Investigationof MechanicalProperties of Al_2O_3/PU Coated PES Fabric

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Abstract: *In this study, the influences of two different concentration of Al_2O_3 particles in PU coating solution and the amounts of coating thickness on mechanical properties of polyurethane coated polyester fabrics were investigated.*

Keywords: *mechanical properties; fabrics; polyurethane; coatings.*

1. Introduction

Textilesurfacematerialscoatedwithchemicalstructureshavebeendevelopedcontinuouslyforseverallastdecades. The basic substrate of the surface material is mostly textilefabriccoated on oneorbothsideswithoneormorepolymerlayers. Thiskind of productswiththebasictextilematerial has manyimprovedpropertiesandmultipleadvantagesovertheclassictextilematerial [1-3].

Polymerlayer can be polyurethane. Toimproveitsproperties, appropriateadditivesareadded: fillingmaterials, bindersetc. Coatedpolymersareappliedtothetextilematerialdirectlyandindirectly.
The chemicalcompositions of polymercoatingsareconstantlydevelopedandnewtypes of polymeradditivesareincreasinglyintroduced. Abrasionresistanceandstrengthareby far higher inpolyurethane in comparisontootherpolymers. Polyurethane has theproperty of goodadhesionwhich can be strengthenedbyaddition of cross-linkingagents [1,4].

2.Materials and Methods

2.1.Coating of fabrics

Scoured polyester microfibrefabrics of weight 93,8 g m^{-2}wascoatedbyknifeover roller machine. The coatedfabricsweredried at 120 ° C for 2 minandthencured at 150 ° C for 2 min. The thickness of thecoatedfabricswere 0,05 and 0,1 mm, respectively.

2.3. Material Mechanical Performance Tests

ISO test methods 13934-2, ISO 13937-1and 12947-4 wereemployedforbreakingstrength, tearingstrengthandmartindaleabrasionfabrictesting. Allfabricsweretested in thewarpdirectionand in theweftdirectionwhensamplequantityandgeometryallowed. Formechanicaltestingthreereplicationswereconducted on eachsample.

3.Results

3.1.Breaking Test Results

The breaking test results, summarized in Table 2, show a significant decrease in breaking force in warp directions and increase in weft directions compared to those of uncoated fabrics. Example breaking test plots from warp direction testing (meaning fill yarns broke) are reproduced in Figure 1. Visually, we noticed that uncoated samples caused more overall deformation than coated samples during the breaking load test. In warp direction, the application of coating decreased the breaking load substantially. While, increased coating thickness caused only a slight decrease in the breaking load, increased Al_2O_3 content caused a slight increase in the breaking load, as shown in Figure 1.

Table 2. Breaking force test results

Sample	Warp direction load (N)	Weft direction load (N)
Uncoated	558	676,5
0,05-10g Al_2O_3	482,76	733,8
0,05-20g Al_2O_3	490,2	784,35
0,1-10g Al_2O_3	456,83	598,6
0,1-20g Al_2O_3	458,7	604,15

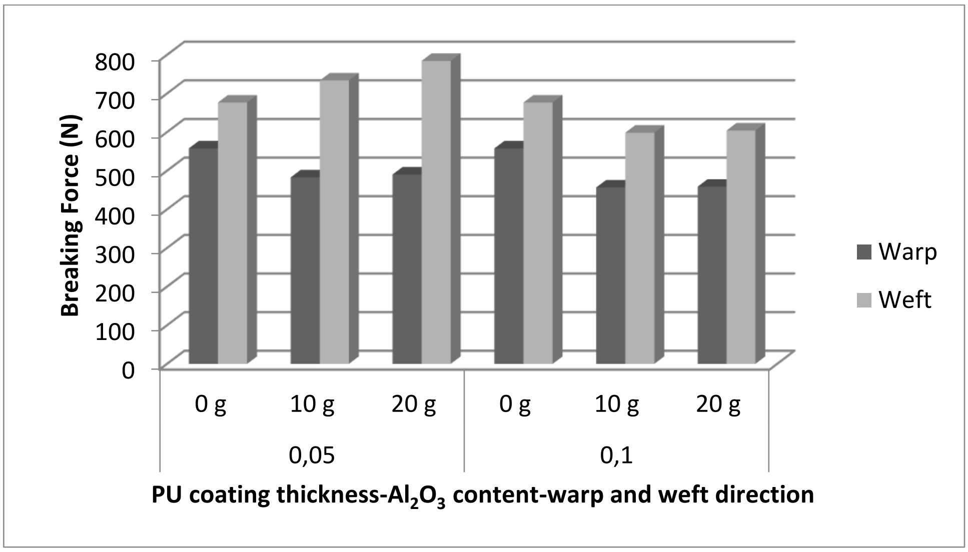

Figure 1. Breaking load test results

3.2.Tearing Test Results

In this study, we use PN-EN ISO 13937-1:2000 standard “Textiles”. Tear properties of fabrics-Part 1. Determination of tear force using ballistic pendulum method” (Elmendorf). The method of sample preparation and its clamping in the jaws is shown in Figure 2. For clothing fabrics, the sample cut distance is 20 ± 0,5 mm and the tear distance is 43 ±0,5 mm.

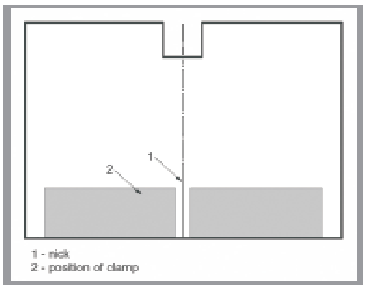

Figure 2.A method of sample preparation and of clamping in the Elmatear according to PN-EN ISO 13937-1:2002.

The tear test results summarized in Table 3. They show a significant increase in tear strength in warp directions and decrease in weft directions compared to those of uncoated fabrics. In warp tearing load, the coated sample sustained less contraction.

Table 3. The tear test results

Sample	Warp direction load (N)	Weft direction load (N)
Uncoated	14,83	15,94
0,05-10g Al_2O_3	16,46	13,01
0,05-20g Al_2O_3	15,24	12,86
0,1-10g Al_2O_3	17,58	15,33
0,1-20g Al_2O_3	15,69	13,99

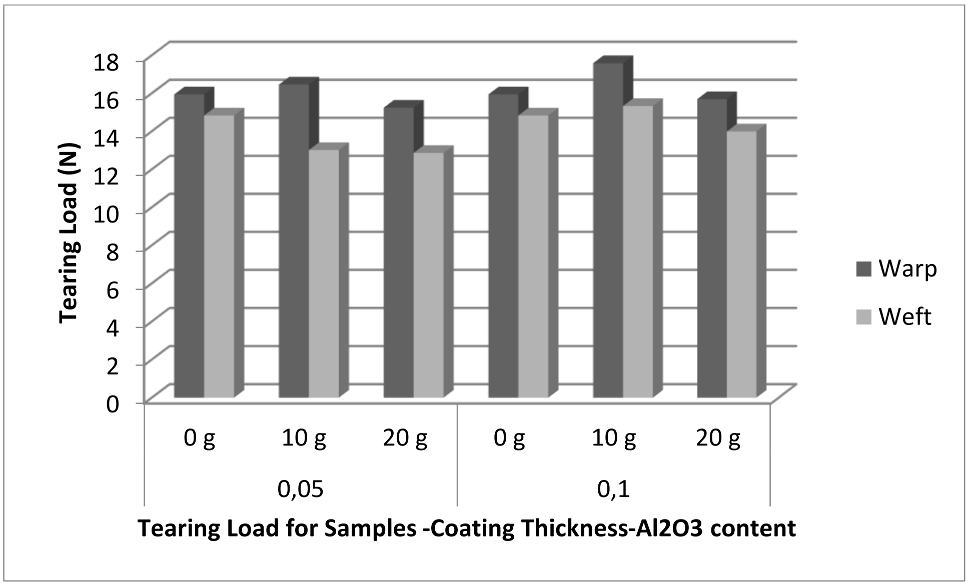

Figure 3.Contrast of warpandwefttearingloadforsamples

As seen in theFigure 3, tearingforce of coatedfabric is highercomparedtouncoatedfabric. It is explainedthatcoatedfabricsbypolyurethane-Al $_2$ O_3becomelesselasticforeasyformabilityandlowextensionandbreakingproperty.

3.3.Abrasion Test Results

To test the abrasion resistance of polyurethane-Al_2O_3 coated fabrics, the determination of pilling in appearance by the EMPA standard SN 198525 after 30,000 cycles according to the ISO 12947-4 were used. Theabrasion test results summarized in Table 4.

Table4. The abrasion test results

Sample	Pilling test values
Uncoated	3-4
0,05-10g Al_2O_3	4-5
0,05-20g Al_2O_3	4-5
0,1-10g Al_2O_3	4-5
0,1-20g Al_2O_3	4-5

Inadditiontotheconsiderableincrease in abrasionresistance, thecoatusedcontributedto a verysignificantincreasein fabricresistancetopilling. Thetestsperformedshowthatthisresistanceof thefabricscoatedwasincreasedfromthelevel 2 – 3 foruntreatedfabrictothehighestlevel of assessment: 5, whichindicatesa smoothfabricsurfacewithoutanysigns of abrasivewear.Thisverygoodresistancetopilling isalsoillustrated in thephotos of fabricsamplestakenfromtheMartindaleapparatusafterthepilling test (30000cycles)-Figures 4a, 4b, 4c &4d showfabricscoatedwith PU-Al_2O_3 .

4.Conclusions

1. It can be concluded from experimental results that breaking force and tearing force of coated fabrics exhibit different conclusions. Coated woven fabrics by polyurethane-Al_2O_3 become more elastic. Therefore, breaking force of coated fabrics decrease compared to uncoated fabrics. However, tearing force of coated fabrics is higher than that of uncoated fabric.

2. The mechanical properties of the PU- Al_2O_3coating can have a significant effect on the tear properties of coated woven fabrics. The tear properties of a PU-coated woven fabric depend on the coating thickness used.

3. The application of Al_2O_3 /PU-coatingappearstoimprovetheabrasionresistance of thesamples. An increase in thethickness of thecoatingalso has apositiveeffect on theabrasionresistance of thecoatedfabrics.

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