.

Over the past few years evidence is accumulating that the major fibrous collagens of the dermis (types I and III) are composed of a mixture of collagen types. Type I has been reported to contain type III, type V, and very recently type XII.[19] Type III has been shown by immunohistochemical studies to be present in the type I fibres regardless of the diameter. Its presence has been confirmed by the identification of a cross-link between type I and type III α-chains.[36] Recently a study of disrupted adult dermal fibres using double immunolabelling with antibodies to both type I and III collagen, has been carried out in an attempt to determine the distribution of the various types. The large type I fibres were found to possess type III on the periphery of the fibres.[37] Whether the are part of the hexagonal packing of the type I molecules, or exist as separate fibrils on the surface is not clear. More recently type XII collagen has been reported to exist on the surface of type I fibres in foetal tendon[19], but whether they are retained through to maturity of the tissue is as yet unknown. The presence of the type III and type XII collagens on the surafce poses the question as to their function, for example, are they regulating the fibril growth, controlling ultimate fibre diameter, or facilitating interaction of the fibre with other components of the matrix eg. fibronectin or proteoglycan. The mechanism of growth and regulation of fibre diameter is an important unsolved question in collagen biochemistry.

An unusual but well known characteristic of the dermal collagen fibres is their waviness seen under the microscope. When examined between cross polaroids the fibre exhibits birefringence or a periodic light and dark axial banding with a repeat of about 100-200 μm. This banding is referred to as the crimp structure and is considered in structural terms as a rigid planar zigzag with inflexible hinges.[38] The periodicity of the crimp increases with age of the tissue. On stretching of the fibre the wave form is removed. The crimping of collagen fibres is a general feature of most collenous tissues, but they do not

60

occur in cartilage and bone. Analysis by X-ray diffraction and electron microscopy supports the existence of the crimp and the latter shows a sharp bend in the fibre corresponding to the crimp. In the stress-strain curve of fibres from mature tissue there is a definite toe region before the linear part of the curve and the loss of this toe region on stretching corresponds to the loss of the crimp. The provision of such a limited compliant region which would have a decelerating effect on movement suggests that the crimp could be considered as a 'shock absorber' against potentially injurious mechanical shock.

The nature of the collagens in the bundle sheath and their resistance to liming and enzymes determines 'opening up' of the structure and hence plays a major role in determining the final quality of the leather. Both type I and type V collagen fires apear to be present in these bundle sheaths.

Another, and perhaps more important aspect of the stability of the hide in addition to the type of collagen is the nature and extent of the intermolecular cross-linking within the fibres. The reducible aldimine bonds are readily cleaved by the change in pH, leading to swelling, but a high proportion of the mature cross links prevents swelling and opening-up of the fibre bundles and consequently the penetration of the tanning solutions. A more vigorous treatment is therefore required for these skins but leads to a reduction in quality. Type VI collagen is distriubted throughout the grain layer and the corium.[39] The function of these type VI filamentous structures has not been determined but it has been suggesed that their position between the thicker type I fibres indicates a role in maintaining the alignment of the fibres in the tissue. This proposal is based primarily on the large number of cell binding sequences (Arg-Gly-Asp or RGD) in the short triple helical region, and its widespread distribution. The type VI collagen fibres do not possess the stabilising covalent lysine-derived cross-links, but are polymerised by disulphide bonds. The type VI fibres are therefore highly likely to be damaged by the liming process. If type VI indeed plays a role in aligning the fibres, then its removal from a hide a containing a high proportion of this collagen could lead to an opening up of the structure leading to a change in the quality of the leather.

The proportion of dermatan sulphate, hyaluronate, and to a lesser degree chondroitin sulphate, each of which bind water, determines the resilience of the skin, but these components would be degraded or even removed by the liming or enzyme processes and therefore also play a role similar to type VI collagen. The longitudinal splitting of the larger fibre bundles into elementary fine fibres of about the same size ie. 100 nm suggest that the interfibrillar matrix may be very important in the 'opening-up' process. The change in the srength of binding of these components particularly wtih age needs to be more thoroughly investigated.

The fine fibrils are internally cross-linked and therefore highly stable but the weak interactions stabilising the interfibrillar matrix removed during the processing can then be replaced by tanning fluids.

Collagen is relatively inert to chemical and biological attack but to increase both the mechanical strength and ability to resist deterioration hides are stabilised by cross-linking agents. Considerable variation can be achieved by the type of intermolecular bond introduced. The most commonly used are metal salts such as chrome, organic aldehydes such as glutaraldehyde and by vegetable tannins.[40] The mineral tanning agents cross-link through co-ordination bonds with the carboxyl side chains of glutamic and aspartic acids. Hydrated chromium III sulphate forms extended coordination complexes with itself and the hydroxyl, oxo, or sulphate groups of the complex can react with the side chains or peptide backbone of two collagen molecules to form a cross-link. The pH and water content can be adjusted to form stable complexes which can increase the thermal shrinkage temperature by as much as 30°C. Organic aldehydes form covalent cross-links by reacting with the Σ-NH_2 groups of lysine. Considerable variation in the type of adehyde employed can be exercised, although formaldehyde and glutaraldehyde are the most commonly used. The reaction with formaldehyde is reversible but glutaraldehyde forms chemically stable bonds. The nature of the latter are very complex and have not yet been fully characterised. Glutaralde

-61

hyde increases the shrinkage temperature by about 15°C, and renders the collagen stable to dilute acids and bases. Variation in the length of the cross-linking molecule can be achieved by polymethylene derivatives eg. polymethylene diisocyanates or imido-esters. Vegetable tannins ie. high molecular weight polyhydroxy compounds, form inter-molecular hydrogen bonds and salt links. The shrinkage temperature in these cases is little affected, but the collagen is hydrothermally more stable since the tannins effectively block the ingress of water.

2) Cross-Linking of Collagen

From his work on gelatin Procter prophesied the presence of units linked together by cross-links, and that the extent of this cross-linking would be greater in the native fibre of the dermis. The chemistry of these cross-links has now been worked out and provides an explation of the high mechanical strength of the collagen fibre and hence of the dermis. These cross-links are covalent bonds formed between the individual molecules within the fibre at highly specific points due to their precise alignment in the fibre. In the absence of these cross-links the fibre has no mechanical strength whatsoever, demonstrating that they are crucial for the optimal functioning of collagen fibres as a framework structure in the body.[5, 41]

The cross-links are formed by the oxidation of specific lysyl and hydroxylysyl residues in the globular terminal regions by the enzyme lysyl oxidase. The binding site for the enzyme is the sequence Hyl-Gly-His-Arg within the helix, which because of the end overlap arrangement of the molecules in the fibre is opposite the single lysine or hydroxylysine in the enzyme binding site to form a divalent cross-link, dehydro-hydroxylysinonorleucine, between two molecules.[5] If the aldehyde formed is hydroxylysine-aldehyde then following formation of the aldimine bodn a spontaneous Amadore Rerrangement occurs to give keto-imine cross-link, hydroxylynoketo-norleucine. These two divalent cross-links polymerise the molecules in a head to tail fashion and this provides strength to the fibre. However, the divalent cross links are only intermediates and with time are converted to multivalent cross-links capable of linking several molecules. For such a reaction to occur the molecules would have to be in register. We have therefore proposed that cross-linking takes place in two stages (Fig. 11), an initial longitudinal cross-linking of the end-overlapped molecules, and secondly by interaction of these cross-links between two microfibrils in register.[42]

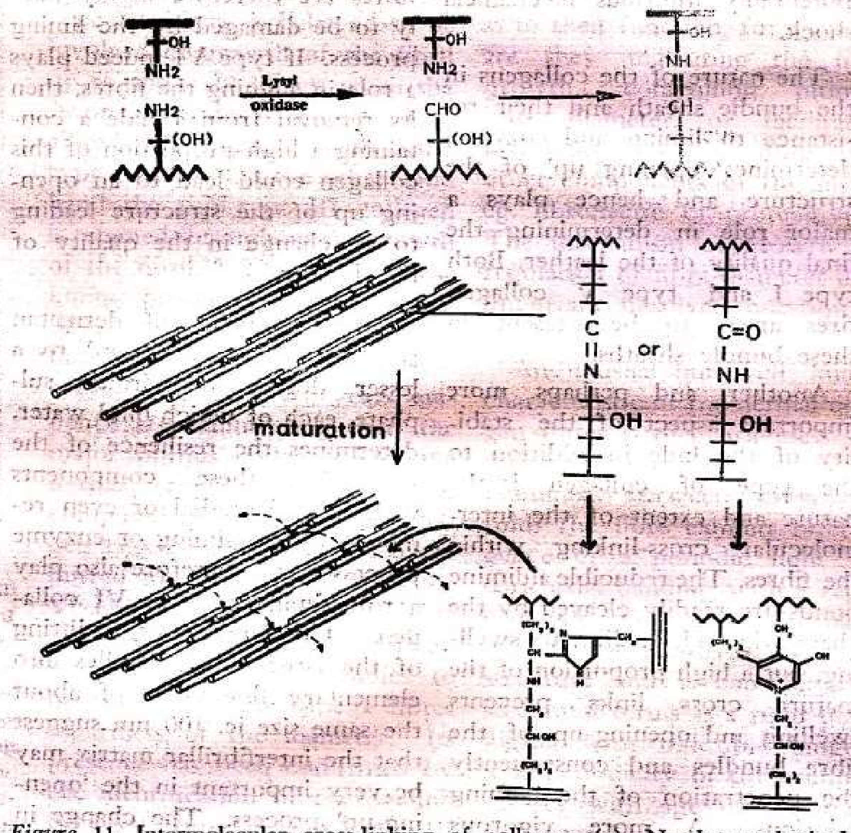


Figure 11. Intermolecular cross-linking of collagen. (a) Newly synthesised collagen showing the action of lysyl oxidase on the lysine side-chain to produce the covalent cross-link. (b) location and maturation of the cross-links. The divalent cross-links polymerise the molecules in a longitudinal array within a microfibrillar unit. On maturation these divalent cross-links interact to form the trivalent cross-links that link the individual microfibrils.

62

Several of these multi-valent cross-links have now been characterised but not all have been confirmed as cross-links. The aldimine bond is stabilised by the addition of histidine across the double bond of the Schiff base to give histidino-hydroxylysinonorleucine (HHL).[43] This trivalent cross-link may link three molecules, but it is possible that the histidine involved is derived from the enzyme binding sequence of the initial cross-link in which case it would only link two molecules. Further reaction of the keto-imine cross-link with another hydroxylysine-aldehyde results in the formation of the ring compound pyridinoline.[44] The mechanism is not yet clear. Pyridinoline may link two or three molecules depending on the mechanism of formation. A derivative of pyridinoline derived from lysine rather than hydroxylysine in the lysyl oxidase binding site has also been identified[54], but in most tissues is only about 10% of the hydroxylysyl-pyridinoline. Other unconfirmed candidites are an Ehrlich's chromagen[46], 3-deoxypyridinoline[47] and compound M.[48]

The formation of the divalent bonds and the conversion to the trivalent cross-links certainly accounts for the steadily increasing tensile strength of collagen fibres with increasing age. The cross-linking of skin collagen varies with the physiological age of the animal (Fig. 12). Foetal skin is stabilised by hydroxylysino-keto-norleucine but postnatally the major cross-link is the intermediate dehydro-hydroxylysinonorleucine. With incrasing age the latter is converted to the stable trivalent cross-lnik HHL. Only a small proportion (about 10% of the HHL) of pyridinoline is present in adult bovine skin.

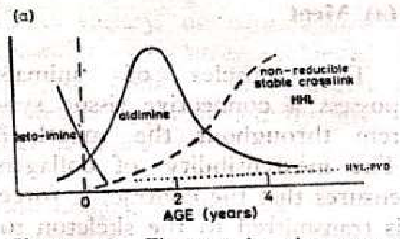


Figure 12. Changes in the nature and relative proportions of the cross-links in dermal collagen from foetal to maturity.

Some Applications of Collagen

Collagen in the Medical Industry

The first collagen product used in surgery was catgut, which having considerable strength only required sterilization. Modern sterilization techniques for collagen products now generally involve ethylene oxide or irradiation.

Of the numerous polymers used as implants collagen has considerable advantages: primarily its high tensile strength, controllable cross-linking, low antigenicity, haemostatic effect, interaction with other matrix components, [49] and its degradable by the body's own natural enzymes. An acceptable prosthesis should be similar to the tissue it is substituting, in structure, physical properties and function. It is also important that vascularization can occur within the implant otherwise degeneration occurs, together with the possibility of lipid and calcium deposition. In essence the prosthesis should provide a temporary framework to allow the ingrowth of cells and capillaries.

The swelling and rate of resorption of the impant can be controlled by the extent of cross-linking prior to implantation. This can be achieved by many compounds varying from simple mono and dialdehydes such as formaldehyde and glutaraldehyde and dialdehyde starch to carbodiimides and diphosphonates.

Collagen can be used in a variety of forms, from solutions injected into the vitreous humour of the eye, or under the dermis as a cosmetic aid; as powders for its haemostatic action, as fibres in suture materials and heart valve prostheses, as films in surgicl dressings; as sponges for dermal implants; and as tubing for blood vessel prostheses and reconstruction of organs eg. oesophagus and trachea.

Collagen implants can therefore act as a strong inert and non-antigenic supporting framework, but in addition they can also be involved in the healing process. Several reasons have been listed as to why collagen should promote wound healing viz.

(a) Guiding function—collagen fibres serve the same function as fibrin fibres in guiding the fibroblasts. Thus a collagen sponge acts as a template for permeation of fibroblasts and for vascularization

(b) the collagen fibres act as a chemotactic substance attracting cells, which release products that promote wound healing

63

(c) nucleation—it is possible that the fibres also act as a nucleating point for the formation of new fibres.

The body's mechanisms for repairing and remodelling damaged tissue are complex, involving an orderly sequence of cells and factors attracted to the wound, the formation of a collagenous granulation tissue, reepitheliaalisation and then wound contraction and rebuilding of the dermis.[50] Implants are therefore being made incorporating fibronectin and proteoglycan or hyaluronate, and in the future may possibly involve the incorporation of chemotatic factors, angiogenic factors, cytokines and growth facors.

The use of collagen sponges as wound dressings is being actively pursued primarily because of its haemostatic action and its non-antigenic properties making it highly acceptable to the body, but the ultimate objective must be the design of an artificial skin.[51]

Collagen in the Food Industry

I should now like to turn my attention to collagen in the food industry. Firstly I will discuss the role of collagen in determining the texture of meat, and secondly the alternative use of hides as sausage casings and lastly the properties of the denatured form of collagen, gelatin. Here again the studies on composition and properties of collagen have played an important role in understanding the eating quality and the processing and gelling properties of gelatin.

(a) Meat

The muscles of animals possess a connective tissue system throughout the muscle.[52] The inextensibility of collagen ensures that the contractile force is transmitted to the skeleton to provide movement with little loss of energy. Meat can be considered as a 'two component' system composed of a complex intracellular contractile apparatus and the comparatively minor (about 2%) extracellular collagen. The intrinsically higher tensile strength of collagen compared to the fragile contractile element readily suggests its involvement in the toughness of meat, but it must be remembered that when we are talking about texture we mean cooked meat, generally at temperatures higher than the denaturation temperature of collagen.

Correlations of total collagen content and texture have been made over the past several decades, but only partial or conflicting correlations were obtained. This was primarily due to a lack of understanding of the fundamental properties of collagen, but from the 1970s it became clear, primarily from the basic work on inter-molecular cross-links stabilising collagen, and particularly their heat stability, that it was the quality of the collagen, not the quantity that was critical.[53] Based on these specific thermal properties, a rationale for the role of collagen in determining the texture of meat can be presented. However, to present this hypothesis it is necessary to be aware of the nature and distribution of the collagen in muscle.

Muscle collagen can be distinguished morphologically as three separate hierarchies, the epimysium or outer muscle sheath, the perimysium or intramuscular collagen binding the muscle fibres together, and the endomysium or sheath surrounding the individual muscle fibres.[52] The collagen averages around 2-5% of the muscle protein by weight, and the other components of connective tissue namely elastin, glycoprotein and proteoglycan are present in even smaller quantities.

Using immunohistological techniques followed by biochemical analysis we have shown that the epimysium is predominantly type I collagen, the perimysium contains a high proportion of type III, whilst the endomysium is a composite of a thin basal lamina (15-30 nm) composed of type IV with associated fine fibrils of type I, type III and type V collagen (Fig. 13).[54]

Studies of the amounts of type III in the perimysium in relation to texture have provided equivocal answers. In several muscles a reduction in the type III correlated with increasing tenderness, but there were exceptions. The role of the endomysium in texture is unlikely to be significant based on the relatively small amount compared to the perimysium and its delicate structure. An intact endomysium certainly has some strength since it is capable of resisting the swelling of the myofibrils and contracts on heating generating a small tension, but is unlikely to be significant compared with the perimysium.

64

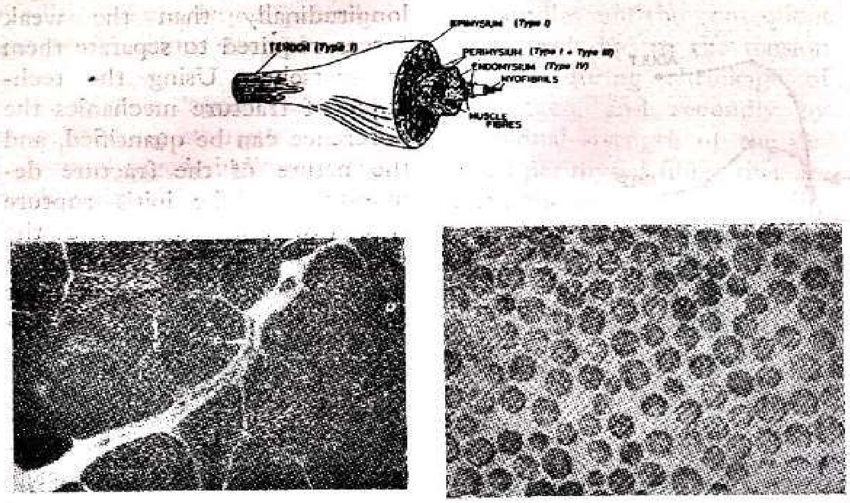


Figure 13: (a) Distribution of collagen in muscle, illustrating the epimysium, perimysium and endomysium. (b) Immunofluorescent staining of the perimysium by type III collagen antibody, (c) Immunofluorescent staining of the endomysium by type IV collagen antibody.

The minor collagens type V and type VI are only present in extremely small amounts and are unlikely to make a significant contribution. The much more abundant type I and type III fibres of the perimysium are therefore presumed to make the major contribution to meat texture.

It is now worth considering the properties of the collagen cross-links that provide the fibre with its high tensile strength and the changes in its properties on heating about its denaturation temperature. Because of its highly crytalline structure, collagen shrinks sharply at 65-67°C to form gelatin. The fibre is converted from a highly organized inextensible fibre to a randomly organized inextensible fibre to a randomly organized elastic fibre. The properties of this elastic fibre are determined by the heat stability of the intermolecular cross links. In tissues cross-linked by the aldimine bond, the tension generated when the fibre is heated under isometric conditions does not achieve its full potential due to the cleavage of the cross-link during heating. On maintaining the temperature the continued rupture of theee cross-links leads to a dramatic loss of tension. If the cross-link is stabilised by borohydride reduction the tension is much higher and the maximum tension reached its maintained on further heating. Similarly, with increasing age, the aldimine bond is converted to the heat stable trivalent histidino-hydroxylysinonorleucine cross-link resulting in the generation of a greater tension, and a significant residual tension is maitained on further heating. In tissues possessing a preponderance of the keto-imine cross-link a high tension is generated since this bond is heat stable, and consequently a significant tension is retained at high temperatures. The residual tension increases with age of the animal, thus in cooked meat the strength and solubility of the collagen fibre depends on the age of the animal, which in turn depends on the nature of cross-links. For emample, the collagen in muscle from a calf is readily soluble and possesses little strength following heat denaturation, whilst that from an old cow is barely soluble and possesses a significant tensile strength, albeit several orders of magnitude lower than the intact fibre. Based on this knowledge of the properties of collagen it should be possible to construct an hypothesis to account for the role of collagen in determining the texture of meat.

An analysis of the changes in in the texture of muscles with increasing temperatures reveals that the shear value increases initially at 40-45°C and then again at 65-70°C.[55] The first stage is due to the denaturation of the actomyosin compex, these proteins aggregating and releasing water. The second stage occurs at the shrinkage temperature of collagen, at 65°C (Fig. 14). As we have seen with isolated fibres heated under isometric conditions the collagen shrinks and generates a tension. When the collagen shrinks in muscle the muscle proteins act as a constraint against the shrinkage, resulting in a squeezing together of the denatured myofibrils and a dramatic increase in the loss of fluid from the meat. With older animals the shear value at the first stage is barely affected, but at the second stage the shear value is increased significantly. This is due to the increased tension generated by the older collagen, which in turn is determined by the increased stability of the

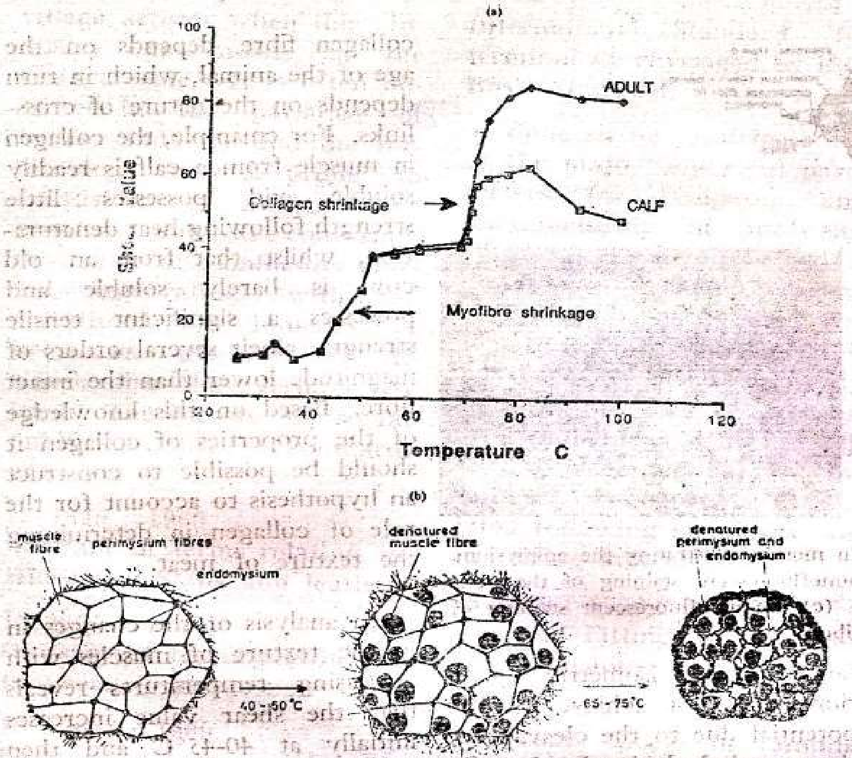


Figure 14. (a) Changes in shear force values on cooking of meat. (b) diagrammatic representation of the changes in the muscle protein and the collagen at the first and second stage increases in shear force.

'mature' cross-links in the old collagen. The majority of this shrinkage is exerted by the fibrous perimysium. However, a small effect may be produced by the shrinkage of both the basal lamina and the associated endomysial fibres of the endomysium. Certainly the shrnnkage of the endomysium should generate sufficient force to push fluid out of the muscle fibres and in effect force them closer together. The relative importance of the endo- and perimysium in generating force is clearly unknown, but the small amount of endomysium compared to the perimysium suggests that the contribution of the former would be small.

The action of collagen during cooking is therefore to contract and thereby shrink the meat by forcing it to lose fluid. The result is the packing of more protein into a given volume and as the shear values testify the meat is tougher. The question then is, which of the denatured proteins, actomyosin or collagen, is now the strongest component when the meat is sheared during eating, or determined objectively with a mechanical tester. The muscle fibres become insoluble and harder as evidenced by the increase in shear value, but the collagen is now elastic and very much reduced in its mechanical properties.

The tensile properties of cooked meat have long been known to be much stronger longitudinally than the weak forces required to separate them transversely. Using the technique of fracture mechanics the difference can be quantified, and the nature of the fracture demonstrated. The initia rupture is seen to follow the path of the perimysial sheaths. When a transverse slice of cooked meat is pulled apart in a direction perpendicular to the muscle fibre axis, cavities are observed to open up throughout the slice. Close examination at high magnification reveals that the cleavage occurs between the permysium and the endomysium.[56] It would appear therefore that the weakest component of cooked meat and therefore the first to break is the junction of fine fibres between the endo- and perimysiums. At higher loads these cavities join up to form a fracture path, with strands of perimysium bridging the gaps and carrying the load. Thus the breaking strength of the meat depends on the amount and strength of the perimysium.

When the meat is subjected to tensile forces parallel to the muscle fibre direction the breaking strength is substantially more than that of raw meat, and the initial event is again debonding of the fibre bundles from each other by rupture of the endomysial-perimysial junction. On increasing the load the individual muscle fibre bundles carry the load and it is these inextensible units that then fail. The extensible perimysial strands are then the last to break. In 'non-aged' meat the longitudinal breaking strength is ten times higher than the transverse breaking strength, since the muscle fibre

66

bundles make a larger contribution to breaking strength.

As meat is 'aged' the transverse breaking strength is essentially unchanged, indicating that conditioning has little effect on the perimysium.[57] There is evidence of some enzyme degradation but this is presumably insufficient to affect the strength to any significant extent. In contrast the longitudinal breaking strength decreases substantially, again presumably because the muscle bundles are more sensitive to the action of the conditioning enzymes. Indeed examination of the conditioned meat in the electron microscope reveals considerable cleavage of the Z-lines.[58] Clearly, whether transverse or logitudinal loading, the initial action is the rupture of the endo-perimysial junction and the breaking load is determined by the strength of the perimysium. As we have discussed above the strength of the perimysium will vary with the age of the animal and from muscle to muscle depending on the nature of the cross-links. This is due to the low turnover rate of collagen which permits age-related changes to take place. In contrast, the composition of the muscle fibres remains constant since they are turning over at a significant rate even in old animals. Collagen must therefore be considered the major determinant in the toughness of meat.[53]

In summary, the texture of meat is provided by the denatured myofibrillar proteins, but the expression of that texture is determined firstly by the squeezing together of the muscle fibre bundles and the consequent loss of fluid due to the tension generated during shrinkage of the collagen, and secondly by the residual strength of the denatured perimysial fibres that are binding the muscle fibre bundles together. The extent of the tension generated and the residual strength of the collagen are in turn determined by the nature and extent of the collagen cross-links.

It is clear that despite being a minor component of the meat, collagen plays a major role in determining the texture of cooked meat, rather than only exercising a subtle background effect as previously believed.

The fundamental studies on the nature of the molecular structure of collagen, its alignment within the fibre and the nuture and changes in he intra-molecular cross-links with age have allowed us to propose this rationale for the role of collagen in determining the texture of meat.

(b) Collagen Casings

Regenerated collagen casings were developed as a replacement for natural gastrointestinal tract in sausage manufacture as the process became automated. The use of these casings has several advantages over natural gut including superior product uniformity and storage stability, together with the advantage of added value on the bovine hides used to generate the collagen fibres.[59]

Collagen casing manufacture depends on retaining a relatively high degree of the native collagen fibrous structure rather than dissolution as gelatin. This is achieved by converting the corium collagen to an acid swollen gel or dough, which is then extruded as a tube. During extrusion the collagen fibres tend to align in parallel to the exis of the tube as it emerges from the extruder. The combination of extruder design and fibre length produces a weave of cross hatched collagen fibres. The tube is then passed through a concentrated salt solution and then a chamber of ammonia to precipitate the collagen. The original swollen gel contracts under these conditions to produce a film of reasonable strength. Plasticisers such as glycerol are often added. The tube is hot air dried to 10-15% water content. The diameter and thickness of the tube can be modified to suit individual requirements.

(c) Gelatin

Collagen serves both as source of leather and of gelatin or glue. Indeed the name collagen is derived from the Greek word meaning glue-forming.

Gelatin is an important food product, and highly purified gelatins with precise and reproducible characteristics are in great demand by the food industry, particularly as a filling or as a stabiliser for dairy products. The pressure from the consumer for convenience products, eg. water-soluble powders, quick setting gels with 'melt in the mouth' themoreversible products has ensured that the study of gelatin has continued to the present day.

67

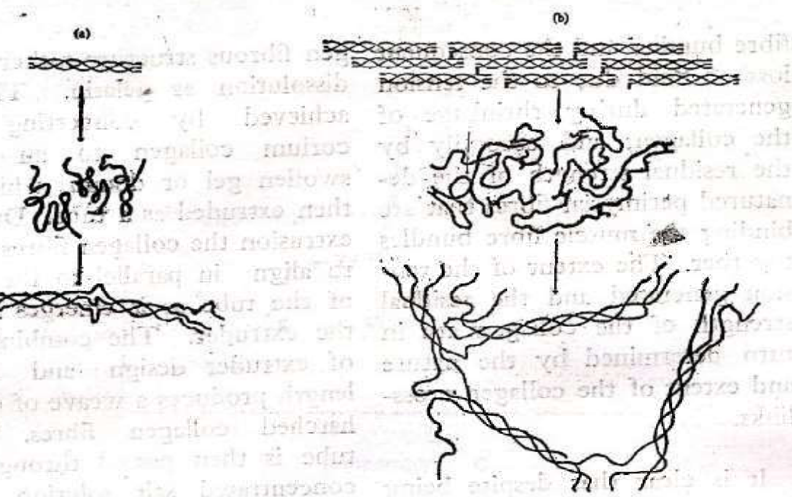


Figure 15. Denaturation of collagen to gelatin (a) denaturation of the collagen molecule to three independent chains. On cooling there is a partial regeneration of the triple helix. (b) denaturation of cross-linked collagen fibres to random chains in which the chains are cross-linked together. On cooling interaction occur between the chains to form crystalline areas which are believed to be triple helices derived from chains of different molecules. The chains may interact to form several crystalline areas.

Henry Procter realised that the peptide chains of gelatin were cross-linked units. How perceptive he was I will attempt to show by the recent studies on the rate of gelation and the ultimate gel strength of gelatin gels.

Commercial gelatin is a heat denatured and partially degraded form of the native collagen. The method of extraction of the gelatin depends on the source and age of the tissue and consequently on the nature and extent of the cross-linking (Fig. 15). If the cross-links are aldimine eg. as in young skin then the collagen readily goes into solution as random chains since the cross-links are cleaved by dilute organic acids or by heat. However, if a proportion of the cross-links are keto-imine, or the trivalent 'mature' cross-links, the yield of extractable gelatin is reduced and the gelatin contains dimers, trimers and higher polymers, producing a gel with a wide distribution of molecular weight components. Harsher methods of extraction would result in an even more heterodisperse gel by cleavage of peptide bonds, and vigorous chemical treatment eg. alkali, can affect the ionic charge of the gelatin by deamidation of the glutamine and asparagine residues. Commercial gelatins have therefore to be confined to a particular source of collagen, eg. young pig skin, since there is little ability to control the molecular weight distribution.

Detailed investigations of the refolding of the random chains of gelatin into the collagen triple helix have been undertaken.[60,61] The rate of refolding will obviously depend on the molecular weight heterogeneity, ie. the peptide chain length, and also the chain cross-linking which registers the ends of the chains and hence encourages rapid refolding. When denatured collagen is quenched to to 4°C there is a rapid recovery of the optical rotation indicating the formation of a large fraction of triple helix. In contrast, there is only a small recovery of the viscosity, indicating that the products are not long triple helical native collagen molecules but rather short triple helical segments. Further, the average molecular weight is higher than collagen indicating there is considerable association between the chains. The low thermal stability also suggests that the triple helical segments are short and mismatched between region of the chains, and interrupted by many non-helical regions. The optimum yield of correctly formed collagen molecules is achieved at 26°C ie. 10°C below the denaturation temperature of the molecule. Higher yields can only be obtained by constantly fluctuating the temperature between 4°C and 22°C.

Cross-links can have a significant effect on the rate of refolding for example, the intramolecularly cross-linked γ-component renatures in 3 minutes[62] compared to the prolonged efforts required to refold single α-chains into the triple helix even employing the annealing process. In the commercial gelatins which are heterogeneous with respect to cross-links and molecular weight, the cross-links must have a profound effect on both the rate of gelation and the stability of the gel. In addition any cleaved cross-links could reform to further stabilise the gel during maturation. Although studies on single molecules and optical

68

rotation studies indicate the formation of segments of triple helices, other workers have suggested that the polyproline helices of the individual ∝-chains lie in a side by side association in what has been termed the microcrystallite junction zones, or the fringed micelle model.[63]

Clearly the greater the degree of microcrystallite formation, or triple helix formation, the greater the strength of the gel. The thermoreversibility of the gels in water suggests that these interactions are non-covalent. However, following maturation the gel is no longer thermo-reversible and this may be due to the formation of aldehyde type cross-links. This ability of the ∝-chains to refold into a collagen-like triple helix is presumed to involve specific regions in the chain with the most likely nucleating sequences ie. Gly-Pro-Hyp— whilst the more polar regions of the chains probably make up the amorphous regions.[64] Such nucleating sequences are more numerous in mammalian collagens than fish collagens, which consequently have a low thermal denaturation temperature and poorer gelling properties. Following nucleation, as in most crystallization processes, propagation and maturation occurs and the kinetics of these processes can be studied. Variation of the nucleation and propagation periods can be used to modify the gel strength. The strength and stiffness increases with time as the number of microcrystallite regions increases. Whether these regions are triple helices or single chains aligned in parallel needs to be elucidated for a better understanding and consequent control of gel formation. Similarly the nature and distribution of the cross-links on the rate of gelation and maturation of the gel requires detailed study.

Henry Procter spent much of his research activity studying gelatin, the results of which led to his FRS. However, I am sure he would have been fascinated by the structural simplicity of the collagen triple helix, its crystalline properties and the elegant way the random chains in gelatin reform the collagen triple helix to stabilise the gel.

In conclusion, I have attempted in this review to demonstrate the progress that has been made in our understanding of the fundamental properties of collagen from the gene to the various final supramacromolecular structures since the time of Professor Henry Procter. I have also, in line with the philosophy of Henry Procter, tried to demonsrate how this knowledge can be related to the practical problems of the industries that collagen serves.

(*Received December, 1991*)

References

1 Ward, A. G. *J. Soc. Leather Technol. Chem.*, 1975, 59, 61.
2 Procter, H. R. *Collegium* (London), 1915, 1, 3.
3 Ramachandran, G. W. and Kartha, S. *Nature*, 1955, 174, 269.
4 Hodge, A. J. and Petruska, J. A. (1963) in *Aspects of Protein Structure* (G. Ramachandram Fd) Acad. Press, NY.
5 Banley, A. J., Robms, S. P. and Balram, G. *Nature*, 1974, 251, 105.
6 Vuorio, E. and deCrombrugghe, B. *Ann. Rev. Biochem*, 1990, 59, 837.
7 Mayne, R. and Burgeson, R. E. *Structure and Function of Collagen Types*, Acod. Press, Orlando, Fl. (1987).
8 Burgeson, R. E. *Ann. Rev. Cell. Biol.*, 1988, 4, 551.
9 Hulmes, D. J. S., Miller, A, Parry, D., *et al*, *J. Mol. Biol*, 1973, 79, 127.
10 Guhn, K., Wiedermann, H. Timpl, R., *et al*, *FEBS Letts.*, 1981, 125, 123.
11 Timpl, R. *Aantomy*, 1989, 185, 367.
12 Labermeier, V. and Kenny, M. C. *Biochem. Biophys. Res. Communs.*, 1985, 116, 619.
13 Jander, R., Korsching, E. and Rauterberg, J. *Eur. J. Biochem.*, 189, 601.
14 Kwan, A. P. L., Cummins, C. E., Chapman, J. A., *et al*, *J. Cell Biol.*, 1991, 114, 3.
15 Lunstrum, G. P., Sakai, L. Y., Keene, D. R., *et al*, *J. Biol. Chem.*, 1980, 261, 9042-9048.
16 Von der Mark, K. Aumailley, M., Wick, G. *et al*, *Eur. J. Biochem.*, 1984, 142, 493.
17 Bruns, R. R., Press, W., Engvall, E., *et al*, *J. Cell Biol.*, 1986. 102, 203.
18 Vanghan, L., Mendler, M. Huber, S., *et al*, *J. Cell. Biol.*, 1988, 106, 991.
19 Keene, D. R., Luntrum, G. P., Mouns, N. P., *et al*, *J. Cell Biol.*, 1991, 113, 971.
20 Dublet, B. and Van der Rest, M. *J. Biol. Chem.*, 1991, 266, 6853.
21 Reid, K. B. M. *Biochem. J.*, 1979, 179, 367.
22 Mays, C. and Rosenberry, T. L., *Biochemistry*, 1981, 20, 2810.
23 Bamford, D. H. and Bamford, J. K. H. *Nature*, 1990, 344, 479.
24 Boedtker, H., Fuller, F. and Tate, V. *Intern. Rev. Connect. Tissue Res.* 1983, 10, 1.
25 Sykes, B. *Mol. Biol. Med.*, 1989, 6, 19.
26 Kivirikko, K. J. and Myllyla, R. *Methods in Enzymol.*, 1982, 82, 245.
27 Vogel, B. E., Doelz, R., Kadler, K. E., *et al*, *J. Biol. Chem.*, 1988, 263, 19249.

28 Kadler, K. E., Torre-Blanco. A., Adashi, E., *et al, Biochemistry*, 1991, 30, 5081.
29 Stacey, A., Bateman, J., Choi, T., *et al, Nature*, 1988, 332, 132.
30 Byers, P. H. *Amer. J. Med Genetices*, 1984, 34, 72.
31 Bruckner-Tiederman, L., Mitsuhashi, Y., Schnyder, V. W., *et al, J: Invest. Dermatol.*, 1989, 93, 3.
32 Lenaers, A., Ansay, M., Nusgens, B., *et al, Eur. J. Biochem.*, 1971, 23, 533.
33 Bailey, A. J. and Lappiere, C. M. *Eur. J. Biochem.*, 1973, 34, 91.
34 Epstein, E. M. and Munderloh, N. H. *J. Biol. Chem.*, 1978, 253, 1336.
35 Fleischmeyer, R., Perlish, J. S. Burgeson, R. F., *et al, Am. N.Y. Acad. Sci.*, 1990, 580, 161.
36 Henkel, W. and Glanville, R. W. *Eur. J. Biochem.*, 1982, 122, 205.
37 Fleischmeyer, R., MacDonald, E. D., Perlish, J. S., *et al, J. Struct. Biol.*, 1991, 105, 162.
38 Gathercole, L, J. and Keller, A. *Matrix*, 1991, 11, 214.
39 Keene, D. R., Engvals, E. and Glanville, R. W. *J. Cell. Biol.*, 1988, 103, 1995.
40 Harlan, J. W. and Feairheller, S. H. *Adv. Expt. Medicine and Biology*, 1976, 86A, 425.
41 Eyre, D. R. *Adv. Meat Research*, 1985, 4, 69.
42 Bailey, A. J., Light, N. D. and Atkins, E. D. T. *Nature*, 1980, 288, 408.
43 Yamauchi, M., London, R. E., Guenat, C., *et al, J. Biol. Chem.*, 1987, 262, 11428.
44 Fujimoto, D., Akiba, K. Y. and Nakamura, N. *Biochem. Biophys. Res. Commun.*, 1977, 76, 1124.
45 Ogawa, T., Ono, T., Tsuda, M., *et al, Biochem. Biophys. Res. Commun.*, 1982, 107, 1252.
46 Scott, J. E., Hughes, E. W. and Shuttleworth, A. *Biosci. Rep.* 1, 1981, 611.
47 Barber, M., Bordoli, R. S., Elliot, G. J., *et al, Biochem. Biophys. Res.* 1982, 109, 1041.
48 Barnard, K., Light, N. D., Sims, T. J., *et al, Biochem. J.*, 1987, 244, 303.
49 Chvapil, M., Kronenthal, R. L. and van Winkle, W. *Intern. Rev. Connect. Tissue Res.*, VTCC, F, V.
50 Clarke, R. A. F. *Molecular Biology of Wound Healing.*
51 Prunieras, M. *Matrix*, VTTV, VV, CJB.
52 Fawcett, D. W. *A Textbook of Histology*; W. B. Saunders & Co., Philadelphia, USA (1968).
53 Bailey, A. J. and Light, N. D. *Connective tissue in Meat and Meat Products*, Elsevier Appl. Sci. (1989).
54 Bailey, A. J., Restall, D., Sims, T. J., *et al, J. Sci. Food Agric.*, 1989, 30, 203.
55 Davey, C. L. and Gilbert, K. *J. Sci. Food Agric.*, 1985, 26, 755.
56 Purslow, P. P. *Adv. Meat Res.*, 1987, 4, 187.
57 Lewis, G. J., Purslow, P. P. and Rice, A. E. *Meat Sci.*, 1991, 30, 1.
58 Dayton, W. R., Reville, W. J., Goll, D. E., *et al, Biochemistry*, 1976, 15, 2159.
59 Hood, L. L. *Adv. in Meat Res.*, VTRE, D, VJT.
60 Harrington, W. F. and von Hippel, P. H. *Adv. in Protein Chem.*, 1961, 16, 1.
61 Beier, G. and Engel, J. *Biochemistry*, 1966, 5, 2744.
62 Drake, M. P. and Veis, A. *Biochemistry*, 1964, 3, 135.
63 Djabourov, M. and Papon, P. *Polymer*, 1983, 24, 537.
64 Stainsby, G. *Adv. Meat Res.*, 1985, 4, 209.

70

WORLD MSME DAY 2023: HOW TO EMPOWER MSMES THROUGH FINANCIAL INNOVATION FOR SUSTAINABLE DEVELOPMENT

A bustling powerhouse of innovation and entrepreneurship, MSMEs play a strategic role in India's economy, contributing nearly 27 per cent to India's GDP and employing over 111 million people across approximately 63 million enterprises.

When the United Nations designated June 27 as Micro, Small, and Medium-sized Enterprises (MSME) Day in 2017, it was an acknowledgement not just of the significant contribution that MSMEs make to the global economy but also how integral they are to achieving the Sustainable Development Goals (SDGs). A bustling powerhouse of innovation and entrepreneurship, MSMEs play a strategic role in India's economy, contributing nearly 27 per cent to India's GDP and employing over 111 million people across approximately 63 million enterprises.

MSMEs are responsible for a significant 33 per cent of the nation's manufactured goods, they contribute to more than 49 per cent of total exports, and they manufacture over 8,000 products with added value, spanning from traditional to advanced tech items. MSMEs are also pivotal in fostering regional development through the industrialisation of rural and undeveloped areas and reducing socioeconomic disparities.

Development of the MSME sector can support in achieving multiple SDGs including SDG 1 (end poverty), SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 5 (gender equality), SDG 8 (promote inclusive and sustainable economic growth, employment and decent work), and SDG 9 (improve sustainable industrialisation and fostering innovation).

Enhancing productivity

Enhancing productivity is crucial for fostering higher incomes and ensuring a decent standard of living for all. In India, significant strides have been made in productivity growth over recent decades. However, a substantial segment of the workforce continues to engage in low-productivity and informal work, with agriculture being a prominent sector. Through strategic capital deployment to maximise productivity gains, there has been a notable impact on uplifting incomes in areas where it is most needed.

MSMEs contribute significantly to the employment creation process of the private sector. In emerging markets, 4 out of 5 new positions in the formal sector were created by MSMEs, which is about 90 per cent of total employment. This approach has also facilitated the development of innovative and cost-effective goods, particularly in sectors that align with the SDGs. Moreover, it has stimulated the creation of new markets, contributing to overall economic growth and prosperity.

MSMEs are bridging the healthcare gap

MSMEs are increasingly assuming a pivotal role as innovators of cost-effective and scalable delivery models, driven by intensifying competition within the same customer segment. However, these enterprises encounter numerous challenges, including the absence of stringent regulatory standards and limited resources to hire skilled professionals capable of addressing operational inefficiencies. Facilitating support for small and medium-sized healthcare enterprises in overcoming these obstacles can significantly enhance healthcare provision and contribute to advancements in this field. With over 13,000 registered MSMEs in the pharmaceutical sector, India is witnessing improved health outcomes as a result, promoting good health and overall well-being.

Gender inclusivity

Based on available data, the rate of women's employment in registered MSMEs stands at 20.45 per cent, while in unregistered enterprises, it is reported at 13.02 per cent. Financial inclusion can play a significant role in promoting gender equality, with evidence indicating that 80 per cent of women-owned businesses facing credit needs are underserved or completely unserved, resulting in a financing gap of approximately $1.7 trillion. Women entrepreneurs, particularly those from rural and economically disadvantaged communities, often face challenges in growing their businesses due to a lack of land deeds or collateral necessary to access formal credit sources.

However, research shows that women are diligent savers, responsible borrowers, and calculated risk-takers. MSMEs, like larger corporations, can be motivated to implement gender-inclusive policies both internally and throughout their value chains. This entails guaranteeing equal pay and benefits for work of equal value, adopting a zero-tolerance approach towards workplace violence, offering flexible work arrangements to support women, providing childcare and dependent care assistance, promoting women to managerial positions, and striving for gender balance within their teams.

Promoting sustainability

Sustainability and environmental consciousness must be ingrained in the DNA of MSMEs. As we chart a path toward a greener future, MSMEs can lead the way by adopting sustainable practices, embracing clean technologies, and minimising their carbon footprint. Investing in renewable energy, waste management, and resource efficiency can not only enhance their competitiveness but also contribute to India's commitment to a sustainable and resilient future. MSMEs that prioritise environmental, social and governance (ESG) factors can access innovative financial products, which increases their access to much-needed finance for them to grow and play a pivotal role in the transition toward a more sustainable global economy.

Despite the remarkable contributions of the MSME sector, several challenges hinder its full potential. For India's MSMEs to thrive in a rapidly evolving business landscape and contribute to India's roadmap to a $20 trillion economy by 2047, it is crucial to address these challenges through the right support and strategic interventions. A healthy and vibrant MSME sector is not just desirable but necessary for India's economic ambitions.

To fully unleash the power of MSMEs, we must harness the sector's growth potential effectively by focusing on reducing the cost of credit, providing access to modern technology, streamlining the regulatory environment, and creating a robust infrastructure for skill development. Of course, one must remember that financial innovation is a means to an end and not an end in itself. We must ensure that these advancements reach all MSMEs, especially those in developing economies and remote areas. Investments must be aligned with government priorities. Collaboration and partnerships between investors, government agencies, and industry associations must ensure the effective utilisation of resources.

The resilience, agility, and adaptability displayed by MSMEs have solidified their position as a vital pillar of our economy. We must work towards empowering and equipping our MSMEs, ensuring their readiness for the future, and enabling them to continue as the catalysts for India's economic growth and innovation as we march towards the vision of India@100!

(Financial Express – 25/06/2023)

ALERT! CHEQUE BOUNCE MAY LAND YOU IN JAIL

Cheque bounce is back in the news with three cases making the headlines. A court in Maharashtra's Thane district sentenced a businessman to rigorous imprisonment for three months and directed him to pay double the bounced amount. A metropolitan court punished a man in Gujarat with a one-year jail sentence. The Sikkim high court recently ruled that offences under Section 138 of the Negotiable Instruments Act can be compounded at any stage.

What is a cheque bounce?

Cheque bounce or 'dishonour of cheque' occurs when a drawee is unable to withdraw money using a cheque due to certain limitations. It is covered by the Negotiable Instruments Act (NI Act), 1881, which aims to deter the issuance of cheques without sufficient funds in the bank account, and provides legal remedy to the aggrieved party.

Section 138 of the NI Act mentions two reasons for cheque bounce. Tushar Agarwal, advocate, Supreme Court of India, says, “First, there is insufficient money in the account. Second, the cheque amount exceeds the arrangement the account holder has with the bank.”

The second reason refers to the cheque amount being higher than the account’s withdrawal limit. Over time various other reasons have emerged.

Signature or number mismatch:

A cheque can be dishonoured if there is a discrepancy between the drawer’s signature on the cheque and the specimen signature available with the bank. Pratyush Miglani, managing partner, MVAC Advocates & Consultants, says, “This is done to avert fraudulent activities like forgery.”

A number mismatch may arise if the cheque number entered in the MICR (Magnetic Ink Character Recognition) code line doesn’t correspond with the pre-printed cheque number.

Expired or damaged cheque:

A cheque is usually valid for three months from the date of issuance. If presented after this period, it is not honoured. The bank may also declare a damaged or mutilated cheque as invalid.

Miglani says, “Essential elements like the date, payee’s name, amount, and signature must be legible and undamaged for successful processing.”

Stop payment instruction:

The issuer may have instructed the bank to stop the payment due to reasons like a dispute, suspicion of fraud, loss of the cheque, or change in circumstances.

Legal consequences

Cheque bounce is a criminal offence under Section 138 of the NI Act Suhael Buttan, counsel, SKV Law Offices, says, “The sentence can be for up to two years; a fine, which can be extended to twice the amount covered by the dishonoured cheque; or both.”

Anushkaa Arora, principal & founder, ABA Law Office, adds, “Bail can be secured when the matter is pending in lower court. Post-conviction the chances of bail become bleak.” Regarding legal notice, Abhinay Sharma, managing partner, ASL Partners, points out, “The receiver of the bounced cheque can send a legal notice to the issuer within 30 days of receiving the bounce memo from the bank.”

Sections 143A and 148 have been inserted through recent amendments. Buttan says, “These sections give the trial or the appellate court the right to direct payment of interim compensation during the trial and deposit of a certain minimum sum in an appeal by the drawer of cheque against conviction.”

The Sikkim high court recently ruled that offences under Section 138 of the NI Act can be compounded at any stage. This means the parties can enter into a compromise and settle the matter out of court.

Proceed with caution

Keep sufficient funds in your bank account until the cheque is cleared. Fill all details correctly. If there is any doubt, verify with the bank that your signature hasn’t changed. Also avoid overwriting. If availability of funds is an issue, communicate with the payee and resolve the matter instead of issuing the cheque.

Use the Sikkim high court’s recent ruling to compromise and settle out of court. M Barve, founder, MB Wealth Financial Solutions suggests making online payments. Landlords can use cheque bounce laws to their advantage.

“Take one or a few signed cheques in advance. The stringent consequences of bounced cheques will ensure you get the rent on time and there is no default.” Check bounce: Fallout can be expensive The bank may charge the issuer a penalty, which can range from Rs 50 to Rs 750. If the cheque amount is not paid within the stipulated time, the receiver may be entitled to claim interest on the cheque amount and the issuer’s credit score could take a beating. Also, this can make it difficult to obtain credit in the future.

(Rediff.com – 18/05/2023)

CAD DOWN TO 0.2% OF GDP IN Q4 FY23 AS TRADE GAP SHRINKS

India’s current account deficit (CAD), a key indicator of the external sector, narrowed to $1.3 billion, or 0.2 per cent of the gross domestic product (GDP), in the January-March quarter (Q4) of fiscal 2022-2023 (FY23), mainly on account of moderation in trade gap and rise in services exports.

In the January-March quarter (Q3) of FY23, CAD — the difference between exports and imports of goods and services — was $16.8 billion, or 2 per cent of GDP. In Q3 of FY22, it was $13.4 billion, or 1.6 per cent of GDP, according to the data released by the Reserve Bank of India (RBI) on Tuesday.

"The sequential decline in CAD in Q4 FY23 was mainly on account of a moderation in the trade deficit to $ 52.6 billion in Q4 FY23 from $71.3 billion in Q3 FY23, coupled with robust services exports," the RBI said.

Aditi Gupta, an economist at Bank of Baroda, said the uptick in merchandise imports due to higher global commodity prices led to the widening of trade deficit. This was offset to some extent by resurgent services exports as well as remittances.

For the full year (FY23), the current account balance recorded a deficit of 2 per cent of GDP, compared to a deficit of 1.2 per cent in FY22 as the trade gap widened to $265.3 billion to $189.5 billion a year ago, RBI data showed.

"We expect further improvement (in CAD) on the back of lower commodity prices. Merchandise exports are expected to remain downbeat as global growth weakens. Overall, we expect CAD in the range of 1.2 to 1.6 per cent of GDP in FY24," Gupta said. The balance of payments (BoP) stood at a surplus of $5.6 billion in Q4 FY23 compared to a surplus of $11.06 billion in preceding quarter, the RBI said.

In FY23, net invisible receipts rose due to increase in net exports of services and net private transfer receipts, even though net income outgo was higher than a year ago. In Q4 FY23, private transfer receipts, mainly representing remittances by Indians employed overseas, increased to $28.6 billion, up by 20.8 per cent from their level a year ago.

Net foreign direct investment (FDI) at $6.4 billion in Q4 FY23 was higher than $2 billion in the preceding quarter, although lower than a year ago ($13.8 billion). In FY23, net FDI inflows declined to $28 billion from $38.6 billion in FY22.

Net foreign portfolio investment (FPI) recorded an outflow of $1.7 billion in Q4 FY23 driven by the equity segment, compared to an outflow of $15.2 billion in the year-ago quarter. The net FPI outflow was $5.2 billion as compared to an outflow of $16.8 billion a year-ago.

Net external commercial borrowing (ECB) to the country recorded an inflow of $1.7 billion during the fourth quarter as against an inflow of $2.5 billion in the preceding quarter and an inflow of $3.3 billion in Q4 FY22.

During the Q4 period, there was an accretion to the foreign exchange reserves (on a BoP basis) of $5.6 billion as against a depletion of $16 billion in Q4 FY22. In FY23, there was a depletion of $9.1 billion of the foreign exchange reserves (on BoP basis).

(IndianExpress.com – 28/06/2023)

ECONOMIC SLOWDOWNS IN US, EUROPE MAY AFFECT 40% OF INDIA'S EXPORTS

Micro, small and medium enterprises (MSMEs), accounting for about 40 percent of India's exports, is expected to face headwinds from the imminent economic slowdown in advanced countries, particularly the US and Eurozone as these two geographies account for a large chunk of India's overall exports- nearly one-third.

Resultantly, one out of five MSMEs are expected to see a stretch in its working capital days. These MSMEs are in sectors already grappling with high working capital requirements. The Ahmedabad cluster has a major presence of MSMEs into dyes and pigments, pesticides, and pharmaceuticals. The working capital stretch is expected due to an inventory pile-up following dumping by Chinese producers, the recent earthquake in Turkey and a slowdown in the US. These three account for 20-25 percent of the total exports of dyes and pigments, pesticides and pharmaceuticals, according to an analysis by CRISIL MI&A Research.

90 percent of India's diamond exports emanate from Surat. Diamonds constitute more than half of India's gems and jewellery exports and a substantial decline in demand from the US, the largest export market, is having a significant impact. That, in turn, is having a bearing on receivable days, leading to an increase in working capital days from about 140 prior to the pandemic to more than 200 this fiscal.

In the construction-roads sector, underachievement of budgeted capex last fiscal — to rein in fiscal deficit — has added to the challenges of developers in meeting working capital demand amid high commodity prices. This has led to an increase of more than 100 days in their working capital cycle this fiscal, compared with pre-pandemic levels.

Furthermore, the total debt requirement for the MSME sector is estimated at about Rs 100 lakh crore. However, not all of this demand is addressable by the formal financial institutions, as some firms are either not commercially viable or voluntarily exclude themselves from formal financial services. The challenges to accessing capital include high credit risk, lack of collateral, regulatory barriers, etc. Hence with about 70 percent debt sourced from informal sources, the cost of capital is extremely high.

According to the RBI, about 80 percent of India's MSME sector debt is in the high-risk category and the non-performing assets have increased substantially, which indicates a significant credit gap in the MSME sector hampering its growth and development.

Although, there has been progress in providing access to capital to MSMEs with the new initiatives like priority sector lending norms, cluster-based lending and government schemes. Albeit there is a need for more enabling policies and infrastructure to support the MSME sector and its financing needs.

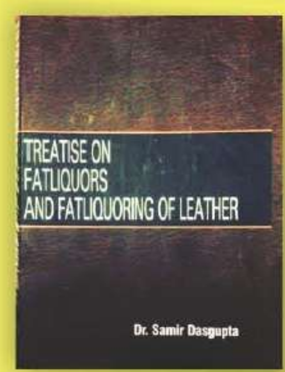
(CNBCTV18.COM – 28/06/23)

-: J I L T A : -

***Owner**: Indian Leather Technologists' Association, **Publisher & Printer**: Mr. S. D. Set, **Published From**: 'Sanjoy Bhavan', (3rd floor), 44, Shanti Pally, Kasba, Kolkata - 700107, West Bengal, INDIA and **Printed From**: M/s TAS Associate, 11, Priya Nath Dey Lane, Kolkata- 700036, West Bengal, INDIA*

ILTA PUBLICATION

Now available



Title of the Book
Treatise on Fatliquors and Fatliquoring of Leather

Author
Dr. Samir Dasgupta

Price per copy*
₹ 1500.00 / $ 60.00

Title of the Book
Comprehensive Footwear Technology
(Presently out of stock)

Author
Mr. Somenath Ganguly

Price per copy*
₹500.00 / $ 50.00

Title of the Book
An Introduce to the Principles of Leather Manufacture

Author
Prof. S. S. Dutta

Price per copy*
₹800.00 / $ 50.00

Title of the Book
Analytical Chemistry of Leather Manufacture

Author
Mr. P. K. Sarkar

Price per copy*
₹300.00 / $ 10.00

Title of the Book
Synthetic Tanning Agents

Author
Dr. Samir Dasgupta

Price per copy*
₹900.00 / $ 30.00

Title of the Book
Hand- Book of Tanning

Author
Prof. B. M. Das

Price per copy*
₹ 750.00 / $ 25.00

*Packing and forwarding charge extra

ILTA
Since 1950

Indian Leather Technologists' Association

[A Member Society of International Union of Leather Technologists' and Chemists Societies]

'Sanjoy Bhavan', 3rdFloor, 44, Shanti Pally, Kolkata- 700 107, WB, India
Phone : 91-33-2441-3429 / 3459 WhatsApp +91 94325 53949
E-mail : admin@iltaonleather.org; mailtoilta@rediffmail.com
Website : www.iltaonleather.org

History and Activities of Indian Leather Technologists' Association

Registration No. KOL RMS/074/2022-24

The Indian Leather Technologists' Association (ILTA) was founded by Late Prof. B. M. Das, the originator of Das-Stiasnay theory and father of Indian Leather Science on 14 th August' 1950. The primary objectives of the oldest Leather Technologists' Association which celebrated its Diamond Jubilee year in the 2010, are:

- To bring all concerned with the broad spectrum of the leather industry under one umbrella.
- To organize seminar, symposium, workshop in order to create information, knowledge and latest development for the benefit of all concerned. To offer a common platform for all to interact with each other in order to understand each other's problems and prospects.
- To publish monthly journal as a supplement to those above objectives. The monthly journal of ILTA is known as journal of Indian Leather Technologists' Association and is the most widely circulated technical journal concerning leather technology.
- To publish text books for the benefit of students at various levels of study, for the researchers and industry.
- To have interface between urban and rural sector.
- To assist Planning Commission, various Government Institutions, Ministry and autonomous bodies to formulate appropriate policies acceptable and adoptable to the industry.
- To organize practical training and to provide skilled manpower and to motivate good students for study.
- To conduct activities related to the growth of the export of leather and leather goods from India.

ILTA also organizes Prof. B. M. Das Memorial Lecture every year during the Foundation Day Celebrations on 14 th August and Sanjoy Sen Memorial Lecture on 14 th January, the birthday of our late President for several decades. Many reputed scientists, industrialists and educationists have delivered these prestigious lectures. Foreign dignitaries during their visits to India have addressed the members of ILTA at various times.

ILTA have published the following books:

1. An Introduction to the Principles of Physical Testing of Leather by Prof. S.S. Dutta
2. Practical Aspects of Manufacture of Upper Leathers by J. M. Dey
3. An Introduction to the Principles of Leather Manufacture by Prof. S. S. Dutta
4. Analytical Chemistry of Leather Manufacture by P. K. Sarkar
5. Comprehensive Footwear Technology by Mr. Somnath Ganguly
6. Treatise on Fatliquors and Fatliquoring of Leather by Dr. Samir Dasgupta
7. Synthetic Tanning Agents by Dr. Samir Dasgupta
8. Hand Book of Tanning by Prof. B. M. Das

ILTA presents awards in the name of Prof. B. M. Das Memorial, Sanjoy Sen Memorial and J. M. Dey Memorial Medals to the top rankers at the University graduate and post graduate levels. J. Sinha Roy Memorial Award for the author of the best contribution for the entire year published in the monthly journal of the Indian Leather Technologists' Association (JILTA). From the year 2023 ILTA has started to present a Scholarship namely Prof. Moni Banerjee Memorial Scholarship to a Student of B.Tech / M.Tech Leather Technology who is meritorious but financially crippled.

ILTA is the Member Society of IULTCS (International Union of Leather Technologists' and Chemists Societies) which is a 125 years old organization. The International Congress of this union is held in different locations of the world once in two years. In its 125 years history, for the first time the Congress was held in January 1999 outside the developed countries and that too in India at CLRI, Chennai. Indian Leather Technologists Association organized the Congress under the able leadership and guidance of Late Sanjoy Sen, the then President of ILTA and IULTCS and Dr. T. Ramasami, the then Vice-President of ILTA and Director, CLRI, Chennai. In 2017 IULTCS Congress was successfully held again at Chennai, India for the second time.

In order to promote and provide marketing facilities, to keep pace with the latest design and technology, to have better interaction with the domestic buyers, ILTA has been organizing LEXPO fairs at Kolkata from 1977, Siliguri from 1992 and Durgapur from 2010. To help the tiny, cottage and small-scale sectors industries in marketing, LEXPO fairs give the exposure for their products. Apart from Kolkata & Siliguri and Durgapur, ILTA have held LEXPO at Bhubaneswar, Gangtok, Guwahati, Jamshedpur and Ranchi. In commensurate with the time, demand and new perspective of the modern leather users, ILTA has started to organize LEXPO at Kolkata from 2022 in a new shape with the Manufacturers and Exporters of Leather Goods from all over India.

ILTA has celebrated its Golden Jubilee with a year-long programme from 14 th August' 2000 to 13 th August' 2011 along with the first conference of South East Asian Countries at Netaji Indoor Stadium, Kolkata.

ILTA has also celebrated its Diamond Jubilee with a year long programme from 14 th August' 2010 to 13 th August' 2011 which included National Seminars, B. M. Das Memorial Lecture, Sanjoy Sen Memorial Lecture, Moni Banerjee Memorial Lecture, Y. Nayudamma Memorial Lecture and 3 day's AICLST (Asia International Conference on Leather Science and Technology) at Hotel 'The Stadle' at Salt Lake City, Kolkata.

The Association's present (as on 31.03.2023) strength of members is around 550 from all over India and abroad. Primarily the members are leather technologists passed out from Govt. College of Engineering and Leather Technology – Kolkata, Anna University – Chennai, Harcourt Butler Technological Institute – Kanpur, B. R. Ambedkar National Institute of Technology – Jalandhar and Scientists and Research Scholars from Central Leather Research Institute (CLRI).

In order to strengthen its activities, ILTA have constructed its own six storied building at 44, Shanti Pally, Kasba, Kolkata – 700107, West Bengal, India and have named it as "Sanjoy Bhavan".

This Association is managed by an Executive Committee duly elected by the members of the Association. It is absolutely a non-profit making voluntary organization working for the betterment of the Leather Industry. None of the Executive Committee members draws any remuneration for their services rendered but they get the satisfaction of being a part of this esteemed organization.

ILTA
Since 1950

Indian Leather Technologists' Association
[A Member Society of International Union of Leather Technologists' and

'Sanjoy Bhavan', 3rdFloor, 44, Shanti Pally, Kolkata- 700 107, WB, India
Phone : 91-33-2441-3429 / 3459 WhatsApp +91 94325 53949
E-mail : admin@iltaonleather.org; mailtoilta@rediffmail.com
Website : www.iltaonleather.org