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Design and Waterproof of Car Coatings Using Art Simulation Techniques and Flora Polyacrylamide

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Abstract

Since car is one of the issues that people deal with constantly and daily, improving the efficiency of its components, such as seat covers, not only does not reduce its value, but also provides greater comfort to passengers. Improving the design of car coatings and waterproofing of fabrics which have different advantages such as reducing accumulation of dirt on the cloth are considered in this research. The aim of the study is using flora polyacrylamide (FPAA) waterproof material with a chemical structure of weak cationic, non-ionic through the conventional padding method on polyester fabrics along with art simulation techniques. For this purpose, different concentrations of the composition of flora poly-acrylic waterproof coating was used on polyester fabric. Hydrophilic and hydrophobic properties of polyester fabrics were evaluated by water absorption tests based on a standard test method called the American Association of Textile Chemists and Colorists 79 -2003. As such, art simulation techniques were applied to car seat covers. The results of the study demonstrate that the use of appropriate amounts of waterproofing flora polyacrylamide composition could significantly prevent water absorption from polyester fabrics. Therefore, waterproofed fabrics designed by art simulation techniques can be used in auto production centers in Iran.

Keywords: Design; Polyester; Seat covers; Simulation techniques; Waterproof

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1. Introduction

From the assessment point of view, automotive industry gives undivided attention to convenience. Hence, driver condition is one of the most important issues that must be considered in the process of automotive design. Therefore, in process of creating convenience in conjunction with the car, the driver and passengers are the main parameters in automotive industry. The term “seat comfort” normally refers to the short-term effect of a seat on the human body (Eibner, Fuhrman, & Purgathofer, 2009). The most effective approach here is asking several people to sit on different seats in a short timeframe and express their feelings. This method is often used for different cars (Dadashian & Godarzi, 2015). One of the important parameters which are effective in the car seat comfort is air permeability in car seat cover. This is one of the important factors of fibers and also a crucial parameter in some technical applications, such as filters, canopies, sails and clothing. The most effective structural parameters on the air permeability encompass the size of fibers, the size of liner warp and weft and the texture (Dehnavi, 1995). This characteristic is defined as the rate of air flow in substances under the differential pressure between two levels of a fiber (Noorpanah, 1999). The supplementation that repels water, oil and solid contaminants is very important in all the stages of textile industry, including weaving, homemade and technical textiles. Water repelling or hydrophobic is performed using fluoro carbon. Waterproof solutions could be utilized as a hydrophobic layer around a knitted fiber especially cotton textiles made with synthetic fibers and also a knitted cotton cloth (Chaitanya, 2013). Among the outstanding features after completion of waterproof fabrics are high durability during washing and dry cleaning, compatibility with cationic and non-ionic products, being diluted with hot and cold water, and not damaging the darkness or natural color (Noorpanah, 1999). The most commonly used fabric for car seat covers is polyester which normally has both warp and weft. There are pores between the warp and weft of yarns of the fabric which play an important role in the application of textile industry including underwear, flammability, thermal insulation, and protective functions. The presence of pores in fabric causes air permeability (Araujo, Fanguerio, & Hong, 2003). Simulation is one of the most affordable methods. Simulation is imitating the real thing, social status or a process that usually represents a number of characteristics or key behaviors in a physical or abstract system. The design ability for powerful statistical solutions ensures that directors achieve their organization goals (Shephard, 2009). In this research, a flora polyacrylamide (FPAA) waterproof material with a chemical structure of weak cationic, non-ionic was applied to polyester fabrics in order to waterproof and design car coatings using art simulation techniques. Therefore, the study aims at improving the design of car coatings and waterproofing of fabrics which have different advantages such as reducing accumulation of dirt on the fabrics.

2. Materials and Methods

2.1. Procedure and method of preparation

In this study, eight 15 × 30 cm polyester samples, each piece 4 g weight, were used, the total weight being about 32 g. The warp yarn filaments score $\frac{150\ \text{den}}{\text{Fy}}$ was fusion- intermingle of texture and the weft yarn of Fdy common polyester score was about 150 den. Also, the warp density was about 32 Dwf /1 cm, and the weft density was 23 Dwf /1 cm.

2.2. Pre-washing

In order to eliminate waste materials and starched fabrics, the samples of polyester fabrics were prewashed under instruction presented before the finishing operations in Table 1. Then, to overcome the effects of debris, they were rinsed several times. Finally, the samples were dried at ambient temperature.

Table 1 Pre-washing of polyester fabric at accurate condition

Run	Terms of use	The quantities needed
1	Sodium carbonate 10 %	1.0 %
2	Detergent 3%	3.0 %
3	L:R	1 : 30
4	Polyester fabric	28 g
5	Temperature	60 oc
6	Time	15 min

2.3. Impregnation of polyester samples with waterproof materials

Impregnated of polyester samples were performed and completed with padding by different amounts of waterproof materials called flora polyacrylamide (FPAA). Various concentrations of FPAA waterproof agent were used as the major variable of the technical part in this research. The reason for this selection was the high adjustability of the FPAA agent with the polyester synthesized fiber, the easy availability of the commercial form, and its reasonable price. FPAA was used with the different percentages of 1.0, 5.0, 10.0, 20.0, 30.0, and 40.0 % (based on the weight of bath: O.W.B.). A concentration higher than 40.0 % (O.W.B.) causes not only undesirable feelings in the fabric handle, but also leads to limitations concerning its economic aspect. Therefore, concentrations lower than 40.0 % (O.W.B.) were considered in this study. The exposure time of the impregnated fabric was three minutes in a solution, which was stirred with a glass stirrer. After removing the fabric from the solution, it was placed on the pad machine. The used polyester samples and materials are presented in Fig 1.

Fig 1 Dispersing FPAA bath of for impregnating of polyester fabric

2.4. Drying and curing of samples

The drying and curing process took place respectively after the impregnating treatment of polyester samples with waterproof materials. Accordingly, the samples were dried at 120 °C for five minutes and the curing was performed at 130 °C for four minutes.

3. Results and Discussions

The water drop absorption time of polyester fabrics was determined based on AATCC 79-2000. A drop of water from a specific distance was placed on the surface of fabrics in order to evaluate the hydrophobic features of the treated samples, and then the spreading time of the water drops was recorded by a stopwatch. Moreover, an oil absorption test like moisture absorption test was examined. This test was performed by the mean values of three on each sample separately and in different areas of the fabric that were presented in Fig 2 and 3. Therefore, the static water contact angle values were measured on a self-developed goniometer apparatus coupled with a high-resolution camera. The water droplets, each of which with the volume of 5 μL, were utilized in the contact angle tests; the reported values presented the average of three measurements at different locations (Shateri-Khalilabad & Yazdanshenas, 2013). The process of air permeability test was measured using a standard test method. Another consideration and evaluation was the abrasion resistance in the design of car seat covers fabrics. To conduct such a test, the fabric abrasion device was used as a Rubtester that was manufactured in Hungary. The fabric was prepared in dimensions of 30

× 20 cm and was then cut by a stencil in a circular shape. Afterwards, the fabric was inserted into the machine and the abrasion procedures were performed. To view the samples with different levels of waterproofing material, as well as control samples, a scanning electron microscopy device named SEM PHENOM Prox model was used. To achieve this, different magnifications of × 5000, × 10000, × 15000, and × 20000 were utilized.

Fig 2 Water drop test

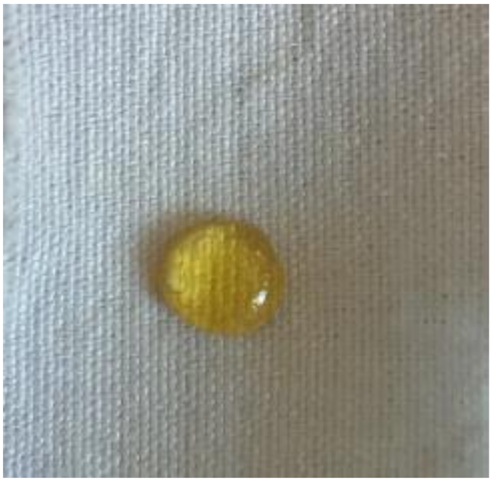


Fig 3 Oil drop test

Table 2 Different properties of impregnated polyester fabrics with FPAA

Run	FPAA % (O.W.B)	Water absorption (s)	Static contact angle (degree)	Oil absorption (s)	Add-on (%)	Air permeability	Abrasion resistance
Control	------	21.6	90 < ϴ < 100	18	-----	16.250	2975
Washed	------	9.0	80 < ϴ < 90	14	-----	19.072	1100
1	1.0	47.1	100 < ϴ < 110	300	0.43	16.274	985
2	5.0	47.2	110 < ϴ < 120	300	2.7	17.778	2004
3	10.0	300.0	120 < ϴ < 130	600	2.7	20.119	1812
4	20.0	450.0	140 < ϴ < 150	1200	3.4	19.774	3343
5	30.0	600.0	150 < ϴ < 160	1200	3.4	20.348	3648
6	40.0	800.0	150 < ϴ < 160	1200	3.4	17.004	4731

The influence of FPAA treatment on the static water contact angle, the absorption time of water and oil control, and the washed and treated polyester fabric surfaces were reported in Table 2. The FPAA treatment significantly led to the increase of the static water contact angle, oil and water drop absorption time (Table 1). Treatments with FPAA assist the coating of some of hydrophobic components on polyester surface fabrics. Static water contact angle and the absorption time of water and oil on treated polyester samples increase with higher concentrations of FPAA as it could be illustrated for each of the following Runs (Run: 1-6, Table 1). For the polyester samples treated at 30.0 and 40.0 % FPAA (Run: 5-6, Table 1), the static contact angle was $150 < \Theta < 160$ which demonstrated a super hydrophobic property of the fabric (Nosonovsky & Bhushan, 2009). The results of the air permeability standardized test exhibited in Table 2 demonstrate that air passing through the sample Run: 5 is at the very least. The final limit of using FPAA to improve air throughout is 30%. Therefore, sample Run: 5 with 30% of the waterproofing material was able to give the best results in this test. The results of the abrasion resistance test show that whenever the level of FPAA became higher in samples, the abrasion resistance was increased. A positive relationship was therefore found between FPAA and the abrasion resistance. In the sample Run: 6 where the highest percentage of FPAA was used, the abrasion resistance was maximized. By increasing the amounts of FPAA, air permeability test was minimized. In compliance with the ASTM D570 and ASTM D3393-91 standards, it could be concluded that the increasing weight after sample Run: 4 was constant. The percentage of the FPAA use and the content absorbed by sample Run: 4 and 5 were also constant. Consequently, the optimized sample was sample number 5.

3.1. Design tools

It could be suggested that canvas and application of fabric are one of the best basis for the simulation. Painting tools included the markers, acrylic paint, glue stick, spray, and brush.

3.2. Air simulation techniques

In this study, art simulation techniques refer to the process by which the designer starts creation, innovation, and design production, applying the science of art materials and instruments based on the type of the used fabric in research, as the final production has a complete sense of the produced fabric. It should be mentioned that the dominant element in the art simulation techniques of fabric is texture utilization which has a significant effect on the creation of the fabric sense.

The term ‘collage’ is taken from French which denotes the paste of colors. Collage is an imaging method in which objects or other shapes take place on the surface, called the base, to assist in the process of designing. After some initial plan, 20 projects were approved, which are presented in Fig 4.

Fig 4 Approved samples based on art simulation techniques

3.3. Texture

Some of the plans were sent to the factory after the confirmation, and the results illustrated that the tissue had the capability to be designed and could be applied to reach mass production.

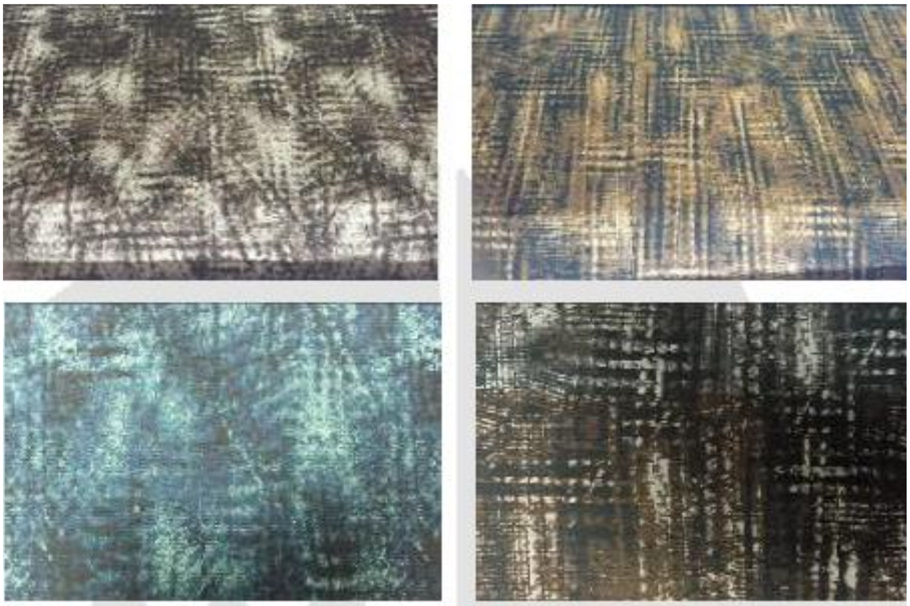
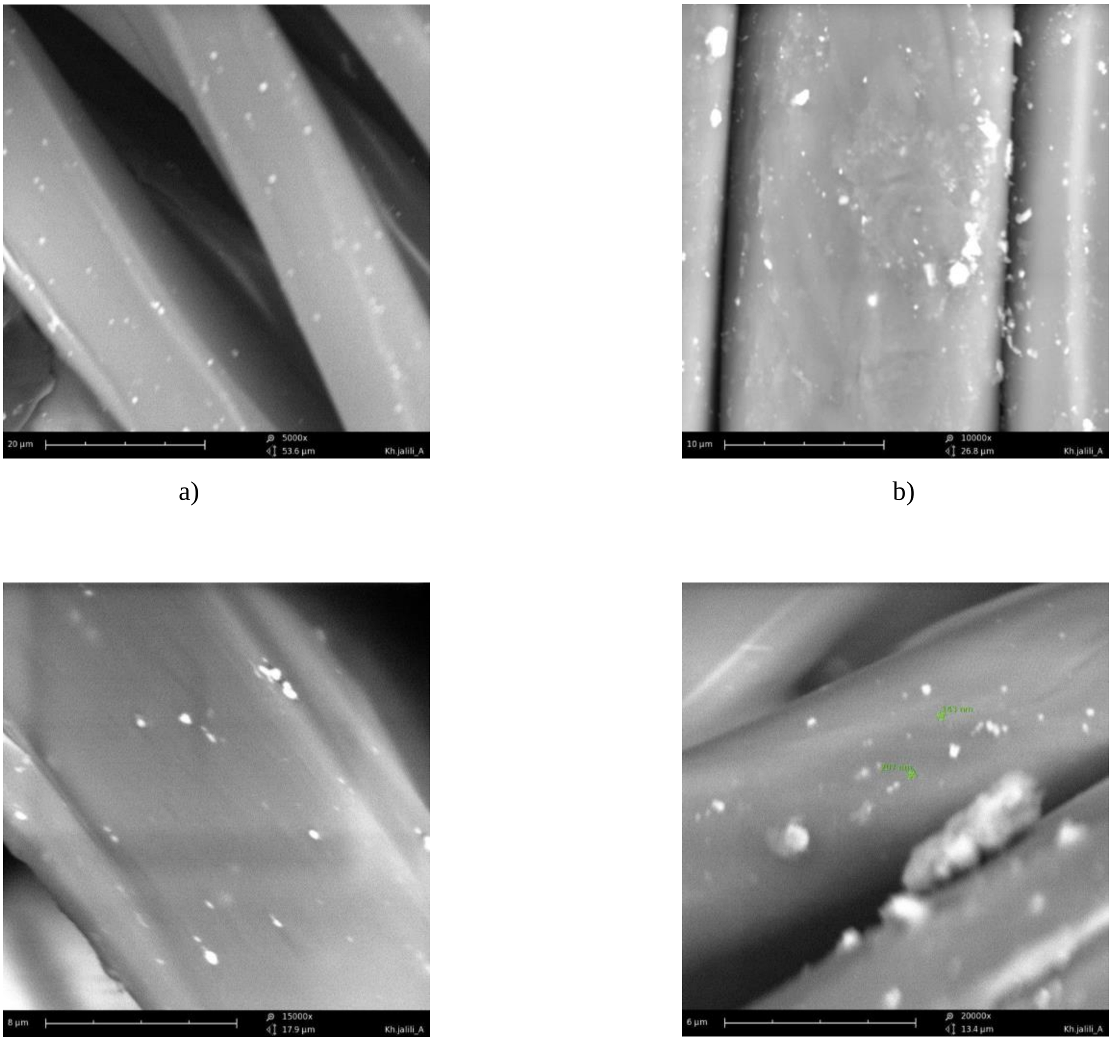


Fig 5 Texture mapping of fabrics

3.4. Scanning Electron Microscope (SEM)

In order to evaluate the uniformity and to indicate the distribution of different surfaces of water-resistant polyester fabric structure, SEM analysis was utilized. Samples with × 5000, × 10000, × 15000, and × 20000 magnifications were analyzed. As it could be seen from the changing moisture content and the focus of microscope, the particle size was changed. The SEM images of the washed polyester fabrics with different magnifications are illustrated in Fig 6.



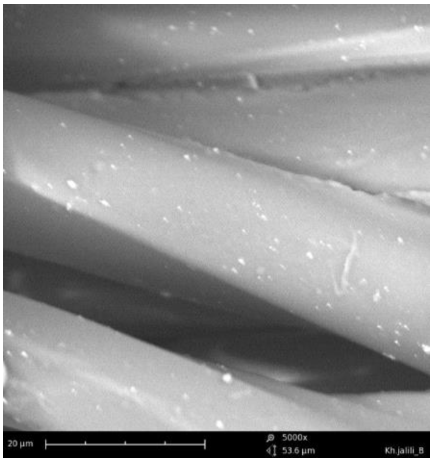
a) b)

c) d)

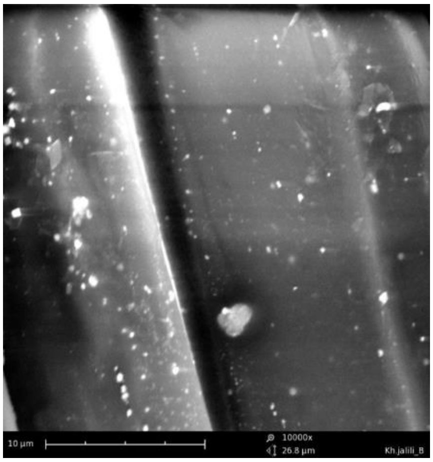
Fig 6 SEM of washed sample with different magnifications

(a) × 5000, b) × 10000, c) × 15000, d) × 20000)

Besides, the SEM images of the treatment with 5% FPAA (Run: 2) are exhibited in Fig 7. No FPAA polymeric agent was used in the washed polyester fabric.



a)



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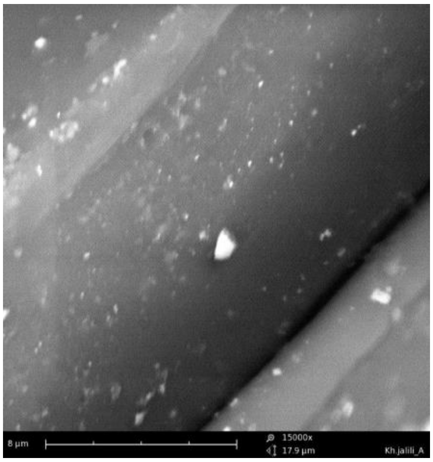
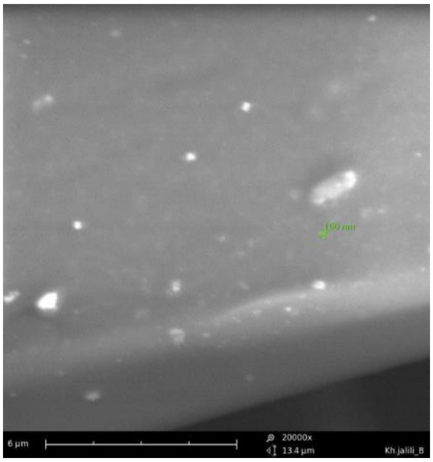


c)



d)

Fig 7 SEM of impregnated polyester sample with 5% FPAA (Run: 2) with different magnifications (a) × 5000, b) × 10000, c) × 15000, d) × 20000)

The SEM images of polyester fabric treated with 30.0% FPAA (Run: 5) is shown in Fig 8. The textile covering operations were carried out by 30.0% water-resistant techniques. Also, when the percentage of FPAA was increased, more particles could be seen throughout the fiber.

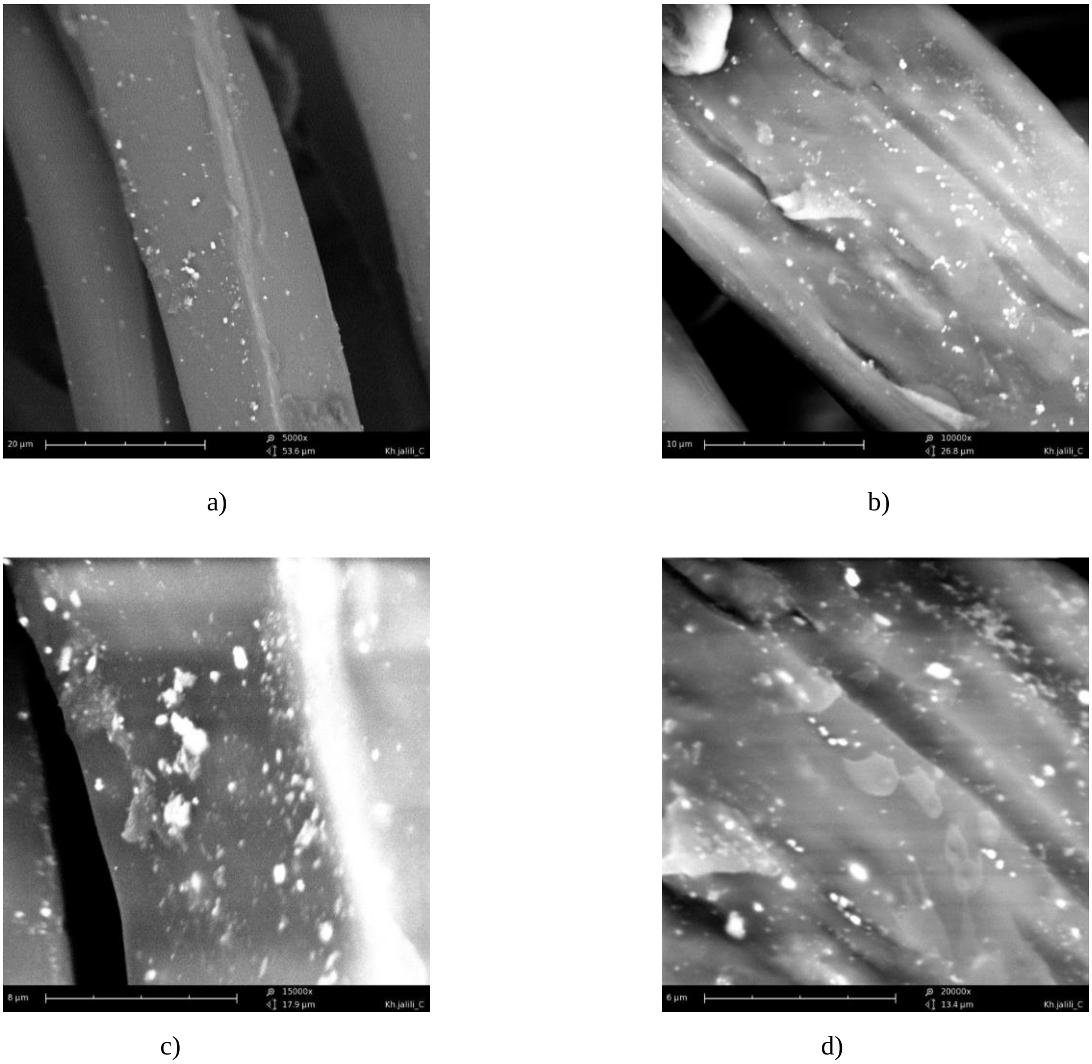


Fig 8 SEM of impregnated polyester sample with 30% FPAA (Run: 5) with different magnifications (a) × 5000, b) × 10000, c) × 15000, d) × 20000)

4. Conclusion

Based on the previous literature on the fabrics of car seat covers, and due to the dearth of references in Persian and the limitations concerning the lack of domestic textile factories for cars seats, the obtained results encompass at least 20 car seat cover fabrics that were designed. The present study hence investigated the cases in order to answer to the main research question. The resultant design, due to its water-resistant capacity, contributes to the increase of confidence in the term of high-risk pollutions. Due to the properties of air permeability, making use of the fabrics that have been prepared out of such samples could be very optimal in preventing passengers from high transpiration. The obtained samples could also be widely utilized because of the strength and stability of fabrics in the long-term. Distinctive design is the capability that makes the design of a car seat cover fabric particular, which could be achieved by simulation techniques. It was tried, in this study, to apply as many colors and techniques as possible in the textile design, which were appropriately based on the science of psychology of colors and forms.

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