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EFFECT OF MACRO, MICRO AND NANO SILICONE EMULSION SOFTENERS ON PHYSICAL AND COLORIMETRIC PROPERTIES OF COTTON FABRIC

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ABSTRACT

Begum MS A (2012) Effect of macro, micro and nano silicone emulsion softeners on physical and colorimetric properties of cotton fabric. *Ins. Engg. Tech.* 2(2), 34-42.

Different sized particles of silicone emulsion softeners restore and increase softness on the cotton fabric which is lost in scouring and bleaching processes to different degrees. This study examines the effect of macro, micro and nano sized particles of silicone emulsion softeners of different quantities on physical and colorimetric properties of blue and red colored single jersey fabrics by experimental analysis. Therefore, three different sized particles of silicone emulsions of different quantities are applied on both colored fabrics. The results show that nano silicone emulsion provides excellent absorbency, higher color yield, minimum shade change and good soft handle to the both colored fabrics but nano silicone emulsion reduces the wet rubbing fastness. Macro silicone emulsion provides excellent softness, acceptable shade change, increased color yield, good absorbency and improves wet rubbing fastness. On the other hand micro silicone emulsion provides acceptable wet rubbing, soft handle, acceptable shade change, increased color yield and good absorbency to both colored fabrics.

Key words: *macro, micro, cotton, bending length, colorimetric properties*

INTRODUCTION

Cotton fabric is used most widely, but it is lacking in the luster of the silk and heat-protecting properties of wool (Shenai 1980). During preparation (scouring and bleaching) cotton can become embrittled because natural oils and waxes are removed. Finishing with softeners can overcome this deficiency and even improve on the original suppleness (Schindler and Hauser, 2004). No fabric reaches the customer's hand without finishing, this finishing depend on the end use of the fabrics. There are various types of finishes like organdie, luster, crease-resistance, filling, softness, shower proofing or water repellency, mildew-proofing, moth-proofing, flame-proofing or flame retardancy, antistatic, soil-resistance etc. But softening finishes are among the most important of textile chemical finishing (Shenai 1995). To make the fabric soft various types of softeners are used, such as fatty acid based and silicone based softeners. But silicone based softeners provide the fabric permanent very soft handle. There are different types are silicone softeners like Poly dimethylsiloxane, Epoxy functional silicone softeners, Amino functional silicone softeners, Cationic silicone softeners, Hydrophilic silicone softeners etc. Schindler and Hauser (2004). According to particle size there are three types commercially available modified polysiloxane silicone softeners, these are macro, micro and nano silicone emulsions (Tomasino 2000). The handle effects with softness depend not only on the chemical character, but also on their position in the textile. If the softener is attached mainly on the outside of the yarns, then it is the primary effect of the chemicals character which is felt; moist, dry, fatty, oily, smooth, rubbery etc. However, if the softener is able to penetrate into the yarn between the individual fibres, a secondary handle effect is obtained: so- called "inner softness" produced by the reduction in friction between the individual fibres. Every textile softener is applied in the form of an aqueous dispersion or emulsion. The type of attachment formed depends on a physical property, i.e. the particle size of the active substances. The majority of softeners consist of a mixture of particles of different size which can vary between 300 and 100000 nm in diameter. Softeners in the form of macro emulsions consist of particles with a diameter of greater than 150. Softeners in the form of micro emulsions consist of particles with a diameter of 50 to 150 nm and softener in the form of nano emulsions consist of particles with a diameter of 10 nm. Assuming a circular cross-section of the individual fibres, the smallest possible distance between the fibres is 2000 – 4000 nm. It is easy to say that only very finely emulsified products, will be able to deposit themselves between the fibres. Coarsely emulsified products will mainly be deposited on the yarn surface. Micro and nano emulsions, on the other hand, can penetrate easily into the fibre bundle and deposit themselves almost completely between the fibres. So both emulsions have no problem in penetrating between the individual fibres and producing an "inner softness. On the other hand macro emulsion provides a very pleasant surface smoothness with soft voluminous handle to the goods. (Clariant literature). So the aim of this experiment is to know the effect of macro, micro and nano silicone emulsion softeners on physical properties like drape ability, bending length, absorbency (Drop test) and colorimetric properties like color change, color strength, rubbing fastness etc.

EXPERIMENTAL PART

Fabrics:

100% cotton knit single jersey, 170 GSM, dyed with blue and red colors.

Softeners:

Macro Silicone Emulsion (Solusoft UP Liq., Clariant) is a milky, liquid macro emulsion, modified polysiloxane and nonionic softener. Micro Silicone Emulsion (Solusoft MW Liq., Clariant) is a yellowish, modified polysiloxane, nonionic micro emulsion softener. Nano Silicone Emulsion (Solusoft TOW Liq., Clariant) is a clear special compounded polysiloxane, weakly cationic softener.

Here 10 g/l, 20 g/l, and 30 g/l solution of macro micro and nano silicone emulsion softeners are applied on red and blue colored fabrics by padder with 80% pick up and the fabrics are dried at 130^0c. After that color change, color strength, rubbing fastness test, drop test, bending length test, drape co – efficient test etc are done.

DATA ANALYSIS

Color Change / Gray Scale (Data color), ISO/ AATCC

Blue Colored Fabric

Table 01

Emulsion Type	Quantity g/l	Gray Scale Value	Gray Scale Rating
Macro Emulsion	10	4.75	4 - 5
Macro Emulsion	20	4.33	4 - 5
Macro Emulsion	30	4.24	4 - 5
Micro Emulsion	10	4.72	4 - 5
Micro Emulsion	20	4.49	4 - 5
Micro Emulsion	30	4.39	4 - 5
Nano Emulsion	10	4.65	4 - 5
Nano Emulsion	20	4.41	4 - 5
Nano Emulsion	30	4.28	4 - 5

Red Colored Fabric

Table 02

Emulsion Type	Quantity g/l	Gray Scale Value	Gray Scale Rating
Macro Emulsion	10	4.57	4 - 5
Macro Emulsion	20	4.25	4
Macro Emulsion	30	4.18	4
Micro Emulsion	10	4.87	5
Micro Emulsion	20	4.45	4 - 5
Micro Emulsion	30	4.20	4
Nano Emulsion	10	4.73	4 - 5
Nano Emulsion	20	4.62	4 - 5
Nano Emulsion	30	4.51	4 - 5

In tables 2 & 3 it is clearly understood that not significant color change has happened on both blue and red colored fabrics after applying different sized particles of silicone emulsions with different quantity but higher quantity of macro and micro can change little red color than blue color.

Color Strength (Data color)

Blue Colored Fabric

Table 03

Emulsion Type	Emulsion Quantity, g/l	Strength %
Without Finish	0	100
Macro Emulsion	10	103.19
Macro Emulsion	20	108.48
Macro Emulsion	30	109.83
Micro Emulsion	10	104.14
Micro Emulsion	20	107.50
Micro Emulsion	30	108.34
Nano Emulsion	10	105.03
Nano Emulsion	20	107.43
Nano Emulsion	30	108.05

Red Colored Fabric

Table 04

Emulsion Type	Emulsion Quantity, g/l	Strength %
Without Finish	0	100
Macro Emulsion	10	107.22
Macro Emulsion	20	112.70
Macro Emulsion	30	114.71
Micro Emulsion	10	102.73
Micro Emulsion	20	110.50
Micro Emulsion	30	112.50
Nano Emulsion	10	105.65
Nano Emulsion	20	108.04
Nano Emulsion	30	109.32

In tables 3 & 4 it is clearly understood that higher quantity of silicone emulsions increase color strength of fabrics but nano silicone emulsion increases less color strength of fabrics than others two. So it can say that finishes with silicone softeners on dyed textiles can increase depth of the shades.

Rubbing Fastness

ISO CO6 X 12

Red colored Fabric

Table 05

Emulsion Type	Quantity, g/l	Dry Rub	Wet Rub
Without Finish	--	5	4.5
Macro Emulsion	30	5	4.8 (5)
Micro Emulsion	30	5	3.8 (4)
Nano Emulsion	30	5	3.7 (4)

Blue colored Fabric

Table 06

Emulsion Type	Quantity, g/l	Dry Rub	Wet Rub
Without Finish	--	5	4.5
Macro Emulsion	30	5	4.9(5)
Micro Emulsion	30	5	4.6
Nano Emulsion	30	5	4.4

In tables 5 & 6 it is clearly observed that nano silicone emulsion reduces wet rubbing fastness but macro silicone emulsion improves little bit wet rubbing fastness of both colored fabrics.

Drop Test

Blue Colored Fabric

Table 07

Emulsion Type	Quantity, g/l	Drop Absorbed, sec.	Comments on Hydrophilicity
Without Finished	0	1	Very Good
Macro Emulsion	10	30	Moderate
Macro Emulsion	20	33	Moderate
Macro Emulsion	30	34	Moderate
Micro Emulsion	10	2	Good
Micro Emulsion	20	2	Good
Micro Emulsion	30	2	Good
Nano Emulsion	10	1	Very Good
Nano Emulsion	20	1	Very Good
Nano Emulsion	30	1	Very Good

In this table we can say that after applying nano silicone emulsion on fabric, fabric will be better absorbent than others.

Red Colored Fabric

Table 08

Emulsion Type	Quantity, g/l	Drop Absorbed, sec.	Comments on Hydrophilicity
Without Finished	0	1	Very Good
Macro Emulsion	10	30	Moderate
Macro Emulsion	20	33	Moderate
Macro Emulsion	30	34	Moderate
Micro Emulsion	10	2	Good
Micro Emulsion	20	2	Good
Micro Emulsion	30	2	Good
Nano Emulsion	10	1	Very Good
Nano Emulsion	20	1	Very Good
Nano Emulsion	30	1	Very Good

Bending Length (Shirley stiffness tester m/c)

Bending length is a property of a fabric related to stiffness. It is the length of the fabric that will bend on its own weight to a definite extend. A high value of bending length corresponds to a stiff fabric and vice versa.

Bending Length

Blue Colored Fabric

Table 09

Silicone Type & quantity	Ends	Bending length Face UP, in cm	Face Down In cm	Average In cm
Without silicone	1st	2.25	1.80	2.03
	2nd	2.25	1.75	
10 g/l, Macro silicone	1st	2.15	1.55	1.838
	2nd	2.20	1.45	
20 g/l, Macro silicone	1st	2.15	1.50	1.78
	2nd	2.05	1.40	
30 g/l, Macro silicone	1st	2.00	1.40	1.69
	2nd	2.00	1.35	
10 g/l, Micro silicone	1st	2.22	1.55	1.868
	2nd	2.20	1.50	
20 g/l, Micro silicone	1st	2.20	1.50	1.825
	2nd	2.10	1.50	
30 g/l, Micro silicone	1st	2.10	1.50	1.763
	2nd	2.00	1.45	
10 g/l, Nano silicone	1st	2.15	1.50	1.825
	2nd	2.20	1.45	
20 g/l, Nano silicone	1st	2.10	1.40	1.77
	2nd	2.15	1.42	
30 g/l, Nano silicone	1st	2.15	1.50	1.763
	2nd	2.00	1.40	

Red colored fabric

Table 10

Silicone Type & quantity	Ends	Bending length Face UP, in cm	Face Down In cm	Average In cm
Without silicone	1st	2.35	1.75	2.088
	2nd	2.40	1.85	
10 g/l, Macro silicone	1st	2.20	1.45	1.825
	2nd	2.15	1.50	
20 g/l, Macro silicone	1st	2.10	1.35	1.70
	2nd	2.05	1.30	
30 g/l, Macro silicone	1st	2.05	1.30	1.65
	2nd	2.00	1.25	
10 g/l, Micro silicone	1st	2.25	1.55	1.90
	2nd	2.30	1.50	
20 g/l, Micro silicone	1st	2.20	1.50	1.843
	2nd	2.22	1.45	
30 g/l, Micro silicone	1st	2.00	1.35	1.69
	2nd	2.00	1.40	
10 g/l, Nano silicone	1st	2.20	1.55	1.88
	2nd	2.22	1.55	
20 g/l, Nano silicone	1st	2.15	1.50	1.763
	2nd	2.00	1.40	
30 g/l, Nano silicone	1st	2.00	1.35	1.68
	2nd	2.00	1.35	

Drape Test

Drape is the term used to describe the way a fabric hangs under its own weight.
Drape coefficient = mass of shaded area/ total mass of paper ring X 100%
The higher the drape coefficient the stiffer is the fabric.

Blue colored fabric

Table 11

Silicone Type	Drape Co – efficient in %
Without Finished Fabric	87.403
10 g/l Macro silicone	81.300
20 g/l Macro silicone	81.230
30 g/l Macro silicone	80.170
10 g/l Micro silicone	85.463
20 g/l Micro silicone	83.628
30 g/l Micro silicone	83.275
10 g/l Nano silicone	84.246
20 g/l Nano silicone	83.604
30 g/l Nano silicone	82.216

Red colored fabric

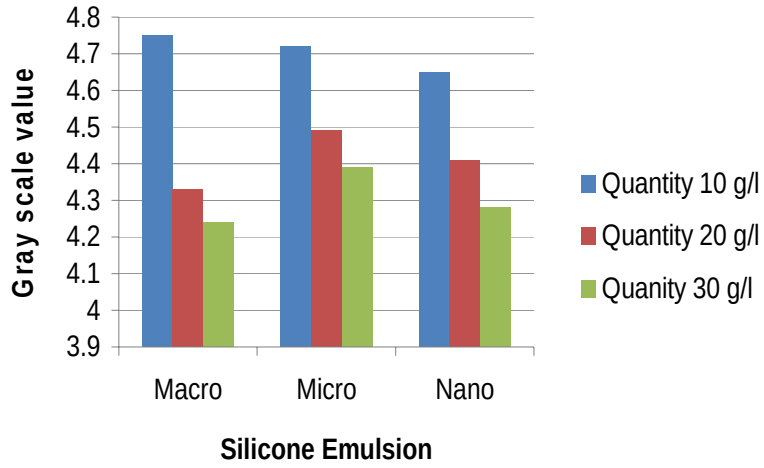
Table 12

Silicone Type	Drape Co – efficient in %
Without Finished Fabric	87.368
10 g/l Macro silicone	83.980
20 g/l Macro silicone	83.170
30 g/l Macro silicone	81.300
10 g/l Micro silicone	86.192
20 g/l Micro silicone	84.933
30 g/l Micro silicone	82.750
10 g/l Nano silicone	85.180
20 g/l Nano silicone	84.500
30 g/l Nano silicone	82.290

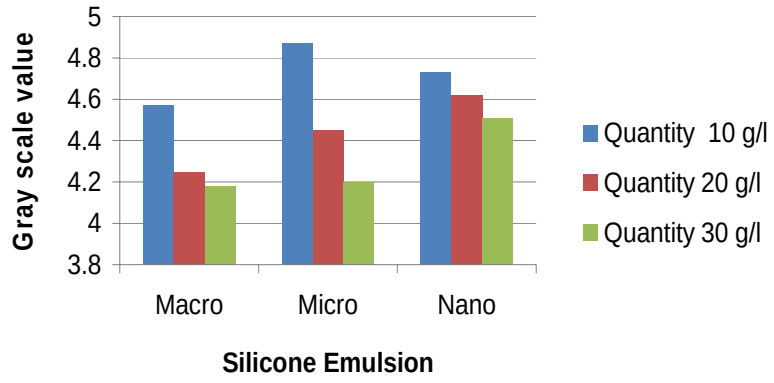
In above four tables it is clearly understood that higher quantity of macro silicone emulsion can able to make the fabric softer than others silicone emulsions.

RESULTS

Color Change (Data Color)
ISO/AATCC
Blue Colored Fabric
Figure 01

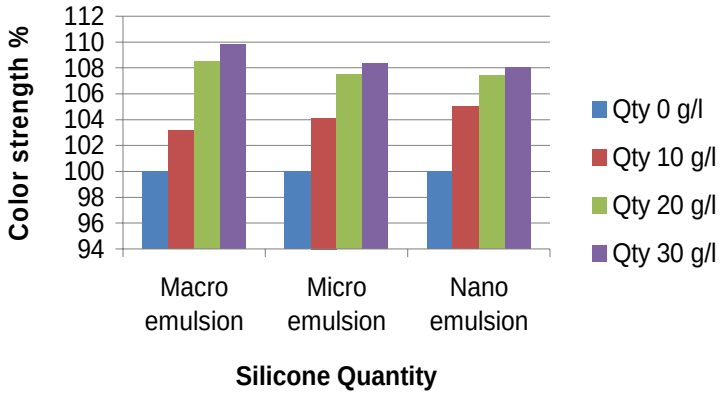


Red Colored Fabric
Figure 02

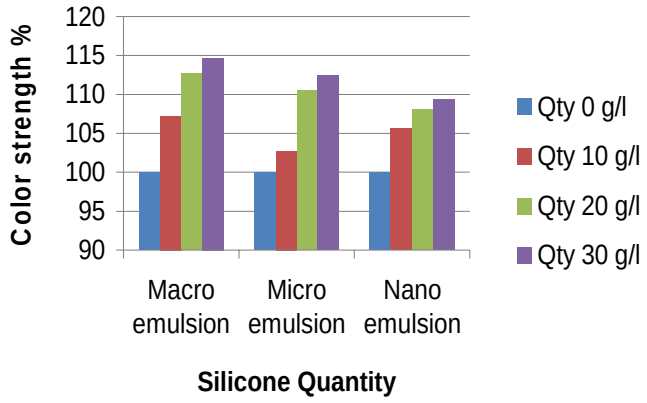


In Figure 1 & 2 it is clearly seen that color change values of both colored fabrics after applying different sized particles of silicone emulsion with different quantity is very insignificant but color change of nano silicone is less than others two Chattopadhyay and Vyas (2010).

Color Strength (Data Color)
Blue Colored Fabric
Figure 03

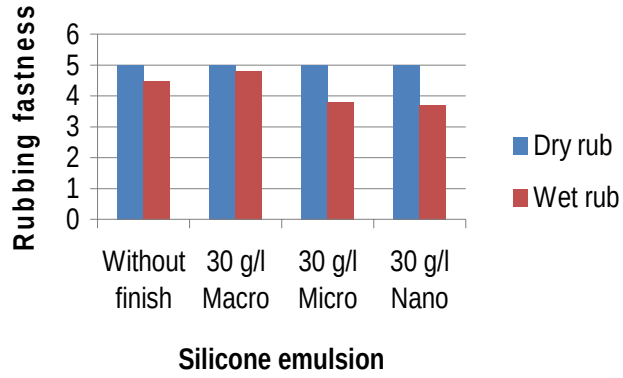


Red Colored Fabric
Figure 04



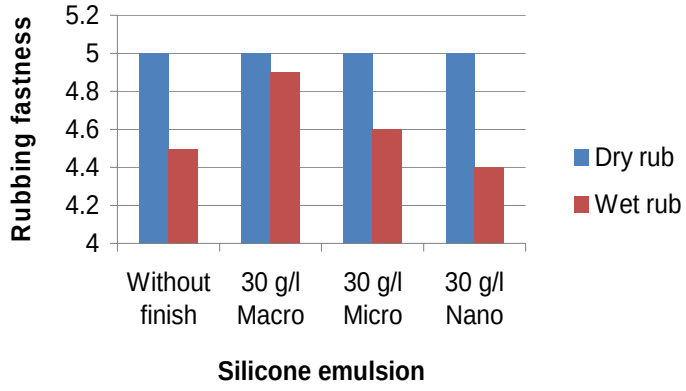
In Figure 3 & 4 it is clearly seen that silicone emulsion increase the color yield. From chart we can say that higher quantity of macro emulsion has increased high color yield.

Rubbing Fastness Test: (ISO / AATCC), Grey scale to staining
Blue Colored Fabric
Figure 05



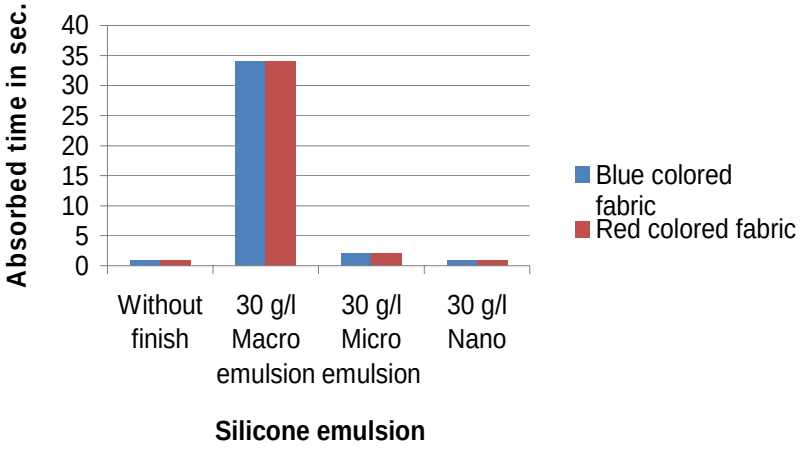
In Figure 05 it is clearly understood that nano silicone emulsion has reduced the wet rubbing fastness but macro silicone emulsion has improved the wet rubbing fastness.

Red Colored Fabric
Figure 06



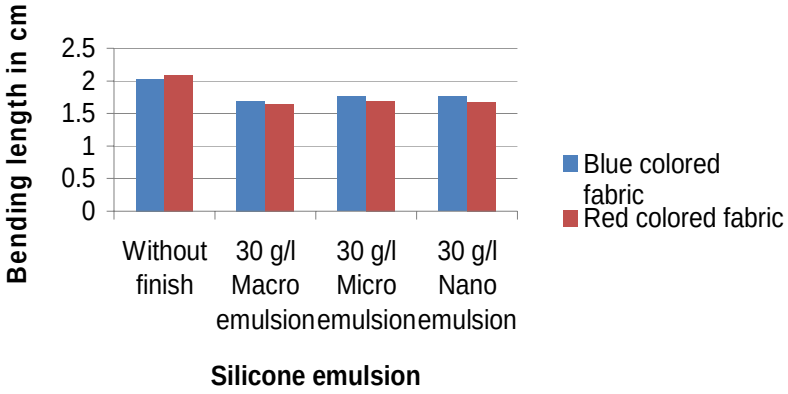
In figure 06 it is clearly understood that nano silicone emulsion has reduced the wet rubbing fastness but macro silicone emulsion has improved the wet rubbing fastness.

Fabric Absorbency (Drop test)
Blue & Red Colored Fabric
Figure 07



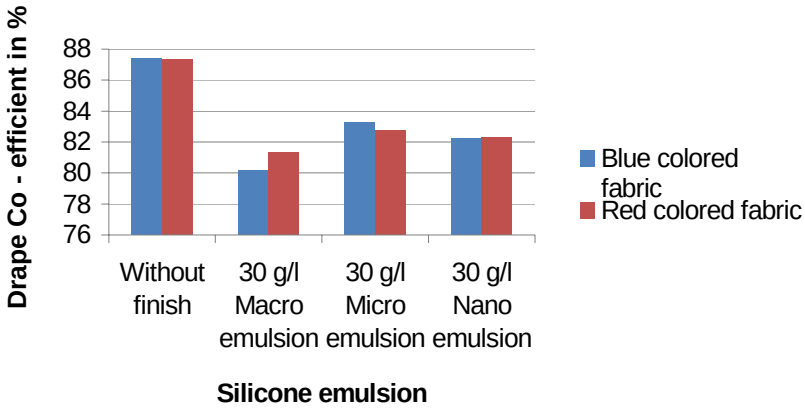
In Figure 07 it is clearly understood that nano silicone emulsion has provided best absorbency to both colored fabrics compared to others but macro silicone emulsion has provided little water repellent to the both colored fabrics.

Bending Length
Blue & Red Colored Fabric
Figure 08



In Figure 08 it is clearly understood that macro silicone emulsion has made both colored fabrics very soft compared to micro and nano silicone emulsion.

Drape Test
Blue & Red Colored Fabric
Figure 09



In figure 09 it is clearly understood that macro silicone emulsion has made both colored fabrics very soft compared to micro and nano silicone emulsion.

CONCLUSION

In this study, red and blue colored fabrics are treated with macro, micro and nano sized particles of silicone emulsion with different quantities and after treatment shade change, color yield, rubbing fastness, absorbency (Drop test), bending length and drape co-efficient tests are studied for both colored fabrics. In this experiment, macro silicone emulsion provided high softness, improved wet rubbing fastness, moderate absorbency, minimum shade change and increased color yield. Micro silicone emulsion provided good softness, good rubbing fastness, good absorbency, minimum shade change, increased color yield. Nano silicone emulsion provided good softness, minimum shade change, poor wet rubbing fastness, excellent absorbency, increased color yield for both colored fabrics. Hopefully this experimental data may help finishing technologists to produce different types of finishing recipes. Further experiments can be done after several wash of these finished fabrics and different construction of fabrics with various kinds of yarn count. After using these types of silicone emulsion wash fastness and light fastness also can be done.

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