RESEARCH & DEVELOPMENT

The main objectives of the division are to develop the sustainable textile processing solutions for the benefit of textile industries and to save our mother earth. To achieve this goal, we have been working on the major research projects such as salt-free dyeing, natural dyeing, $SCCO_2$dyeing, use of alternate chemicals for finishing and related processes and novel effluent treatment techniques. In addition, this division is also focusing on the application of functional finishes for the welfare of human beings.

MAJOR PROJECTS

- Saltfree dyeing of cotton materials
- A method for Decolourisation of Textile Effluents – Patent filed
- Development of eco baby wear using natural mordants and natural dyes – Patent filed
- Development of Eco-Clothing by Greener reduction process of Natural Indigo Dye - Patent filing in progress
- Durable Non-Fluorinated functional Textiles using Fumed silica sols
- Development of Multifunctional protective cotton fabrics using Biopolymer Nano composites
- Waterless Dyeing
- Development of breathable, reusable and oxo-biodegradable coverall using biocidal polyester – Sponsored by Board of Research In Nuclear Sciences (BRNS).
- Antioxidant Cosmetic textiles: Durable Nano-encapsulated Vitamin E Finishes on Textile Fabrics and Its Controlled Release Study - Sponsored by the Department of Science and technology (DST-WOSA)
- Development of methods for cost effective and improved fastness in dyeing for production of KovaiKora Cotton Sarees
- Dyeing of Nylon sutures using Haematin Black (Logwood Extract)
- Study on fixing of Inlet Quality standards for the CETP's in Tamilnadu – TNPCB

SITRA also believes that collaborations with suitable industry partners and likeminded research organizations will only help either parties to exchange knowledge in their respective areas of expertise and come out with commercially workable model / solutions for the industry. The list of organizations with whom SITRA has collaborated in the recent are given below:

+ MEMORANDUM OF UNDERSTANDING – (MOU)

1. M/s. Super sales India Limited, Coimbatore.
2. M/s. Croda India Company Private Ltd, Mumbai.
3. M/s. Mak India Limited, Coimbatore.
4. M/s. World Wide Fund for Nature – India.
5. M/s. Tamil Nadu Agricultural University (TNAU), Coimbatore.
6. M/s. Hydra Consulting Services private Limited, Coimbatore.
7. M/s. Devan Supercritical private Limited, Pune.
8. M/s. Premier Evolvics, Coimbatore.
9. M/s. Precot Ltd, Coimbatore.
10. M/s. Colourtex Industries Private Limited, Surat.
11. M/s. Sri Kannapiran Mills Limited, Coimbatore.
12. M/s. Forest College and Research Institute (FC&RI), Mettupalayam.
13. M/s. The Synthetic & Art Silk Mills' Research Association (SASMIRA), Mumbai.
14. M/s. Viswam Dyes & Chemicals, Tirupur.

A. Completed funded projects (last 10 years)

1. Development of eco-clothing by greener reduction process of natural indigo dye. (Funded by Ministry of Textiles, Government of India).

Reduction of natural Indigo dye using green reducing agent and green alkali was investigated to develop an eco-friendly Indigo dyeing process. Optimization of green reducing agent and alkali was carried out by keeping the concentration of either green reducing agent or green alkali variable and other parameters such as temperature and time constant. The best results were obtained using a green reducing agent and a green alkali. The reduction potential of the vat was -756 mV and pH was 12.36 after a vatting time of 30 minutes. During the dyeing process, the reduction power was maintained at stable level for a longer time and a stronger color yield was obtained on garments. The fabrics were also analysed for colour fastness to washing, light and rubbing as per Oeko-Tex standard for baby clothing. It was observed that, the cotton fabrics on dyeing gave better color strength and fastness properties which is within acceptable limits.

2. Durable non-fluorinated functional textiles using fumed silica sols. (Funded by DST-SERB, Government of India).

Innovative silica nanoparticles and low cost crosslinkers based hydrophobic chemicals formulation with commercial potentialities was formulated which is environmentally friendly. The research findings can lead to business development with industries, which are interested in the area of green chemical based functional finishes and also application of nano-silica in textile industries. Utilization of silica nanoparticles and low cost crosslinkers as alternative for fluorinated chemicals will open up a new resource for chemicals industries and textiles industries.

3. Development of cost effective and better fastness dyeing methods for the production of KovaiKora cotton sarees. (Funded by Department of Handloom and Textiles, (DHT).

This project was taken to fulfill the demand of the dyers, the dyeing of Kora Yarn in acid dyes with suitable methods to increase the fastness property of the dyeing and better weaving performance Single bath partial degumming and dyeing was developed by SITRA has yielded as good strength of yarn when compare to grey silk yarn and in addition to better fastness property to all agencies.

4. Dyeing of Nylon mono filament (for suture applications) usingHaematin BlackNatural dye. (Funded by Madurai).

5. A comparative study on the Bleaching of cotton fabrics using Per Acetic Acid (PAA) and Hydrogen Peroxide. (Funded by Mars Chemicals and SITRA).

B. Completed in-house projects (last 10 years):

1. A study on the salt free dyeing of cotton materials.

Reactive dyes are the best one for the dyeing of cotton fabric based on their brilliant and fast colours with a wide range of shade using various eco-friendly procedures. However all the reactive dyeing system require huge amount of salt and alkali to exhaust and fix the dye respectively. The presence of salt in the effluent causes increase in Total dissolved solids (TDS). Higher TDS level in the effluent creates multiple problems. SITRA has developed a cationisation technology using newly synthesized eco-friendly chemicals to enhance the affinity between cotton fiber and reactive dyes without using salt.

2. Characterization of natural dyes.

A simple method for the identification of Indigo through color change was explored by SITRA Textile Chemistry Division. The available methods for the identification of natural and synthetic indigo dyes are 1) Kit method 2) High Performance Liquid Chromatography (HPLC) 3) Thin Layer Chromatography (TLC) 4) UV-VIS analysis 4) FT-IR 5) Nuclear Magnetic Resonance (NMR) analysis. Kit test is considered as a preliminary test, TLC is the mandatory test and any one of the optional test (HPLC/UV/FT-IR/NMR) needs to be performed for the identification of natural indigo dye. Based on the cost and efficiency of results, spot test, TLC and HPLC analysis were chosen for the identification of natural and synthetic dye from the dye extract.

3. Development of multifunctionalprotective textiles using biopolymer nano composites.

4. Determination of sugars in stickycotton and measures to mitigate the stickiness.

5. Development of polyester wool blended kids overcoat clothing using eco-friendly natural dyes.

6. Development of a greener printing process for textile garments.

7. Development of baby clothing using an eco-mordant for natural dyes on cotton fabrics.

8. A studyof inter-relationship between various Physical and Chemical properties of cotton fibres and their effect on dyeability.

9. A comparative study on the bleaching of cotton fabrics using Per Acetic Acid (PAA) and Hydrogen Peroxide.

C. On-going funded projects

1. Antioxidant cosmetotextiles: Durable nano-encapsulated vitamin E finishes on textile fabrics and its controlled release study. (Funded by DST-WOS A, Government of India).

Oral dosage and topical creams and lotions may be preferable route for the vitamin E supply. But the risk is some of the oral vitamin E products may contain excipients, such as polyethylene glycol, propylene glycol, or polysorbate 80 which have been associated with adverse drug reactions in children. Further, expensive cosmetics are selectively applied on a few areas of the human body and not on the whole skin. Hence the supplementation of vitamin E through fabric may be considered as a perfect choice. In cosmetic textile fields, micro and nano-encapsulation techniques containing vitamins are being applied in order to improve safety and durability of functional materials. Nanocarriers with increased surface area and lipid carrier ability would result in higher stability and higher drug loading capacity. Nanocapsules containing vitamin E for underwear, towels, T-shirts and bedding, those have direct contact with the skin; the release of vitamin E to the skin will be sustained for a long period of time.The present work is on the nano-encapsulation of vitamin E from the natural source and commercial source, the application of nano-formulation on the textile fabric.

2. Development of breathable, reusable and oxo biodegradable coverall using biocidal polyester. (Funded by BRNS, Government of India).

SARS-COV-2 continues to spread rapidly around the world, and health care providers are on the frontlines of battling the novel pandemic COVID-19. Health care providers are extensively affected, and the pandemic will continue to inexplicably affect them if proper precautions are not taken. As a preventive measure, the use of personal protective equipment (PPE), such as face mask, coverall, gloves, shoe cover and goggles have been the first protective means that can prevent the spread of the virus. Though the available disposable coverall products are cheaper and lighter in weight, they offer least comfort to the wearer and less effective against COVID-19 viruses. Hence, the access to effective antiviral PPE for health workers is a key concern. The present proposal is aimed to develop leak protecting, biocidal, reusable and oxo-biodegradable coverall using affordable raw materials to minimize the disease transmission and to combat COVID-19. The main objective of this proposal is to develop fabric with breathable, reusable, oxo-biodegradable and inherent antiviral properties.

D. On-going in-house projects

1. Development of water free dyeing techniques by using supercritical carbon di-oxide (SC-CO_2)

The elimination of process-water and chemicals would be a real breakthrough for the textile dyeing industry. Waterless dyeing technology using supercritical carbon dioxide (SC-CO_2) can solve the problem. Replacing water with Supercritical carbon dioxide is found to offer the major environmental advantages for the textile dyeing industry. Supercritical carbon dioxide (SC-CO_2) technology can be used as an alternative to present conventional method. Using SC-CO_2 as a solvent to replace water based processes has the advantages like no water usage, recycling of CO_2, zero waste water emission. Thus, it fully complies with future clean, green environmental manufacturing concept. Internationally in this area, research started in the year of 1990s. However still in India, the research study on $SCCO_2$ dyeing techniques is very minimal. SITRA is developing SC-CO_2 dyeing techniques in which polyester dyeing has shown encouraging results in Pilot scale.

1. Achievements

Dr. Prakash Vasudevan, Director and Mr. S. Sivakumar, Head – Textile Chemistry have contributed to the "Technology Vision 2035 chapter on Manufacturing – Textile and Apparel Industry" published by TIFAC Department of Science and Technology, Government of India

2. List of publications

1. Cu-mediated synthesis of differentially substituted diazepines as AChE inhibitors; validation through molecular docking and Lipinski's filter to develop novel anti-neurodegenerative drugs.
   N. Sudhapriya, A. Manikandan, M. Rajesh Kumar, P.T. Perumal
   Bioorganic & Medicinal Chemistry Letters, 29, 2019, 1308-1312.
   Impact factor: 2.823

2. p-TSA.H_2O mediated one-pot, multi-component synthesis of isatin derived imidazoles as dual-purpose drugs against inflammation and cancer
   M. Rajesh Kumar, V. Violet Dhayabaran,**N. Sudhapriya**, A. Manikandan, Daniel A. Gideon, S. Annapoorani.
   Bioorganic Chemistry, 102, 2020, 104046.
   Impact factor: 5.275

3. Dyeing of textiles with natural dyes extracted from Terminaliaarjuna and Thespesiapopulnea fruits.
   K. Amutha, S. Grace Annapoorani,**N. Sudhapriya**
   Industrial Crops and Products, 148, 2020, 112303.
   Impact factor: 5.645

4. Ecofriendly dyeing of textiles with natural dyes extracted from 3 commercial food processing waste mate
   K. Amutha, S. Grace Annapoorani,P. Sakthivel, **N. Sudhapriya**
   Journal of Natural Fibers, (Accepted for publication in Oct 2021)
   Impact factor: 5.323

5. **S. Sivakumar**, Dr. K.P. Chellamani and M.K. Vittopa and published a research article on "Studies on quality attributes of Bt-Cottons" – Asian Textile Journal, ISSN 0971-3425, Vol. 23 No. 10, October 2014, pp 68-72

6. **D. Ranganathan** has published a research article on "Phytochemical analysis of Caralluma Nilagiriana using GC –MS" in Journal of Pharmacognosy and Phytochemistry May 2014, ISSN 2278-4136, Vol. 3, Issue 1, PP155-159.

3. Photo Gallery

(Note: Kindly include the display picture taken on 02.12.2021)
(See the next page for images)

Salt free dyeing bulk trials at industry

Salt-free dyeing of cotton materials using synthesized cationising agents

Video Gallery