

# The Study on Preparation and Performance of Surface Treating Agent for PVC Coated Fabric

Lingyu Chang, Ruiting Huo

Key Laboratory of Advanced Textile, Composites Department of Textiles, Tianjin Polytechnic University,  
Tianjin, China

Email: changlingyu1987@gmail.com, huort@tjpu.edu.cn

**Abstract:** PVC coated fabric has poor ageing resistance and plasticizer migration problem. The surface treatment can prevent the plasticizer in the PVC from migrating to the surface, and improve the ageing resistance and the service life of the PVC coated fabric. The effects of the thickener, fluorocarbon resin, hydrophobic additive and the silicone emulsion in the top finish formulation on the performance of the coated fabric were investigated. The experimental results showed that the contact angles of water droplet on the surface of the treated material were  $100.5^\circ$  and the water droplet could easily roll off the surface. The adhesive property between the top layer and PVC layer was excellent. The ageing resistance and the anti-fouling and self-cleaning performance of the finished material were improved.

**Keywords:** PVC coated fabric; Surface treatment; Fluorocarbon resin

## 1. Introduction

Polyvinyl chloride (PVC) coated fabric is a composite material which is produced by coating or laminating process<sup>[1]</sup>. The material and fabrication technology of base fabric have a major impact on the mechanical properties such as tensile strength and tear strength of PVC coated fabric. The performances of the coated fabric, such as waterproof, fire retardance, light transmission and resistance to ultraviolet radiation, were mainly determined by PVC layer.

PVC coated fabric has been used widely in stadiums, entrance corridor, public entertainment square, and exhibition center, shopping centers, etc<sup>[2]</sup>, because of its lower price. However, PVC coated fabric has a short service life when it is directly exposed to UV light. Moreover, it's well known that the plasticizers migrate towards the surface over time and then they attract and retain dirt, which causes the appearance becoming ugly and seriously affects its application effects. So a surface treatment is necessary to protect the under layers of the PVC coated fabric from UV degradation and to prevent plasticizers from migrating towards the surface.

With the surface treatment, the performance of PVC coated fabric, such as durability and pollution resistance, were improved, and the service life had been extended<sup>[3]</sup>. The commonly used surface treating agents are mainly solvent type PVDF and polyacrylate, containing VOC which is harmful to human and environment. With the increasingly stringent environmental regulations, their application will be limited<sup>[4]</sup>.

Water-base fluorocarbon has characters of self-cleaning, anti-pollution, UV-resistance and weather resistance<sup>[5]</sup>. The surface treating with water-base polymer has many advantages such as low energy consumption, low emis-

sions, and low pollution<sup>[6]</sup>. Recently, the study of water-base fluorocarbon becomes more and more active. In high-performance coatings fields, water-base fluorocarbon raised concerns because of high age resistance and contamination resistance as building exterior wall paint and low pollution as building interior wall paint<sup>[7]</sup>.

In this paper, the application of water-base fluorocarbon resin in top finish of PVC coated fabric was investigated. The effects of the concentrations of fluorocarbon resin, thickener and additive in formulation on the surface performance were studied.

## 2. Experimental

### 2.1 Materials

The materials used in this experiment are F-500 (water base fluorocarbon resin), RT (thickener), HC (self-made hydrophobic additive) and PVC coated fabric.

### 2.2 Top treatment of PVC coated fabric

The surface of PVC coated fabric was treated with a surface treating agent containing fluorocarbon resin, thickener and additive HC. Then, the coated fabric was dried for 3min at  $100^\circ\text{C}$  and cured for 2.5min at  $170^\circ\text{C}$ . The concentrations of fluorocarbon resin and thickener in formulation were 0~30% and 0.2~5%, respectively.

### 2.3 Property test

The surface property of the PVC coated fabric was characterized by contact angle and rolling angle of water droplet on the coated fabric. The adhesive property between top layer and PVC layer was estimated according to GB9286-1998. The heat aging properties was tested according to HG/T3049-1999. The dust resistance of the PVC coated fabric was estimated by the dust removal

extent when water drop crawled over the dust particles on the inclined surface of PVC coated fabric.

### 3. Results and Discussion

#### 3.1 Effect of the amount of thickener RT on properties of the surface treating agent

The used fluorocarbon resin has low viscosity and high fluidity, which is a disadvantage to the surface treatment of PVC coated fabric. So it is essential for thickener to be added in the formulation, in order to obtain a viscosity suitable for the surface coating of PVC coated fabric. The influence of RT on the performance of the surface treating agent was shown in the Table1.

With the increase of the thickener RT content, the viscosity of surface treating agent increased. If the ratio of thickener RT to fluorocarbon resin was 0.2%, the surface treating agent had low viscosity and high fluidity, resulting in an uneven top layer on the treated PVC coated fabric when coat PVC. However, when the ratio of thickener RT to fluorocarbon was above 2%, the surface treating agent had so high viscosity that the coating property of the surface treating agent was poor, and the formed surface on PVC coated fabric was tacky. It was found that the optimal ratio of thickener RT to fluorocarbon resin was 0.5%.

#### 3.2 The influence of the concentration of fluorocarbon

#### resin on the property of surface treating agent

Fluorocarbon resin has low surface energy and good UV-resistance. So fluorocarbon resin plays an important role in top finish of the PVC coated fabric. The surface treatment with fluorocarbon resin can improve the ageing resistance and service life of the PVC coated fabric by limiting the migration of plasticizer in PVC, and impart self-cleaning performance to the coated fabric by reduction of rolling angle. The effect of fluorocarbon resin on the performance of the surface treating agent was shown in Table 2.

When the concentration of fluorocarbon resin was less than 9%, it was hard to form an entire membrane on the surface of PVC coated fabric and the contact angle is small, the coated fabric had poor ageing resistance. It was found that the ageing resistance of the treated PVC coated fabric increased with the increase of fluorocarbon resin concentration

Compare with the untreated PVC coated fabric, the weight loss of the treated PVC coated fabrics were less. With the increase of the fluorocarbon resin concentration in the formulation, the amount of weight loss, color difference and the change in contact angle of the treated PVC coated fabrics reduced after the heat aging process. This showed that the resin plays an important role in limiting the migration of plasticizer and improving the ageing resistance of PVC coated fabric.

**Table 1 Effect of thickener RT on the performance of surface treating agent**

RT/ Fluorocarbon resin	Viscosity (Pa·s)	Application property
0.2%	8080	Bad
0.5%	12300	Good
1%	282000	Good
2%	2350000	Bad
5%	—	Bad

**Table 2 Effect of fluorocarbon resin on the performance of surface treating agent**

No.	Concentration of fluorocarbon resin	Contact angle/°	Ageing resistance			
			$\Delta g\%$	$\Delta \theta\%$	Adhesion rank	$\Delta E^*$
1	0	42.8	2.136	2.438	0	1.430
2	9%	55.3	1.149	1.581	0	0.732
3	13%	58.6	1.092	1.485	0	0.793
4	17%	65.1	1.073	0.850	0	0.573
5	20%	66.0	0.996	0.596	0	0.556
6	23%	67.8	0.970	0.512	0	0.442
7	26%	67.9	0.935	0.508	0	0.448

$\Delta g\%$  --- Weight loss after heat treatment;  $\Delta \theta\%$ --- change of contact angle after heat treatment;  $\Delta E^*$  --- Color difference after heat treatment.

**Table 3 Effect of HC on properties of the surface treatment agent**

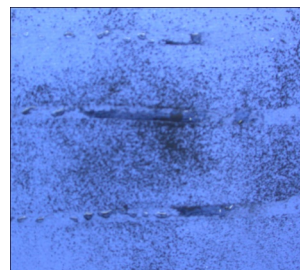
No.	Concentration of HC (%)	Contact angle/°	Rolling angle/°	Adhesion rank
1	0	80.8	15	0
2	2	88.2	13	0
3	5	93.4	12	0
4	10	90.0	12	0
5	15	92.3	11	0
6	20	93.4	11	0
7	25	94.8	10	0
8	30	97.7	10	0
9	35	92.4	9	0
10	40	94.5	10	0
10	45	98.5	9	0
11	50	95.3	9	0

When the concentration of fluorocarbon resin was above 20%, the PVC coated fabric had better heat ageing performance, with a little change in weight, contact angle and color. It was also found that the concentration of fluorocarbon resin has little effect on the adhesion between top layer and PVC layer.

**3.3 Effect of additive HC on the property of surface treating agent**

The hydrophobicity additive can reduce the surface energy, and it can affect contact angle and rolling angle. So hydrophobicity additive plays an important role in the self-cleaning of the PVC coated fabric. The effect of HC on properties of the surface treatment agent was shown in Table 3.

When PVC coated fabric were treated with the surface treating agent without HC, the contact angle was small and the rolling angles were big, leading to a poor self-cleaning ability (see Fig. 1). It was found that the contact angle can reach above 90° if the PVC coated fabric was treated with the surface treating agent containing HC, and the rolling angle decreased with the increase of HC content. When the concentration of HC in the formulation was 15%, the treated PVC coated fabric had better self-cleaning ability (see Fig. 2).



**Figure 1 PVC coated fabric without treatment.**



**Figure 2 The treaded PVC coated fabrics**

**4. Conclusions**

The effects of the components in the water-base surface treating agent were investigated. It was found that the treated PVC coated fabric had better performance in self-cleaning ability, heat ageing resistance and adhesion between the top layer and PVC layer of the coated fabric, when the concentrations of fluorocarbon resin and additive HC were 20% and 15%, respectively, and the ration of RT/ fluorocarbon resin was 0.5%.

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