INVESTIGATION ON ENZYME TREATED POLYESTER MICRO FIBRE KNITTED FABRICS

A PROJECT REPORT

Submitted by

MARY INDRA BALA BRINDA .I	71206212013
MOHANKUMAR .T	71206212014
STANLEY PHILIP BHARATHI .A	71206212036
PRABHAKAR .S	71206212311

In partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

In

TEXTILE TECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE _ 641 006

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2010

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report **"INVESTIGATION ON ENZYME TREATED POLYESTER MICRO FIBRE KNITTED FABRICS** is the bonafide work **I.MARYINDRA BALA BRINDA, T.MOHANKUMAR, A.STANLEY PHILIP BHARATHI** and **S.PRABHAKAR** who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
DR.K.THANGAMANI	MR.N.JEGADEESAN
HEAD OF THE DEPARTMENT	**SUPERVISOR**
	Lecturer
Department of Textile Technology,	Department of Textile Technology,
Kumaraguru College of Technology,	Kumaraguru College of Technology,
Coimbatore-641006	Coimbatore-641006

Viva- voce examination is conducted on 16.-04.-2010

(INTERNAL EXAMINER)	**(EXTERNAL EXAMINER)**

ACKNOWLEDGEMENT

We the students of this project humbly honor **'THE ALMIGHTY'** for the blessings and his doings.

First and foremost we thank our beloved Co-Chairman **Dr. B.K. Krishnaraj Vanavarayar,** respected Director **Dr.J.Shanmugam** and our respected Principal **Dr.S.Ramachandran** for providing us the wonderful opportunity to carry out this project. We take this opportunity in expressing our profound thanks to **Dr.K.Thangamani**, Professor&Head(i/c), Department of Textile Technology, whose constant encouragement was instrumental in completing this project work.

Our sincere thanks and profound gratitude to our Project Coordinator **Prof.M.Dhinakaran**, Assistant professor and Project Guide **Mr.N.Jegadeesan**, Lecturer for their Wonderful guidance, enthusiasm and invaluable help rendered throughout the project.

We pay our sincere thanks and credit to **Mr.S.Shanmugasundaram,** GM (Marketing), **Reliance Industries Limited, Coimbatore** for their guidance and contribution of raw material to finish our project work successfully.

We must thank at this moment to all who ever helped us to succeed this project. We pay our sincere thanks to **Siemens Knitting, Tirupur** for providing their facillity and invaluable time to produce fabric.

We are obliged to express our sincere thanks and gratitude to **KCT-TIFAC CORE, SITRA and Karunya University**, for completing the project work successfully. We thank all the **Teaching and Non-Teaching** staff of Kumaraguru College of Technology especially C. Moses Immanuel for their help during this project.

Our sincere thanks to **Dr.Shoba.U.S,** Assistant Professor of Science and Humanities, Kumaraguru College of Technology who helped us on concluding our project with our test results.

We also wish to thank our **parents** for their constant encouragement, help rendered and also making all the facilities necessary to carry out this project.

ABSTRACT

This study investigates the surface modification of normal denier polyester and micro denier polyester single jersey fabrics. The surface modification was done by alkaline hydrolysis and lipase enzyme. Micro denier fabrics is dimensionally more stable than normal denier fabrics because of less loop shape deformation and characterized by better stitch density and tightness factor. Among the treatment given enzyme treatment improves the capillary action in the normal denier as well as micro denier fabrics by causing surface modification .wick ability is good for enzyme treated fabrics because of the more number of pores and modified surface.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SAMPLE CODING

FTIR TEST

A1 - Soaped Polyester
B1 - NaOH Treated polyester
C1 - Enzyme Treated polyester
A2 - Soaped Micropolyester
B2 - NaOH Treated micro polyester
C2 - Enzyme Treated micro polyester

BURSTING STRENGTH AND AIR PERMEABILTIY

2.1 - Soaped polyester
2.2 - Soaped micro polyester
3.1 - NaOH Treated polyester
3.2 - NaOH Treated micro polyester
4.1 - Dyed Polyester
4.2 - Dyed micro polyester
6.1 - Dyed Polyester (NaOH Treated)
6.2 - Dyed micro Polyester (NaOH Treated)
7.1 - Enzyme Treated polyester
7.2 - Enzyme Treated micro polyester
8.1 - Dyed Polyester (Enzyme Treated)
8.2 - Dyed Micropolyester (Enzyme Treated)
9.1 - Enzyme polyester(Dyed Polyester)
9.2 - Enzyme micro polyester(Dyed micro Polyester)

CHAPTER 1

INTRODUCTION

Microdenier fibers have many favorable properties such as high strength and resilience, resistance to many chemicals, resistance to abrasion, better smooth good moisture and air transmission. It has a demerit of moisture absorbency when compare with hydrophilic fibres. In order to modify the surface of the polyester, enzymes are used. Lipase is a enzyme that acts by cleaving the polymer chain through hydrolysis of ester bonds of the polyester fibers

Alkaline hydrolysis is one of the most documented methods for modifying the chemical and physical characteristics of polyester fabrics.

The nucleophilic attack of a base on the electron deficient carbonyl carbon in PET causes chain scissions at the ester linkages along the PET chain, producing carboxyl and hydroxyl polar end groups. The increased surface polarity leads to better wettability and soil-release properties.

Lipases are known to catalyze the hydrolysis of lipids of fatty acids and glycerol at the lipid-water interface. It is therefore conceivable that the hydrolyzing enzymes may also catalyze the hydrolysis of ester linkage in PET. These hydrolyzing enzymes improve the water wetting and retention properties of the polyester fabrics with negligible changes in fabric mass and pore structure. From the above points, this project is taken and an attempt has been made to investigate the effect of enzyme treatment on microdenier polyester knitted fabrics.

CHAPTER 2

LITERATURE REVIEW

Ramakrishnan et al [1] from their research work entitled "An investigation into the properties of knitted fabrics made from viscose microfibers" concluded that microdenier fabrics are more dimensionally stable than normal denier fabrics which is because of less loop shape deformation and they also concluded that moisture transmission properties of micro fibre knitted fabrics were found to be good. This in turn can be used for apparel purposes.

Hsieh et al [2] found that alkaline hydrolysis can modify the surface of normal and microdenier polyester fabrics and also concluded that wetting has improved for both normal and microdenier fabrics. This was because of change in the surface energy and the contact angle.

Hsieh [3] found that alkaline hydrolysis is one of the evident methods of modifying the physical and chemical properties of polyester fabrics. Due to the carbonyl carbon in polyester causes chain scissions at the ester linkages which produces carboxyl and hydroxyl polar end groups. This polarity gives better wettability for alkaline treated polyester fabrics. Alternatively enzyme hydrolysis can be than using lipases. This lipase can catalyze the hydrolysis of lipids of fatty acids and glycerol at the lipid-water interface. This causes hydrolyzing of ester linkage in polyester.

Ian Holme [4] from his paper entitled on "Enzymes for innovative textile treatments" found that lipase enzymes can be used for improving surface characteristics of polyester fabrics without affecting the strength of the fabrics.

Das et al [5] from their research work on "Studies on moisture transmission properties of PV blended fabrics" concluded that moisture transmission characteristics of fabrics affected by yarn count , yarn twist and proportion of polyester content and also concluded that linear density of yarn can play a significant role for determining air permeability and water vapor permeability of the fabric .

CHAPTER 3

AIM AND SCOPE

- To produce single jersey fabric with normal denier polyester and microdenier polyester.
- To modify polyester surface using lipase enzyme and alkaline hydrolysis (NAOH)
- To Characterize the above produced fabrics.

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIAL

Polyester microfilament having 80 denier with 108 filaments specification and normal polyester filament having 80 denier with 36 filaments kindly supplied by Reliance Industries Limited , Ahmedabad were used.

4.2 SAMPLE PREPARATION

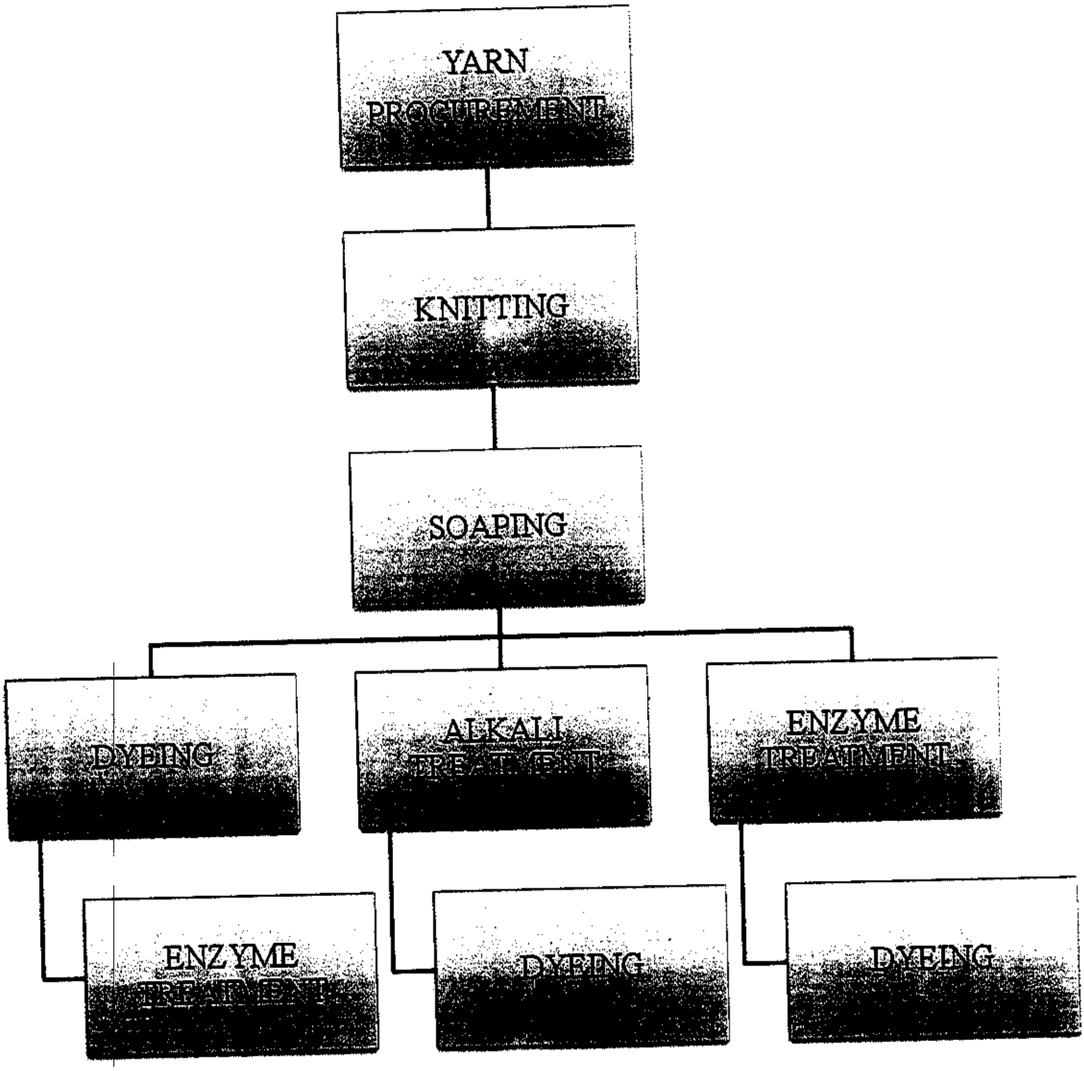
Both micro and normal filament were knitted on a single jersey knitting machine With the following specifications.

Table 4.1 Knitting Machine Details

Knitting machine make	PMW, Ludhiana
Speed rpm	25
Needle	Groz – Beckert
No of feeders	16
Diameter	16
Gauge	26

4.3 PROCESS SEQUENCE

The procured yarn is converted to knitted fabric . This knitted fabric is treated with alkali and enzyme seperately . Then the fabric is dyed and compared.



4.3.1 Soaping

Soaping is a process done to normal polyester and micro polyester knitted fabric to remove oil stains. It is done in soft flow machine at 60° C at normal pressure. The parameters are given below:

Table 4.2 Process Details of Soaping

Machine	Soft flow
Temperature	60 deg
Pressure	Normal
Wash	Cold wash
Duration	45 min
M:L ratio	1:20

4.3.2 Alkali treatment

The soaped polyester is taken and treated with alkali. This is done to see the change in the structure and various properties. It is also used to compare the fabric with enzyme treated fabric.

Table 4.3 Process Details of Alkali treatment

Machine	Winch
Temperature	55 deg
Pressure	Normal
Wash	Hot wash
Duration	45 min
Concentration	15%
M:L ratio	1:20

4.3.3 Enzyme treatment

The soaped polyester and micro polyester is taken and treated with enzyme. The fabric that is dyed is also treated with enzyme in order to compare with each other.

Table 4.4 Process Details of Enzyme Treatment

Enzyme	Lipase
Temperature	Room temperature
pH	7.5
Concentration	2 gpl
M:L ratio	1:10
Duration	90 min
After wash	Cold wash

4.3.4 Dyeing

The soaped polyester and micro polyester fabric is dyed. All the above produced samples were dyed with the following particulars. Then finally the results are compared.

Table 4.5 Process Details For Dyeing

Machine	Soft flow
Dye	Disperse dye blue-79
Temperature	140 deg
M:L ratio	1:20
Concentration	2 gpl
Duration	75 min
pH	4
After wash	Cold wash

4.4 TESTING METHODS

The processed fabric is subjected to various tests. These tests are done in order to know the change in fabric properties.

4.4.1 Fabric dimensional stability

Fabric properties have been studied by conducting various tests. Course per cm, Wales per cm, areal density, stitch density, loop length, Kc, Kw, Ks, tightness factor and loop shape factor were done. The above tests were done using GSM cutter and counting glass.

4.4.2 Bursting strength

Table 4.6 Bursting Strength Details

Standard	(IS 1966-1975 reaffirmed 1999)
Unit	kgs/sq.cm
RH	65%
Temperature	21 deg

The sample to be tested is placed in the diaphragm and the air is blown. This is used to test the bursting strength of the fabric.

4.4.3 Air permeability

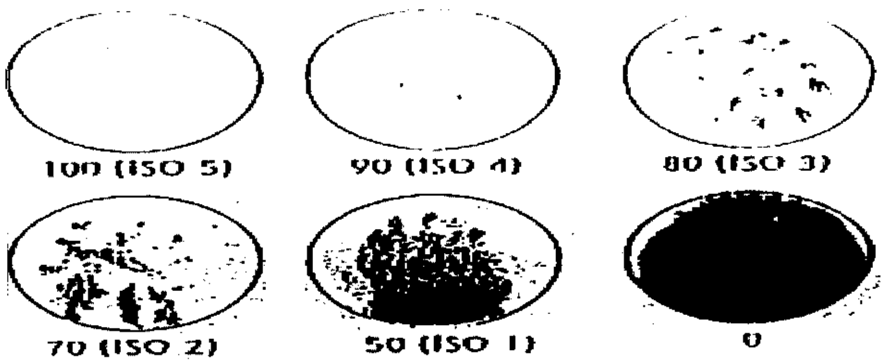
Table 4.7 Air Permeability Test Details

Standard	ASTM D 737
Unit	CC/sq.cm/sec
pressure	125Pa
Sample	38 sq.cm
RH	65%
Temperature	21 deg

Air permeability is used to measure the amount of air passing through the fabric in a given time for a given amount of air. The fabric is placed in the diaphragm and the air is sucked through it then the level of pointer is noted down and the air permeable value is found out.

4.4.4 Spray test

Standard Spray Test - Ratings



SPRAY RATING TEST

- 100 ISO 5- No Sticking or wetting of the specimen face
- 90 ISO 4 - Slight Random sticking or wetting of the specimen face
- 80 ISO 3 - Wetting of Specimen face at spray points
- 70 ISO 2 - Partial wetting of specimen face beyond the spray points
- 50 ISO 1 - Complete wetting of the entire specimen face beyond the Spray points
- 0 - Complete wetting of the entire face of the specimen

Table 4.8 Spray Test Details

Standard	AATCC-22 & CNS 10461
Sample size	152 sq mm

The above figure shows the spray test result .It is a standard comparison for different absorbency of the fabric sample at each process. It is passed with 250 ml water is sprayed on Sample size.

4.4.5 Wickability

Table 4.9 Wickability Test Details

Standard	In-House test method
Sample size	23x2.5 cm
Time	5 min

This is a bias wicking test. The sample is hung on the clamp and it is immersed in the water then after some time , the water transport action is noted and measured by a ruled scale. This test method measures the distance water will wick up a cut edge of fabric. Caution is advised when using the results obtained by this test to measure comfort, as comfort involves the ability of a textile to absorb water in the flat state.

4.4.6 Computer Colour Matching

Computer Color Matching (CCM) was done using Gretag Macbeth color i 5. 25mm circular specimen was used as sample size.

4.4.7 FTIR Test

Table 4.10 FTIR Test details

Machine	SHIMADZU
Sample	1 sq.inch

Fourier Transform Infrared Spectroscopy (FTIR) is a powerful tool for identifying types of chemical bonds in a molecule by producing an infrared absorption spectrum that is like a molecular "fingerprint".

4.4.8 Scanning Electron Microscope

Scanning electron microscope was used to investigate the surface structure of the fabric knitted from normal denier as well as micro denier fibre. Samples were investigated at the magnification levels of 300x, 1000x, 2000x, 4000x, and 10,000x.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 FABRIC DIMENSIONAL STABILITY

Table 5.1 Fabric Dimensional Stability of Polyester Fabrics

Fabric	Course per Cm	Wales per Cm	Stitch Density Per sq.cm	Loop length Cm	Kc	Kw	Ks= Kc*Kw	Tightness factor	Loop shape Factor (Kc/Kw)	Areal density
Soaped polyester	30	22	660	0.2	6	4.4	26.4	1.5	1.36	136
NaOH treated polyester	31	24	744	0.2	6.2	4.8	29.76	1.5	1.29	121
Dyed polyester	32	25	800	0.2	6.4	5	32	1.5	1.34	132
Dyed polyester (NaOH treated)	34	24	816	0.2	6.8	4.8	32.64	1.5	1.41	136
Enzyme treated polyester	34	24	816	0.2	6.8	4.8	32.64	1.5	1.41	132
Dyed polyester (Enzyme treated)	34	24	816	0.2	6.8	4.8	32.64	1.5	1.41	127
Enzyme polyester (dyed polyester)	33	25	825	0.2	6.6	5	33	1.5	1.32	132

From the table we can observe that there is no much change in loop shape factor among the normal polyester fabrics.

Table 5.2 Fabric Dimensional Stability of Micropolyester Fabrics

Fabric	Course per Cm	Wales per Cm	Stitch Density per sq.cm	Loop length Cm	Kc	Kw	Ks= Kc*Kw	Tightness factor	Loop shape Factor (Kc/Kw)	Areal density
Soaped micro polyester	33	30	990	0.2	6.6	6	39.6	1.5	1.1	130
NaOH treated micro polyester	34	31	1054	0.2	6.8	6.2	42.16	1.5	1.09	125
Dyed micro polyester	35	32	1120	0.2	7	6.4	44.8	1.5	1.09	132
Dyed micro polyester (NaOH treated)	35	32	1120	0.2	7	6.4	44.8	1.5	1.09	128
Enzyme treated micro polyester	34	31	1054	0.2	6.8	6.2	42.16	1.5	1.09	126
Dyed micro polyester (Enzyme treated)	35	33	1155	0.2	7	6.6	46.2	1.5	1.06	126
Enzyme micro polyester (dyed polyester)	35	32	1120	0.2	7	6.4	44.8	1.5	1.09	132

From the table we can find that the same observation found in the loop shape factor. But when we compare loop shape factor of Normal and Micro denier fabrics, micro denier fabrics are more stable than normal fabrics. This may be attributed due to more no of filaments in the yarn cross-section. Hence we can say that micro denier fabrics are more dimensionally stable than normal denier fabrics.

5.2 BURSTING STRENGTH

Table 5.3 Bursting Strength of Polyester Fabrics

Material	Bursting strength (IS 1966-1975 reaffirmed 1999)kgs/sq.cm
Soaped polyester	6.9
NaOH treated polyester	6.05
Dyed polyester	6.85
Dyed polyester(NaOH treated)	6.8
Enzyme treated polyester	6.25
Dyed polyester(Enzyme treated)	6.95
Enzyme polyester (dyed polyester)	7.25

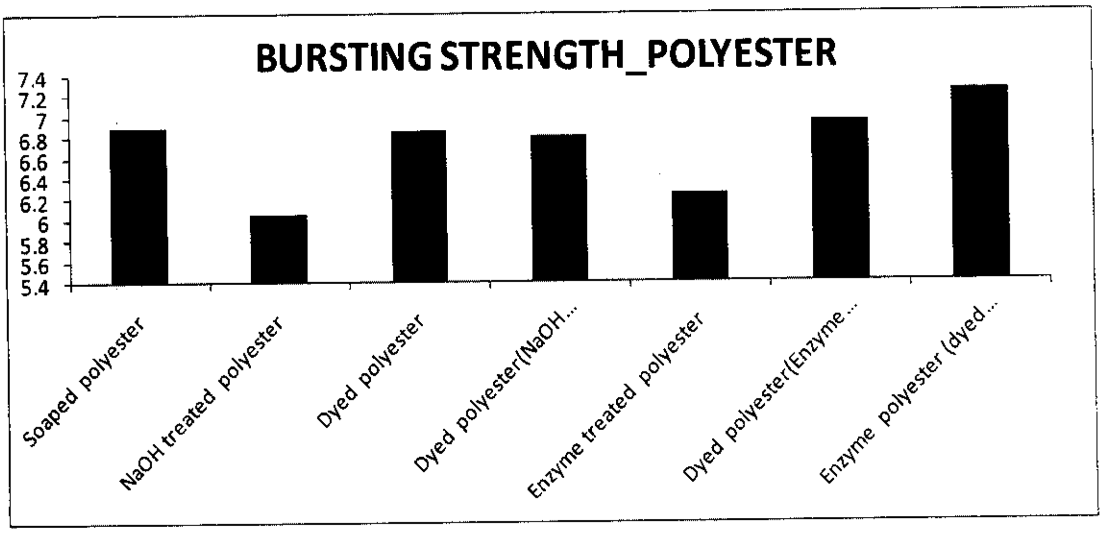


Figure 1

From the above table and figure we can conclude that there is a loss of strength due to Alkaline hydrolysis. This may be due to molecular level damage in the polyester fibre.

Table 5.4 Bursting strength of MicroPolyester Fabric

Material	Bursting strength (IS 1966-1975 reaffirmed 1999)kgs/sq.cm
Soaped micro polyester	6.25
NaOH treated micro polyester	6.2
Dyed micro polyester	6.9
Dyed micro polyester(NaOH treated)	6.05
Enzyme treated micro polyester	5.95
Dyed micro polyester(Enzyme treated)	6.9
Enzyme micro polyester (dyed polyester)	7

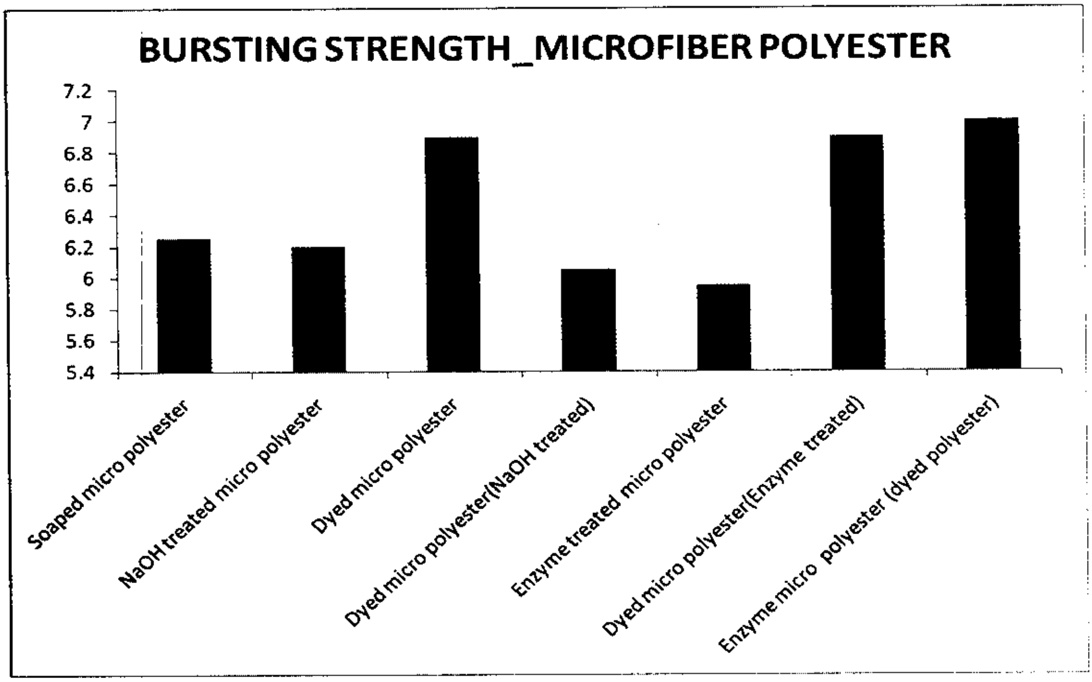


Figure 2

Bursting strength of the micro polyester is found and made as standard sample. Because of alkali treatment the surface of the fabric is corroded so the value of bursting strength is less. Similarly for enzyme followed by dyeing and dyeing followed by enzyme treatment there is improvement in bursting strength .Plain

5.3 AIR PERMEABILTIY

Table 5.5 Air permeability results for Polyester Fabrics

Material	Minimum value	Maximum value	Air permeability (ASTM D 737) CC/sq.cm/sec
Soaped polyester	98.8	105	101
NaOH treated polyester	93.7	101	96
Dyed polyester	95	114	103
Dyed polyester(NaOH treated)	87.5	106	101
Enzyme treated polyester	93	99.3	97
Dyed polyester(Enzyme treated)	128	147	142
Enzyme polyester (dyed polyester)	91.5	111	101

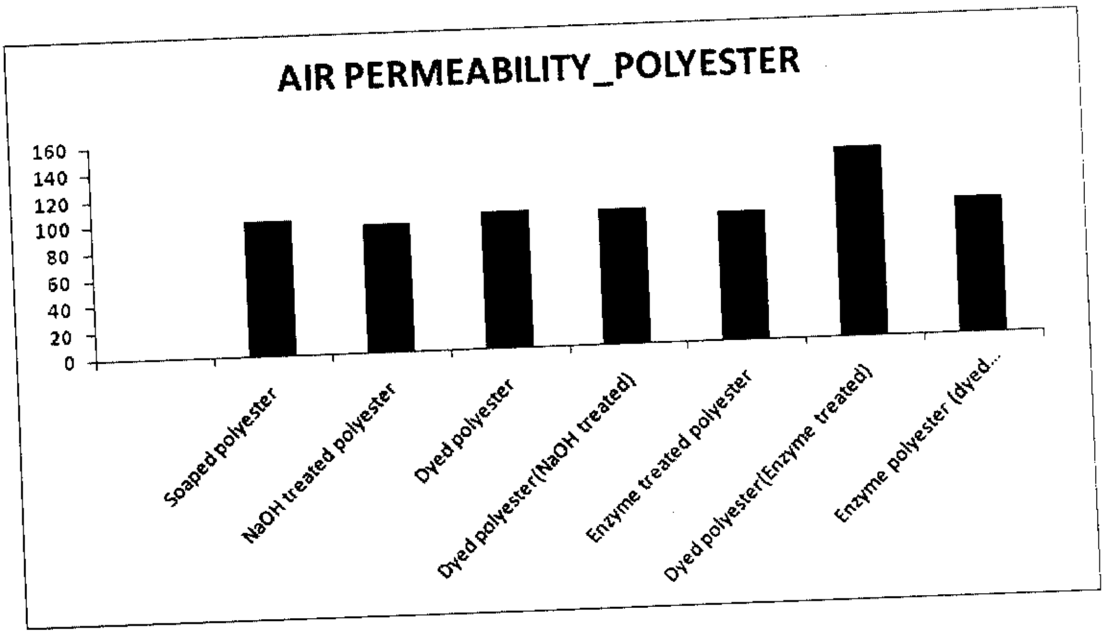


Figure 3

The polyester knitted fabric is soaped first and then treated with NaOH and Lipase enzyme separately. This soaped polyester is made as standard sample for the test result comparison. The fabric treated with NaOH is compared with the standard sample it is found that the air permeability is improved because of the pores formation. These pores are other wise called as corrosion. This damage in the surface is caused by the alkali treatment. At the same time when we treat the fabric with lipase enzyme we found that the air permeability is improved because of surface variation. This is because of the enzyme attack on the surface but the impact is not as much as NaOH treatment . The corrosion is more in alkali treatment but in enzyme treated the fabric corrosion is less. We find certain variation in the air permeability in dyed, NaOH treated followed by dyeing, enzyme treated followed by dyeing and dyeing followed by enzyme treatment, this is because of the surface modification at various processes. In dyed polyester (enzyme treated) we can see some drastic variation in the airpermeabilty, from this we can say that enzyme has more impact on the polyester surface.

Table 5.6 Air permeability results for MicroPolyester Fabric

Material	Minimum value	Maximum value	Air permeability (ASTM D 737) CC/cm2/sec
Soaped micro polyester	58.7	65.8	61.7
NaOH treated micro polyester	51.7	60.4	55.6
Dyed micro polyester	60.4	71.8	66
Dyed micro polyester(NaOH treated)	63.7	68.9	66.1
Enzyme treated micro polyester	55.1	63.3	57.8
Dyed micro polyester(Enzyme treated)	90.7	118	105
Enzyme micro polyester (dyed polyester)	62.1	72.3	67.4

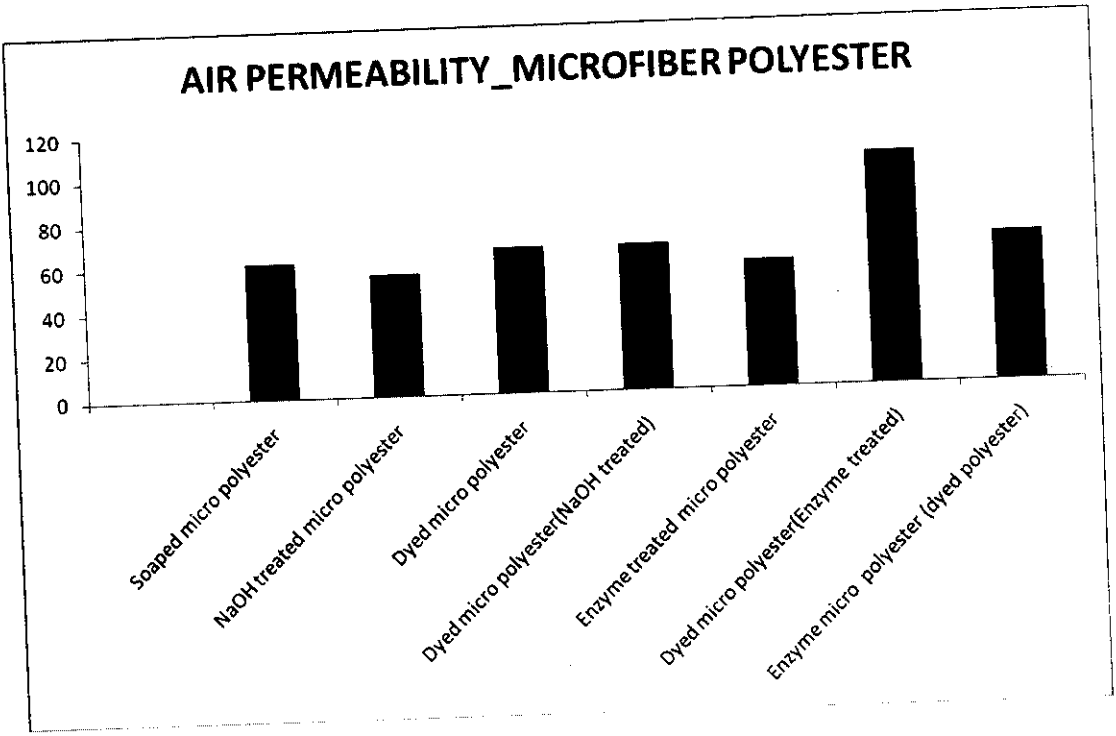


Figure 4

The soaped micro polyester knitted fabric is made as standard sample for the test comparison. The fabric treated with NaOH is compared with the standard sample it is found that the airpermeability is improved because of the pores formation. This damage in the surface is caused by the alkali treatment. At the same time when we treat the fabric with lipase enzyme we found that the air permeability is improved because of surface variation. This is because of the enzyme attack on the surface of micro polyester but the impact is not as like as NaOH treatment. The corrosion is more in alkali treatment but in enzyme treated the fabric corrosion is less. We find certain variation in the air permeability in dyeing followed by NaOH treated, dyeing followed by enzyme treated and enzyme treatment followed by dyeing. This is because of the surface change at various processes. In dyed micro polyester (enzyme treated) we can see some drastic variation in the airpermeabilty, from this we can say that enzyme has more impact on the micro polyester surface. Higher number of yarns per unit area of fabric causes improvement in air permeability. There is improvement in air permeability in enzyme cum dyed when compared to soaped micro polyester. Because of enzyme treatment, more number

5.4 SPRAY TEST

Table 5.7 Spray Test results for Polyester Fabrics

Material	Spray Test (AATCC)
Soaped polyester	50 ISO 1
NaOH treated polyester	50 ISO 1
Dyed polyester	0
Dyed polyester(NaOH treated)	50 ISO 1
Enzyme treated polyester	0
Dyed polyester(Enzyme treated)	0
Enzyme polyester (dyed polyester)	0

Spray test done for the polyester fabric at soaped stage. Then the fabric is compared with AATCC standards for spray test and found the above results. The absorbency of the enzyme treated fabric is more when compared to the NaOH treatment and normal soaped fabric. Also the dyeing followed by enzyme treated and enzyme treated followed by dyeing have the same property in terms of absorbency.

Table 5.8 Spray Test results for Micropolyester Fabrics

Material	Spray Test (AATCC)
Soaped micro polyester	70 ISO 1
NaOH treated micro polyester	0
Dyed micro polyester	0
Dyed micro polyester(NaOH treated)	50 ISO 1
Enzyme treated micro polyester	0
Dyed micro polyester(Enzyme treated)	0
Enzyme micro polyester (dyed polyester)	0

The soaped micro polyester is tested for spray analysis. In micro polyester soaped fabric shows 70 ISO 1. That is partial wetting of the fabric. Similarly it shows good improvement in terms of absorbency in Enzyme treated, enzyme treated followed by dyeing and dyeing followed by enzyme treated. That is, '0' means complete wetting. This can be finalized that there will be improvement when the micro polyester is treated with enzyme.

5.5 WICKABILITY

Table 5.9 Wickability of Polyester Fabrics

Material	Wickability (cm)
Soaped polyester	3
NaOH treated polyester	5.8
Dyed polyester	6.8
Dyed polyester(NaOH treated)	6.1
Enzyme treated polyester	7.5
Dyed polyester(Enzyme treated)	7.1
Enzyme polyester (dyed polyester)	5.0

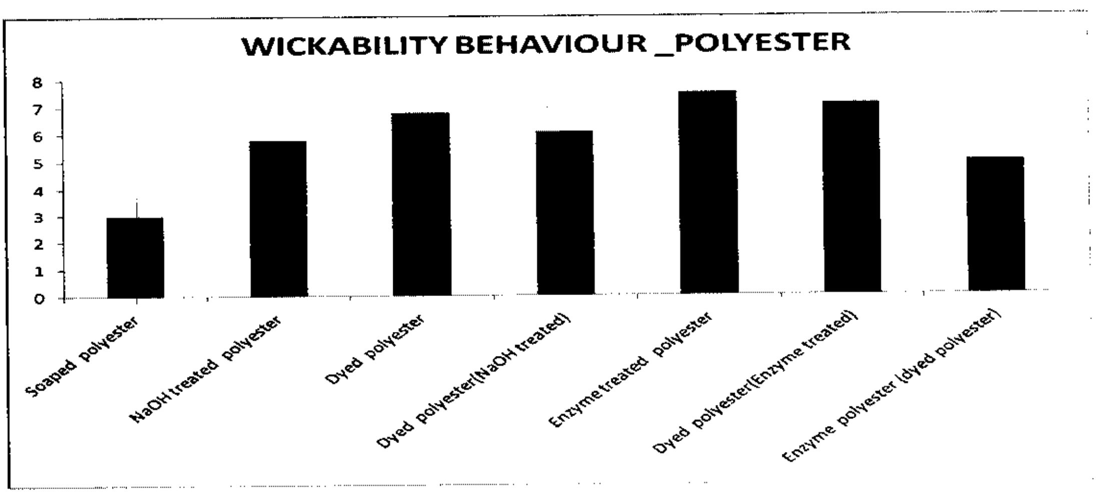
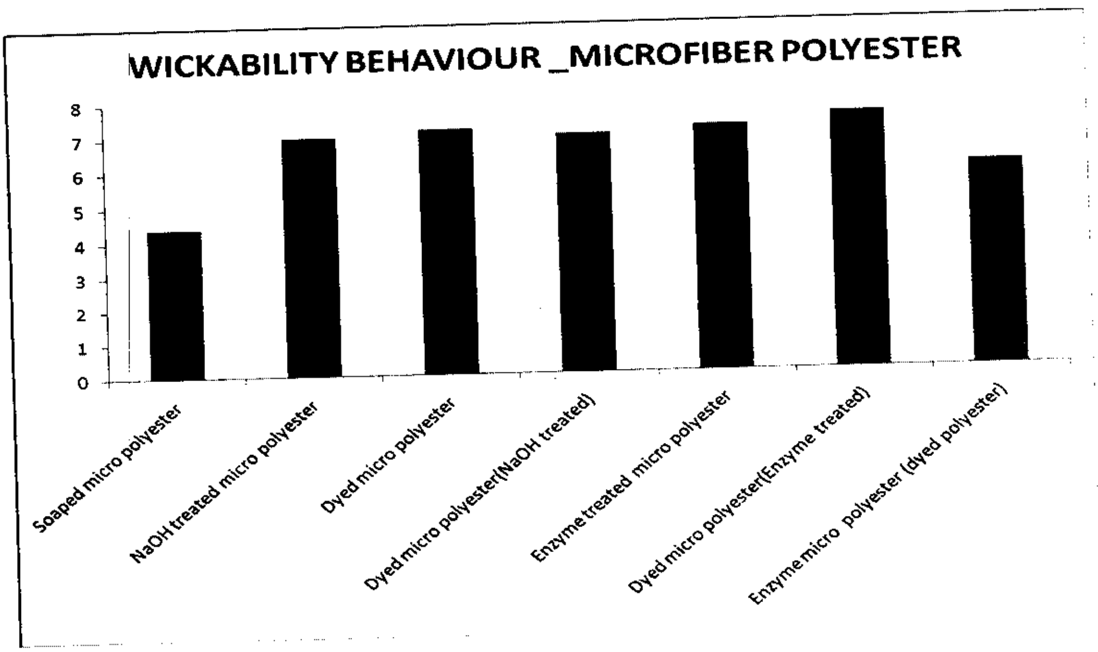


Figure 5

The wickability behavior of polyester knitted fabric is as follows. The normal polyester has low wickability. But after NaOH treatment and enzyme treatment the wickability is improved. Enzyme treatment and Enzyme treatment followed by dyeing has improved the wickability but in dyeing followed by enzyme treatment the wickability property is lowered. More pores cause more dragging of water because of capillary action.

Table 5.10 Wickability of Micropolyester Fabrics

Material	Wickability (cm)
Soaped micro polyester	4.4
NaOH treated micro polyester	7.0
Dyed micro polyester	7.2
Dyed micro polyester(NaOH treated)	7
Enzyme treated micro polyester	7.2
Dyed micro polyester(Enzyme treated)	7.5
Enzyme micro polyester (dyed polyester)	6



The wickability behavior of micro polyester knitted fabric is as follows. The normal micro polyester has low wickability but slightly better than normal polyester. But after NaOH treatment and enzyme treatment the wickability is further improved. Enzyme treatment and Enzyme treatment followed by dyeing has improved in wickability but in the case of dyeing followed by enzyme treatment the wickability property is lowered. Yet the wickability is more than soaped micro polyester. Micropolyester has more pores compare to normal polyester, so the wickability has been improved.

5.6 COMPUTER COLOUR MATCHING

Polyester

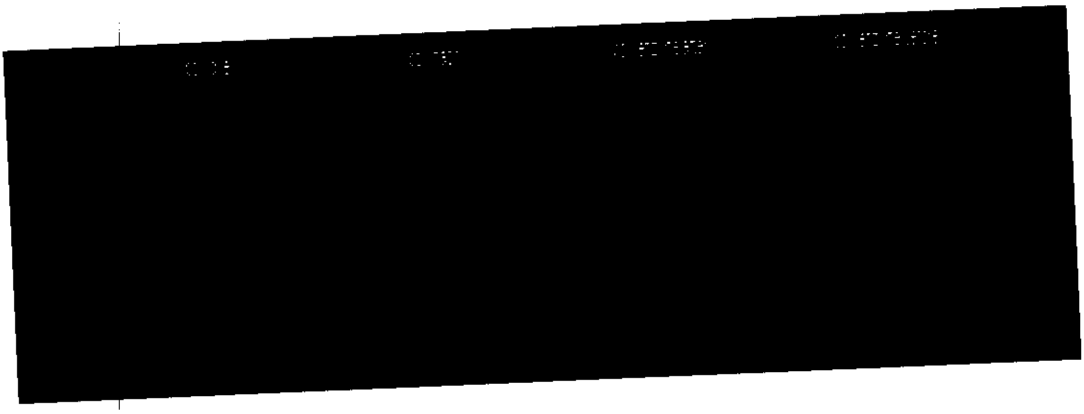


Table 5.11 Strength results for polyester fabrics by CCM

Polyester Material	Strength-Sum %
Dyed Polyester (NaOH Treated)	98.02
Dyed Polyester (Enzyme Treated)	83.27
Enzyme polyester(Dyed Polyester)	96.45

Here in Computer Colour Matching test the fabric taken are NAOH treated followed by dyeing, Enzyme treated followed by dyeing and dyeing followed by enzyme treatment. From the results it is found that the strength of dye is good in NAOH treated followed by dyeing.

Micro polyester

Table 5.12 Strength results for Micropolyester fabrics by CCM

Micropolyester Material	Strength-Sum %
Dyed micro Polyester (NaOH Treated)	107.27
Dyed micro Polyester (Enzyme Treated)	82.18
Enzyme micro polyester (Dyed micro Polyester)	107.4

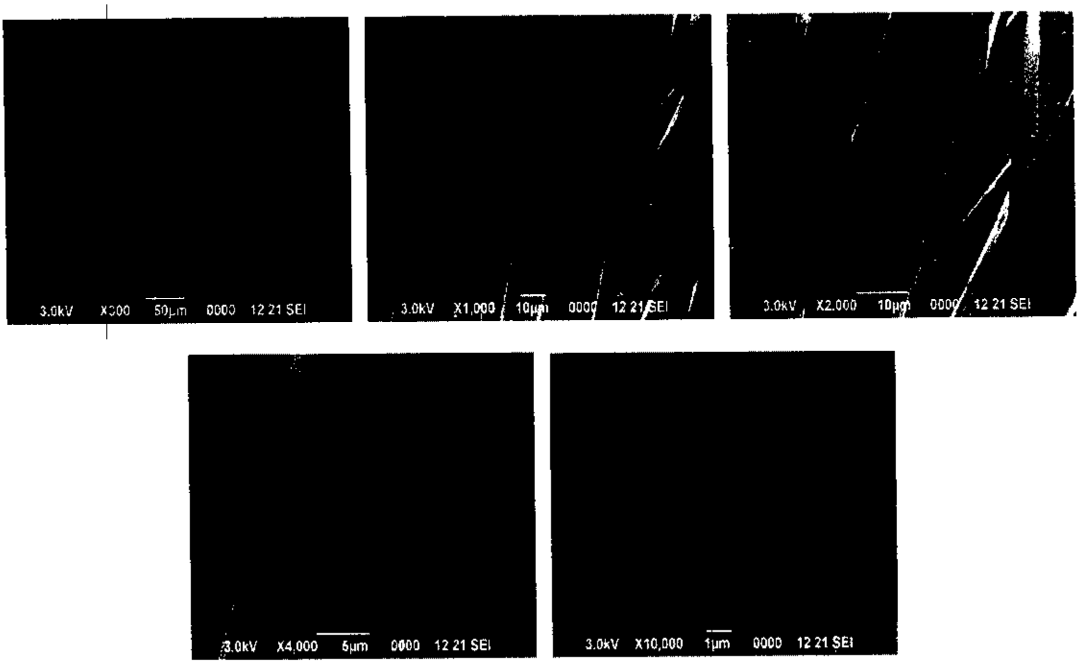
Here in Computer Colour Matching test the fabric taken are NAOH treated followed by dyeing, Enzyme treated followed by dyeing and dyeing followed by enzyme treatment. From the results it is found that the strength of dye is good in dyeing followed by enzyme treatment. This is because of molecular level change.

5.7 FTIR TEST

In FTIR test, we found that hydroxyl group is improved in NaOH treatment as well as enzyme treatment. Among the these two samples, enzyme treated has given better results. The figures are attached in the appendix.

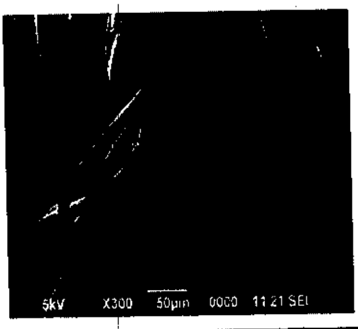
5.8 SCANNING ELECTRON MICROSCOPE

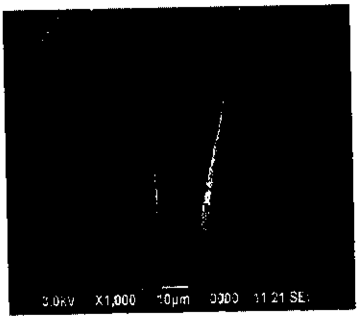
SOAPED POLYESTER

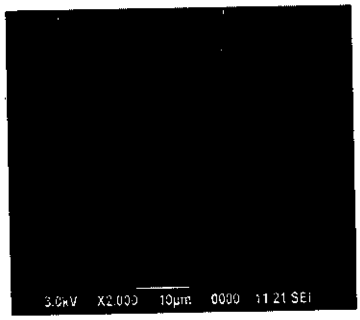


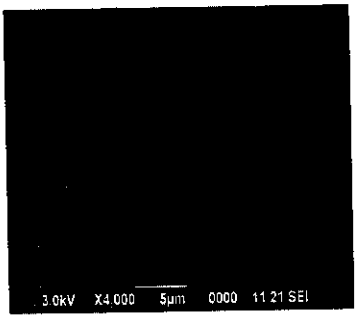
Soaped polyester is the standard for our SEM analysis. In this photograph we can see the structure of the soaped polyester at various magnifications. We took the photograph at the magnification of 300X, 1000 X, 2000 X, 4000 X, 10000 X. In those magnifications we took several range of length like 50 μm, 10 μm, 5 μm, 1 μm.

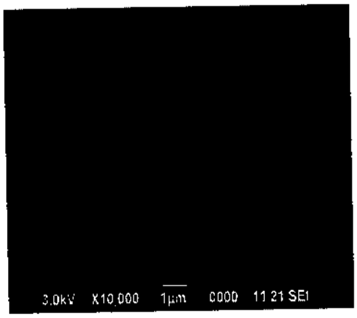
NaOH POLYESTER





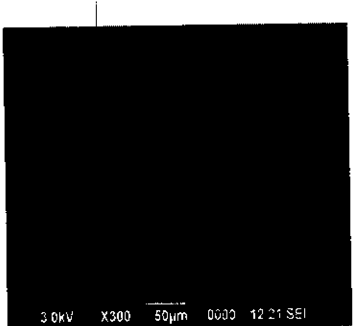


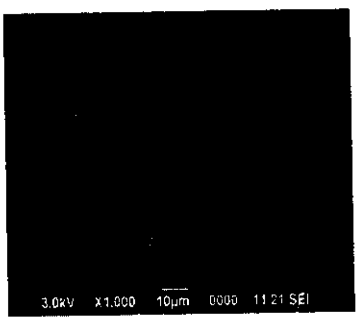


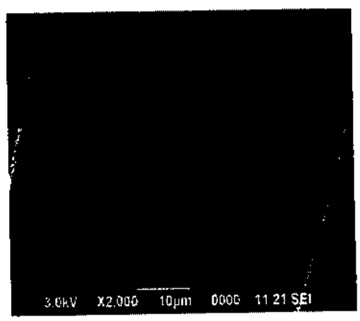


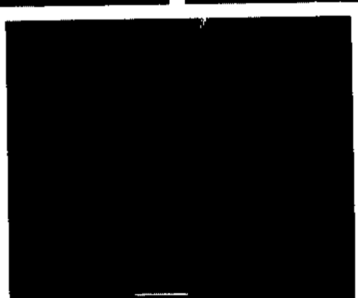
This treated fabric is now taken with SEM photograph. On comparing with the standard, we find no difference at 300 X but at the magnification of 4000 X we find mild change on the surface. At 10000 X magnification we can clearly see the surface corrosion on the polyester. So, this comparison shows the change in the surface of the NaOH treated polyester.

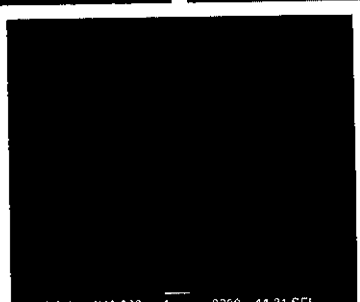
DYED POLYESTER (NAOH TREATED)





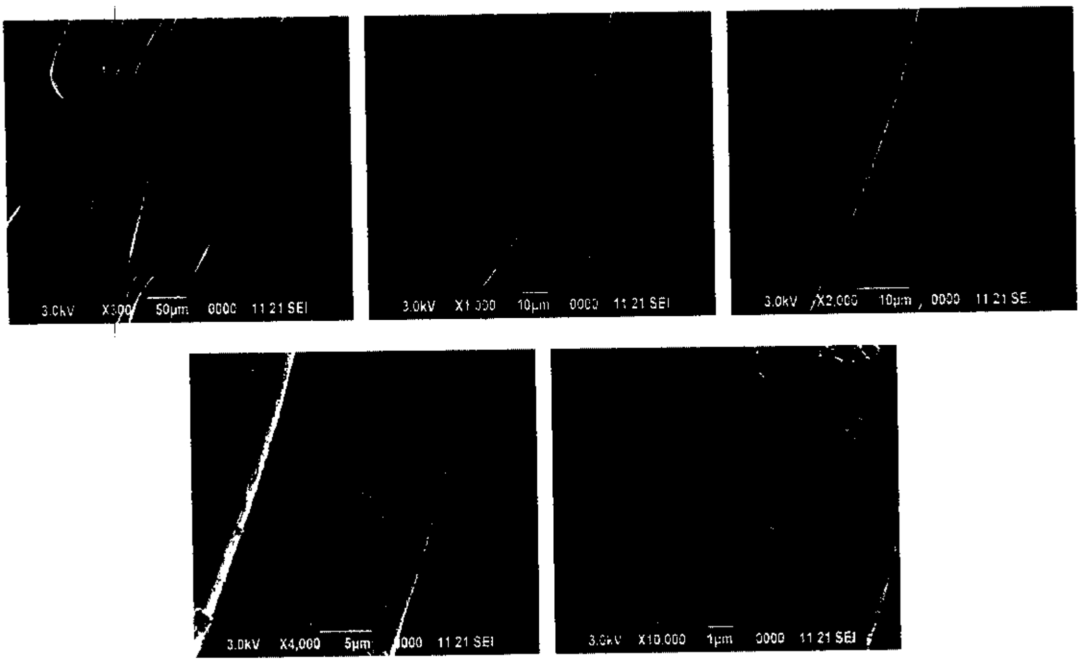






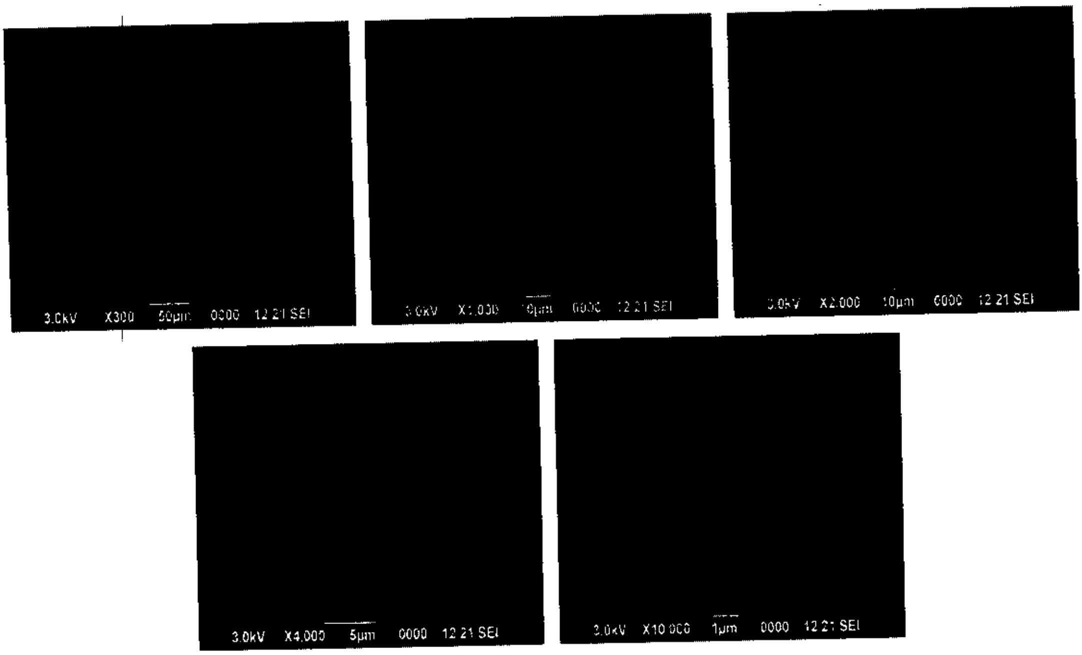
The fabric is dyed with disperse dye blue 79. Here in the SEM photograph, on comparison with the standard and NaOH treatment we find that the pores created during plain NaOH treatment is covered by the dye. It is clearly visible that the structure damage is less at 5µm and 1µm. From this we can say that the pores are filled up.

ENZYME TREATED POLYESTER



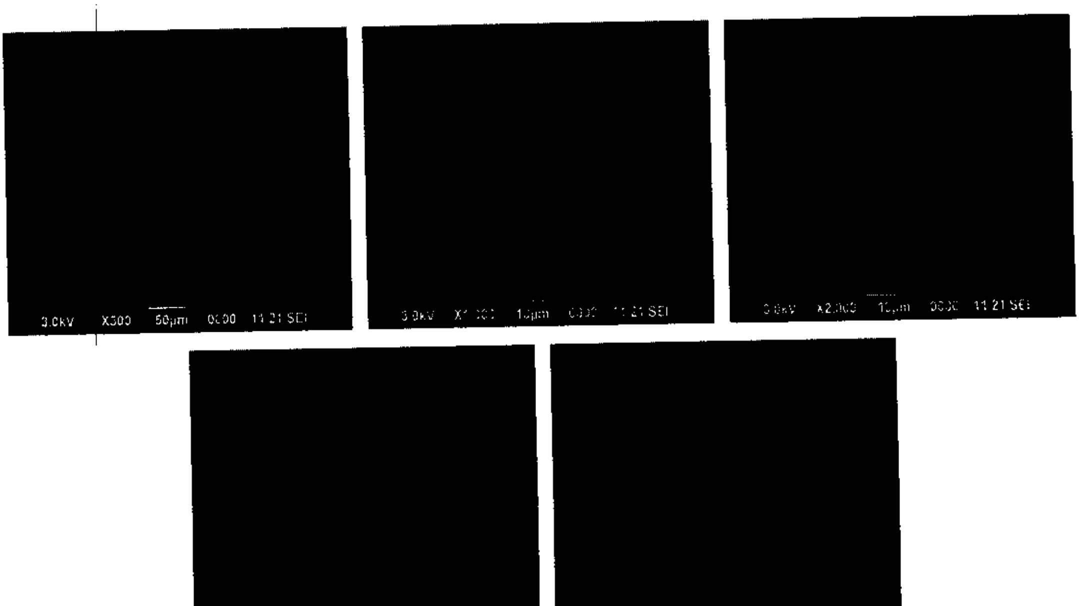
Now the soaped polyester is treated with enzyme. In this photograph at 4000 X and 10000 X , it is visible that the pores are formed but not as much as in NaOH treatment. Even though the structural change is not more, we still find some pores and there is no corrosion type of photograph is seen. This photograph is taken at 5µm, 1 µm length.

DYED POLYESTER (ENZYME TREATED)



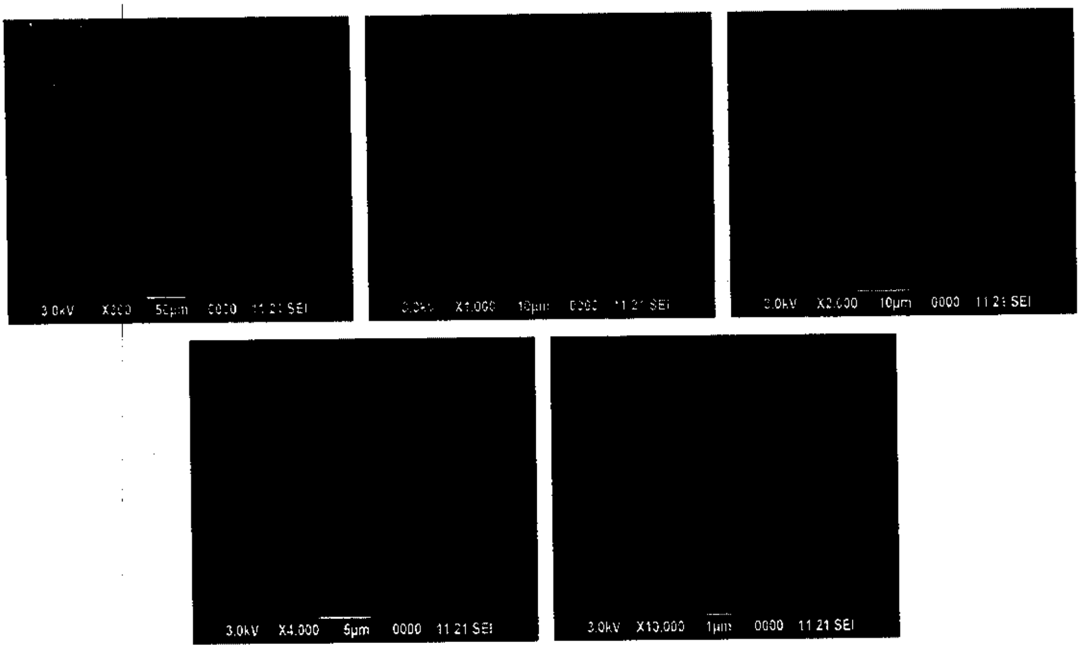
After the enzyme treatment the fabric is dyed with blue 79 disperse dye. In these photographs certain changes are visible at 4000 X and 10000 X. The pores that are formed during the enzyme treatment are reduced by the dyeing process. This is because the dye reacts with the surface of the polyester and fills the pores.

ENZYME POLYESTER (DYED POLYESTER)



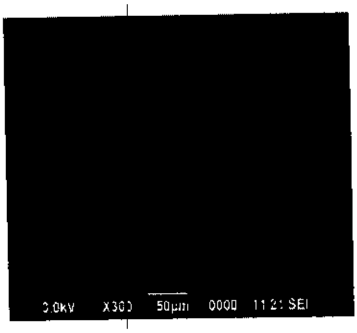
This is a process of treating the fabric with enzyme after dyeing treatment. We can take the magnification of 4000 X and 10000 X. In those magnifications, the enzyme reacts with the dyed surface and forms similar surface structure as like in enzyme treatment followed by dyeing.

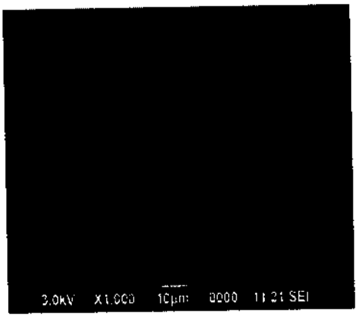
SOAPED MICROPOLYESTER

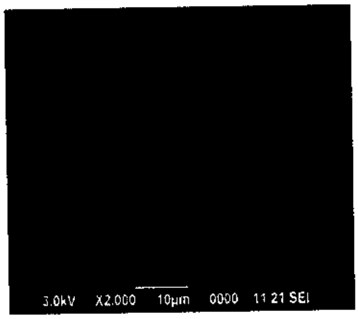


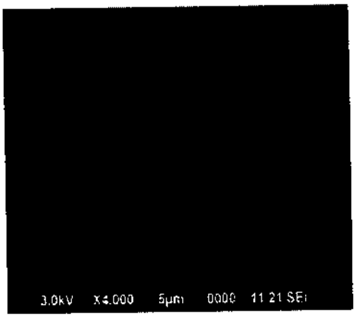
Soaped micro polyester is the standard for our SEM analysis. Photograph taken from SEM shows the structure of the soaped polyester at various magnifications. We have taken the magnification of 300 X, 1000 X, 2000 X, 4000 X, 10000 X. In those magnifications we took several range of length like 50 µm, 10 µm, 5 µm, 1 µm. we made the SEM photograph of soaped micro polyester as standard also we did the same magnification for the succeeding processes.

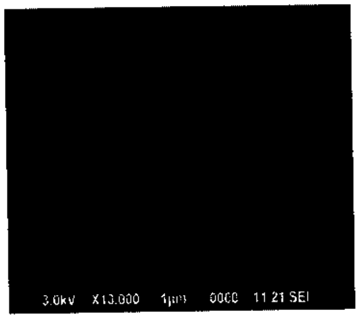
NaOH MICROPOLYESTER





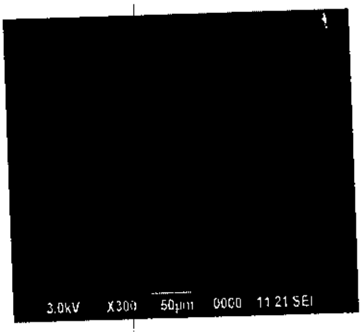


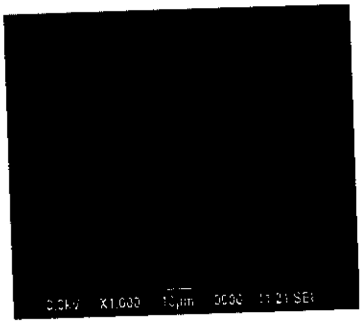


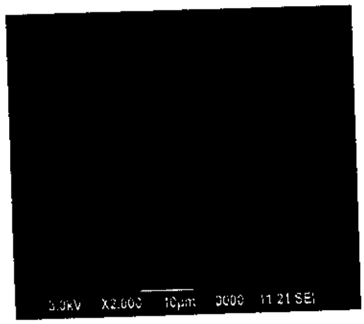


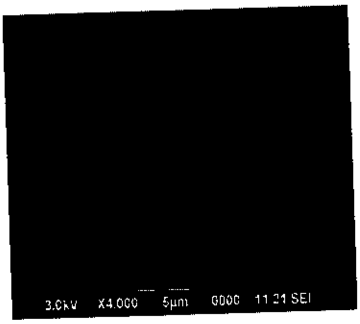
Micro Polyester fabric is treated with NaOH. This treated fabric is now taken with SEM photograph. On comparison, we find no difference between the standard and NaOH treated fabric at 300X but at the magnification of 4000X we find mild change on the surface. At 10000X magnification we can clearly see the surface corrosion on the micro polyester surface. So, this comparison shows the change in the surface of the NaOH treated micro polyester.

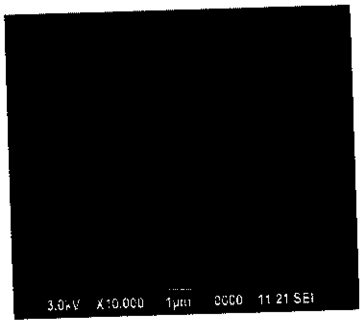
DYED MICRO POLYESTER (NAOH TREATED)





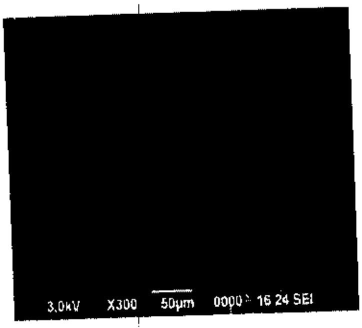


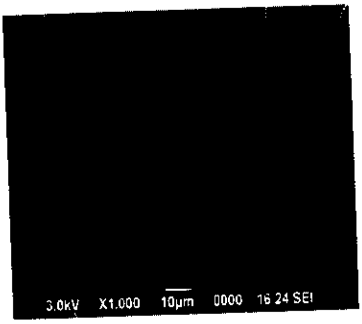


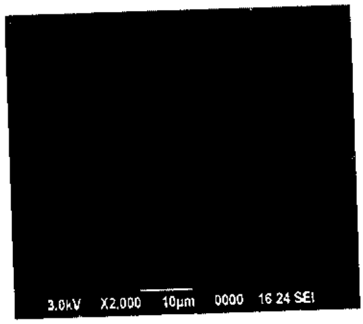


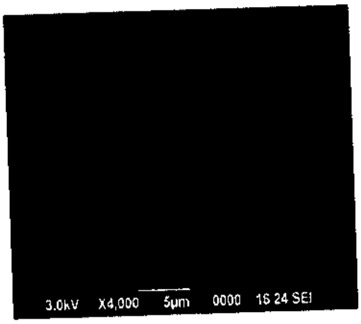
The micro polyester knitted fabric is dyed with disperse dye, blue 79. In the SEM photograph, on comparing with the standard and NaOH treatment, we find that the pores created during plain NaOH treatment is covered by the dye. It is clearly visible that the structure damage is less at 5µm and 1µm by this we can say that the pores are filled up.

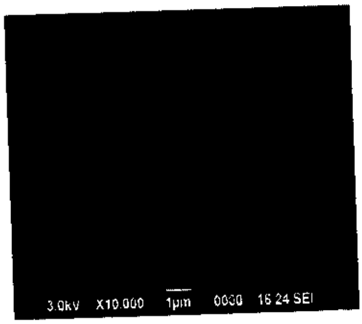
ENZYME TREATED MICRO POLYESTER





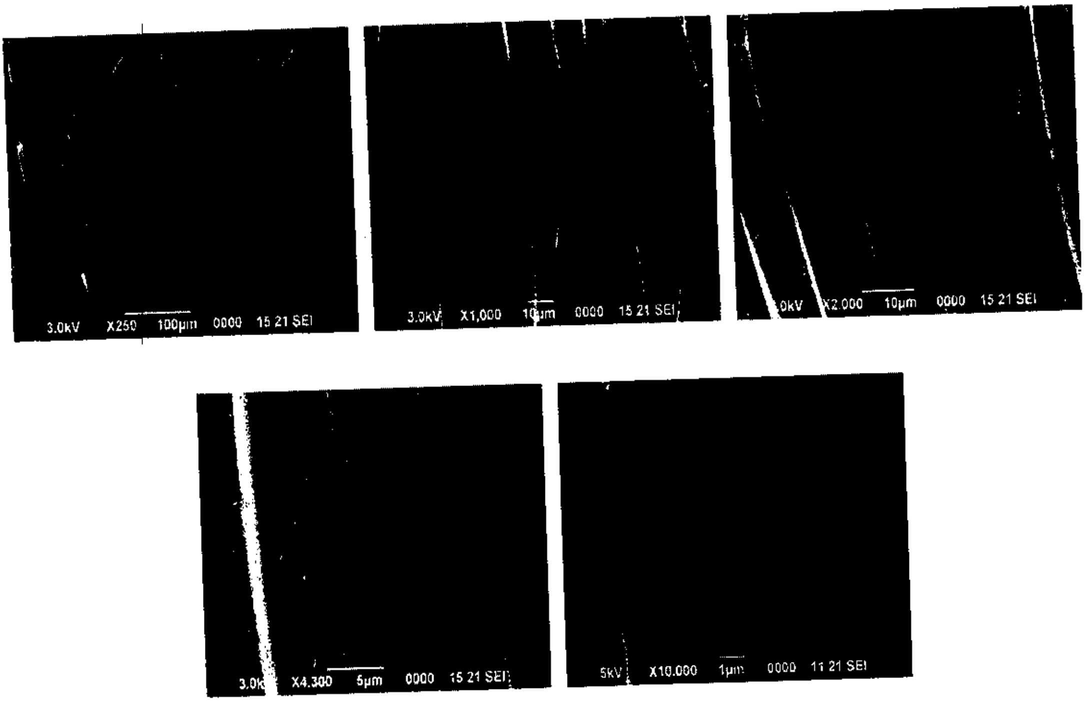






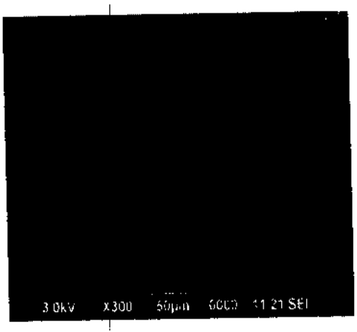
The soaped polyester is now treated with enzyme. In this photograph at 4000X and X10000, it is visible that the pores are formed but not as much as in NaOH treatment. Even though the structural change is not more, we still find some pores and there is no corrosion type of photograph is visible. This photograph is taken at 5µm, 1 µm length. Also the surface has some improved whiteness than the previous, soaped micro polyester.

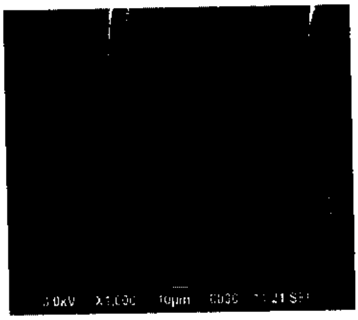
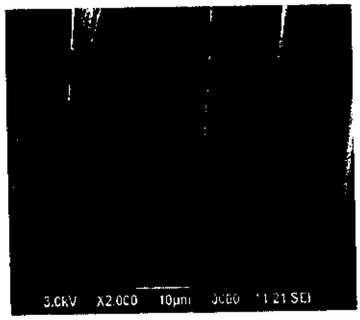
DYED MICROPOLYESTER (ENZYME TREATED)

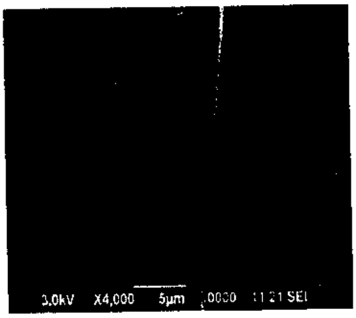


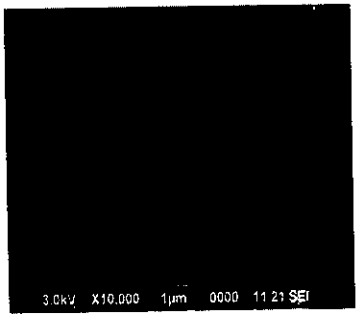
After the enzyme treatment, the micro polyester fabric is dyed with blue 79 disperse dye. In these photographs certain changes are visible at 4000X and 10000X. The pores that are formed during the enzyme treatment are reduced by the dyeing process. This is because the dye reacts with the surface of the micro polyester and fills the pores. Here there is a difference in whiteness of micro polyester when we compare to normal polyester treated in the same manner.

ENZYME MICRO POLYESTER (DYED MICRO POLYESTER)







This is a process of treating the fabric with enzyme after dyeing treatment. We can take the magnification of 4000X and 10000X at 5µm and 1µm respectively. In those magnifications, the enzyme reacts with the dyed surface and forms some kind of variations in the surface of micro polyester. This enzyme treatment shows difference between the normal polyester and micro polyester.

CHAPTER 6

CONCLUSION

From the results we conclude the following:

- Dimensional stability of microdenier fabrics are good when compare with normal denier fabrics. This is due to less deformation in the loop shape factor.

- There is a reduction in the bursting strength of both the normal as well as microdenier fabrics. This is due to the change in the chemical structure.

- Air permeability of enzyme treated fabrics of both the normal as well as microdenier fabrics are good.

- Wickability of both micro as well as normal denier fabrics shown better results. This is due to more number of pores formed after treatments.

- Surface analysis of the micro as well as normal denier fabrics shown mixed results.

CHAPTER 7

SCOPE FOR THE FUTURE WORK

- Mass production study can be done.
- Blends of microdenier polyester and other fibres can be done.
- Further finishing can be given and thorough study can be made.

REFERENCES

1. G. Ramakrishnan, Mrs. Bhaarathi Dhurai and S. Mukhopadhyay, "An investigation into the properties of knitted fabrics made from viscose microfibers", JTATM, Volume 6, Issue 1 Spring 2009.

2. Y.L.Hsieh, A.Miller and J.Thompson, "Wetting, pore structure, and liquid retention of hydrolyzed polyester fabrics", Textile Res. J. 66 (1), 1-10, 1996

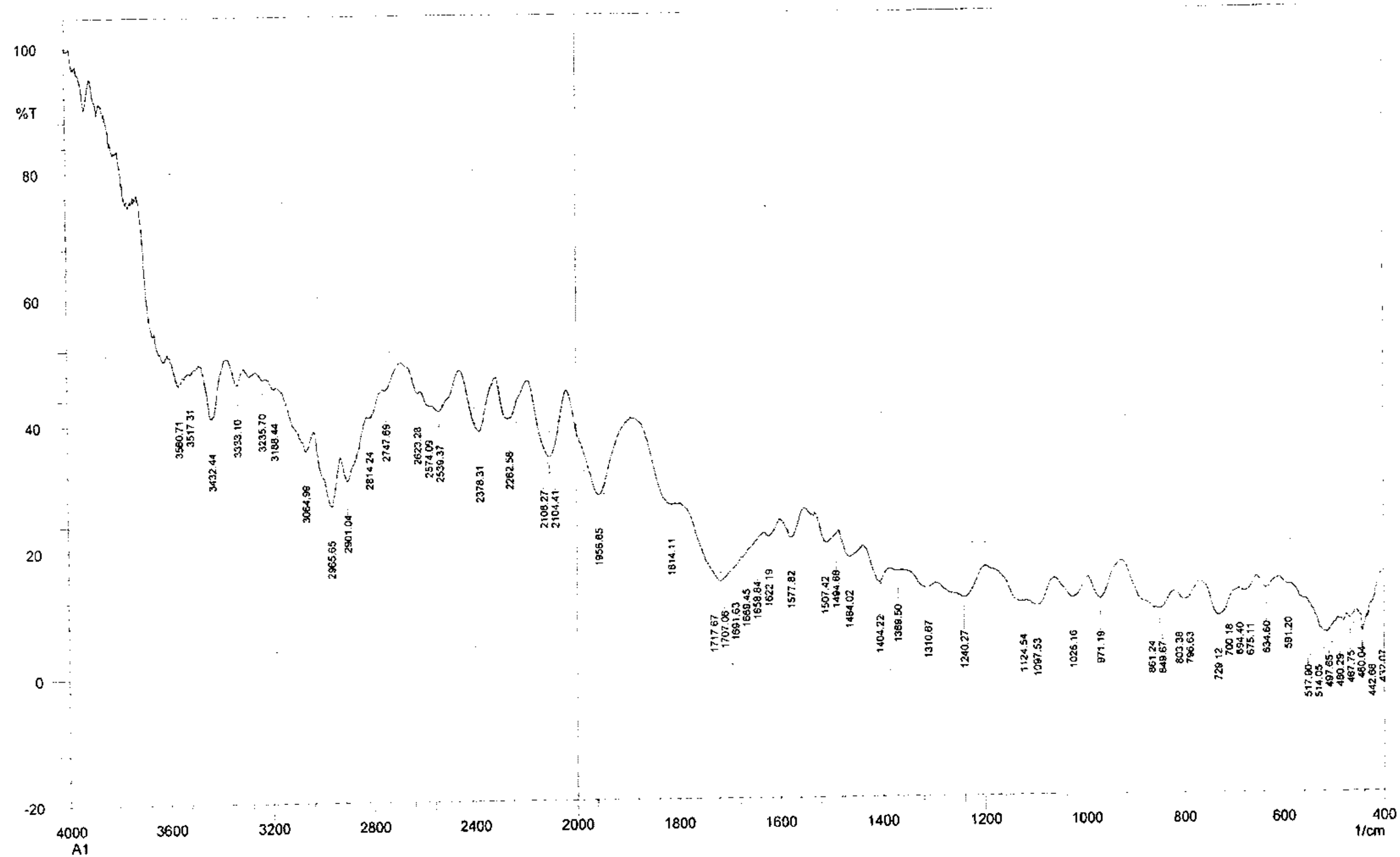
3. Y. L. Hsieh and Lisa A.Cram "Enzymatic hydrolysis to improve wetting and absorbency of polyester fabrics", Textile Res. J. 68 (5), 311-319, 1998

4. Ian Holme, "Enzymes for Innovative Textile Treatments", Textiles Magazine, 3, 1-14, 2004

5. Brojeswari Das, A. Das, V.K. Kothari, R. Fangueiro and M. de Araujo, "Studies on moisture transmission properties of PV-blended fabrics", Journal of Tex. Inst. Vol. 100, No.7, 588-597, 2009.

APPENDIX

SHIMADZU

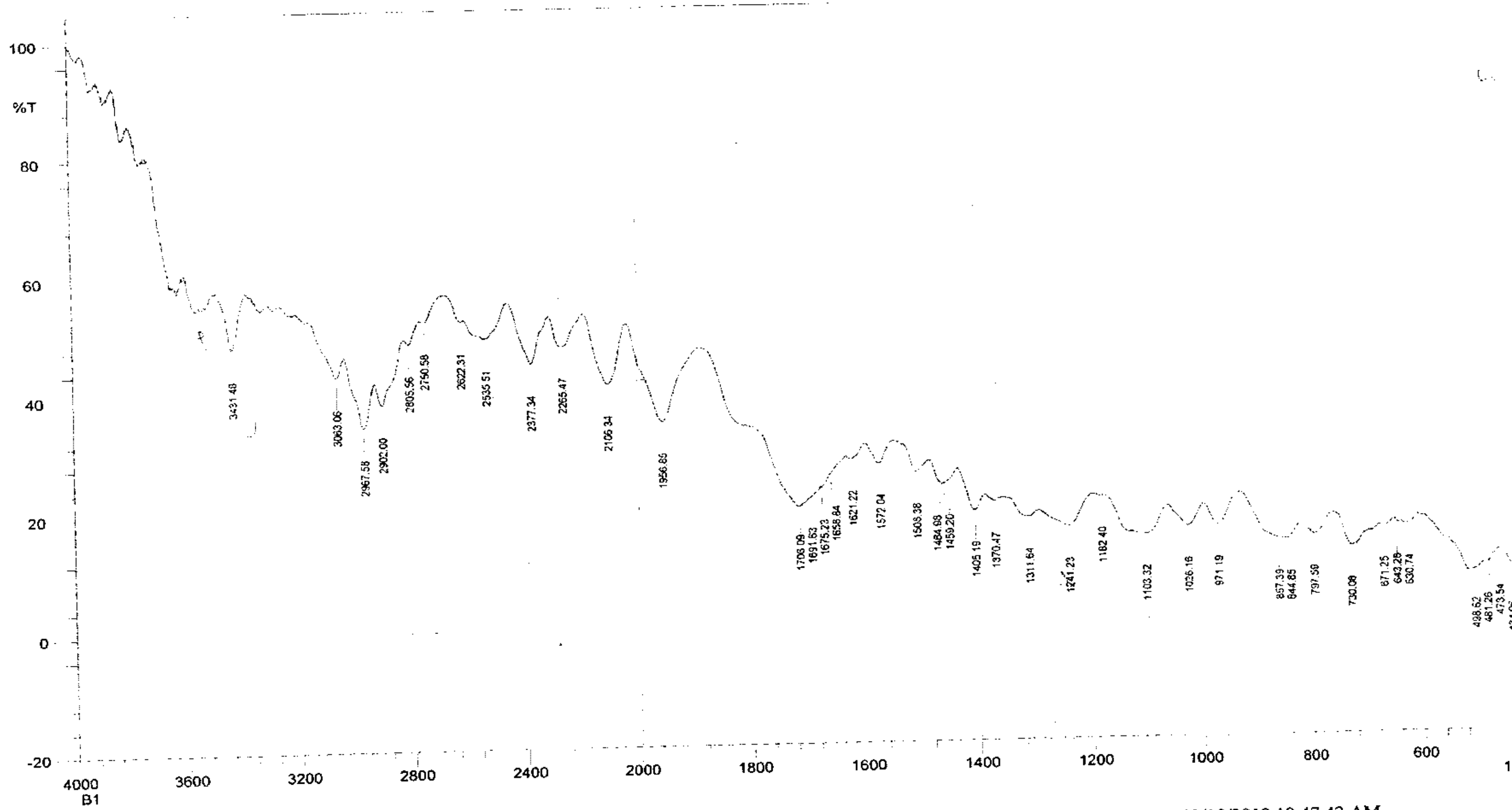


Comment;
A1

No. of Scans;
Resolution;
Apodization;

Date/Time; 03/10/2010 10:39:35 AM
User; Administrator

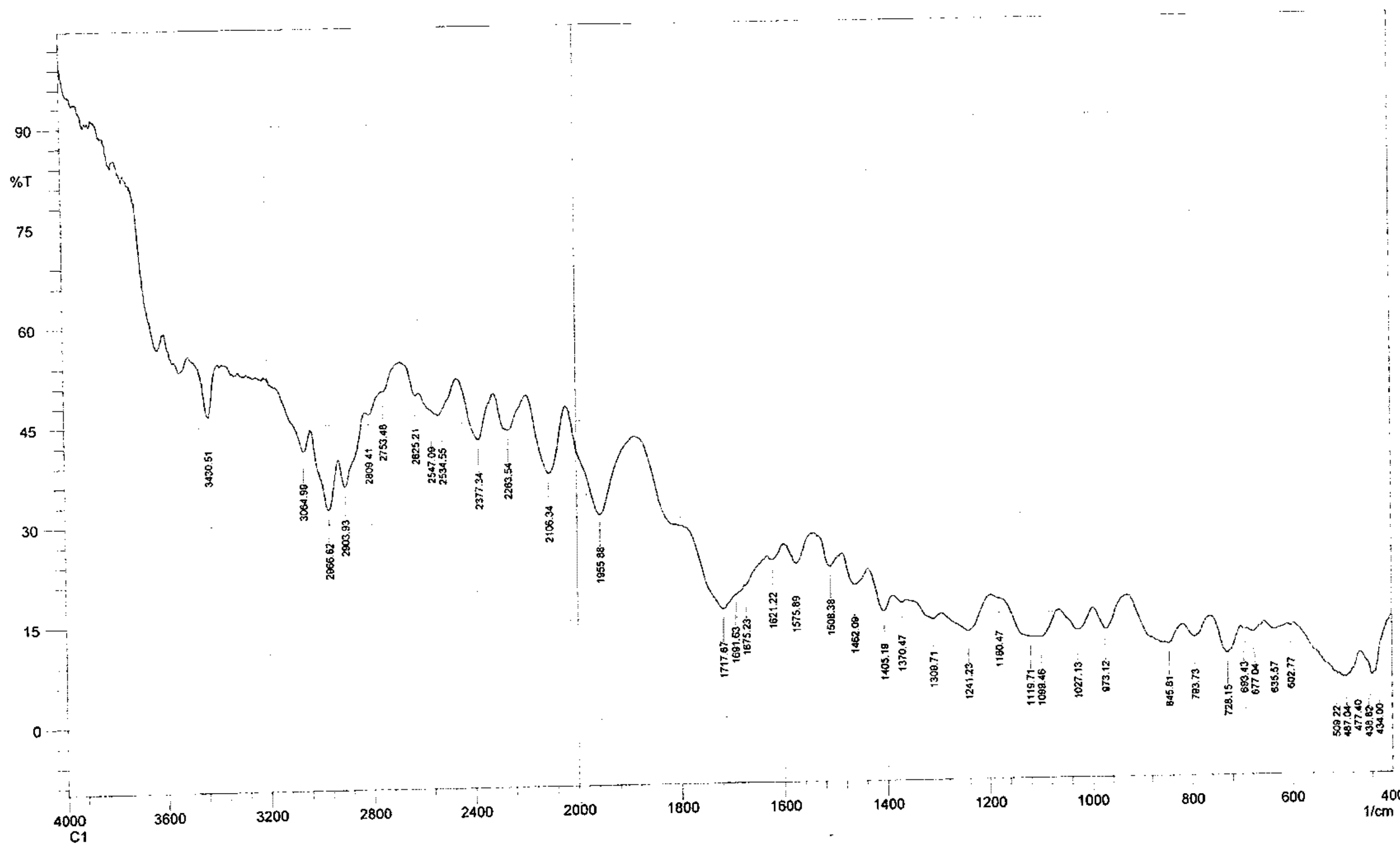
SHIMADZU



Comment;
B1

No. of Scans;
Resolution;
Apodization;

Date/Time; 03/10/2010 10:47:42 AM
User; Administrator

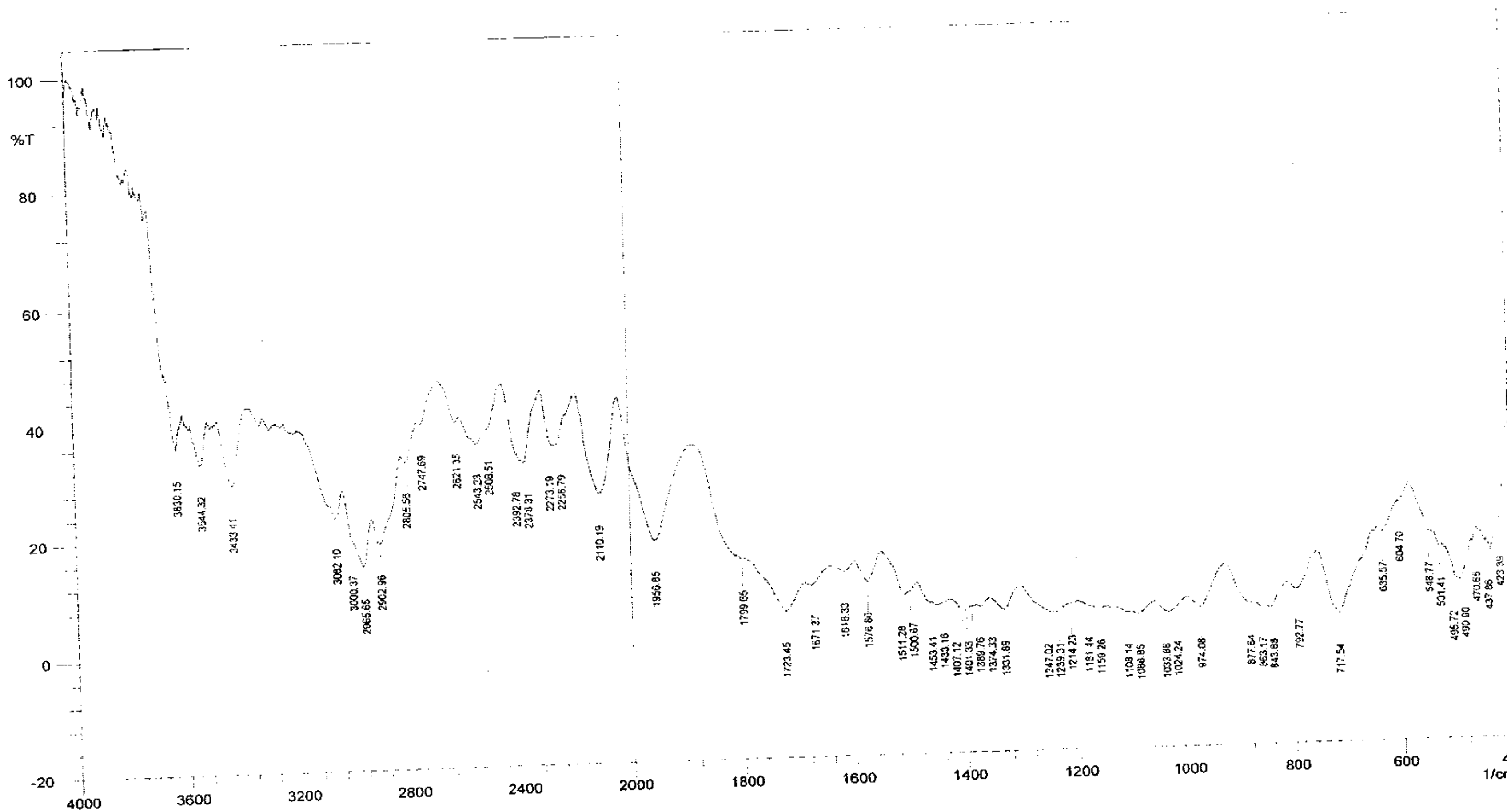


Comment;
C1

No. of Scans;
Resolution;
Apodization;

Date/Time; 03/10/2010 10:58:03 AM
User; Administrator

SHIMADZU

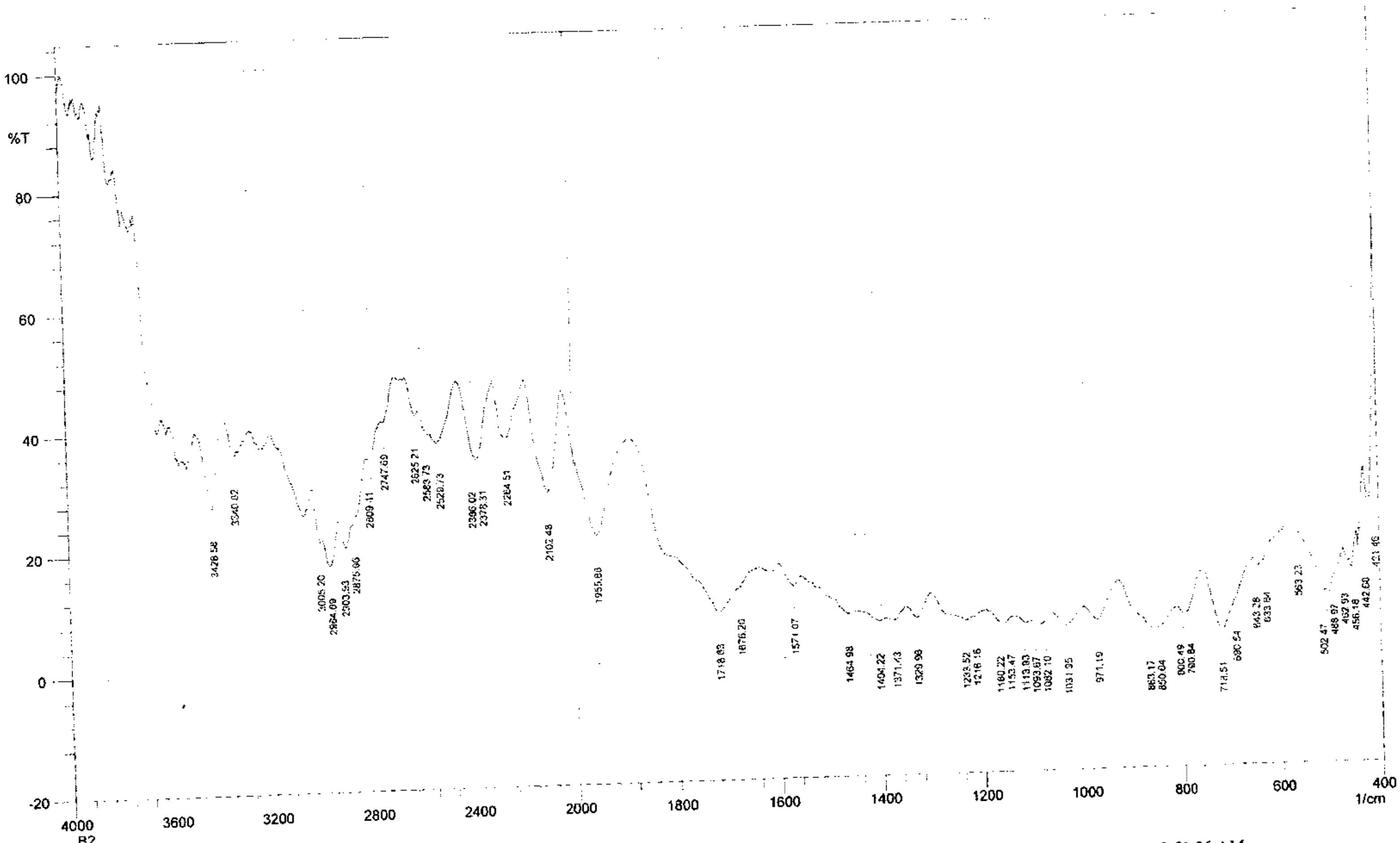


A2

Comment;
A2

No. of Scans;
Resolution;
Apodization;

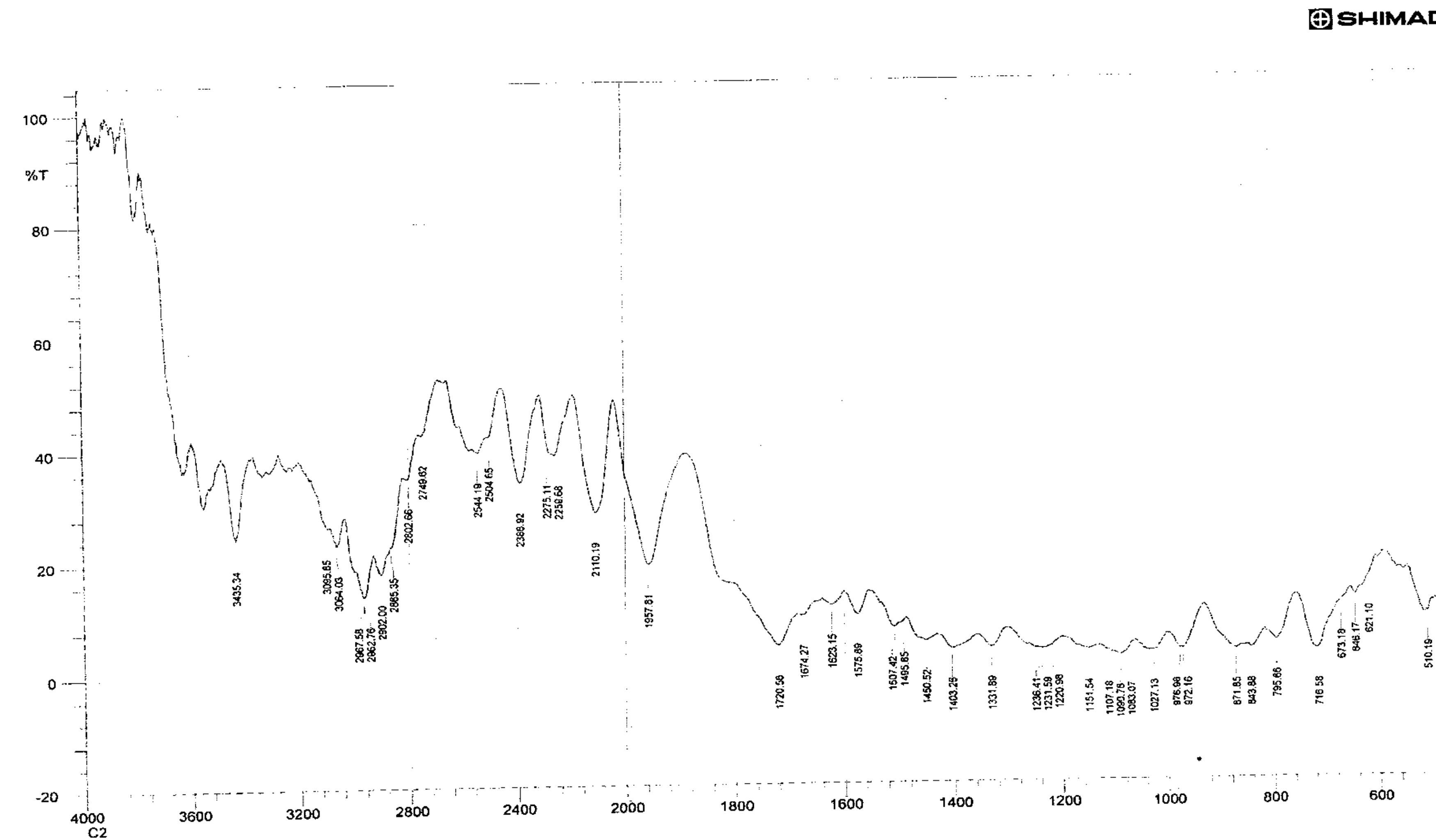
Date/Time; 03/10/2010 10:43:27 AM
User; Administrator



Comment;
B2

No. of Scans;
Resolution;
Apodization;

Date/Time; 03/10/2010 10:51:06 AM
User; Administrator



Comment;
C2

No. of Scans;
Resolution;
Apodization;

Date/Time; 03/10/2010 11:02:52 AM
User; Administrator

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
SITRA PHYSICAL LABORATORY
13/37, Avinashi Road, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA.
Grams : SITRA Phone : (0422) 2574367-9, 6541488, 6544188 Fax : (0422) 2571896
E-mail : sitraindia@dataone.in Website:http://www.sitra.org.in

Address all correspondence to the Director ISO/IEC 17025:2005 NABL ACCREDITED
Cert. Number:T-358

Fabric Test Report No.:468 Kumaraguru College of Technology,

Samples Tested at : R.H. 65% +/- 2% and Temp. 21 Degree C +/- 1 Degree C

Lab Code No.	C_981	C_982	C_983	C_984
Sample Particulars.:	FABRIC SAMPLE MARK-2.1	FABRIC SAMPLE MARK-2.2	FABRIC SAMPLE MARK-3.1	FABRIC SAM MARK-3.2
FABRIC - BURSTING STRENGTH (As per IS 1966-1975) Reaffirmed 1999				
Kgs/sq.cm	6.9	6.25	6.05	6.2

Lab Code No.	C_985	C_986	C_987	C_988
Sample Particulars.:	FABRIC SAMPLE MARK-4.1	FABRIC SAMPLE MARK-4.2	FABRIC SAMPLE MARK-6.1	FABRIC SAM MARK-6.2
FABRIC - BURSTING STRENGTH (As per IS 1966-1975) Reaffirmed 1999				
Kgs/sq.cm	6.85	6.9	6.8	7.05

Lab Code No.	C_989	C_990	C_991	C_992
Sample Particulars.:	FABRIC SAMPLE MARK-7.1	FABRIC SAMPLE MARK-7.2	FABRIC SAMPLE MARK-8.1	FABRIC SAM MARK-8.2
FABRIC - BURSTING STRENGTH (As per IS 1966-1975) Reaffirmed 1999				
Kgs/sq.cm	6.25	5.95	6.95	6.90

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
SITRA PHYSICAL LABORATORY
13/37, Avinashi Road, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA.
Grams : SITRA Phone : (0422) 2574367-9, 6541488, 6544188 Fax : (0422) 2571896
E-mail : sitraindia@dataone.in Website:http://www.sitra.org.in
Address all correspondence to the Director ISO/IEC 17025:2005 NABL ACCREDITED

Cert. Number:T-358

Fabric Test Report No.:468 Kumaraguru College of Technology,

Samples Tested at : R.H. 65% +/- 2% and Temp. 21 Degree C +/- 1 Degree C

Lab Code No.	C_993	C_994
Sample Particulars.:	FABRIC SAMPLE MARK-9.1	FABRIC SAMPLE MARK-9.2
FABRIC - BURSTING STRENGTH (As per IS 1966-1975) Reaffirmed 1999		
Kgs/sq.cm	7.25	7.0

End of Report

R. [signature]

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
SITRA PHYSICAL LABORATORY
13/37, Avinashi Road, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA.
Grams : SITRA Phone : (0422) 2574367-9, 6541488, 6544188 Fax : (0422) 2571896
E-mail : sitraindia@dataone.in Website:http://www.sitra.org.in
Address all correspondence to the Director ISO/IEC 17025:2005 NABL ACCREDITED
Cert. Number:T-358

Fabric Test Report No.:468 Kumaraguru College of Technology,

Samples Tested at : R.H. 65% +/- 2% and Temp. 21 Degree C +/- 1 Degree C

Lab Code No.	C_981	C_982	C_983	C_984
Sample Particulars.:	FABRIC SAMPLE MARK-2.1	FABRIC SAMPLE MARK-2.2	FABRIC SAMPLE MARK-3.1	FABRIC SAM MARK-3.2
FABRIC - AIR PERMEABILITY (As per ASTM D 737)				
Air Permeability in c.c/cm.sq./sec.	101	61.7	95.9	55.6

Lab Code No.	C_985	C_986	C_987	C_988
Sample Particulars.:	FABRIC SAMPLE MARK-4.1	FABRIC SAMPLE MARK-4.2	FABRIC SAMPLE MARK-6.1	FABRIC SAM MARK-6.2
FABRIC - AIR PERMEABILITY (As per ASTM D 737)				
Air Permeability in c.c/cm.sq./sec.	103	66.0	101	66.1

Lab Code No.	C_989	C_990	C_991	C_992
Sample Particulars.:	FABRIC SAMPLE MARK-7.1	FABRIC SAMPLE MARK-7.2	FABRIC SAMPLE MARK-8.1	FABRIC SAM MARK-8.2
FABRIC - AIR PERMEABILITY (As per ASTM D 737)				
Air Permeability in c.c/cm.sq./sec.	97.0	57.8	142	105

Lab Code No.	C_993	C_994
Sample Particulars.:	FABRIC SAMPLE MARK-9.1	FABRIC SAMPLE MARK-9.2
FABRIC - AIR PERMEABILITY (As per ASTM D 737)		
Air Permeability in c.c/cm.sq./sec.	101	67.4

R. Ramapathy

SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 08.28.45.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 08:28 - 17.03.2010, 08:31
SAMPLE ID:	C- 981	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 2.1		

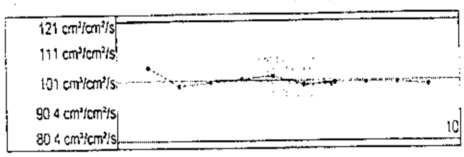
Static Air Permeability

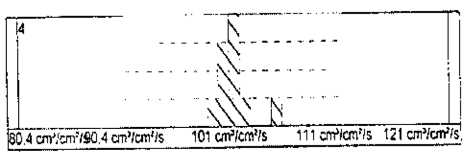
Test pressure:	125 Pa	Date/time:	17.03.2010, 08:28 - 17.03.2010, 08:31
Test area:	38 cm²	Instrument:	Textest FX 3300-III, s/n: 1198

1:	105 cm³/cm²/s
2:	98.8 cm³/cm²/s
3:	100 cm³/cm²/s
4:	101 cm³/cm²/s
5:	102 cm³/cm²/s
6:	99.1 cm³/cm²/s
7:	99.9 cm³/cm²/s
8:	100 cm³/cm²/s
9:	100 cm³/cm²/s
10:	99.2 cm³/cm²/s

Commentary:

Avg:	101 cm³/cm²/s	Nominal:	101 cm³/cm²/s
Min:	98.8 cm³/cm²/s	Min:	90.4 cm³/cm²/s
Max:	105 cm³/cm²/s	Max:	111 cm³/cm²/s
CV:	1.8 %	Tests:	10
CI:	1.3 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 08.55.23.LBD — LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 08:55 - 17.03.2010, 08:58
SAMPLE ID:	C- 982	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 2.2		

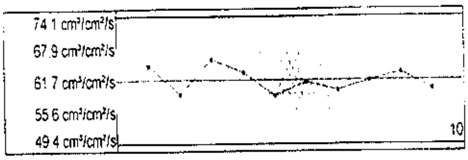
Static Air Permeability

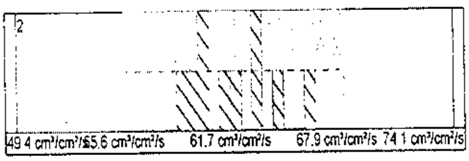
Test pressure:	125 Pa	Date/time:	17.03.2010, 08:55 - 17.03.2010, 08:58
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	64.5 $cm^3/cm^2/s$
2:	59.0 $cm^3/cm^2/s$
3:	65.8 $cm^3/cm^2/s$
4:	63.2 $cm^3/cm^2/s$
5:	58.7 $cm^3/cm^2/s$
6:	61.4 $cm^3/cm^2/s$
7:	59.8 $cm^3/cm^2/s$
8:	61.7 $cm^3/cm^2/s$
9:	63.2 $cm^3/cm^2/s$
10:	60.1 $cm^3/cm^2/s$

Commentary:

Avg:	61.7 $cm^3/cm^2/s$	Nominal:	61.7 $cm^3/cm^2/s$
Min:	58.7 $cm^3/cm^2/s$	Min:	55.6 $cm^3/cm^2/s$
Max:	65.8 $cm^3/cm^2/s$	Max:	67.9 $cm^3/cm^2/s$
CV:	3.9 %	Tests:	10
CI:	2.8 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 09.00.09.LBD

LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 09:00 - 17.03.2010, 09:02
SAMPLE ID:	C- 983	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 3.1		

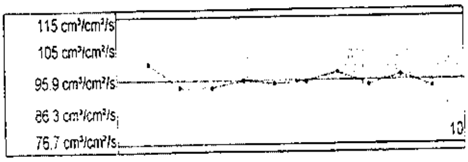
Static Air Permeability

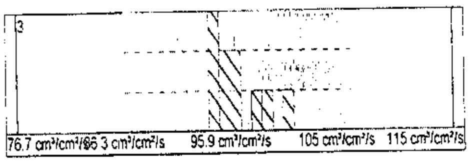
Test pressure:	125 Pa	Date/time:	17.03.2010, 09:00 - 17.03.2010, 09:02
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	101	$cm^3/cm^2/s$
2:	93.8	$cm^3/cm^2/s$
3:	93.7	$cm^3/cm^2/s$
4:	95.8	$cm^3/cm^2/s$
5:	94.8	$cm^3/cm^2/s$
6:	95.6	$cm^3/cm^2/s$
7:	98.3	$cm^3/cm^2/s$
8:	94.5	$cm^3/cm^2/s$
9:	97.5	$cm^3/cm^2/s$
10:	94.0	$cm^3/cm^2/s$

Commentary:

Avg:	95.9 $cm^3/cm^2/s$	Nominal:	95.9 $cm^3/cm^2/s$
Min:	93.7 $cm^3/cm^2/s$	Min:	86.3 $cm^3/cm^2/s$
Max:	101 $cm^3/cm^2/s$	Max:	105 $cm^3/cm^2/s$
CV:	2.5 %	Tests:	10
CI:	1.8 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 09.08.52.LBD

LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 09:08 - 17.03.2010, 09:12
SAMPLE ID:	C- 984	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 3.2		

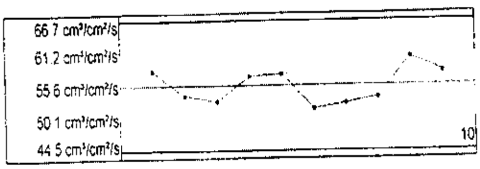
Static Air Permeability

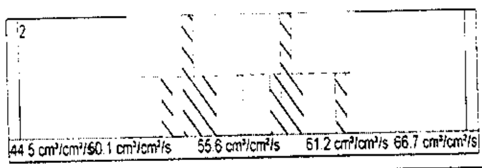
Test pressure:	125 Pa	Date/time:	17.03.2010, 09:08 - 17.03.2010, 09:12
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	58.2 $cm^3/cm^2/s$
2:	53.9 $cm^3/cm^2/s$
3:	53.0 $cm^3/cm^2/s$
4:	57.2 $cm^3/cm^2/s$
5:	57.6 $cm^3/cm^2/s$
6:	51.7 $cm^3/cm^2/s$
7:	52.6 $cm^3/cm^2/s$
8:	53.6 $cm^3/cm^2/s$
9:	60.4 $cm^3/cm^2/s$
10:	58.0 $cm^3/cm^2/s$

Commentary:

Avg:	55.6 $cm^3/cm^2/s$	Nominal:	55.6 $cm^3/cm^2/s$
Min:	51.7 $cm^3/cm^2/s$	Min:	50.1 $cm^3/cm^2/s$
Max:	60.4 $cm^3/cm^2/s$	Max:	61.2 $cm^3/cm^2/s$
CV:	5.4 %	Tests:	10
CI:	3.8 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 09.28.33.LBD

LBD240

Style: STYLE-1
SAMPLE ID: C- 985
PARTICULARS 1: FABRIC SAMPLE
PARTICULAR 2: MARK : 4.1

Date/time: 17.03.2010, 09:28 - 17.03.2010, 09:33
Operator: SN

Static Air Permeability

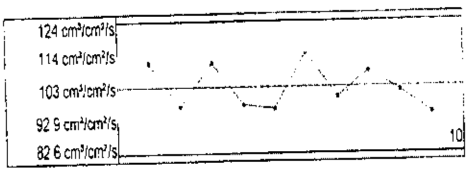
Test pressure: 125 Pa
Test area: 38 cm^2

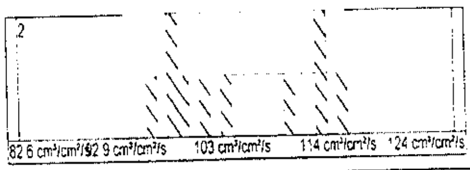
Date/time: 17.03.2010, 09:28 - 17.03.2010, 09:32
Instrument: Textest FX 3300-III, s/n: 1198

1:	111 $cm^3/cm^2/s$
2:	97.1 $cm^3/cm^2/s$
3:	111 $cm^3/cm^2/s$
4:	97.8 $cm^3/cm^2/s$
5:	96.6 $cm^3/cm^2/s$
6:	114 $cm^3/cm^2/s$ +
7:	100 $cm^3/cm^2/s$
8:	108 $cm^3/cm^2/s$
9:	102 $cm^3/cm^2/s$
10:	95.0 $cm^3/cm^2/s$

Commentary:

Avg:	103 $cm^3/cm^2/s$	Nominal:	103 $cm^3/cm^2/s$
Min:	95.0 $cm^3/cm^2/s$	Min:	92.9 $cm^3/cm^2/s$
Max:	114 $cm^3/cm^2/s$ +	Max:	114 $cm^3/cm^2/s$
CV:	6.8 %	Tests:	10
CI:	4.9 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 09.35.36.LBD

LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 09:35 - 17.03.2010, 09:40
SAMPLE ID:	C- 986	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 4.2		

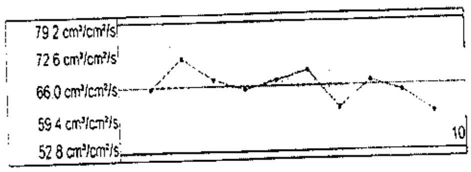
Static Air Permeability

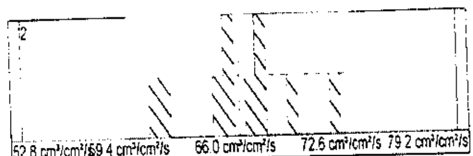
Test pressure:	125 Pa	Date/time:	17.03.2010, 09:35 - 17.03.2010, 09:39
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	65.6 $cm^3/cm^2/s$
2:	71.8 $cm^3/cm^2/s$
3:	67.3 $cm^3/cm^2/s$
4:	65.3 $cm^3/cm^2/s$
5:	67.1 $cm^3/cm^2/s$
6:	69.1 $cm^3/cm^2/s$
7:	61.3 $cm^3/cm^2/s$
8:	66.9 $cm^3/cm^2/s$
9:	64.8 $cm^3/cm^2/s$
10:	60.4 $cm^3/cm^2/s$

Commentary:

Avg:	66.0 $cm^3/cm^2/s$	Nominal:	66.0 $cm^3/cm^2/s$
Min:	60.4 $cm^3/cm^2/s$	Min:	59.4 $cm^3/cm^2/s$
Max:	71.8 $cm^3/cm^2/s$	Max:	72.6 $cm^3/cm^2/s$
CV:	5.1 %	Tests:	10
CI:	3.7 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 10.11.01.LBD

LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 10:11 - 17.03.2010, 10:22
SAMPLE ID:	C- 987	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 6.1		

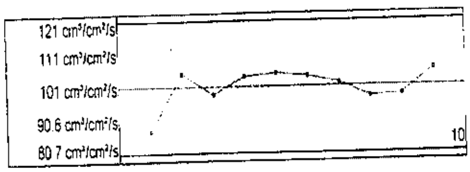
Static Air Permeability

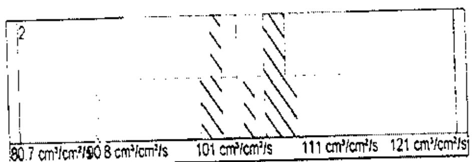
Test pressure:	125 Pa	Date/time:	17.03.2010, 10:11 - 17.03.2010, 10:22
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	87.5 $cm^3/cm^2/s$ -
2:	105 $cm^3/cm^2/s$
3:	98.7 $cm^3/cm^2/s$
4:	104 $cm^3/cm^2/s$
5:	105 $cm^3/cm^2/s$
6:	104 $cm^3/cm^2/s$
7:	102 $cm^3/cm^2/s$
8:	97.8 $cm^3/cm^2/s$
9:	98.5 $cm^3/cm^2/s$
10:	106 $cm^3/cm^2/s$

Commentary:

Avg:	101 $cm^3/cm^2/s$	Nominal:	101 $cm^3/cm^2/s$
Min:	87.5 $cm^3/cm^2/s$ -	Min:	90.8 $cm^3/cm^2/s$
Max:	106 $cm^3/cm^2/s$	Max:	111 $cm^3/cm^2/s$
CV:	5.5 %	Tests:	10
CI:	4.0 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 10.29.16.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 10:29 - 17.03.2010, 10:32
SAMPLE ID:	C- 988	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 6.2		

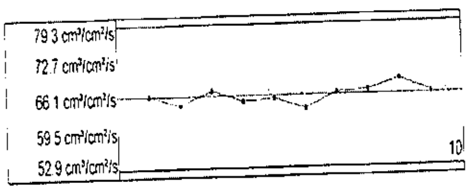
Static Air Permeability

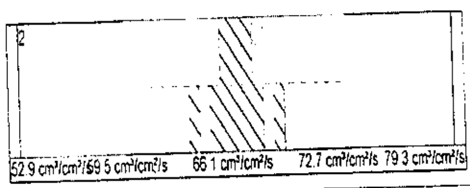
Test pressure:	125 Pa	Date/time:	17.03.2010, 10:29 - 17.03.2010, 10:32
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	66.2 $cm^3/cm^2/s$
2:	64.5 $cm^3/cm^2/s$
3:	67.1 $cm^3/cm^2/s$
4:	65.1 $cm^3/cm^2/s$
5:	65.6 $cm^3/cm^2/s$
6:	63.7 $cm^3/cm^2/s$
7:	66.5 $cm^3/cm^2/s$
8:	66.9 $cm^3/cm^2/s$
9:	68.9 $cm^3/cm^2/s$
10:	66.4 $cm^3/cm^2/s$

Commentary:

Avg:	66.1 $cm^3/cm^2/s$	Nominal:	66.1 $cm^3/cm^2/s$
Min:	63.7 $cm^3/cm^2/s$	Min:	59.5 $cm^3/cm^2/s$
Max:	68.9 $cm^3/cm^2/s$	Max:	72.7 $cm^3/cm^2/s$
CV:	2.2 %	Tests:	10
CI:	1.6 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 10.42.11.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 10:42 - 17.03.2010, 10:44
SAMPLE ID:	C- 989	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 7.1		

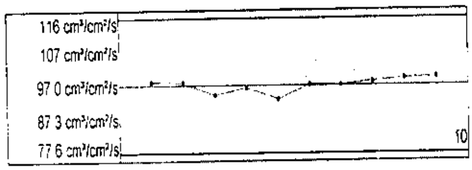
Static Air Permeability

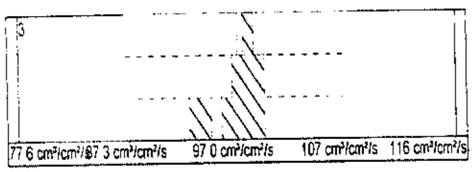
Test pressure:	125 Pa	Date/time:	17.03.2010, 10:42 - 17.03.2010, 10:44
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	98.0 $cm^3/cm^2/s$
2:	97.8 $cm^3/cm^2/s$
3:	94.2 $cm^3/cm^2/s$
4:	96.4 $cm^3/cm^2/s$
5:	93.0 $cm^3/cm^2/s$
6:	97.2 $cm^3/cm^2/s$
7:	97.1 $cm^3/cm^2/s$
8:	98.0 $cm^3/cm^2/s$
9:	98.9 $cm^3/cm^2/s$
10:	99.3 $cm^3/cm^2/s$

Commentary:

Avg:	97.0 $cm^3/cm^2/s$	Nominal:	97.0 $cm^3/cm^2/s$
Min:	93.0 $cm^3/cm^2/s$	Min:	87.3 $cm^3/cm^2/s$
Max:	99.3 $cm^3/cm^2/s$	Max:	107 $cm^3/cm^2/s$
CV:	2.1 %	Tests:	10
CI:	1.5 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 10.54.06.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 10:54 - 17.03.2010, 11:05
SAMPLE ID:	C- 990	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 7.2		

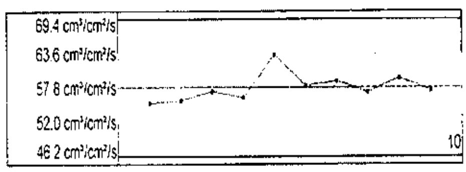
Static Air Permeability

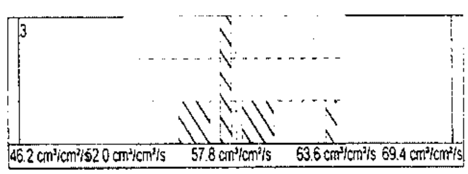
Test pressure:	125 Pa	Date/time:	17.03.2010, 10:54 - 17.03.2010, 11:05
Test area:	38 cm²	Instrument:	Textest FX 3300-III, s/n: 1198

1:	55.1 cm³/cm²/s
2:	55.6 cm³/cm²/s
3:	57.2 cm³/cm²/s
4:	56.1 cm³/cm²/s
5:	63.3 cm³/cm²/s
6:	58.1 cm³/cm²/s
7:	58.9 cm³/cm²/s
8:	57.0 cm³/cm²/s
9:	59.4 cm³/cm²/s
10:	57.4 cm³/cm²/s

Commentary:

Avg:	57.8 cm³/cm²/s	Nominal:	57.8 cm³/cm²/s
Min:	55.1 cm³/cm²/s	Min:	52.0 cm³/cm²/s
Max:	63.3 cm³/cm²/s	Max:	63.6 cm³/cm²/s
CV:	4.1 %	Tests:	10
CI:	2.9 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 11.16.18.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 11:16 - 17.03.2010, 11:20
SAMPLE ID:	C- 991	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 8.1		

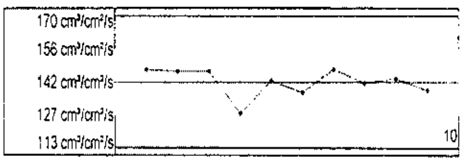
Static Air Permeability

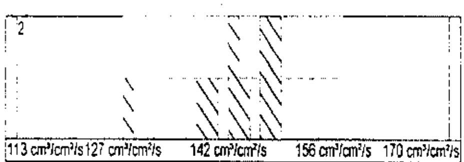
Test pressure:	125 Pa	Date/time:	17.03.2010, 11:16 - 17.03.2010, 11:20
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	147 $cm^3/cm^2/s$
2:	146 $cm^3/cm^2/s$
3:	146 $cm^3/cm^2/s$
4:	128 $cm^3/cm^2/s$
5:	142 $cm^3/cm^2/s$
6:	137 $cm^3/cm^2/s$
7:	147 $cm^3/cm^2/s$
8:	141 $cm^3/cm^2/s$
9:	143 $cm^3/cm^2/s$
10:	138 $cm^3/cm^2/s$

Commentary:

Avg:	142 $cm^3/cm^2/s$	Nominal:	142 $cm^3/cm^2/s$
Min:	128 $cm^3/cm^2/s$	Min:	127 $cm^3/cm^2/s$
Max:	147 $cm^3/cm^2/s$	Max:	156 $cm^3/cm^2/s$
CV:	4.2 %	Tests:	10
CI:	3.0 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 11.25.45.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 11:25 - 17.03.2010, 11:32
SAMPLE ID:	C- 992	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 8.2		

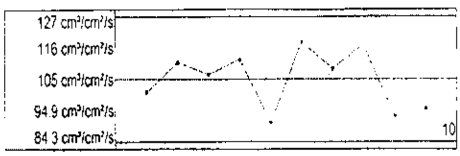
Static Air Permeability

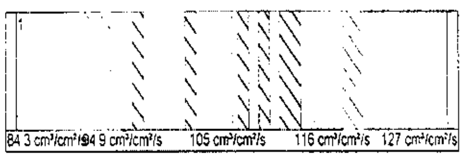
Test pressure:	125 Pa	Date/time:	17.03.2010, 11:25 - 17.03.2010, 11:32
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	101 $cm^3/cm^2/s$
2:	111 $cm^3/cm^2/s$
3:	107 $cm^3/cm^2/s$
4:	112 $cm^3/cm^2/s$
5:	90.7 $cm^3/cm^2/s$ -
6:	118 $cm^3/cm^2/s$ +
7:	109 $cm^3/cm^2/s$
8:	117 $cm^3/cm^2/s$ +
9:	93.0 $cm^3/cm^2/s$ -
10:	95.6 $cm^3/cm^2/s$

Commentary:

Avg:	105 $cm^3/cm^2/s$	Nominal:	105 $cm^3/cm^2/s$
Min:	90.7 $cm^3/cm^2/s$ -	Min:	94.9 $cm^3/cm^2/s$
Max:	118 $cm^3/cm^2/s$ +	Max:	116 $cm^3/cm^2/s$
CV:	9.3 %	Tests:	10
CI:	6.7 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 11.37.43.LBD   LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 11:37 - 17.03.2010, 11:42
SAMPLE ID:	C- 993	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 9.1		

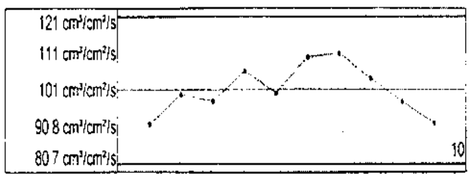
Static Air Permeability

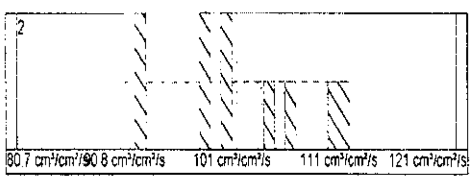
Test pressure:	125 Pa	Date/time:	17.03.2010, 11:37 - 17.03.2010, 11:42
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	91.5 $cm^3/cm^2/s$
2:	99.5 $cm^3/cm^2/s$
3:	97.7 $cm^3/cm^2/s$
4:	106 $cm^3/cm^2/s$
5:	100 $cm^3/cm^2/s$
6:	110 $cm^3/cm^2/s$
7:	111 $cm^3/cm^2/s$
8:	104 $cm^3/cm^2/s$
9:	97.6 $cm^3/cm^2/s$
10:	91.8 $cm^3/cm^2/s$

Commentary:

Avg:	101 $cm^3/cm^2/s$	Nominal:	101 $cm^3/cm^2/s$
Min:	91.5 $cm^3/cm^2/s$	Min:	90.8 $cm^3/cm^2/s$
Max:	111 $cm^3/cm^2/s$	Max:	111 $cm^3/cm^2/s$
CV:	6.7 %	Tests:	10
CI:	4.8 %	CI:	





SITRA, COIMBATORE, INDIA

Test Report no. 2010.03.17, 12.03.58.LBD LBD240

Style:	STYLE-1	Date/time:	17.03.2010, 12:03 - 17.03.2010, 12:06
SAMPLE ID:	C- 994	Operator:	SN
PARTICULARS 1:	FABRIC SAMPLE		
PARTICULAR 2:	MARK : 9.2		

Static Air Permeability

Test pressure:	125 Pa	Date/time:	17.03.2010, 12:03 - 17.03.2010, 12:06
Test area:	38 cm^2	Instrument:	Textest FX 3300-III, s/n: 1198

1:	66.3 $cm^3/cm^2/s$
2:	62.1 $cm^3/cm^2/s$
3:	72.3 $cm^3/cm^2/s$
4:	69.0 $cm^3/cm^2/s$
5:	66.0 $cm^3/cm^2/s$
6:	68.0 $cm^3/cm^2/s$
7:	71.9 $cm^3/cm^2/s$
8:	64.3 $cm^3/cm^2/s$
9:	69.3 $cm^3/cm^2/s$
10:	64.6 $cm^3/cm^2/s$

Commentary:

Avg:	67.4 $cm^3/cm^2/s$	Nominal:	67.4 $cm^3/cm^2/s$
Min:	62.1 $cm^3/cm^2/s$	Min:	60.6 $cm^3/cm^2/s$
Max:	72.3 $cm^3/cm^2/s$	Max:	74.1 $cm^3/cm^2/s$
CV:	4.9 %	Tests:	10
CI:	3.5 %	CI: