ANNUAL REPORT 2020-21

The Bombay Textile Research Association

MEMBERS OF THE GOVERNING COUNCIL

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We have great pleasure in presenting the 67th Annual Report of The Bombay Textile Research Association (BTRA). It highlights the R & D and other activities of BTRA and also presents the Audited Statement of Accounts for the year ending 31st March 2021.

1. INTRODUCTION

During this pandemic, the Indian Textile Industry is in a critical state which has impacted not only the Indian economy but also the global economy. Although the textile industry had been doing very well in the recent past, before the pandemic, its relevance is currently challenged by the lack of focus in Research and Development (R & D) as other issues have taken the forefront. However, the industry has to keep innovating for the current needs in medical textiles which are being focussed during this time. A lot of new research is required hence there is a need to train the talent for process and product innovation.

In the current scenario, the textile industry has been concentrating on developing value-added products in the high technology platform primarily focussing on medical textiles best suited for combating COVID. Efforts are being made in product/process development and diversification into more technology-based products. At our Centre of Excellence, Geo-synthetics, we have strengthened several testing facilities. Even at our Electro-spinning unit, we are undertaking designated jobs from DRDOs. Hence, BTRA has taken major steps with financial assistance from the Ministry of Textiles, the Government of India, and other funding agencies such as DRDO, BARC, IREL to develop expertise and provide services to the textile industries.

We at BTRA strongly believe in the importance of R & D, particularly for product/process development, even cost reduction, and enhancing efficiency in textile mill operations. The essence of R & D is two-fold (i) to make the existing products better, faster, and at affordable prices and (ii) to develop new products. BTRA is also strengthening its training activities for providing need-based training to technical/supervisory and operator levels. In this regard, BTRA has also initiated the training activity on Effluent Treatment Plant, Water Recycling, and Sustainable Technology in collaboration with M/S Austro Water Technologies, Pvt Ltd, Tirupur. BTRA has been working on these and other thrust areas and a glimpse of some of the work carried out during the period under review is briefly highlighted as follows.

Overview

❖ **On-going sponsored projects -** The number of ongoing sponsored projects are two for the period under review. Details are as follows.

✓ In the project entitled ‘Development of a standard method for identification of dope dyed and exhaust dyed polyester fibers/fabrics’ The fabric of the same color but produced by dope and exhaust-dyeing routes, looks similar. Dope dyeing is the process of adding dye or pigment during the melt or solution spinning of yarn. While in the exhaust dyeing process, dyeing of textile material is done after manufacturing. However, the performance of the dope dyed and exhaust dyed fabric in terms of color fastness is different which may create shade-off or a tonal variation during use in Army uniforms. This project covers a systematic investigation to identify the dope dyed and exhaust dyed polyester and aramid filaments/fabrics by subjecting them to various tests procedures. Different tests were conducted on exhaust dyed and dope dyed yarn. In sublimation, washing, and light fastness, thermal treatment in a muffle furnace, the color value of exhaust dyed yarn is reduced while there is not much change in dope dyed yarn. Shrinkage of exhaust dyed yarn is also less than that of dope dyed yarn. While birefringence and TGA analysis did not provide any distinguishing results between the two. Other experimentation is in progress.

✓ In the project entitled 'Eco-friendly Natural Dyeing of Cotton and Silk using Rare Earths (RE) Metal Salts as Mordants', The project is related to natural dyeing of cotton and silk fabrics using nonconventional mordant salts. These nonconventional mordants are rare earth salts such as Cerous sulphate, lanthanum chloride, and yttrium chloride. They have been used for the first time in natural dyeing and the project was funded by IREL. The project was aimed to tackle some genuine problems faced by natural dyers. The problems faced are poor rubbing fastness of Indigo dye, poor wash and lightfastness of turmeric dye, and in general low color intensities of naturally dyed fabrics. We were able to demonstrate that natural dyeing using rare earth salts (RE) could show a marked difference in the improvement of rubbing fastness for natural indigo dye. Similarly, turmeric also showed improved wash and light fastnesses. 13 natural dyes have been demonstrated to show better results as compared to conventional mordants. Even the quantity of rare earth mordant required to get desired results is about 60-80% less. Thus the use of rare earth mordant has good prospects in the Natural dyeing of silk and cotton fabric.

❖ **Product Development Assistance to the industry**

- In the Plasma Treatment Machine, twenty meters of fabric was processed for two academic / research institutes.

- In the Nanoparticle mediated Antimicrobial coating with the Copper and Silver nanoparticle. The antibacterial effect (~99%)and the wash sustainability (10 wash cycles) of copper nanoparticles have been very good.

- BTRA is trying to develop a hydrophobic coating using cheaply available Rice husk. So far we have been able to get a contact angle of 127°, however, our target is to attain a contact angle of >150°. Work is in progress for minimizing the particle size of the silica.

❖ **In-house project**

✓ In the project entitled 'Nanoparticles synthesis and its coating for antimicrobial application, Cu and Ag Nanoparticles were prepared by chemical and bioreduction process respectively. These nanoparticles were coated over the fabric using pad-dry – cure method and analysed in terms of antimicrobial activity, SEM, and EDX measurements. Related work is included in this report.

✓ In the project entitled 'Atmospheric pressure plasma treatment of textiles for dyeing of various fabrics with natural and synthetic dyes, Increasing environmental concerns owing to the large quantities of water and hazardous chemicals used in the conventional textile finishing techniques lead to the development of new technologies. In recent decades, plasma technology has gained great importance among all available surface modification processes. It is a dry, environmentally friendly method to achieve surface alteration without modifying the bulk properties of the materials. In particular, non-thermal plasmas are especially suited because most textile materials are heat-sensitive polymers. Among plasma technologies, atmospheric plasma is an alternative and cost-competitive method compared to wet chemical treatments. Plasma technology has proved to intensify dyeing rates of textile polymers improving the diffusion of dye molecules into the fibres, enhancing colour yield of fabrics, and modifying the wettability of several fibres and fabrics such as cotton, polyamide, polyester, polypropylene, silk, and wool.

- ✓ In the project entitled 'Development of Nylon 6, Polypropylene/ Graphene Oxide (GO) high-performance nanocomposite filaments, A polymer nanocomposite (PNC) is made up of a polymer matrix in which nano-sized additives are incorporated. The nano-sized additives can be of zero-dimensional (nanoparticle), one-dimensional (nanofibres), two-dimensional (graphene sheets) or three-dimensional (spherical particles).PNCs have attracted considerable interest due to the infusion of merely a small quantity of inorganic nano-scale filler into the polymer matrix leads to prominent enhancement in mechanical, optical, electrical, and thermal properties of the resulted materials as compared to the neat polymers or micro filters composites.

❖ Calibration, Technical Services, and Training

- ✓ BTRA calibration laboratory received accreditation from NABL as per ISO/IEC 17025:2005 standards for Mass, Balance, Volume, and Force. BTRA is ready to provide calibration services to other NABL accredited testing laboratories for Mass, Balance, Volume, and Force parameters.

- ✓ BTRA undertakes extensive liaison and consultancy services to solve problems related to quality, maintenance, productivity, water/energy conservation, etc., at various levels from time to time. Also, special studies such as vendor selection, valuation of fixed assets, manpower planning, etc. are undertaken for the mills. For the period under review, BTRA provided services in the areas of Accredited partner audits, boiler efficiency audits, and fabric inspection.

- ✓ BTRA conducted several training programs at the mills' premises covering subjects such as Technology, Upgradation, Quality Control and Third-party auditing of ETP, Fabric Inspection, Size Application, and Evaluation, Cuprammonium fluidity test, and Good Work Practices & Utility Conservation. BTRA imparted training (theory and practical) at the testing laboratories/pilot plants covering subjects such as Technical Textiles (Geotech), Textile Terminology and Processing, Yarn testing and sizing, Sizing and Testing, Mechanical

&Chemical Testing, and General elements of textiles.

- **Others**

Research, development, testing, and consultancy activities at BTRA have been directed towards innovative product/process or test method development and providing an essential database for the industry. BTRA will make sure that the industry gets maximum benefit out of all activities that we are pursuing. In the years ahead, BTRA will strive to make its mark in the area of utility conservation, effluent load reduction, chemical management system, eco-management for process houses. Also, we will make a mark in cutting-edge research in the fields of fibre science technology, high performance, and nanomaterials.

2. ON-GOING SPONSORED PROJECTS

2.1Development of a standard method for identification of dope dyed and exhausts dyed polyester fibers/fabrics

Abstract

The fabric of the same color but produced by dope and exhaust-dyeing routes looks similar. Dope dyeing is the process of adding dye or pigment during the melt or solution spinning of yarn. While in the exhaust dyeing process, dyeing of textile material is done after manufacturing. However, the performance of the dope dyed and exhaust dyed fabric in terms of color fastness is different which may create shade-off or a tonal variation during use in Army uniforms. This project covers a systematic investigation of the dope dyed and exhaust dyed polyester and aramid filaments/fabrics by subjecting them to various tests like colour fastness to sublimation, washing, and light fastness to colour stripping, shrinkage, DSC, and TGA analysis.

1. INTRODUCTION

Dope dyeing of filaments/fibers has gained considerable interest in academics as well as in the industrial community in recent years due to the intrinsic dyeing of polyester during fiber spinning. It has altogether good physical and chemical properties than exhaust dyed material. The use of dope-dyed polyester yarn is preferred in certain specific application areas like Army uniforms due to its higher fastness properties. In this context, it has also been realized that dope dyed polymer gives less burden to the environment. Despite this, the textile processors might compromise on this front because of a marginal increase in cost. Therefore, exhaust dyeing is still popular in the textile wet processing industry not only due to its lower cost and easy accessibility but also have much more choices of different colors, unlike dope dyeing where only fiber/filaments manufacturer have their choices with a limited number of color pigments. The polyester fabric of the same color but produced by dope and exhaust-dyeing routes looks similar. However, the performance of the dope dyed and exhaust dyed polyester fabric in terms of color fastness to various chemical agents and environmental conditions is different. This difference in fabric performance may create shade-off or a tonal variation, which creates hurdles to achieve desired long-term properties. However, there is no standard method available to distinguish exhaust or dope dyeing methods of polyester fibers/fabrics. Efforts are being made in this direction, but no confirmative result has been reported yet. Therefore, there is a necessity to develop a standard method to understand whether the sample is dope dyed or dyed using the exhaust dyeing route. The current project covers a systematic investigation of the dope dyed and exhaust dyed polyester filaments/fabrics through physical, chemical, optical, thermal, microstructural, and morphological studies.

2. METHOD

In this project, PET dope dyed and exhaust dyed samples were produced in the lab as well as procured from the industry. Similarly raw white and dope dyed para-aramid and meta-aramid samples were procured from the industry. To prepare PET yarn samples is lab melt spinning of PET was done. For the preparation of dope-dyed yarn, Clariant red master batch is added. The dyeing of prepared PET raw white samples and industrial samples was done in three stages. It is first pretreated with surfactant Tween 80 and then dyed with Coralene dark red disperse dye with 0.3% and 0.5% shade percentage in a high-temperature high-pressure beaker dyeing machine at 130°C for 45 minutes. It was then treated with sodium carbonate and sodium dithionite at a temperature of 100°C for 15 min followed by a normal wash.

For dyeing of aramid yarns, pretreatment with DMF at 80°C for 30 min was done before dyeing so that yarn complex structure could open up and facilitate dyeing. It was then dyed with Coracryl Red Modified Basic dye with 3% shade in a high-temperature high-pressure beaker dyeing machine at 130°C for 1.5 hours. It was then treated with sodium carbonate and sodium dithionite at a temperature of 100°C for 15 min followed by a normal wash.

Prepared samples were then analyzed for colour stripping, colour fastness to light, washing, sublimation, birefringence, shrinkage, TGA, DSC, and their colour value.

3. RESULT AND DISCUSSION

Stripping of exhaust dyed and the dope dyed polyester yarn was done in a Soxhlet Assembly with solvent dichloromethane. Results showed that more than 95% of colour strips in lab exhaust dyed samples, while colour of lab dope dyed sample remains intact. In the case of industrial samples, more than 99% of colour stripped in both samples which indicates that particle size of pigment in industrial dope dyed is small causes easy removal from the polyester fiber surface. Similarly stripping of aramid samples was also done in DMF solvent and the result showed that stripping of exhaust dyed aramid yarn is more that of dope dyed yarn.

In boiling water shrinkage test, shrinkage of exhaust dyed yarn is less than dope dyed yarn in all samples. This is due to exhaust dyed yarn already shrunk in high-temperature dyeing.

In colour fastness to sublimation, PET dope dyed industrial samples showed staining in the adjacent multi-fabric at 180^{0}C and high staining at 210^{0}C while lab dope dyed sample showed no staining at temperature 180^{0}C and slight staining at temperature 210^{0}C. While exhaust dyed yarn of both types of the sample shows staining at temperature 210^{0}C while no staining at temperature 180^{0}C. Sublimation fastness in aramid samples was performed for a longer duration. With the increase in time, the colour value of exhaust dyed yarn decrease while there was a slight change in colour value of dope dyed yarn.

In colour fastness to washing, PET and aramid samples were subjected to washing with standard IS/ISO 105 C10:2006. No sample showed any change in colour or staining in adjacent multi-fabric in PET, as well as aramid samples with Method B and C. Washing of Aramid samples, was done with method E. With the consecutive washes, there is a decrease in colour value of exhaust dyed yarn while there was not much change in dope dyed yarn.

In colour fastness to light, industrial PET exhaust dyed sample started fading first after 63.5 hours of exposure while no fading in dope dyed yarn was observed. Aramid samples are observed for change in colour value with time. In exhaust dyed yarn colour value reduced with time while in the case of dope dyed yarn colour value increased slightly with time.

In the birefringence test of PET industrial samples, there was a slight difference in values of both types of yarn by which both types of yarn could not be distinguished from this test. Similarly in TGA analysis, there was no difference observed in the thermal behavior of both types of yarn observed.

Aramid yarns were subjected to hot air treatment in a muffle furnace at temperature 300^{O}C for 2 minutes and found that there is a change in tone of aramid exhaust dyed samples while no change in dope dyed yarn was observed.

2.2 Eco-friendly Natural Dyeing of Cotton and Silk using Rare Earths Metal Salts as Mordants

Dyeing results with Indigo

The current project is aimed at making significant improvements in the area of Natural dyeing by using rare earth salts. In this study, the eco-friendly rare earth was used as mordant in the natural dyeing of cotton & silk fabrics. The influences of dyeing conditions were studied. The cotton & silk fabrics dyed using rare earth as mordant exhibited higher colour shade stability against pH variation. Using rare earth as mordant in natural dyeing enhanced the colour fastness to washing, rubbing, and light of the cotton & silk fabrics as compared to Fe^{2+} and Cr^{6+}. Rare earth salts were found to be more efficient, resulting in a decrease of mordant concentration in natural dyeing. Thus, rare earth salts were shown to be effective mordant in the natural dyeing of cotton & silk fabrics.

The ion of rare earth elements can form a bond with hydroxyl, carbonyl group, etc. of natural dyestuff and fiber, making rare earth salt a good candidate to be used in dyeing. We have shown that it can be used as pre-mordant as well as post-mordantdepending on the type of the natural dye. In the case of Mulberry leaf extract, we have used RE as pre-mordant, while in the case of indigo dye we have used the RE salts as post-mordant.

In the pre-mordanting process of the silk fabric, the rare earth salt ion can be envisaged to improve capillary action by its ion causing swelling of fiber and structural relaxation for better dye diffusion as well as effective interaction with the fiber. In addition, rare earth elements can make coloring matter activation on the fiber by better coordination.

The rare earth salts used in our study were cerium nitrate, Cerous sulphate, Lanthanum chloride, Yttrium oxide, and Yttrium chloride. Cerous sulphate, Lanthanum carbonate, and yttrium oxide showed lesser solubility in water, thus citric acid was used with these RE salts. The complexation of the RE salt with citric acid has been shown in figure-1. This coordination with citric acid makes the RE salt not only solubilize but also acts as a co-catalyst in mordanting step. These complexes were used in mulberry extract dyeing of cotton & silk fabrics.

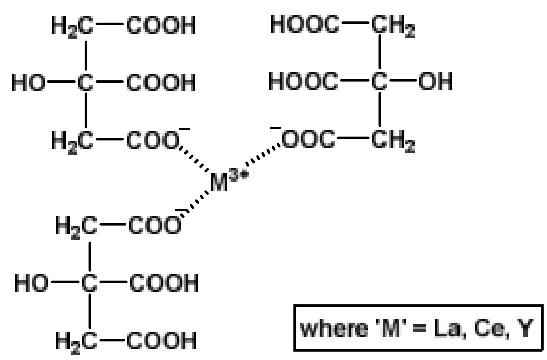


Figure-1 RE salt and Citric acid complexation

The usual drawback with some of the natural dyes is their fastness properties and it is for this purpose that mordants are used to bind the colourant to the fabric.

The binding capacity of Lanthanides (La, Ce, and Y) is better than transition metal ions (Fe, Cr) as the rare earth salts have greater coordination as shown in figure-2 with indigo colorant.

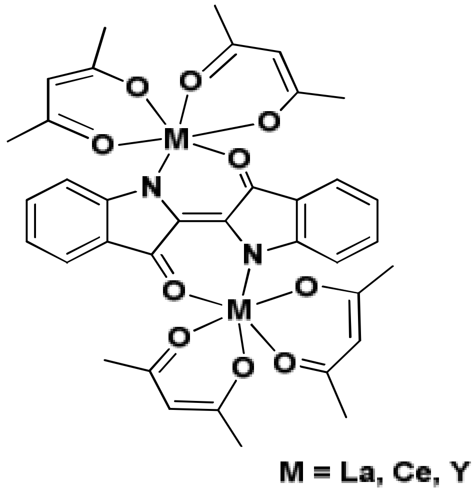


Figure -2 RE salt with indigo dye

Among the fastness properties- Wash, light rubbing, and perspiration, individual natural dyes show their characteristic behavior. For example- Turmeric dye has a poor wash and light fastnesses but has reasonable rubbing fastness. Indigo has a good wash and light fastnesses but poor rubbing fastness. Conventional use of Transition metal salts did not solve the fugitiveness of Turmeric dye, nor could they bring about improvement in rubbing fastness of Indigo dye. Even Mulberry dye has poor wash and light fastnesses.

We have been able to improve the fastnesses of Turmeric, Indigo, and Mulberry dyes with the use of RE salts. Here we have described the improvement in rubbing fastness in indigo dyeing and wash and light fastnesses in Mulberry dye.

Since rubbing fastness is a major issue faced by indigo dyers. We tried to experiment with rare earth salts -Cerous sulphate, Lanthanum chloride, and Yttrium chloride through post-mordanting. It is known that rare earth metals form chelates with dye molecules particularly with Yttrium salts as shown in table-1.

Table-1 Rubbing Fastness of Indigo dyed silk swatches

Indigo samples post mordanted	Rubbing fastness (dry)	Rubbing fastness (wet)
Control	2	2
4 % Alum	2	2
4 % Ferrous Sulphate	2-3	2
0.4 % CerrousSulphate	3-4	3-4
0.4% Lanthanum Chloride	3-4	3-4
0.4% Yttrium Chloride	4	4

The best results were obtained with yttrium chloride. The rubbing fastness (dry and wet) both increased by 2 units as shown in the table-1. The control and alum mordanted silk fabrics showed the rubbing fastness as 2 while yttrium chloride mordanted fabric showed the values as 4. This incremental value of rubbing fastness for indigo by post-mordanting with RE salts has proven that these RE salts have played a very pivotal role in arresting the colour of the fabric. With the optimum use of 0.4% of the concentration of RE salt as post mordanting, the results obtained were remarkable.

Dyeing results with extract of Mulberry leaves

The RE metals used in this research work were Cerous sulphate, Lanthanum chloride, and Yttrium chloride.It was proved that using RE salts in just 0.4 % as pre-mordant enhanced the colour fastness to washing, rubbing and light of silk fabrics dyed. The colour depth was found to be better than the unmordantedand conventional mordant- which was used in 4 %. The best results of premordanting with RE salts with mulberry leaf extract dye were with lanthanum chloride and Yttrium chloride as can be seen in table -2. The colour depth in terms of K/S values obtained from $LaCl_3$(126.23) and Y Cl_3 (127. 47) are far more than the unmordanted(52.33) and the alum mordanted (80.07) silk swatches. It is known that Metal-complex dyes adsorbed on silk inhibit marginal migration due to the high stability of the dye–fibre linkages and produce invariably bright good shades with good light and wash fastness as shown in table-2

Figure-3 Colour Palette from dyeing silk (Std- control); Batch-1-Alum; Batch-2 Ce N:CA; Batch-3 La C :CA; Batch-4 YO: CA; Batch-5 Ce Sul ; Batch-6 La Cl; Batch -7 Y Cl

The wash and light fastness showed in table-3of dyed silk swatches pre-mordanted by RE salts show a higher value than unmordanted or even alum mordanted. The mordant quantity required for RE salt was just 0.4 %. The colour depth as shown in figure-4 for batch 6 and 7 (lanthanum chloride and Yttrium chloride mordanted) were apparently darker and the fastness properties values shown in table-3 also showed marked improvement.

Table -3 Wash and Lightfastness of the Dyed silk swatches with Mulberry leaves

Mordant	Wash Fastness	Light Fastness
Control	3	1
Alum	3-4	2
Cerous Sulphate	4	2
Lanthanum Chloride	4	3
Yttrium Chloride	4-5	3

Conclusion: The use of Rare earth salts as post-mordant in the case of Indigo dye made a good improvement in rubbing fastness, while in the case of Mulberry leaf extract pre mordanting with rare earth

Table-2CIELab values of the Dyed silk swatches with Mulberry leaves

S.No	Mordant	K/S Value	L	a	b	C	H	dE	Remark
Std	Control	52.33	52.87	-23.58	13.33	27.09	150.53	--	
1	Alum	84.07	40.45	-15.38	11.54	19.23	143.12	14.99	
2	Ce N : CA	70.43	45.06	-17.09	15.56	23.12	137.69	10.39	
3	La C: CA	81.30	40.84	-15.19	11.30	18.93	143.37	14.80	
4	YO: CA	60.69	47.74	-17.31	16.12	23.65	137.05	8.56	
5	Ce Sul	79.33	41.84	-15.47	13.12	20.29	139.71	13.68	
6	$LaCl_3$	126.23	32.54	-11.54	6.05	13.03	152.32	24.72	**Good**
7	Y Cl_3	127.46	31.91	-10.96	4.04	11.69	159.77	26.16	**Best**

extract showed good colour depth. The major attributes of using rare earth salts are--Shorter dyeing time, reduction in usage of mordant percentage (from 4 % in the case of Alum to 0.4% in the case of rare earth salts), and environmentally benign make them an ideal additive for Natural dyeing even on an industrial scale.

In-house project

2.3 Nanoparticles Synthesis and its coating for antimicrobial application

Synthesis of copper and silver nanoparticles was carried out by chemical and bioreduction methods respectively. Ascorbic acid and lemon leaves extract was used as reducing agents. Synthesized nanoparticles were coated over the cotton fabric by the pad-dry cure method with maintaining 75% pickup. The deposition of Copper and Silver nanoparticles (Cu-NPs and Ag-NPs) was analyzed by scanning electron microscope with energy dispersive X-ray (SEM-EDX) as well as antibacterial activity.

Scanning electron micrographs and Energy dispersive X-ray (EDX) scans were recorded using JEOL JSM IT 200 & Element make EDX, to confirm the surface morphology and elemental composition of the CuNP's coated fabrics.

The surface morphology of the CuNP and AgNP coated cotton samples showed the uniform distribution of Cu and Ag nanoparticles over the substrate as shown in (Fig.1).

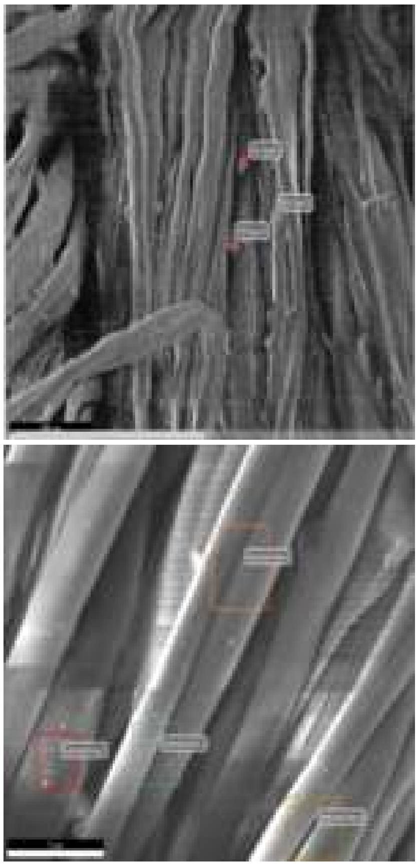
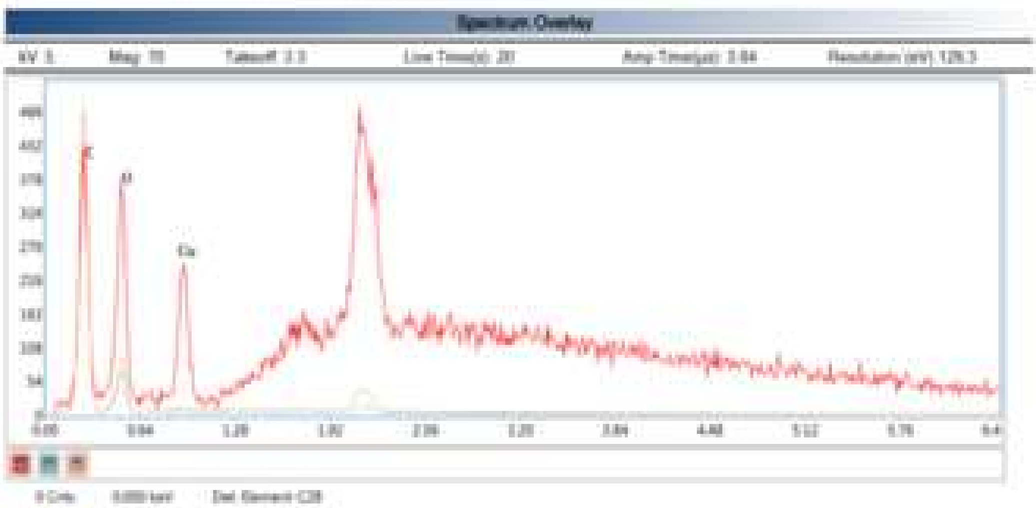


Fig. 1Scanning electron micrograph (SEM) of CUNP and AgNP coated samples



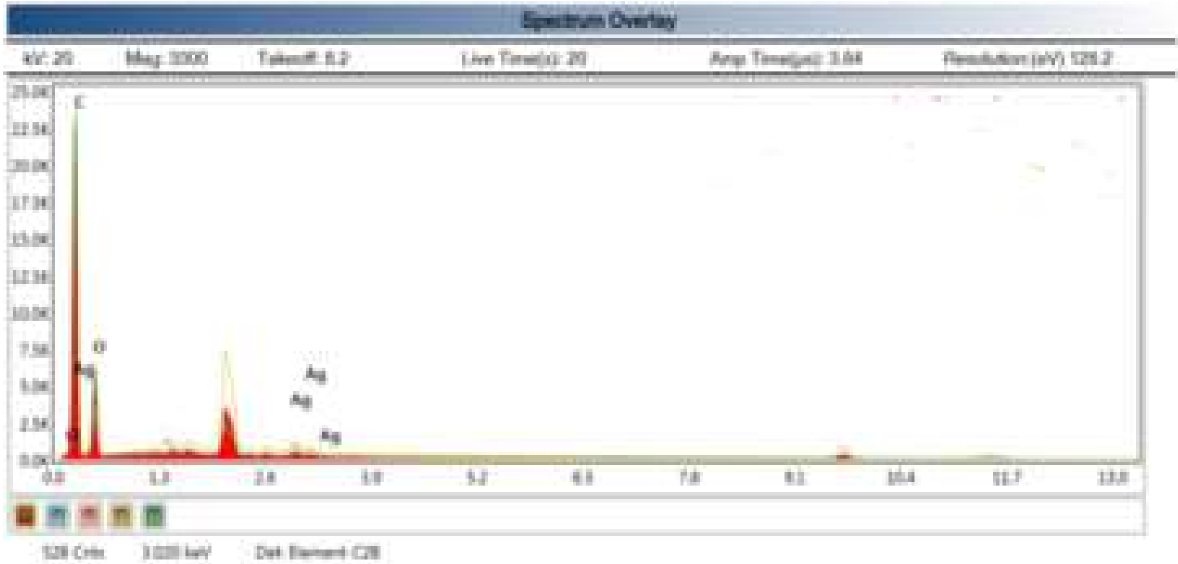


Fig. 2 EDX Spectra of CuNP coated Fabric

The EDX spectra (Fig.2) showed the signals for Cu and Ag along with oxygen and carbon in the case of CuNP and AgNP coated samples respectively. The appearance of carbon and oxygen peaks in the spectrum are due to the cotton fabric over which Nanoparticles are coated.

The antimicrobial property of CuNP's coated cotton fabrics was studied by the AATCC-100 procedure which gives a quantitative estimate of the antibacterial activities of the fabrics. Both Cu NP, as well as Ag NP, coated fabrics showed excellent antibacterial activity towards Gram-positive (Klebsiella Pneumoniae) and Gram-negative bacteria (Staphylococcus aureus).

In the case of CuNP coated fabric, the antibacterial rate reached 99.44% towards bacteria Klebsiella Pneumoniae and 99.96% towards bacteria Staphylococcus aureus after 24 hrs duration. Whereas for AgNP coated fabrics, it reached 99.75% and 98.19% for Klebsiella Pneumoniae and Staphylococcus aureus respectively.

Conclusion: Highly efficient antimicrobial cotton fabric was obtained by coating CuNPs as well as AgNPs over the cotton fabric by the Pad-Dry cure method. Cu and Ag NP deposition over cotton substrate were confirmed by SEM/EDX analysis.

2.4 Atmospheric pressure plasma treatment of textiles for dyeing of various fabrics with natural and synthetic dyes

Introduction:

Increasing environmental concerns owing to the large quantities of water and hazardous chemicals used in the conventional textile finishing techniques lead to the development of new technologies. In recent decades, plasma technology has gained great importance among all available surface modification processes. It is a dry, environmentally friendly method to achieve surface alteration without modifying the bulk properties of the materials. In particular, non-thermal plasmas are especially suited because most textile materials are heat-sensitive polymers. Among plasma technologies, atmospheric plasma is an alternative and cost-competitive method compared to wet chemical treatments. Plasma technology has proved to intensify dyeing rates of textile polymers improving the diffusion of dye molecules into the fibres, enhancing colour yield of fabrics, and modifying the wettability of several fibres and fabrics such as cotton, polyamide, polyester, polypropylene, silk, and wool.

Justification for the Project: The effect of plasma treatment is studied on all possible fabrics for dyeability with different dyes. However, a holistic study concerning natural and synthetic fabrics and dyes is not done to the best of our knowledge. Therefore there is a scope to study the effect of plasma on natural and synthetic fabrics using various classes of dyes and to understand the generality in dyeing behaviour of each fabric type as well as dye.

Hence, we propose to use atmospheric pressure plasma treatment to improve the dyeability of textiles fabrics and study the effluent characteristics to understand the environmental impact of plasma technology.

Objectives of the Project: The main objective of this study aims to investigate the effects of DBD plasma discharge on various textile fabrics and to understand the nature and the mechanism of the dye adsorption process promoted by DBD plasma.

2.5 Development of Nylon 6, Polypropylene/ Graphene Oxide (GO) high-performance nanocomposite filaments

Introduction:

A polymer nanocomposite (PNC) is made up of a polymer matrix in which nano-sized additives are incorporated. The nano-sized additives can be of zero-dimensional (nanoparticle), one-dimensional (nanofibres), two-dimensional (graphene sheets) or three-dimensional (spherical particles).PNCs have attracted considerable interest due to the infusion of merely a small quantity of inorganic nano-scale filler into the polymer matrix which leads to prominent enhancement in mechanical, optical, electrical, and thermal properties of the resulted materials as compared to the neat polymers or micro filters composites.

The discovery of graphene has led to the succeeding development of graphene-based polymer nanocomposites. The Sheets of graphene have a higher surface-to-volume ratio compared to CNTs, As polymer molecules can access the more surface of the graphene sheets. Thus graphene sheets seem to be a more favorable choice for altering mechanical, rheological, and permeability properties as well as the thermal stability of polymer matrix. The improvement in the mechanical properties of graphene-incorporated nanocomposites is also attributed to the better capacity of graphene to deflect crack growth. The wrinkled structures given rise by graphene sheets or platelets disseminated in polymer matrix tend to unfold instead of a stretch when subjected to stress. This may, to a great extent reduce the stiffness of the material. Nevertheless, these structures could result in mechanical interlocking and allow load transfer between polymer matrix and graphene which could be the reason behind the improved mechanical strength.

However, as graphene is expensive and relatively hard to produce, great efforts are made to find effective yet inexpensive ways to make and use graphene derivatives or related materials. Graphene oxide (GO) is one of those materials - it is a derivative of graphene which bears oxygen functional groups on its basal planes and edges. Structurally, GO is similar to a graphene sheet. The oxygen-containing functionalities in GO enable it to be well-dispersed in water and several types of polymer matrices at the same time it retains much of the properties of pure graphene. Additionally, GO is much easier and cheaper to process and produce in bulk quantities. These characteristics have made GO the more promising filler in the manufacturing of polymer nanocomposites.

There are generally three methods used to produce polymer matrix nanocomposites namely in situ polymerization, melt blending or solution blending.

By solution blending GO has previously been successfully infused to some polymers including poly (methyl methacrylate) (PMMA), polycarbonate (PC), polystyrene (PS), polyimides, and polyacrylamide using this technique. In the fabrication of the reported nanocomposites, the GO surface was usually functionalized using isocyanates, alkylchlorosilanes, and alkylamine to make it more dispensable in organic solvents. By melt mixing nanocomposites fabrication includes polypropylene (PP)/GNP, high-density poly(ethylene) (HDPE)/ nanoclay, PMMA/glass flake, nylon-11/graphene, and nylon-12/graphene; For the in-situ polymerization method, the filler is mingled in neat or multiple monomers to intercalate the monomers between layers of filler. Polymerization is carried out subsequently to separate the layers. The nanocomposite is subsequently produced through precipitation or solution casting. For instance, nanocomposites such as polyamide-6/GO, polyimide/GO, Nylon-6/ADA-MONT have been developed through in situ polymerization. It has been reported that the properties of many polymers such as PVA, PU (polyurethane), epoxy, PC, PMMA, PS have been successfully improved by incorporation of GO; Yang et al. reported that GO/epoxy nanocomposite prepared by solution blending indicated significant improvements in mechanical properties with an increase of 48.3% in compressive failure strength and 1185.2% in toughness respectively when 0.0375wt% of GO is used. Morimune, Nishino, and Goto prepared graphene oxide reinforced PVA by using a simple casting method from an aqueous medium. The Young's modulus (E) of PVA increased dramatically by 76% at low GO loading of 0.1wt%. Super et al. had carried out a study on the thermal and mechanical properties of ultrahigh molecular weight poly(ethylene) (UHMWPE) prepared by solution mixing. It was found that Young's modulus, yield stress improved by approximately 15% while fracture strength enhanced by 25% with the addition of up to 0.5wt% of GO. However, in a different study GO-reinforced polyimide fabricated via in situ polymerisation indicated a different behavior that the modulus did not increase distinctly until the concentration of GO in polyimide reached 10% by weight.

Nylon-6 or polycaprolactam is synthesized through ring-opening polymerization of a cyclic amide namely caprolactam. Nylon is a widely used thermoplastic polymer due to its corrosion resistance, good insulation, and good load-bearing capacity. It has a low density which makes it lighter. For a specific volume, nylon comprises roughly one-eighth of the weight of bronze, 14.3% of the weight of cast iron, and half of the weight of aluminum. Adversely, nylon-6 has a lower modulus and higher absorption rate of moisture than nylon-6/6. Moisture can reduce the tensile strength and stiffness while increasing elongation as plasticizer does. Although moisture absorption confers many undesirable changes in properties, impact strength and general energy absorbing characteristics of nylon increase prominently as moisture content rises.

In studying the properties of nylon-6 nanocomposites, Rangari et al. infused Si3N4 (Silicon nitride) of two different geometries (nanorods and spheres) in nylon-6 via melt processing. They found that the tensile strength and modulus increased by 179.03% and 276.40% respectively. Allafi and Pascal investigated the thermal property of nylon6/nanoclay nanocomposites fabricated by melt compounding via Dynamic Mechanical Analysis (DMA). The storage modulus of the nanocomposites indicated a prominent improvement. Hassani, Ishak, and Mohamed had attempted in producing nanocomposites comprised of nylon-6 and commercial CNT as filler via melt compounding. The melt flow rate started to reduce significantly at 1wt% of CNT loadings due to the non-polar nature of CNT which facilitates the movement of polymer chains by acting as a barrier to polar-polar interaction in nylon-6. Chow and Ishak reported 30.4% and 71.3% of improvement in the tensile modulus and tensile strength respectively in nylon-6 infused with 4wt% of organo-montmorillonite (OMMT) through melt mixing. The nanocomposite exhibited 38.1% and 11.8% increment in flexural modulus and flexural strength correspondingly. Zhang et al. reported GO reinforced polyamide-6 nanocomposites fabricated via in situ ring-opening polymerisations with significant improvement in tensile strength and Young's modulus at low GO contents.

With the above context, in this study, we are interested to investigate processing, thermal, mechanical, microscopic, and spectroscopic properties of GO/Nylon 6 nanocomposites filaments fabricated by melt mixing and spinning method which is claimed to be more environmentally friendly due to elimination of solvent use, cost-effective, faster, easier and applicable in large-scale production.

Nano-filler-based polymer nanocomposites have gained considerable research interest in academics as well as in the industrial community in recent years. This is primarily due to the intrinsic mechanical, thermal, and electrical properties associated with the nano-filler. In this context, it has also been realized that nano-filler also can act as an efficient compatibilizer between polymeric molecular chains, which includes organically modified clay, carbon nanotubes, graphene oxide, and nano-silica.

The research area in the field of graphene (graphene oxide) based polymer nano-composites can be considered as a sub-research area of 'Nanotechnology', wherein graphene oxide is aimed to disperse in their molecular dimension in a bulk polymer matrix, which should alter the mechanical and thermal properties of the polymer nanocomposites and may exhibit various functional properties. However, the mechanism behind this is still not clear. The current project will involve a systematic investigation of the role of graphene oxide in Nylon 6 and Polypropylene (PP) polymer matrix through their thermal, mechanical, morphological, and rheological studies. In addition to this, Polyester (PET) will be also explored if possible.

Objectives of the project:

In this proposed project, the following objectives will be addressed during the study:

1.To study the rheological characterization of Nylon 6 and PP polymer matrix in the presence of exfoliated/intercalated graphene oxide nano-filler.

2. To study the effect of concentration of exfoliated/intercalated graphene oxide on the crystallization behavior, mechanical and thermal properties of the Nylon 6 and PP nanocomposite filaments.

3. To study the morphology of suchNylon 6 and PP matrix in the presence of exfoliated/intercalated graphene oxide via SEM and TEM.

4. To study the effect of annealing on the mechanical and thermal properties of Nylon 6, PP – graphene oxide nanocomposite filaments.

5. To study the correlation among mechanical, thermal, and rheological properties concerning the dispersion of exfoliated/intercalated graphene oxide.

3. Centre of Excellence for Geotech

BTRA (Bombay Textile Research Association) is recognised as the Centre of Excellence (COE) for Geotech in the year 2008. BTRA has an excellent state of art testing facility for Geosynthetics of International standard, accredited by NABL (India) as per ISO/IEC 17025 and GRI, USA. Over the time BTRA has developed many testing facilities related to Geo synthetics, Geo Textiles and Geo Composites and other technical textiles products. We have facilited the manufacureres to do the required test within a short period of time with less cost and now they are not dependednt on foreign labs. At the same time, they witness the test to get confidence in the test report and the product.

BTRA is the second commercial Geotech lab in Asia accredited by GRI, USA. BTRA has an information resource centre having many publications, Journals, Periodicals, and Research report for the industry people. Details of raw material suppliers and geosynthetic manufacturers are available with contact details.

BTRA has a nonwoven development facility, needle punching, and hydroentanglement. Various nonwoven manufacturers have used this facility for the development of nonwoven products for technical application and are used for the same. BTRA also has a small loom for the development of woven technical fabrics. BTRA has developed woven products like Geobag, Geomattress for erosion and flood control applications.

BTRA contributed knowledge in the development of test standards and specifications for the Bureau of Indian Standards. BTRA also actively participated in establishing the specifications for high-performance fibers and geosynthetics.

BTRA is involved in standardising the specifications for products like Geogrid, Geocells, Geocomposites, PVD, and Geotextile both made from synthetics and natural fibres (Coir& Jute) for various applications. Awareness about the use of Geosynthetics created by BTRA through awareness programs, Seminars, and Conferences. This awareness resulted in the growth of the use of Geosynthetics in India.

The Geotech Laboratory at BTRA is accredited by Geosynthetics Institute (GSI), Folsom, Pennsylvania, USA under the GAI – LAP Accreditation Programme for 24 tests of geosynthetics products. It is pertinent to mention that BTRA is the first institute in India and probably only the third institute outside the USA to get this coveted accreditation. What this means to the geosynthetics producers and users is that they can get the products tested in BTRA with utmost confidence that the accuracy of the results is as good as any other GAI-LAP accredited laboratories. They can get the tests done in India, thus saving time and money without compromising on the quality of the results.

Soil Mechanics Laboratory

Bombay textile research association (BTRA) has started the soil and asphalt lab and organized to perform tests on soil and pavement materials. During the construction of bridges, buildings, dams, roads highways, and expressways it is necessary to evaluate the physical and mechanical properties of the soil and pavement materials and mixtures. This state-of-the-art laboratory is equipped with all necessary equipment for conducting tests and research in soil mechanics, foundation engineering, and transportation engineering. Research, consultancy, and regular soil testing works are conducted in this laboratory under the supervision of the head of department and laboratory staff specializing in the area of Geotechnical Engineering and Transportation engineering. All the tests are conducted as per the Indian standards (IS), Indian Road Congress (IRC), American Society for Testing Materials (ASTM), and American Association for State Highway and Transportation Officials (AASHTO) standards. The laboratory tests comprise triaxial, direct shear, vane shear, oedometer test, soil classification test, Marshall Stability, wheel rutting, tensile strength ratio, etc. Apart from the laboratory testing, the soil and Asphalt lab can conduct field testing such as static and dynamic cone penetration test, field CBR test, plate bearing test on soil, filed vane shear, filed density of bituminous pavements, lightweight deflector meter, and core cutting of pavements.

BTRA staff attended the following related to Geotech.

Conferences / Meetings Attended

- Attended 15th BIS Panel virtual meeting on Meditech application on 14th Jan 2021
- Attended BIS Panel virtual meeting on Aggrotech application on 05th March 2021.

4. CALIBRATION LABORATORY

BTRA Calibration facility was set up in the year 2015 for its own needs as well as provide calibration services to other NABL accredited testing laboratories.

Calibration of Measuring Instruments

having accredited traceability is one of the primary processes used to maintain instruments accuracy and is also the requirement of accredited testing laboratories.

BTRA calibration laboratory received NABL accreditation as per 17025:2017 laboratory standards for Mass, Volume Balance, and Force. BTRA is ready to provide calibration services to other NABL accredited testing laboratories for Mass, Volume Balance for the following ranges.

The parameter can be calibrated		**Range**
• Balance	:	1 mg to 5 kg
• Weights	:	1 mg to 5 kg
• Volumetric glassware	:	0.5 ml (500 µl) to 1000 ml

The worth equipment available is Balance, Weight, Force – Standard balance 220 g-1 no's, 3kg-2nos & 5kg- 1nos. weights 1 mg to 200 g, E2 class, 1 mg to 200 g F1 class and 500g, 1000g, 2000g, 3000g F1 class. We were having the load cells with digital indicators in the range of 200N to 100kN. Total certificates issued for Mass, Volume Balance, and Force in the last financial year were72.

5. ACCREDITED PROFICIENCY TESTING PROVIDER

Testing laboratories play a major role in the evaluation of the quality of different products including textiles and geotextiles. The results being reported by the testing laboratories are crucial in deciding the fitness of purpose of a product manufactured. The results should be reliable, repeatable, and reproducible. The competence of testing laboratories can be demonstrated by documenting and implementing a laboratory QMS as stipulated in the international standard ISO/IEC 17025:2017. One of the main critical requirements to be demonstrated by a laboratory as stated in this standard is participation in proficiency testing conducted by a third-party accredited agency.

The organization that conducts proficiency testing is called a Proficiency Testing Provider. The international organization for standardization has stipulated the QMS to be implemented by such an organization in ISO/IEC 17043:2010. NABL has started accreditation of PT Provider by the standard ISO/IEC 17043:2010 from 2011 onwards. So far, over 35 Proficiency Testing Providers are accredited by NABL for testing/calibration of different products/items.

The five main advantages of participation in PT Schemes are as under:

a) Evaluation of the performance of laboratory for specific tests/calibrations;

b) Providing additional confidence to customers of the laboratory;

c) Identification of problems in laboratories and initiation of actions for improvement which, for example, may be related to inadequate test or measurement procedures, the effectiveness of staff training and supervision, or calibration of equipment;

d) Education of participating laboratories based on the outcomes of such comparisons;

e) Validation of uncertainty claims of laboratories;

The deficiencies in the self-organized ILC are as under:

a) Impartiality is not maintained as the organizer is also a participant;

b) Robust statistical techniques are not used in the performance evaluation;
c) Confidentiality of the participants is not maintained and consequently, there is a possibility of collusion between the participants and falsification of the results;
d) The number of participants is less in ILC (around 5 or 6 only) and hence the uncertainty in the assigned value is too large and the outcome of ILC is not dependable;
e) Homogeneity and stability of the samples distributed is not ensured;
f) Handling, storage, and transport of PT items is not satisfactory and consequently. The integrity of the sample is compromised.

The competency of a laboratory to perform testing of any product can be ascertained only through PT participation and not ILC participation.

The above-mentioned deficiencies are rectified in proficiency testing conducted by ISO/IEC 17043:2010. Further, proficiency testing requires **robust statistical methods** to be used for (i) determination assigned value for each measurand or characteristic of the proficiency test item (i.e sample), (ii) determination of evaluation criteria such as Standard Deviation for Proficiency Assessment (**SDPA)**, and (iii) performance evaluation in terms of Z score or Z prime score, etc. All these requirements are stipulated comprehensively in the standard ISO 13528:2018.

To meet the proficiency testing requirements of textile testing laboratories, BTRA has documented and implemented the QMS as per ISO/IEC 17043:2010 and secured accreditation by NABL during 2018. This includes most of the conventional mechanical and chemical tests being performed by textile testing laboratories.

BTRA has added Analytical tests parameters like Banned Amine, Formaldehyde, and Metals to its PT Scope, which no one else in India does, to cater to the textile testing labs as well as chemical manufacturers.

In 2020-2021, BTRA has conducted 2 PT programs as per ISO/IEC 17043:2010 in chemical/mechanical testing, covering 12 chemical (with analytical) and 5 mechanical tests. Over 50 plus textile testing laboratories from different parts of the country as well as overseas have participated in these PT programs. We have received a good response from the laboratories as well as our reports were well accepted by the users.

Now we have launched two programs in collaboration with PTB Germany with participants from SAARC countries. The process is underway.

6. TECHNICAL SERVICES

BTRA has provided extensive liaison and consultancy services to solve problems of quality, maintenance, and productivity at various levels for the textile units. The details are given below.

6.1 Overview

✓ **Technical investigations carried out**	:	18
✓ **Technical enquires attended**	:	43
✓ **Local mill visits made [man-days]**	:	18
✓ **Outstation mill visits made [man-visits]**	:	6

6.2 Type of Assignments Undertaken

- TPP Steam Costing Audit
- Fabric Inspection
- LAPF Evaluation and improvement program
- Spinning and Weaving Maintenance Audit
- Nodal Agency –Technical Work
- Eco management analysis in the Indian Textile Industry
- PMKVY participation handbook Preparation
- Training of Assessors
- Processing Machine Maintenance Audit
- NTC mills valuation Work

Product Development Assistance to the industry

❖ In needle-punch nonwoven and hydro-entanglement pilot plants, 5 samples are developed for applications such as thermal insulation, viscose spun lace, etc.

7. TESTING SERVICES

BTRA Test Laboratories had undertaken wide-range of testing activities such as Fibre Properties, Yarn Properties, Fabric Properties, Fabric Defect analysis, Chemical Testing (chemicals & auxiliaries), Eco-parameters Testing, Geotextiles Testing, Soil Testing, Technical Textiles Testing (other than Geotech), Microbiology Testing, Scanning Electron Microscope Studies, Special Testing [Flammability, static charge measurement, FT-IR / DSC / TGA / X-ray / GPC analysis, Melt Spinning trials, etc.] and Material Testing (non-textile items such as water, paint, oil, etc.). The total number of tests conducted for the period under review is 18786 and section-wise details are as follows.

7.1 Overview

<table>
<tr><th>Test Particulars</th><th>Number of Tests</th></tr>
<tr><td>Physical Testing</td><td>5605</td></tr>
<tr><td>Chemical Testing and Eco-parameters, Chemicals / Dyes / Auxiliaries Testing and Material Testing (non-textile items, water, oil, etc.)</td><td>4903</td></tr>
<tr><td>Fabric Defect Analysis</td><td>216</td></tr>
<tr><td>Geotextile Testing</td><td rowspan="2">4664</td></tr>
<tr><td>Technical Textiles Testing (other than Geotech)</td></tr>
<tr><td>Microbiology Testing</td><td>583</td></tr>
<tr><td>Scanning Electron Microscope</td><td>762</td></tr>
<tr><td>Special Testing (Flammability, static charge, FTIR / DSC / TGA / X-ray/ GPC studies, Melt spinning trials, etc.)</td><td>1980</td></tr>
<tr><td>Calibration Testing</td><td>73</td></tr>
<tr><td>TOTAL TESTS CONDUCTED</td><td>18786</td></tr>
</table>

7.1.1 Proficiency Testing Programs Participation

During the period under review, BTRA Test Laboratories participated in the following proficiency testing programs to maintain its laboratory performance at par with national/international laboratories.

- ASTM Proficiency Test Program on 'Woven Fabrics'
- AATCC Proficiency Test Program on 'Fibre Identification & Analysis'
- AATCC Proficiency Test Program on 'Colour Fastness'

7.1.2 New Machinery/Instruments added

- Spectrophotometer

7.1.3 New Test Methods Launched

BTRA undertakes the following new test methods as per national and international standards.

- ❖ GC MS test methods of analysis of free monomers in polymer samples and analysis of volatile organic carbon (VOC) by headspace GC MS technique
- ❖ Analyzing migration of heavy metals and phthalates from food packaging material
- ❖ HPLC test methods of analysis of Cardinal and sorbitol

7.2 Technical Textiles Testing

BTRA carried out in total 4664 tests for geotextiles and technical textiles (other than Geotech). The following types of testing of technical textiles are undertaken at BTRA.

- ❖ FILTER FABRICS - Woven/ Nonwoven
- ❖ GEOTEXTILES – Woven / Nonwoven
- ❖ PVD BAND DRAIN
- ❖ GEO-MEMBRANE LINER
- ❖ GEO-GRID
- ❖ ROPE GABION
- ❖ METAL GABION
- ❖ NONWOVENS – Wadding, Cover Stock, Face Mask, Interlining, Absorbing/Shoulder Pads, Insulation Pad and Carpets [Nonwoven Type]
- ❖ COATED FABRICS
- ❖ AUTOMOTIVE TEXTILES
- ❖ MEDICAL TEXTILES
- ❖ OTHER TECHNICAL TEXTILES - Narrow Fabrics, Conveyor Belts up to 13 Mm Thick [Dumbbell Shape], Nylon Ropes up to 12 Mm, Composites - Glass Composites / Glass Composites/Mats and Glass Roving / Fabrics

Apart from conducting usual tests such as weight per square meter, weight per linear meter, thickness/density, yarn number, etc., certain unique tests are also undertaken. They are as follows.

- ✓ **FILTER FABRICS** (Woven and Nonwoven): Tear Resistance (Trapezoid Strength), Grab Strength, Water Permeability, Air Permeability, Pore Size by Porometer, Apparent Opening Size, Bursting Strength, Breaking Strength & Elongation

- ✓ **GEOTEXTILES**(Woven and Nonwoven): Abrasion Resistance, Apparent Opening Size, Bursting Strength, CBR Puncture Strength, Cone Drop Test (Dynamic Puncture Test), Grab Breaking Load Machine Direction & Cross Direction, Grab Tensile Strength & Elongation, Index Puncture Resistance, Mullen Bursting, Pore Size by Porometer, Seam Strength, Static Puncture Strength (CBR Puncture Strength), Tensile Strength & Elongation (Warp and Weft), Tensile Strength (Before & After Exposure UV Xenon Arc), Trapezoid Tear Strength, UV Resistance Exposure to Light, Moisture & Heat in Xenon Arc, Water Permeability, Water Permeability of Filter, Wide Width Tensile Strength Machine Direction & Cross Direction.

- ✓ **PVD BAND DRAIN**: Tensile Strength & Elongation (Wide Width), Water Permeability of Filter, Tensile Strength of Core, Grab Strength & Elongation at Break for PVD Composite, Trapezoid Tear for Filter Component only
- ✓ **GEO-MEMBRANELINER**: Density, Tensile Strength, Tear Strength, Puncture Resistance, Carbon Black Content, Melt Flow Index, ESCR, 2% Secant Modulus of Polyethylene Geomembrane
- ✓ **GEO-GRID**: Tensile Strength & Elongation (Single Rib) / Multi-Rib, Carbon Black Content, Melt Flow Index, Aperture Size & Number of ribs per meter
- ✓ **ROPE GABION**: Size, Tensile Strength, Identification of material [TGA / DSC], UV Resistance Exposure to Light Moisture & Heat in Xenon Arc, Tensile Strength (Before & After Exposure UV Xenon Arc), Tensile Strength of Rope after Thermal Treatment (Heating)
- ✓ **METAL GABION**: Size, Thickness of Wire, Tensile Strength of Wire

NONWOVENS

- ❖ **WADDING**: Compressional Recovery, Air Permeability, Thermal Conductivity,
- ❖ **COVER STOCK**: Mass [EDANA], Absorbency [EDANA], Liquid Strike through time [EDANA], Wicking Rate [EDANA], Tensile Strength & Elongation [EDANA]
- ❖ **FACE MASK**: Pore Size, Bacteria Filtration Efficiency [In-house Method]
- ❖ **INTERLINING**: Mass per square meter, Thickness [EDANA], Tensile Strength & Elongation, Heat Shrinkage
- ❖ **ABSORBING / SHOULDER PADS**: Mass per square meter [EDANA], Thickness [EDANA], Absorbency [EDANA]
- ❖ **INSULATION PAD**: Mass per square meter [EDANA], Thickness [EDANA], Thermal Conductivity
- ❖ **CARPETS** (Nonwoven Type): Mass per square meter, Thickness, Compressional Recovery, Hexapod Tumbler Test, Lisson Test [Treading Wheel test], Taber Wear Index [up to 300 cycles], Colour Fastness to Light up to 5 Rating, Dimensional Stability – Heat/ Water, Flammability at 45O, Horizontal Burning Rate, Pill (Camphor / Methenamine) Test, Tuft Withdrawal Strength (Piled Carpets), Static Charge measurement, Surface Resistivity, Volume Resistivity, Antimicrobial Activity, Antifungal Activity
- ✓ **COATED FABRICS**: Mass per square meter, Thickness, Tensile Strength & Elongation, Tongue Tear Strength, Single Rib Tear Strength, Bonding Strength Bonded / Coated, Application

of Adhesive, Water Vapour Transmission [ASTM E: 96 by Gravi Test Instrument], Identification of Coating by FTIR, Taber up to 300 cycles, Hydrostatic Pressure Heat Test, Removal of Coating, Identification of Fibres, Yarn Count, Threads/Inch, Martindale Abrasion Test – 10,000 rubs, Pliability, Blocking Test, Gelling Test, Flexing Test [Dematia Method], Limiting Oxygen Index, Vertical Flame Test, Horizontal Burning Rate

- ✓ **AUTOMOTIVE TEXTILES**: Mass per square meter, Thickness, Abrasion Resistance: Taber H18 / CS10 [Automotive Std.] up to 300 cycles, Flammability at 45O, Horizontal Burning Rate, Pill (Methenamine) Test, Relaxation Shrinkage, Thermal Shrinkage, Odour Test, Tensile Strength [Automotive Std.], Tear Strength [Automotive Std.], Colour Fastness to Light (up to 6), Colour Fastness to Crocking, Colour Fastness to Shampooing, Colour Fastness to Resistance to Cold - 20^{0}C for 2 hours, Pliability, Blocking Test, Gelling Test, Flexing Test [Dematia Method]

MEDICAL TEXTILES

- ✓ **COTTON WOOL PADS**: Acidity or Alkalinity [Methyl Orange / Phenolphthalein], pH at 26^{0}C, Absorbency Sinking Time, Water Holding Capacity, Water Soluble Substance, Ether Soluble Substance, Sulphated Ash, Fluorescence, Bioburden Test (4 Organisms), Drying Rate [67 + 2% R.H. & 27 + 2^{0}C Temp.]

OTHER TECHNICAL TEXTILES

- ✓ **NARROW FABRIC**: Seat Belt Strength, Tape / Webbing Strength & Elongation, Hot Water Shrinkage of Webbing, Tensile Strength & Elongation, Belt for Lift
- ✓ **CONVEYOR BELT**up to 13 mm Thick (Dumbbell Shape): Tensile Strength [In-house Method]
- ✓ **NYLON ROPES**up to 12 mm: Tensile Strength, Diameter of Rope, Linear Density

COMPOSITES

- ➔ **Glass Composites**: Flexural Strength, Lap Shear Strength
- ➔ **Glass Composites / Mats**: Thermal Conductivity, Mass per square meter, Tensile Strength, Thickness, Density
- ➔ **Glass Roving / Fabrics**: Mass per square meter, Yarn Number, Thickness, Density, Breaking Strength & Elongation at Break, pH of Aqueous Extract, Glass Content

7.3 Special Testing

Apart from undertaking testing of fibers, yarns, and fabrics (for physical as well as chemical properties), numerous special tests (that are most sought after) are conducted at BTRA. The same are widely availed by the industry. BTRA carried out 1980 tests under special testing. The type of tests conducted here is as follows.

- ✓ Differential Scanning Calorimetry (DSC) Analysis
- ✓ Thermal Gravimetric Analysis (TGA)
- ✓ Gel Permeation Chromatography for Molecular Weight Distribution
- ✓ X-ray Diffraction Analysis (Mineral analysis / Chart diffraction / Fibre orientation angle / Material identification)
- ✓ FT-IR spectroscopy (Material & Finish identification)
- ✓ Scanning Electron Microscope

- Longitudinal View of Fibres / Yarns
- Cross-section View of Fibres / Yarns
- Micrographs for Powder Sample

✓ Static Charge Measurement
- Total Charge Developed and Half Decay Time [ASTM D:4238]
- Surface Resistivity [ASTM D:257]
- Volume Resistivity

✓ Melt Spinning Experiments

✓ Other special tests undertaken
- UV Protection Factor [AATCC-183]
- Surface Tension – drop volume method (or) contact angle method
- EMI Shielding Effectiveness [ASTM D 4935]
- Birefringence measurement by Polarising Microscope
- Particle Size Analysis
- Contact Angle
- Total Organic Carbon (TOC) Analyser
- Refractive Index of Liquids (Abbe's Refractometer)

✓ **Flammability Tests**

General Apparel

➔ Ease of ignition of vertically oriented specimen [BS EN ISO 6940]
➔ Flame spread properties of vertically oriented specimen [EN ISO 6941 / BS EN 1103]
➔ UK nightwear safety regulation [BS 5438 / BS 5722 Test 1, 2 & 3]

Curtain, Drapes, and Blinds

➔ Ignitability of vertically oriented specimen [BS EN 1101]
➔ Flame spread properties of vertically oriented specimen [BS EN 1102]

Personal Protective Clothing

➔ Limited flame spread [EN 532 / ISO 15025 / BS 5438: 1976 Tests 1, 2 & 3]
➔ Limiting Oxygen Index [IS:13501 / ASTM D 2863]
➔ Vertical Flammability [IS:11871 / BS:3119 / NFPA 1975 / NFPA 2112]
➔ Horizontal Flammability [IS:15061 / ASTM D:5132 / FMVSS / SUZUKI]
➔ 45^{0}C Inclined Flammability [16 CFR 1610 / ASTM D:1230 / IS:11871(B)]
➔ Carpet Flammability [ASTM D:2863 / 16 CFR 1630 / ISO:6925 / BS: 6307]
➔ Vinyl Coated Fabric Flammability [IS:1259]

Flammability of plastics

➔ Vertical Burning Test [UL 94 (VO. V1.V2) / ASTM D:3801 / IEC 60695–11–10(B) / ISO:1210(A) / UL 94 (VTM) / ASTM D: 4804 / ISO:9773 (Non-Rigid Sample) / UL 94 (5V) / ASTM 5048 / IEC 60695-11-20]
➔ Horizontal Burning Test (Wing Top Method) [ASTM D:4986 / ISO:3582 / ISO:9772]
➔ Horizontal Burning Test [UL94HB / ISO:1210(A) / ASTM D:635 / IEC:60695–11–10(A)]
➔ Determining deterioration of visibility due to smoke released on combustion of materials [using Smoke Visibility Tester] as per UIC 564.2 OR Appendix-15 method
➔ Determination of Toxicity Index [Fume Toxicity Tester] as per N.C.D. 1409 method

7.4 Eco-parameters Testing

The following types of tests are undertaken at BTRA.

- Formaldehyde Content in Dyes and Auxiliaries as per GOTS specification
- Allergenic Disperse Dyes
- Glyoxal Content in Textiles
- Polycyclic Aromatic Hydrocarbons (PAH)
- Identification & Quantification of Virgin / Recycled Polyester Fibre
- Free formaldehyde in Textiles/Leather
- Release formaldehyde in Textiles/Leather
- Chlorophenol - PCP / TECP / OPP
- Pesticides -Organochlorine /Organo phosphorous/Herbicides/Total pesticide
- Aryl amines (Banned Amines released from Azo dyes)
- Phthalates
- Chlorinated Organic Carriers(Chloro Benzenes &ChloroToluenes)
- Poly Chlorinated Biphenyls(PCB's)
- Organo tin
- Heavy metals by ICP OESas per Oekotex 100/GOTS/ZDHC specification
- Hexavalent chromium Textiles/Leather/Dyes/Auxiliaries
- Spectro photometric evaluation of dyes/optical whitener - Water-soluble / Solvent soluble samples
- Analysis of organic compounds by - GC-FID /GC-ECD /GC-MS (SIM/SCAN mode) /NIST library search report
- Perfumery/ Hydrocarbon analysis by GC-MS
- TLC analysis
- HPLC-DAD/RID/FLD analysis
- Microwave-assisted acid digestion of samples
- Total and Leachable Metals in Textiles/Polymers/Toys/Packaging materials
- Nickel release
- Lead in Paints
- Solvent residues/VOC's in Textiles
- Triclosan, BHT, BPA, Phenol
- Free /unreacted monomers in the polymer
- Purity and impurity profiles of organic compounds.
- SVHC for REACH/ROHS compliance

… and many more

7.5 Microbiology Testing

Textiles, being an integral part of our everyday life, have been involved in the search for hygienic functional garments with the application of anti-microbial finishes. BTRA carried out 583 tests under microbiology testing. The type of tests conducted at this laboratory is as follows.

- Antifungal activity, assessment on textile materials: Mildew and Rot Resistance of Textile materials Test-II – Agar Plate, Chaetomium globosum [AATCC 30 Test 2]
- Antifungal activity, assessment on textile materials: Mildew and Rot Resistance of Textile materials Test-III – Agar Plate, Aspergillus niger [AATCC 30 Test 3]
- Antifungal activity, assessment on textiles materials: Mildew and Rot Resistance of Textile materials Test – IV – Humidity Jar, Mixed spore suspension [AATCC 30 Test 4]
- Antibacterial Activity of Fabrics, Detection of Agar Plate Method [AATCC 90]
- Assessment of Antibacterial Finishes on Textile Materials [AATCC:100]
- Antibacterial Activity of Fabrics, Assessment of Textile Materials – Parallel Streak Method [AATCC:147]
- Antimicrobial Activity Assessment of New Carpets - qualitative antibacterial assessment / quantitative antibacterial assessment

/ quantitative antifungal assessment. [AATCC 174 – Parts 1 to 3]

- Determination of a population of microorganisms on products [ISO 11737 – Pt I]
- Textile fabrics – Determination of antibacterial activity – Agar Diffusion Plate Test [ISO 20645]
- Textiles – Determination of the antibacterial activity of antibacterial finished products [ISO 20743]
- Determination of the Antimicrobial Activity of Immobilized Antimicrobial Agents Under Dynamic Contact Conditions [ASTM E 2149]
- Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi [ASTM G 21]
- Test for antibacterial activity and efficacy on Textile Products [JIS L 1902]
- Antimicrobial products - Test for antimicrobial activity and efficacy for plastics and other antimicrobial coated hard surfaces. (Film Contact Test Method) [JIS Z 2801]
- Microbiological Examination of Water [IS 1622 & IS 5403]
- Methods for testing cotton fabrics for resistance to attack by microorganisms by Humidity Chamber Method [IS 1389]
- Evaluation of Bacterial Filtration Efficiency of Medical Textiles [In-house Test Method]
- Aerobic Plate count & Yeast and Mold count [Bacteriological Analytical Manual]
- JIS Z 2801:2000 for Paints / Films

Other Services

BTRA continued the activity of supplying chemicals/gadgets, repairing/calibrating gauges/testing instruments, and testing stores accessories for the mills. The details are given in Appendix-6.

Powerloom Service Centres (PSCs)

BTRA runs three Power loom Service Centers (PSCs) [at Ichalkaranji, Solapur, and Madhavnagar-Vita]. To improve the quality, operating efficiency, and productivity of power loom clusters, BTRA PSCs provide technical consultancy, testing services, training in loom working, loom maintenance, disseminating information through training programs, workshops, demonstrations, and discussions. Liaison visits are made by BTRA staff to have a first-hand view of the problems faced by the power loom weavers/processors and on the spot, suggestions are made. The activities of these centers are given in the following Table-2.

Table – 2

Activities of BTRA Powerloom Service Centres

Activities	Ichalkaranji	Solapur	Madhav Nagar-Vita
Total yarn and fabric samples tested for physicals & chemical properties	2262	2664	412
Number of technical assistance / trouble shooting / consultancy given	16	168	11
Total number of persons trained	-	-	36
Total number of trainee man-days	-	-	596
Total seminars/workshops conducted	-	-	03

Activities		Ichalkaranji	Solapur	Madhav-Nagar-Vita
Survey of closure of power looms	Units	-	246	181
	Looms	-	3700	2424
Number of interactive workshops conducted for TUF scheme and Group Insurance scheme		-	-	03
Group insurance facilitations for power loom workers [number of beneficiaries]		-	-	-
Number of Advisory / PPCICC meetings conducted		-	-	-
Number of samples for design development [non-CAD] / Analysis		-	-	-

8. INFORMATION DISSEMINATION / INDUSTRY INTERACTION

(a) BTRA will support ETP solution providers to undertake the ETP turnkey project. The discussion happened with ETP solution providers an MOU to be signed. One MOU was signed with Austro Water Technologies Pvt Ltd, Tirupur and a few more have shown their interest in this kind of collaboration.

(b) A Two-days Training Program for entrepreneurs from Sailu Cotton Processing Cluster under Micro & Small Industries Cluster Development Program (MSICDP) was conducted at BTRA, Mumbai on 1stand 2nd February 2021. The Training Program covered various topics on Technology Upgradation, Quality aspects, Marketing Domestic & Export, etc. pertinent to Cotton Processing In 1st February 2021, after a brief introduction of BTRA's expertise and participants by Mr. Vijay Gawde, the training program was started with the opening remarks by Dr. T. V. Srikumar, Director, BTRA. The first session was conducted by Dr. Panada, BTRA on the various topics relayed to cotton fibers and their processing viz. Morphology of cotton fibre and its properties compared with other fibres, Technology and process control, New trends in ginning and technology up-gradation, Criteria of selection cotton w. r. t. yarn manufacturing/ cotton products, Impact of cotton fiber properties on yarn/fabric / final product, properties of cotton blends, Post Ginning Process (at spinning units), etc. An elaborate discussion thereafter was held based on queries raised by participants.

A detailed BTRA lab visit for the participants was arranged to aware the participants of the various testing-related facilities available in BTRA and some of the textiles-related technologies/products participants could look upon.

On 2nd February 2021, another classroom session was conducted by Mr. Nitin Desai &Hemag Palan on the marketing topics. Topics are related to market trends over the years/scenario, the impact of the textile industry on cotton prices, and steps taken by it. The discussion was also held related to advantages of cluster development, successful setting-up of the cluster, importance related to various aspects related to cluster development/implementation, etc.

In the second half, practical demonstration and explanation of various tests related to cotton fibers e.g.Trash Analyser, Strength/elongation, colour/whiteness index, micronaire, uniformity index, span length, maturity/fibre identification (through a microscope), wax content, honeydew content, absorbency, SEM analysis, etc. were conducted at BTRA Labs. During the said session, discussion on various topics related to cotton fibres testing and test results interpretation was done by BTRA Lab expertise.

At the end of the program on 2nd February 2021, a discussion and review of the various topics discussed over the two-day training program were carried out with the vote of thanks from Mr. Vijay Gawde.

(c) BTRA and Solapur YantramgDharak Sangh organized an ETP awareness program at Solapur on 18th March 2021.

The objective of this program is to develop skills and bring awareness with a focus on water effluent treatments, water recycling activity, and the final impact of pollution on the ecosystem. Also, BTRA explained in detail the pollution source, pollutants from the textile industry, restricted substance and their effect on the eco-system, Pollution removal processes, Environmental norms, various effluent, and restricted substances related test procedures, textile effluent characteristics, stage-wise waste-water treatment, recycling with advanced filtration system complying with zero liquid discharge (ZLD) requirements, ETP design for capacity, MIS and costing for daily operations, cost reduction techniques, checkpoints in ETP, chemical management system, Best management practices and Best available techniques for greener and cleaner sustainable textile production, etc.

d) BTRA recruited two scientists for the Soil Lab and initiated the procedure towards NABL Accreditation.

1. Mr. Lekhaz Devulaplli- Research Officer- B.Tech, M.Tech, Ph.D. (submitted) (Civil)
2. Mr.Yash Gupta – Technical Assistant, B.Tech (Civil)

BTRA Marketing team has approached and informed about the different facilities available regarding Soil Mechanics and Asphalt Testing.

e) **BTRA** developed a reusable protective face mask

BTRA aimed to develop the protective face by reducing the porous size using nanofibre membrane technology. The main objective of this study aims to develop a reusable protective face mask with high bacterial filtration efficiency.

For this project work, 100% cotton was selected. The size of bacteria, microbes, and viruses is in the range of 0.012 to 0.5 micron. However, the pore size of the fabric is much larger than the pathogens and they can easily pass through the fabric pores. Hence, we aimed to reduce the pore size of the fabric using nanomesh. A five-layered face mask was developed using fabric and non-woven and nanomesh.

Special features

- Five layered- front and back soft comfortable cotton, 2nd & 4th non-woven, middle layer- nano- membrane technology (BTRA developed)
- No throughout cut for improved protection
- High bacterial filtration efficiency (98%)
- Low-pressure drop high breathability
- Adjustable ear loop for more comfort
- Anti-fogging adjustable nose clip
- Compliance as per IS 16289 class 2 mask requirements

8.1. Papers Published

Many research papers are published in journals. The same is given in Appendix–2.

8.2 Webinar Programme Conducted

During the lockdown period, BTRA had initiated a Webinar session. Total 9 webinars covered on different topics which are as follows:

- **Webinar on Textile Effluent and its management held on 20th April'2020**

Textile effluent and its management have been the biggest challenge in recent times. Water-based effluent generated in the various activities of wet processing of textiles causes the generation of polluted effluent due to the use of the huge volume of water either in the actual chemical processing or during dyeing, printing, and finishing. Textile effluent is heavily contaminated with pollutants such as dyes, dissolved solids, suspended solids, and toxic metals. One of the factors to be considered in textile effluent is total dissolved solids (TDS). Because of the use of common salt and Glauber salt, the level of TDS increases in textile effluents.

As textile industry is one of the largest industries in the world and different fibres such as cotton, silk, wool as well as synthetic fibres are all pre-treated, processed, coloured and after being treated using large amounts of water and a variety of chemicals, there is a need to understand the chemistry of the textile effluents very well. The textile waste characteristic needs to be understood clearly. Different methods and aspects of Textile Effluents and their management need to be understood to save the environment from polluting further. Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances whose chemistry was emphasised.

The textile dyeing industry is under considerable pressure to reduce the color of process waters directly discharged to municipal water treatment facilities. Two common approaches are practiced:

- The Electrochemical treatment by anodic oxidation using anodes with catalytic coatings to oxidise the dye wastes
- Ion-exchange zeolite treatment with different cations such as Fe(II), Fe(III),

Cu(II), Clinoptilolite, a natural zeolite is quite effective.

During the webinar different treatments of textile, the effluent was discussed in detail, at the end BTRA's capabilities and consultation possibilities, and facilities were discussed which could benefit the Textile mill owners to manage their effluent properly.

- **Webinar on Know your effluent, Various sections of ETP was presented on 1st May'2020**

Various stages of textile effluent treatment were presented. The Primary, secondary and tertiary treatments were explained in great detail. Emphasis was laid on the fact that the BOD/COD ratio needs to be reduced before the effluent can be discharged. The pollutant features of textile wastes differ widely among various processing. Organic substances such as dyes, starches, and detergents in effluent undergo chemical and biological changes which consume dissolved oxygen and destroy aquatic life.
Such organic pollutants should be removed to avoid rendering the stream water unsuitable for municipal, industrial, agricultural and residential uses.

- **Webinar on Quality norms as per regulatory authority was presented on 4th May'2020**

This webinar was mainly focused on the quality norms laid down by the regulatory authorities. It mainly presented the permissible values of a variety of toxic and nontoxic chemicals which are used regularly in textile processing. A mention of a list of banned chemicals was also mentioned. Strict regulatory norms have compelled Textile manufacturers to use safer and greener chemicals.

- **Webinar on Treatability study on ETP was presented on 6th May'2020**

This webinar was focused on the functioning of the effluent treatment plant. The various aspects of treatment, residence time spent at each step were discussed. Based on the characteristics of raw wastewater, the following treatment processes were considered for the treatability: Primary treatment comprising of neutralization and coagulation, followed by Secondary treatment with Aerobic biological oxidation, and finally Tertiary treatment with Activated carbon adsorption. The wastewater from the process was shown to be collected in the equalization tank neutralized and would then be pumped to Primary Settling Tank for settling the precipitated solids. Alum would be dosed to settle the coagulated solids. The overflow of the Primary Settling Tank would be collected in the collection tank from where it would be pumped to secondary treatment. The secondary treated wastewater would then be pumped for the tertiary treatment. The outlet of the tertiary treatment would be pumped finally to the CETP drain.

- **Webinar on Toxic Pollutant and their test methods was presented on 8th May'2020**

Test methods to analyze all the possible toxic chemicals which are used in textile processing were presented. Chemicals used in textile include biocides, Hexa Bromo-cyclo dodecane flame-retardants, organo phosphorous pesticides, per-, and polyfluoroalkyl substances, polycyclic aromatic hydrocarbons, formaldehyde, nonylphenol ethoxylate, and the release through laundering, azo-dyes, and their reduction products, polychlorinated dibenzo-p-dioxins, dibenzofurans, and octachlorodibenzofuran. The test methods about their analysis and the permissible limits were presented.

- **Webinar on Implementation of Chemical Management System (CMS) in Textile processing Industry was presented on 11th May'2020**

Chemical wet processing of textile consumes a huge number of chemicals, dyes, and auxiliaries, and some of them are banned due to carcinogenic or its ill impact. Due to the hazardous nature of chemicals used in textile production, many adverse impacts are seen on human beings, animals/plantations as well as the environment. To overcome this burning issue, it is essential to understand the matter in depth especially in textile production areas right from cotton growing to garment stage. Especially in the processing industry, from pre-treatment to finishing needs to concentrate selection of eco-friendly chemicals including process parameters. Self-assessment of chemical inventory and chemical management systems would be helpful to comply with global chemical legislation, Retailer & Brand Restricted Substance Lists (RSL's), and Manufacturing Restricted Substance Lists (MRSL's). In today's time, CMS is very important and is directly connected with textile effluent quality.

- **Webinar on Know your words and their testing procedures was presented on 13th May'2020**

Some of the common yet very significant test procedures were discussed. The commonly used routine textile testing, the instrument used, and the test methods were discussed for several parameters. The significance of the test parameter and its result directly correlates with the sample's characteristics. To name a few -- Weatherability Testing of various products, Performance Testing of various Chemicals and Auxiliaries used in Textiles (Application and Evaluation)Evaluation of Sizing Agents

- **Webinar on Details of the Removal process for Pollutants was presented on 15th May'2020**

The continuous increase of pollutants in water bodies has necessitated the need to develop cost-effective methods for their removal. Destroying the pollutants to benign chemicals and/or removing these pollutants from contaminated water is imperative for a green environment. Numerous treatment processes have been applied for pollutant removal from wastewater, such as electrochemical oxidation, biodegradation membrane process, coagulation, adsorption, precipitation, and AOP. Though these methods are considered efficient methods for pollutant removal, each method has its benefits and drawbacks. In this section, we will explain some of the most common methods that are frequently used for pollutant removal and their basic principles.

- **Webinar on General idea of treatment in ETP (BMT & BAT) was presented on 18th May'2020**

The efficiency and effectiveness of an effluent treatment plant (ETP) depend on several factors. The production capacity of the textile dyeing unit, the volume of effluent produced, and over what timeframe and characteristics of effluent are all important factors in ETP design, construction, and management. The first steps in ETP construction are to specify the requirements of an ETP concerning the quality of final treated effluent required and to determine the volume and quality of the effluent to be treated. Emphasis was laid on BMT (Bare minimum technology) and BAT (Best available technology).

8.3 BTRA Participated in the following webinar during the period

- Attended webinar on the topic "Reweaving the success stories of Textile Industry" organised by The Indian Textile Journal on 28th April 2020
- Attended webinar on the topic "The Future of Workforce Safety and Health Confirmation" organised by OSH India on 20th May 2020
- Attended Webinar on topic"Scope of Business in Indonesian Textile Industry for Indian Machines & Accessories" organised by ITAMMA on 22nd May 2020
- Attended youtube live webinar "Textile Mahakumbh" organised by Siyaram on 23rd May 2020. The show was aimed to bring together retailers from the textile industry to discuss the best practices to do the business and will focus on shaping the future of the textile business in the country.
- Attended webinar on topic"BUSINESS OPPORTUNITIES IN PERU AND INDIA FOR TEXTILE MACHINERY & ACCESSORIES" organised by ITAMMA on 26th May 2020
- Attended Webinar on the topic"HOW CAN INDIAN TEXTILE INDUSTRY REBOOT ITS BUSINESS AND ENCASH UPON GLOBAL OPPORTUNITIES?" organised by Textile Association(India), Mumbai unit on 5th June 2020
- Attended webinar on topic "Correlation between cotton parameters and yarn parameters" organised by Textile Association(India), South India Unit on 6th June 2020.
- Attended Webinar on "The Future of Workforce Safety and Health Confirmation" organised by OSH India on 20th May 2020
- Attended webinar cum exhibition organised by OSH India Virtual Expo &Conference for Safety Professionals on 16th July 2020
- Attended International Webinar on "Nanotechnology and Its Application in Textiles" on 08th August 2020
- Attended Webinar on "Efficient Steam Systems "on 28th August 2020. Organised by Textile Association (India) – Mumbai Unit
- Attended Webinar on 'Strengthening Trainer development, in Short-term Skill Ecosystem'. Organised by NSDC on 3rd Sept. 2020
- Attended Webinar on "Operational Excellence: Handy Guide to Boost Your Company's Growth" organised by ITAMMA on 19th November 2020.

9. Training Programmes Conducted

BTRA organised many training programs [at BTRA and Unit level] during the year under review. Details are provided in Appendix-3.

9.1 BTRA Publications / Library

A list of BTRA publications brought out during the period under review is given in Appendix–5. BTRA library serves its users and textile units with 'Current Awareness Services' regularly, through the publication of 'BTRA Scan (Quarterly)'.

BTRA Library has added many specialized books especially in the areas of geotextiles, nonwovens, composites, and nanotechnology. The details of additions to the library are given in Appendix–7. It receives around 12 foreign and 20 Indian journals/magazines/newsletters regularly. As of 31st March 2021, the library has 22,965 holdings. BTRA updates its website (www.btraindia.com) at regular intervals.

9.2 Academic Activities

BTRA offered an internship to 8 students from various technical education institutes during the period under review.

Acknowledgments

The major portion of R & D's work at BTRA is based on the financial assistance provided by the various sponsoring agencies. This is apart from various In-house projects that are being carried out. The generous support from the sponsors has also enabled BTRA to build a good and useful infrastructure, which efficiently supports the R & D work. Our in-depth gratitude goes to the Ministry of Textiles, Government of India for their generous support, and to the Board of Research on Nuclear Science, under Department of Atomic Energy, Government of India and Defence Research & Development Organisation, under Ministry of Defence, Government of India. Thanks, are also due to members of BTRA for giving constant encouragement and support to BTRA scientists/technologists to continue their work in uplifting the industry.

Appendix – 1

SPONSORED PROJECTS

On-going Projects:

Defence Research & Development Organisation, Ministry of Defence, Government of India, New Delhi

- Development of a standard method for identification of dope dyed and exhaust dyed polyester fibers/fabrics

IREL (India) Limited, Govt. of India Undertaking-Dept. of Atomic Energy, Mumbai

- Eco-friendly Natural Dyeing of Cotton and Silk using Rare Earths (RE) Metal Salts as Mordants

On-going In-house Projects:

- Nanoparticles Synthesis and its coating for antimicrobial application
- Centre of Excellence for Geotech
- BTRA powerloom service centre – Ichalkaranji
- BTRA powerloom service centre – Solapur
- BTRA powerloom service centre – Madhavnagar

New In-house Project:

- Atmospheric pressure plasma treatment of textiles for dyeing of various fabrics with natural and synthetic dyes
- Development of Polypropylene, Nylon 6/ Graphene Oxide (GO) high-performance nanocomposite filaments

Appendix–2

PAPERS PUBLISHED IN JOURNALS

Staff Name	Title	Journal Name
Ms. Akanksha Pragya, Mrs.Smita C Deogaonkar	'Effect of Fabric Interlacement Pattern on the Surface Electrical Conductivity of Intrinsically Conductive Fabrics''	Journal of Synthetic Metals' Vol.268,116512
Mr. M. P. Sathianarayanan	Determination of hexavalent chromium in water-soluble dyes'	Journal of Chromatographic Science, Oxford Academic, JCS-19-131.R1, 26-10-2020.
Dr. P. K. Panda, Mr. S. R. Tambe, Mr.A. G. Thite	Melt spinning of PVDF/ZnO hybrid filament for smart wearable textile	Journal of Composite Material, Vol 54(25), 2020.
Dr. Padma S. Vankar Archana Gangwar	'Rare earth salts mediated improved rubbing fastness for Indigo dye'	Journal of Textile Science & Engineering, Vol 11:3, 430, 2021
Mr. Tanaji Kadam	'Value Loss Control System in the textile Mill,	Colourage, Feb 2021 P.g.32-35
Mrs.Smita Deogaonkar-Baride,Ms. Pradnya Wakode,and Kaushlesh P. Rawat	'Treatment of Biorefractory Organic Compounds in Dyeing and Printing Process Textile Wastewater with Electron Beam Radiation	Journal of Hazardous, toxic and radioactive waste 2021,25(2):04021007 (1-7).
Mrs.Smita Deogaonkar-Baride and Dr.Padma S.Vankar	'Copper Nanoparticles Synthesis and its coating for antimicrobial applications with improved durability	Journal of 'BTRA Scan' Vol-L No.1, 1-4 Jan 2021.
Dr.Prasanta Kumar Panda and Ms. Archana Gangwar	'Electrospinning Of Polyamide 6 Nanofiber Using Wire Electrodes'	Journal of 'BTRA Scan' Vol-L No.1,5-14, Jan 2021.
Dr.T V Sreekumar	'Indian Carbon Fibre History And Present Challenges'	Journal of 'BTRA Scan' Vol-L No.1,15-20, Jan 2021
Mr.Vijay Shirole	'Textile Process Audit: An Approach Towards Continual Improvement'	Journal of 'BTRA Scan' Vol-L No.1, 22-24, Jan 2021

Appendix – 3

TRAINING PROGRAMMES CONDUCTED

Subject	To Whom	Duration
	On-Site Training	
'Printing & Finishing'	One staff from Jesons Ind Ltd	For 2 days in September 2020
'CPB Dyeing lab to bulk'	One staff from Kudu Processors, Ludhiana	For 2 days in December 2020
'Assessment of assessors'	Six Staff from M/s Rohstoffe International pvt Ltd	For one 1day in January 2021
'Denim manufacturing and ETP'	Four Staff from Shyam Fashions Pvt Ltd., Ahmedabad	For 3 days in February 2021

Appendix – 4

CONFERENCES / SEMINARS / TRAINING PROGRAMMES / WORKSHOPS ATTENDED BY BTRA STAFF

Name of Staff	Occasion	Place	Date
Mr.Tanaji Kadam	Participated in the webinar of 'Nano Technology and its application in Textiles	Bhilwara	8th August 2020
Mr.Vijay Gawde / Mr.Akash Kanse	Participated in the webinar of 'Digi tex-Digital Textile Programme	Coimbatore	19th August 2020
Mr.Tanaji Kadam/ Mr.Vijay Shirole	Participated in the webinar of 'Efficient Steam System'	Mumbai	28th August 2020
Mr.Tanaji Kadam/ Mr.Vijay Shirole/ Mr.Vijay Gawde	Participated in 'Strengthening Trainer Development'	NSDC	3rd September 2020
Mr.Tanaji Kadam/ Mrs.Snehal Dhamdere	Attended meeting at CCI Belapur CBD	Mumbai	21st October 2020

Appendix – 5

PUBLICATIONS RELEASED BY BTRA

'BTRA Scan' completed 50 successful years of publication this year. This magazine covers refereed articles in research in the fields related to Textiles, Polymers, Plastics, Chemical science, Technology, Business, Management, Environmental Science etc. It is now open to all researchers across the globe. BTRA Scan is published Quarterly (4 Issues per year). Following are some of the acheivements of **BTRA Scan** in 2020-21.

- It has become profitable.
- Industry leading magazine.
- Free Softcopy
- Can be downloaded from BTRA website
- Accepting adevertising and sponsorship.
- Increased circulation through e-publication.

Appendix – 6

OTHERS

PRODUCTS / CHEMICALS / INSTRUMENTS / GADGETS SOLD ON A REIMBURSABLE BASIS	• Viscosity cups [19 no.] • Cuprammonium solution [460.5ml] • Drave Test Hook [2 no.]
INSTRUMENTS / GADGETS CALIBRATED	• Various instruments at BTRA Test Laboratories and 3 BTRA PSCs are calibrated regularly
INSTRUMENTS SERVICED	• Servicing of several equipments / instruments at BTRA Test Laboratories

Appendix – 7

NEW ADDITIONS TO BTRA LIBRARY

- 2021 TECHNICAL MANUAL OF AATCC, USA.
- CONFEDERATION OF INDIAN TEXTILE INDUSTRY, CITI
- 12TH WFCFD INTERNATIONATIONAL WORKSHOP ON CRYSTALLIZATION,FILTRATION & DRYING, WFCFD
- SOIL MECHANICS AND FOUNDATIONS, DR.B C PUNMIA/ER.ASHOK K JAIN/DR.ARUN K JAIN
- GENERAL FINANCIAL RULES 2017, MUTHUSWAMY/BRINDA/SANJEEV
- TEXTBOOK OF POLYMER SCIENCE, FRED W BILLMEYER, WILEY INDIA PVT LTD
- FUNDAMENTALS OF YARN WINDING, Milind Koranne, Woodhead Publishing India Pvt. Ltd., New Delhi, 2013 / reprint 2017
- WEAVING CALCULATION, COSTING & PROJECTS, DR.M.K.TALUKDAR AND DR.ANIRBAN GUHA.

CDs / Soft Copy Downloads

- ♣ **Latest International Standard Test Methods:** IS 688, ISO 22609, EN 14683,ASTM F1862, IS 13162,ASTM D6637, ASTM D5261, ASTM D4884, ASTM D6241,ASTM D4632,ASTM D4595,ASTM D4533,ASTM D5323,ASTM D4885,ASTM D6693,ASTM D6767, ASTM D4491,ASTM D6706, ASTM D1693, ASTM D792, ASTM D1004, ASTM D1238, ASTM D737, ASTM D1422, ASTM D1425, ASTM D1683, ASTM D1777, ASTM D3512, ASTM D3774, ASTM D3882, ASTM D4966, ASTM D5034, ASTM D5035, ASTM D5587,ISO-11357-6

Appendix –8

DIRECTOR'S ENGAGEMENTS

Month	Details
February 2021	♣ Attended the meeting with the Ruby Mills, on 23rd February 2021 ♣ Attended the meeting with MPCB, Sion-Mumbai, on 3rd February 2021
March 2021	♣ Dr.V.K.Sarswat, Principal Scientific Advisor of Prime Minister & Member of Niti Ayog, Ministry of Textile, on 16th March 2021.

Appendix – 9

DISTINGUISHED VISITORS TO BTRA

Name of the Visitors	Company
Mr. R.Israel Bakhtsingh, Scientific Officer	DC Accelerator Section
Dr. Vashey, Head	DC Accelerator Section
Mr. Rajesh Kurup, Achitect	Quality Assurance & Technical Services
Mr. S.K.Som, Director	Quality Assurance & Technical Services
Mr. Rupesh Nagda, Director	Family First Capital Advisors Pvt.Ltd
Mr .Milind Bhadsavle	Shamika Projects Designing & Remodelling
Mr. Rajesh Chopra, B.Tech(I.I.T.Delhi),	Timetex Mills-Yarns/Fabrics
Mr. Rajesh Kumar Jha, Enforcement Officer	Employee's Provident Fund Organisation
Mr. Abhijit Chandrakant Malshe, Vice President-Operations	Nina Percept Pvt Ltd
Mr. Sohel Siddiqui, AGM-QA/QC	Nina Percept Pvt Ltd
Dr. Swapneshu Baser, Director	Deven Supercriticals Pvt.Ltd
Mr. Animesh Laha, Manager-Innovation	Welspun India Limited,
Dr. Anu Chaphekar, Research and Technology Manager	Croda India Company Pvt Ltd
Dr. Raghav Mehra, Assistant Manager-Research	Croda India Company Pvt Ltd
Mr. Sameer Patil, Director	S & R Geotechniques Pvt. Ltd
Mr. Kumar Salunkhe,	S & R Geotechniques Pvt. Ltd

Appendix –10

OUTSTATION VISITS BY BTRA STAFF

- ✓ Abhishek Textile.Nagpur
- ✓ Khosla profile Pvt Ltd kudus unit and Khupri unit
- ✓ Pee vee Textiles, Nagpur
- ✓ Cetcon Yarn dyers, Hatkanangale
- ✓ Shyam fashion Pvt Ltd, Ahmedabad
- ✓ MPCB Kolhapur and PSC(Madhavnagar + Ichalkaranji)
- ✓ Solapur PSC
- ✓ D'Decor Exports, Boisar
- ✓ Kamal Textiles, Ahmedabad
- ✓ Kanti Fashion Fab, Ahmedabad
- ✓ Kanswa Textiles and Cottwell fabrics Solapur
- ✓ Komal Texfab, Ahmedabad
- ✓ Maccaferri Environmental Solutions Pvt. Ltd., Gurgaon
- ✓ Ministry of Textiles, Government of India
- ✓ Nagreeka Exports, Kolhapur
- ✓ Pee Vee Textiles, Wardha
- ✓ RSR Mohota Spinning & Weaving Mills, Hinganghat
- ✓ Samir Synthetic Mill, Ahmedabad
- ✓ Selvam Process, Tirupur
- ✓ Shiny Textile Processing, Erode
- ✓ Shivam Devansh Fab Pvt. Ltd., Faridabad
- ✓ Shruti Enterprises, Silvassa
- ✓ Shyam Textiles, Ahmedabad
- ✓ Sintex Industries, Chiripal Industries, Balkrishna Textiles- Ahmedabad and Bindal silk mills, Surat
- ✓ SSM Processors, Erode
- ✓ Vaibhav Processing Mills Erode
- ✓ Weaving Cluster Vadvani, Beed

Appendix – 11

BIS MEMBERSHIP

BTRA staff involved in the following standard development committees of the Bureau of Indian Standards.

Sectional Committees	Title
TXD 01	Physical methods of test
TXD 05	Chemical methods of test
TXD 07	Textile speciality chemicals and dyestuffs
TXD 14	Textile Machinery and Accessories
TXD 28	Silk and silk products
TXD 30	Geo-textiles and industrial fabrics
TXD 31	Man-made fibres, cotton and their products
TXD 32	Textiles protective clothing
TXD 33	Industrial fabrics
TXD 35	Technical Textiles for Agrotech applications
TXD 36	Technical Textiles for Meditech purposes
TXD 37	Technical Textiles for Sportech applications
TXD 38	Technical Textiles for Mobiltech Applications
TXD 39	Technical textiles for Clothtech purposes
TXD 40	Composites and Speciality Fibres Sectional

Appendix – 12

MEMBERS OF THE GENERAL ADVISORY COMMITTEE FOR RESEARCH AND LIAISON [2018-2021]

Dr. Lalit Varshney RRF Room No: 209 Electron Beam Centre, Kharghar, Raintree Marg Sector 7, CBD Belapur Navi Mumbai, Maharashtra-410210	**Dr. T. M. Kotresh** Scientist 'G'/AD, Defence Bioengineering and Electromedical Laboratory, CV Raman Nagar, Bengaluru-560093.	**Dr. G V Raghunath Reddy** Scientist – F, Technology Mission Division (Energy, Water and Others), Department of Science & Technology, Ministry of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi – 110016.
Dr. T.H. Goswami, Defence Materials and Stores Research & Development Establishment (DMSRDE) DRDO, Ministry of Defence, Government of India PO DMSRDE, GT Road, Kanpur-208013	**Dr. Debarati Bhattacharjee** Scientist, FIE, Terminal Ballistics Research Laboratory, Sector 30, Chandigarh - 160 030.	**Dr. Arup R. Bhattacharyya** Department of Metallurgical Engineering & Materials Science, Indian Institute of Technology Bombay, Powai, Mumbai-400076
Prof. Anirban Guha Department of Mechanical Engineering, Indian Institute of Technology, Bombay, Powai, Mumbai 400 076	**Dr. Asim Tewari** Chair Professor Department of Mechanical Engineering Indian Institute of Technology Bombay Powai, Mumbai- 400076.	**Dr Vijay Ramakrishnan** Garware Technical Fibres Ltd., Plot No.11, Block D-1, MIDC, Chinchwad, Pune- 411 019.
Dr. Milind Khandwe The Bhor Chemicals & Plastics Pvt Ltd, Plot no. B/18/2/1, MIDC Ambad, Nashik – 422010.	**Mr. V. Kannan** Reliance Corporate Park, Bldg. No. 8, 1st Floor, ‘A’ Wing, Thane Belapur Road, Ghansoli, Navi Mumbai 400701	**Mr. K. L. Vidur** B-401, NirmanVihar, RajmataJeejabai Road, Andheri (East), Mumbai 400093
Dr. M. K. Talukdar, M/s.Kusumgar Corporates, 101/102, Manjushree Bldg., Hatkesh Co-op. Society, Corner of N.S.Road No.5, JVPD Scheme, Juhu, Mumbai 400 056.	**Dr. R. R. Deshmukh** Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400 019	**Mr. Shahrokh Bagli** Technical Advisor Strata Geosystems (India) Pvt Ltd, Sabnam House, Plot No. A-15/16, Central Cross Road B, MIDC, Andheri (E) Mumbai 400 093

Appendix – 12 (Contd.)

MEMBERS OF THE GENERAL ADVISORY COMMITTEE FOR RESEARCH AND LIAISON [2021-2023]

Dr. Prakash Vasudevan Director, The South India Textile Research Association, 13/37, Avinashi Road, Coimbatore Aerodrome Post, Coimbatore – 641 014	**Mr. Arindam Basu** Director, Northern India Textile Research Association Sector-23, Raj Nagar, Ghaziabad-201002	**Mr. Pragnesh Shah** Director, Ahmedabad Textile Industry's Research Association, P.O. AmbawadiVistar, Ahmedabad - 380 015
Dr. T V Sreekumar Director The Bombay Textile ResearchAssociation Lal Bahadur Shastri Marg, Ghatkopar (West), Mumbai 400 086.		

Appendix - 13

STAFF DETAILS

The total staff strength of BTRA as of 31st March 2021 was as follows:

Director	**1**
At BTRA	
◆ Scientific / Technical Officers	19
◆ Scientific / Technical Staff	28
◆ Skilled / Semi-skilled & Maintenance Staff	17
◆ Administrative Staff	16
Sub-total	**81**
At PSCs	
◆ Scientific / Technical Officers	0
◆ Scientific / Technical Staff	6
◆ Skilled / Semi-skilled & Maintenance Staff	1
◆ Administrative Staff	1
Sub-total	**8**
TOTAL	89@

@ - Including 23 contractual staff & 1 Trainee

Director	**:**	**Dr. Anjan K Mukhopadyay (Till 13-11-2020)** **Dr. T V Sreekumar**
Research		
Advisor	:	Mr. S. Subramanian
Research Advisor	:	Dr. Padma S. Vankar
Advisor	:	Mr. V. K. Patil
Technical Services Division		
Chief Textile Technologist	:	Mr. Tanaji I. Kadam
Senior Scientific Officer Grade-I	:	Mr. V. A. Gawde
Senior Scientific Officer Grade	:	Mr. V. R. Shirole
Library, Information & Publication		
Library Assistant	:	Ms. Sharayu Joshi
Electronics		
Hardware Engineer	:	Mr. Peringeth Jithin
BTRA Test Laboratories		
Laboratory Manager	:	Mr. R. A. Shaikh
(i) Physical Testing Division		
Junior Scientific Officer	:	Mr. D. R. Yadav
Scanning Electron Microscope		
Senior Scientific Officer Grade-II	:	Mr. Amol G. Thite
Geotech Cell		
Senior Scientist	:	Dr. Prasanta Kumar N. Panda
Senior Scientific Officer Grade-II	:	Mr. R. R. Menon
Junior Scientific Officer	:	Mr. G.R. Mahajan
(ii) Chemical Testing Lab.		
Senior Scientific Officer Grade-I	:	Mrs. S. P. Vairagi Mrs. Chandrakala L.M.
Senior Scientific Officer Grade-II	:	Ms. A. U. Shenoy Mrs. Smita A.Baride/ Ms. Tejaswini R. Ghadyale
Senior Scientist	:	Mr. M. P. Sathianarayanan
Junior Scientific Officer	:	Mrs. M. P. D'Souza Mrs. S. D. Mayekar Ms. Karishma Hemani

(iii) Microbiology Lab.

Senior Scientific Officer Grade-II	:	Mrs. Aruna D. Apte

(iv) Plasma Lab.

Senior Scientific Officer Grade -II	:	Ms. S. S. Palaskar
Research Scholar	:	Ms. Archana Gangwar

Engineering Services Section

Officer -Engineering Services	:	Mr. Mohan B. Mane

Administration

Administrative Officer	:	Mr. Jignesh S. Jani
Purchase Officer	:	Mr. M. H. Bondre
Junior Accounts Officer	:	Mrs. Mugdha M. Shinde
Junior Accounts Officer	:	Mrs. Veena A. Dwivedi
Executive Assistant	:	Mr.Vasant Gawde

Marketing

Senior Scientific Officer Grade-I	:	Mrs. Snehal B Dhamdere
Officer - Marketing Co-ordination	:	Mrs. Rohini A. Bantwal Mangalore
Executive Customer Co-ordination	:	Mrs. Swati A Bhaigade

Soil Testing Lab.

Research Officer	:	Mr. Devulapalli Lekhaz

BTRA PSC, Ichalkaranji	**:**	Mr. Sachin R. Tambe
BTRA PSC, Solapur	**:**	Mr. A.V. Patil
BTRA PSC, Madhavnagar	**:**	Mr. N. A. Chavan

Appendix - 14

LIST OF MEMBERS

- Banswara Syntex Ltd., Rajasthan
- Birla Cotsyn (India) Ltd., Mumbai
- BMD Pvt. Ltd., Banswara
- BSL Ltd., Bhilwara
- Century Textiles, Mumbai
- Century Rayon, Shahad ((under the management &operation of Grasim Ind. Ltd.)
- Diversey India Hygiene Pvt.Ltd., Mumbai
- Entremonde Polycoaters Ltd, Nashik
- Finlay Mills Ltd., Mumbai
- Flexituff Ventures International Ltd., Mumbai
- Garware Technical Fibres Limited, Pune
- Hindoostan Mills Ltd., Mumbai
- Hindustan Unilever Ltd., Mumbai
- Indian Oil Corporation Ltd., New Delhi
- Indo Count Industries Ltd., Mumbai
- Indonet Plastic Industries, Vadodara
- Jaya Shree Textiles &Industries, Rishra
- Jeevan Nonwovens, Mumbai
- KadriWovens, Tamil Nadu
- Kusumgar Corporates, Mumbai
- Kudu Knit Process Pvt. Ltd, Punjab
- MaharsheeGeomembrane (India)Pvt. Ltd., Vadodara
- Morarjee Textiles Ltd., Mumbai
- Mohota Industries Ltd, Wardha
- OCM Private Ltd, Punjab
- Nagreeka Exports Ltd., Kolhapur
- National Textile Corporation Ltd.(Western Region), Mumbai
- Pee Vee Textiles Ltd., Jam, Samudrapur, Wardha
- Purity TechtextilePvt. Ltd., Mumbai
- Red-Star, Navi Mumbai
- RSWM Ltd., Mumbai
- Raymond Ltd., Thane
- Reliance Industries Ltd., Navi Mumbai
- Ruby Mills Ltd., Mumbai
- S. Kumars Limited, Mumbai
- Shri Ambika Polymers Pvt.Ltd., Gujarat
- Siyaram Silk Mills, Mumbai
- Strata Geosystems (India) Pvt.Ltd., Mumbai
- Supreme Nonwoven Ind. Pvt. Ltd., Mumbai
- Techfab (India) Industries, Mumbai
- Technocraft Industries (India) Ltd.,Mumbai
- United Bleachers Ltd., Tamil Nadu
- UnitopAquacare Ltd., Thane
- Visaka Industries Ltd., Secundarabad
- Wellknown Polyesters Ltd., Mumbai
- Welspun India Ltd., Mumbai

Technical Consultancy Services offered by BTRA, Mumbai

- Undertake turnkey project for setting-up ZLD ETP for textile industry
- Effluent treatment plant adequacy audit, related issues and problem solving
- Chemical Management System (CMS) in wet processing
- Benchmarking and SOP for weaving and processing
- Water conservation audits
- Boiler efficiency audits
- Six sigma projects for textile processing industry
- Energy conservation audits by certified energy engineers
- Reduction of reprocessing
- Laboratory to shop floor result translation with RFT
- Inspection services backed by diagnosis and testing
- Productivity and quality improvement at shop floor level for weaving and processing
- Comprehensive maintenance audit of machines for weaving and processing
- Documentation vetting of new project-technical aspects for weaving and processing
- Waste control /value loss control for weaving and processing
- Manpower planning for weaving and processing unit
- User need based technical training for textile operators, technician and managerial staff
- Techno-Soft skill training for operators, technicians

For more information, contact:

The Bombay Textile Research Association
L.B.S. Marg, Ghatkopar(W), Mumbai 400086
Tel. : 022-62023636, 62023600
Email : tsd@btraindia.com
info@btraindia.com
Website : www.btraindia.com

BTRA Facility :

Thermogravimetric Analysis (TGA) :

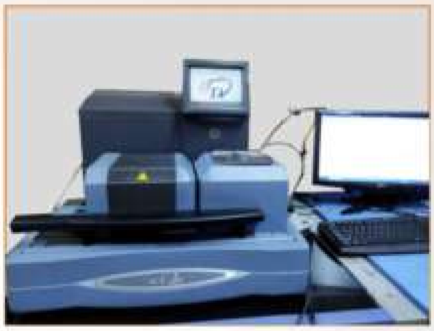
Thermogravimetric Analysis (TGA) is a method of thermal analysis in which the weight loss or gain is measured as a function of temperature or time.

This measurement provides information about physical phenomena such as phase transition, as well as chemical phenomena including thermal decomposition.

Some of the important application of TGA is to find:

1) Moisture and volatile content,
2) Composition of polymer, Filler and carbon content.
3) Thermal stability of Material
4) Decomposition kinetics of material

We have SDTQ600 model in which we can capture simultaneously, DSC as well as TGA signal. In normal DSC we can go only upto 500°C, but the advantage of this instrument is that we can get the DSC signal upto 1200°C

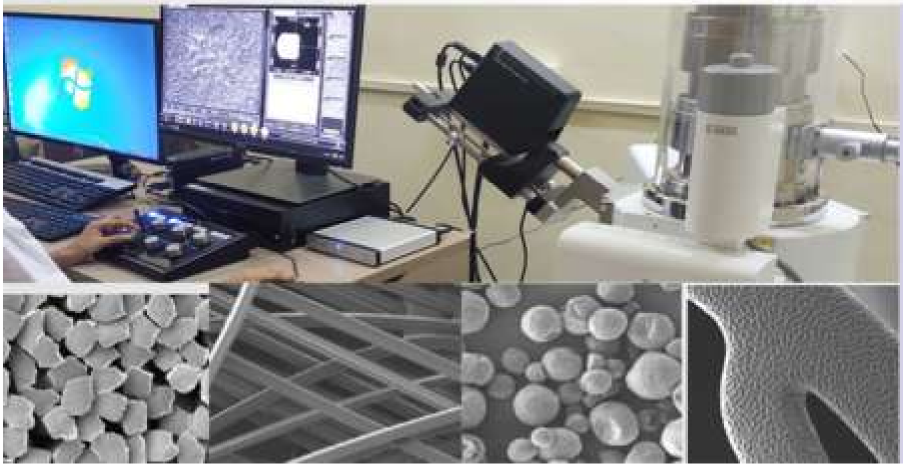


Contact for more details :
Email : info@btrainida.com
Tel. : +91-22-6202 3636

Advanced New JEOL JSM IT 200 LV Scanning Electron Microscope

In BTRA, advanced new JEOL JSM IT 200 LV SEM machine (Japan) have magnification capabilities ranges from 10X to 3,00,000X and resolution of about 10 nm. The surface view and cross-sectional view of the sample can be easily seen. In addition, the elemental composition and mapping of any solid material can be carried out by EDAX (U.S.A.) energy dispersive X-ray spectroscopy (EDS).

Samples from **Textile, Pharmaceuticals, Ceramics, Polymers, Metals and other allied industries** can be analysed on this SEM machine.



For more information, contact:
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