FIBER CROSS-SECTION INFLUENCE ON THE DEPOSITION OF NANOFIBERS ON TEXTILE WEAVED STRUCTURES

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AUTEX 2022
21st World Textile Conference

ABSTRACT

Roughness is directly related to the increase of adhesion between surfaces. Different cross section on fibres implies different longitudinal shape of fibres, altering the roughness of filaments. In this study, a procedure to evaluate the nanofibers adhesion to the substrate has been designed. In order to test it, different cross-section shapes are evaluated to demonstrate its influence on the nanofibers net adhesion. Circular, tetralobal and trilobal fibres were tested. Focused on corroborating it, two yarns with different filament fineness were also tested.

INTRODUCTION

Although nanofibers have many advantages in their application, such as the ability to obtain large electrospun surface areas, a high ratio of electrospun surface area to pore size between fibers and uniform porosity distribution [10], they have several disadvantages in terms of their mechanical handling against rubbing and tensile forces. Because of this, woven and nonwoven collector structures are used to improve the mechanical characteristics and increase their application [11].

The electrospun fibers have a weak adhesion to textile collector structures [11]. It has been demonstrated that moderated roughness enhances the adhesion of coatings in comparison to smooth surfaces [12]. In this work the nanofiber net is used as a coating of fabrics. The aim of this work is to demonstrate whether there is an influence of the cross section of the collector fabric on the deposition of nanofibers.

MATERIALS AND METHODS

The solution used for nanofiber production was polyvinyl alcohol (PVA) Mw 61.000 g/mol. Solutions were prepared with distilled water. Four 100% polyester plain weave fabrics, made up of yarns with different cross-sections (tetralobal, circular and trilobal) and different numbers of filaments (48 and 96), were used as the fabric placed on the collecting surface.

A Nanospider (Bioinicia) was used to produce the nanofibers. Polymer solution (9% w/v) was prepared at 80°C until complete solution. The process parameters were: nozzle-collector distance (15 cm), flow rate (0,3 mL/h), voltage (18 kV) and periods of time (90", 120" and 300").

To evaluate the adhesion of the nanofibers on the fabrics collectors different forces (0,002; 0,5; 2 N) were applied on an acetate film which was placed on the electrospun net for the same period (1 min). Then the weight is removed and the acetate film analyzed.

RESULTS AND DISCUSSION

The nanofibers were placed on different plain weave fabrics with yarns of different cross-section in weft direction, in warp direction the same polyester yarns were used. The yarns with different cross sections used were tetralobal, circular, and trilobal.

Figure 1 shows the adhesion test carried out using a yarn composed of 96 tetralobal filaments. Each image shows, from left to right, the effect of applying 0,002, 0,5 and 2 N force. Figures 2 and 3 show the adhesion tests performed on fabrics composed of 96 filament yarns with circular and trilobal cross section, respectively.

Trilobal section shows less nanofibers on the acetate than the tetralobal one when comparing the same coating density. This means that trilobal shows better adhesion, and circular the lower, what seems to be directly related to roughness.

To evaluate the influence of the number of filaments on the adhesion, the test is carried out on a fabric formed by a circular cross-section yarn with a number of 48 filaments (fig 4). As a result of the comparison with 96 filaments (fig 2) it can be observed the nanofibers produced for 90" remain attached to the fabric with 48 filaments (fig 4a) once the forces are applied, whereas fabrics with 96 filaments (fig 3a) lose part of the nanofibers, transferring it to the acetate film. This implies better adhesion is found when there is a lower number of filaments.

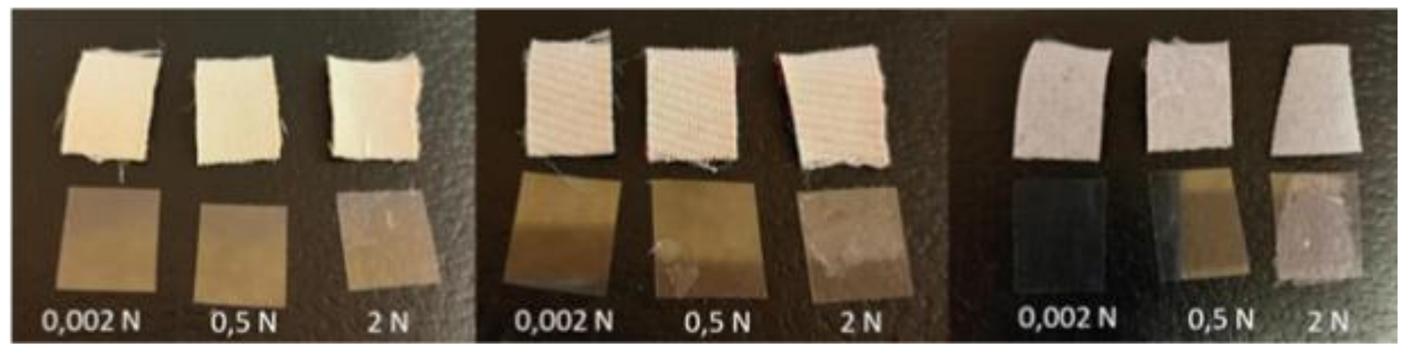

Figure 1. Adhesion test on fabric with tetralobal cross-section 96 filaments. a) 90"; b) 120"; c) 300".

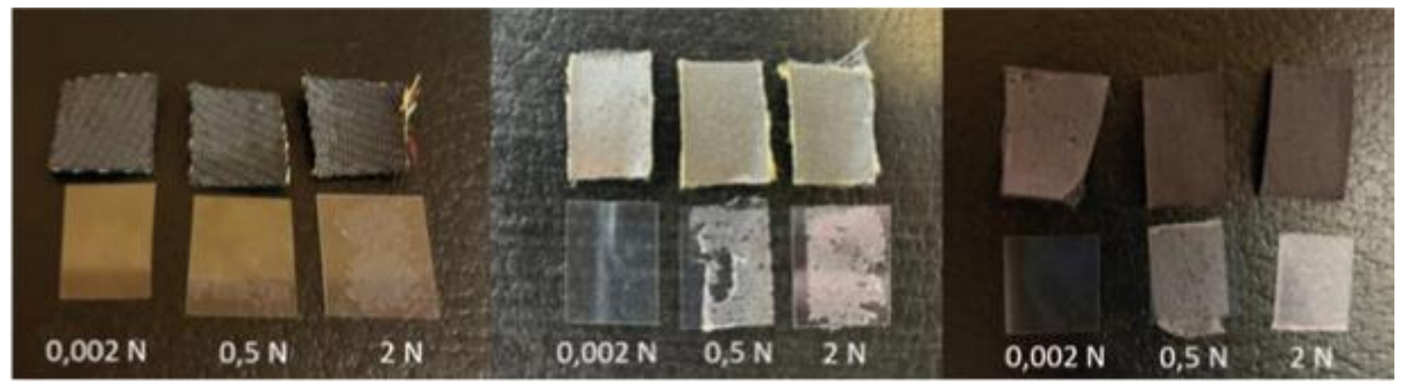

Figure 2. Adhesion test on fabric with circular cross-section 96 filaments. a) 90"; b) 120"; c) 300".

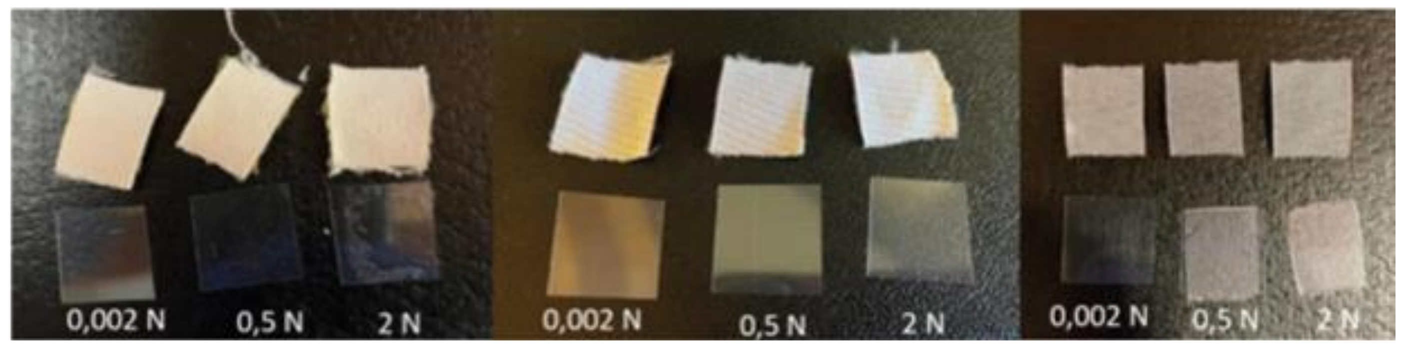

Figure 3. Adhesion test on fabric with trilobal cross-section 96 filaments. a) 90"; b) 120"; c) 300".

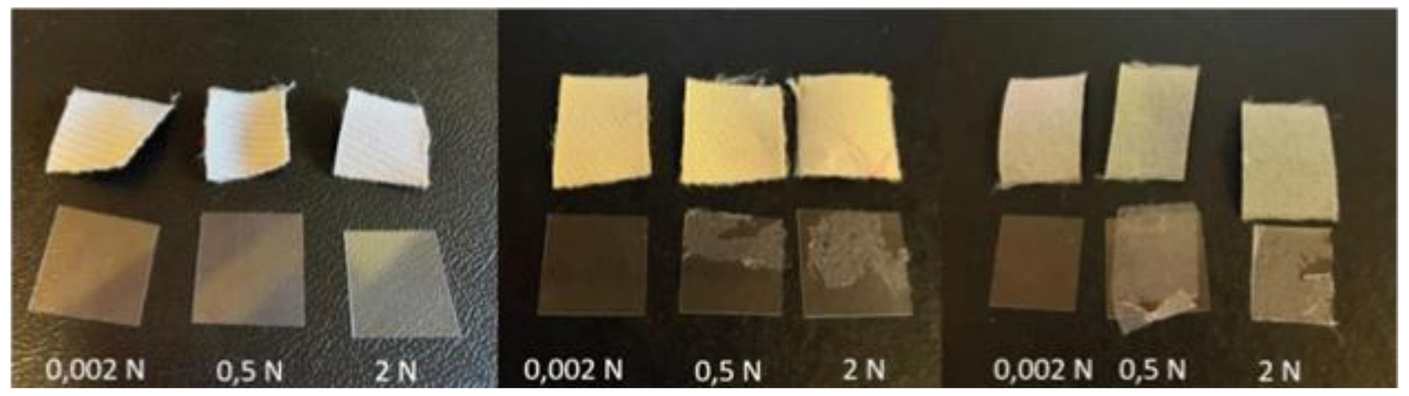

Figure 4. Adhesion test on fabric with circular cross-section 48 filaments. a) 90"; b) 120"; c) 300".

CONCLUSION

The analysis of the results of the adhesion test of the nanofiber coating placed on the fabric surface showed there is a difference on the behaviour of the coating.

Firstly, regarding the effect of cross section, it can be concluded that the circular one offers the lower adhesion to the fabric, the trilobal and tetralobal sections have a similar result, although trilobal one seems to enhance slightly the adhesion. This could be explained as the higher roughness of the filaments, due to the cross section, makes them adhere better to the surface, thus improving their overall adhesion to the collector fabric.

Finally, when comparing the adhesion in fabrics formed by yarns with different number of filaments but the same cross-section, it can be concluded that better adhesion is found when there is a lower number of filaments.

Thus, as a general conclusion we can confirm the method is sensitive enough to determine differences in nanofiber coating adhesion to fabrics, despite that further studies will be conducted in order to polish it. Furthermore, we can confirm that roughness plays an important role on the nanofiber adhesion to the fabric, and the fibre corss-section influences the fabric roughness.

ACKNOWLEDGEMENT

The authors would like to express appreciation for the support of the sponsor, the INSTITUTO VALENCIANO DE COMPETITIVIDAD (IVACE), with the nominative line in favor of the Universitat Politècnica de València, approved by the Budget Law of the Generalitat Valenciana on the years 2020, 2021 and 2022. And Antex company for the yarn samples..

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