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Short Communications

Effect of nano-polysiloxane based finishing on handle properties of jute blended fabric

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Jute: polyester blended yarn has been used to develop union fabric with cotton yarn , which satisfy the desirable properties for the development of a winter garment. Due to presence of jute fibre, it deficits in surface softness. An attempt has made to apply nano-polysiloxane based finishing both in individual as well as in combination with other finishing chemicals on this fabric by conventional pad-dry-cure method in order to improve its handle property. Properties such as bending length, crease recovery angle, and surface morphology have been evaluated as per standard methods. Results show that the nano+micro-polysiloxane based finishing combination shows better improvement in the surface morphology, handle and recovery property of the fabric than other finishing combinations.

Keywords: Blended yarn, Fabric finishing, Fabric handle, Fabric softness, Jute fibre, Polysiloxane, Polyester

Jute is one of the important cellulosic fibres, mainly composed of alpha cellulose, hemicellulose and lignin. It is used in packaging and sackings for the food grains. However, it has some unique properties like roughness, coarseness and stiffness as it is a multi-cellular fibre which is bonded with hemi-cellulose and lignin[1-2]. These properties generally create problem during fabric manufacturing as well as interfering in the performance of a final product. Due to this drawback, jute is not preferred in the apparel textiles. Development of fine yarn from jute fibre by blending with synthetic fibres, cotton or staple viscose rayon is one of the possible ways to prepare jute blended apparel.

A fine jute/polyester (70/30) blended yarn with linear density of 122 tex was prepared on a conventional jute spinning system[3], which was optimized by varying linear density, twist and blend proportion of jute and hollow polyester fibre[4,5] . It was woven with cotton yarn as warp in a handloom for the development of union fabric. The physico-mechanical properties of the fabric were evaluated and compared with conventional apparel fabrics. The results inferred that the properties are matched with basic requirement of a winter garment and hence later winter garment from this jute blended fabric as outer cover has developed[6]. However, due to surface roughness of jute fibre, the handle of the fabric did not meet the required soft feel. Generally, textiles processing like scouring, dyeing and finishing are focused on the value addition as well as improvement in performance of textile products[7].

Chemical finishing that is able to make uniform film on the surface of jute fibre has potential to enhance the handle property of jute blended fabric[8]. Poly-siloxane based chemical finishing can be applied to improve the surface softness and handle properties due to improvement in flexibility of fibre polymer. Poly-siloxane of different sizes i.e. nano, micro and macro emulsion either in individual from or in combination forms can be applied to improve the softness of wool/cotton union fabric[9].

Literature information on application of nano poly-siloxane finishing either in individual form or in combination form on jute blended fabric is still scanty. Therefore an attempt has been made to apply nano-polysiloxane in five chemical finishing formulations to jute-blended fabrics by pad-dry-cure method and its performance is compared.

Experimental

Materials

Union fabric of jute: polyester blended yarn (70:30 ratio/122 tex) in weft direction and 100s cotton yarn in warp direction (40s) with 72 PPI and 66 EPI was taken as experimental sample. To reduce the water consumption in the finishing, finishing chemicals were applied by dry-on-wet method and hence the fabric was used without any pretreatment. Leomin HBN (Cationic softener), Ceraperm MW (cationic micro-polysiloxane emulsion), Ceraperm TOWI (nano-polysiloxane emulsion), Ceraperm UP (macro-polysiloxane emulsion), and Sandoclean PCJ

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(nonionic detergent) were supplied by M/s Clariant Chemicals (India) Ltd., Tirupur, Tamilnadu. All other chemicals used elsewhere were AR grade.

Finishing

For each finishing formulation, 0.25g/L Sandoclean-PCJ was added and the *p*H was adjusted to 5.0±0.2 by adding 0.5 % acetic acid. Fabric of 35cm × 35cm dimension was taken and impregnated in the finishing solution for 5 min at 25°C and padded with 80±5 % expression under 1.5 kg/cm^2 using a laboratory padder (RB Engineering Ltd., Gujarat, India). After padding, the fabric was dried and cured in high temperature steamer (RB Engineering Ltd., Gujarat, India) as per the conditions mentioned in Table 1. After curing, fabric was conditioned, rinsed with distilled water gently to remove non-ionic detergent and dried at ambient condition.

Evaluation of Performance Properties

The properties of finished and unfinished samples such as finish add-on, bending length, flexural rigidity and dry crease recovery angle were evaluated as per the standard procedure[10,11]. For surface study, control and finished jute fibre samples were magnified in JEOL scanning electron microscope (Model JSM 6360).

Results and Discussion

Finish Add-on

Table 1 depicts the amount of finishing chemical added on the jute blended fabric. The percentage finish add-on is higher in nano-polysiloxane based finishing (3.56%) than other nano-polysiloxane combination finishing (<3.08%). The cell wall of swollen natural fibres consist of several hundreds of lamellae, and have pores with a most common pore size of 160- 380 nm (ref. 12), while the size of nano-, micro- and macro-polysiloxane emulsion ranges in 50-100 nm, 200-300 nm and >500 nm respectively.

During application, most of the nano-polysiloxane emulsion can be easily adsorbed on the surface of the fibre and then diffused inside the fibre matrix; micro-polysiloxane emulsion can be penetrated inside the fibre partially; macro-polysiloxane mainly can be spreaded only on the surface of the fibre; while cationic softener can be coated on the surface of the fibre [9]. Due to improved diffusion behaviour of nano-polysiloxane, the extent of deposition is higher than its combination finishing. Also in combination finishing, the other finishing emulsion might hinder the diffusion of nano-polysiloxane to inside the fibre, so that there is a reduction in finish add-on in combination finishing.

Table 1—Finishing combinations for jute blend fabric

Combination No.	Finishing chemical	Amount g/L	Finish add-on, %	Abbreviation used
1	Ceraperm TOWI	80	3.56	Nano
2	Ceraperm TOWI + Ceraperm MW	40 + 40	3.08	Nano + Micro
3	Ceraperm TOWI + Ceraperm UP	40 + 40	2.98	Nano + Macro
4	Ceraperm TOWI + Leomin HBN	40 + 40	3.05	Nano + CS

Dry Crease Recovery Angle

The dry crease recovery angle of finished and unfinished jute blended fabric in both directions is given in Fig. 1.

Jute and cotton fibres have many free –OH groups in their fibre matrix. When treated with pre-polymer of nano-polysiloxane emulsion, they are polymerized in the form of a thin film on the surface of the fibre, thus masking the free –OH groups. The improvement in crease recovery angle is observed in nano+micro and nano+CS combination finished fabrics when compared with untreated fabric in both directions [13.14]. Micro-polysiloxane combination finishing improves the crease recover property of this fabric both in warp

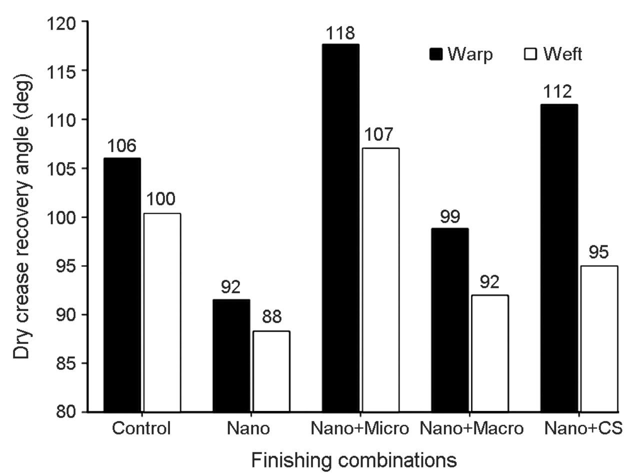

Fig. 1—Dry crease recovery angle of jute blend fabrics finished with nano-polysiloxane based finishing

(10%) and weft (7%) direction. Since nano-polysiloxane improves the inner softness of jute and cotton fibres, it does not show positive improvement in crease recovery. However, the dry crease recovery angles of both finished and unfinished fabrics in warp direction are higher than weft direction, due to the presence of jute fibre in weft yarn.

Bending Length

The bending length of finished and unfinished jute blended fabrics in both directions is given in Fig. 2.

The results show that the bending length of control fabric is higher in weft direction than in warp direction due to variation in linear density between warp and weft yarn as well as stiffness of jute fibre in weft direction. In warp direction, nano+macro-polysiloxane emulsion combination finishing shows more reduction in bending length (10%) than that of nano-polysiloxane based finishing (5%) , while in weft direction, nano-polysiloxane finishing shows more reduction (12%) than that of other finishing combinations (4-9%).

Nano-polysiloxane diffuses well inside the fibre matrix and forms a polymer networking, which improves the softness of fibrils of fibres, i.e. inner softness of jute fibre, hence nano-polysiloxane finishing reduces the bending stiffness of the jute fibre[15]. However, in combination finishing, the improvement in inner softness by the nano-polysiloxane may be reduced, so the reduction of bending length is lesser in warp direction than in weft direction. It is also indicated that (Fig. 3), the nano-polysiloxane has better effect in the reduction of bending stiffness in case of weft yarn (jute:polyester yarn) than in case of warp (cotton yarn).

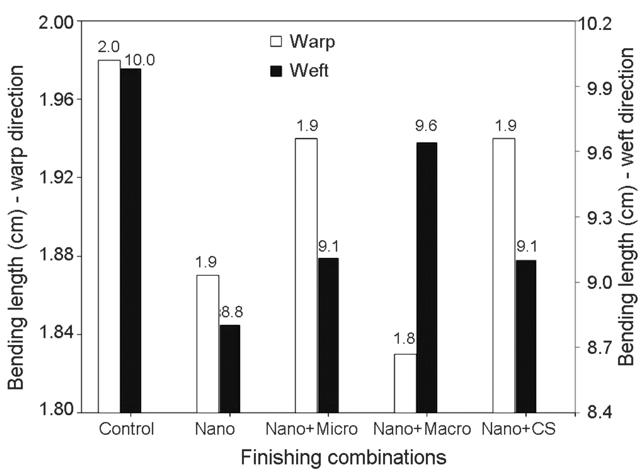

Fig. 2—Bending length of jute blend fabrics finished with nano-polysiloxane based finishing

Flexural Rigidity

The flexural rigidity of finished and unfinished jute blended fabrics in both directions is given in Fig. 3.

Flexural rigidity is a measure of resistance of a cloth against bending by external forces and it correlates with the weight per unit area and bending length of the fabric[16,17]. Being less-elongated natural fibre, jute fibre has more stiffness than cotton fibre and hence the flexural rigidity of blended fabric in weft direction (< 19360 mg/cm) is higher than in warp direction (< 150 mg/cm) both in control as well as in finished fabrics. The reduction in the flexural rigidity is better in nano + macro-polysiloxane combination finishing than in other finishing combinations both in warp (20%) and weft directions (31%).

Cost Effectiveness

The finishing chemicals were applied on the fabric by dry-on-wet technique and then the findings were compared with wet-on-wet technique (commercial). In dry-on-wet method, by using 100 litre of finishing liquor, it is estimated that nearly 143 kg of dry fabric could be finished by each finishing formulations with 70% expression, while in wet-on-wet method by using 100 litre finishing liquor nearly 500 kg wet fabric can be finished , since it took 20% expression of finishing liquor. Keeping the cost in mind, it is suggested that nano + macro or nano + micro-polysiloxane combination finishing in wet-on-wet condition on jute based textiles might reduce the cost of finishing with lasting finishing performance.

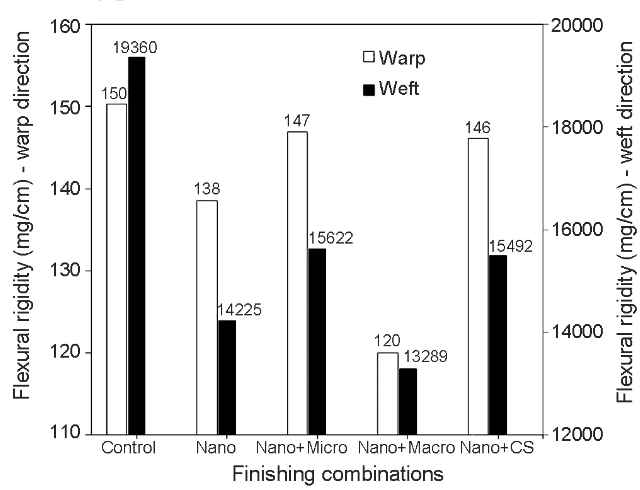

Fig. 3—Flexural rigidity of jute blend fabrics finished with nano-polysiloxane based finishing combinations

SEM Study

The SEM images of control and other four nano-polysiloxane based finished jute fibre are given in Fig. 4. It is inferred that untreated jute have irregular grooves on the surface of the fibre and after finishing, each finishing formulation forms a polymer film on the surface of the fibre. The coating and coverage of grooves are better in nano-polysiloxane finished fibre than in other finishing combinations. Since the add-on is higher in nano-polysiloxane finishing, the coverage is more than in other finishing combinations.

Based on the above chemical finishing study, the following conclusions can be drawn:

- Nano-polysiloxane finishing has positive effect on improvement in handle of jute blended fabric, since it forms uniform polymer film on the surface of the jute fibre, which reduces surface friction and increases softness.
- After finishing, the reduction in flexural rigidity of the fabric is better in nano-polysiloxane / nano + macro-polysiloxane combination finishing than in other combination finishings.
- Nano + micro-polysiloxane combination finishing shows better crease recovery than other finishing combinations on jute blended fabric .
- Nano-polysiloxane finishing reduces the bending rigidity more in weft direction than in warp direction, which indicates that it improves the inner softness of jute fibre better than that of cotton fibre.
- It is concluded that nano + micro-polysiloxane combination finishing has potential to improve the handle properties of jute blended fabric.

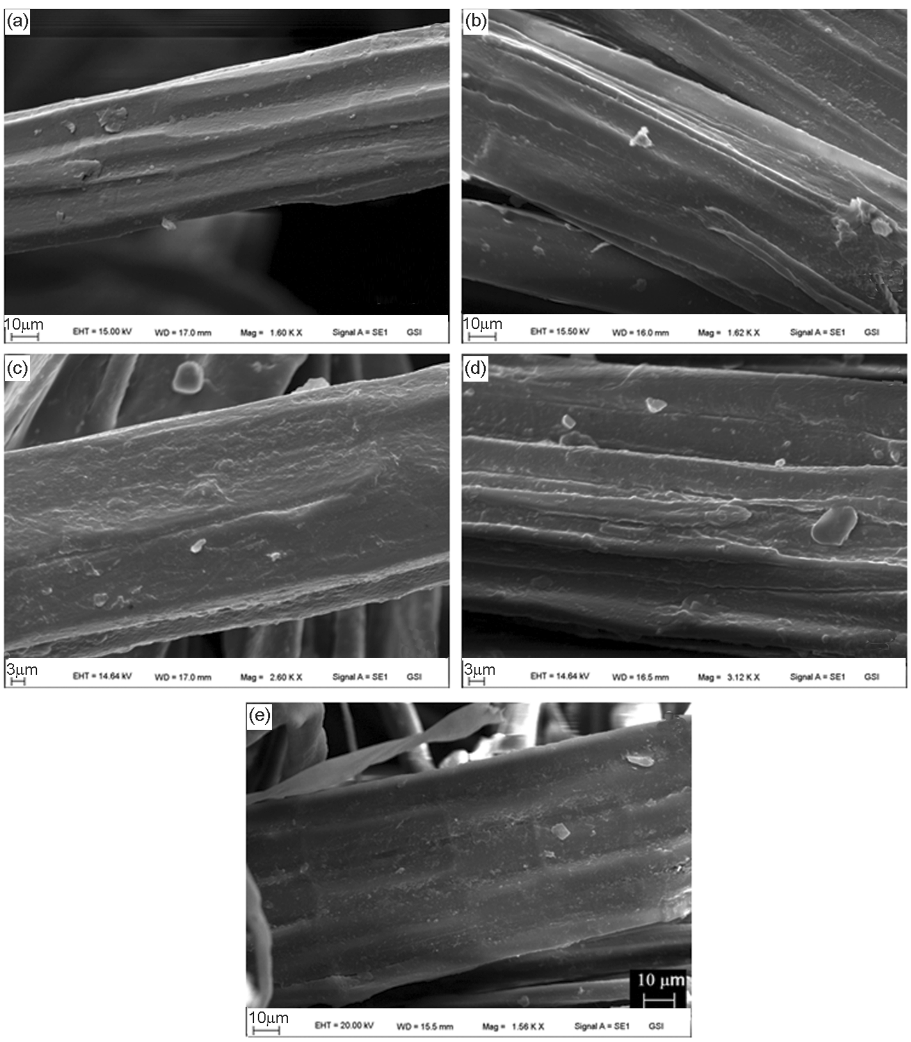

Fig. 4—SEM images of jute fibre finished with different finishing combinations
(a) control (b) nano-finished (c) nano+micro-finished (d) nano+macro- finished (e) CS+nano-finished]

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