Carbohydrate Polymers 113 (2014) 344–352

Contents lists available at ScienceDirect

Carbohydrate Polymers

journal homepage: www.elsevier.com/locate/carbpol

Preparation and properties of polyester fabrics grafted with O-carboxymethyl chitosan

Jingchun Lv[a], Qingqing Zhou[a], Guoliang Liu[a], Dawei Gao[a], Chunxia Wang[a,b,c,*]

[a] College of Textiles and Clothing, Yancheng Institute of Technology, Yancheng, Jiangsu 224051, China
[b] School of Textile and Clothing, Nantong University, Jiangsu 226019, China
[c] Key Laboratory of Eco-textiles, Ministry of Education, Jiangnan University, Jiangsu 214122, China

ARTICLE INFO

Article history:
Received 28 March 2014
Received in revised form 14 June 2014
Accepted 20 June 2014
Available online 11 July 2014

Keywords:
Carboxymethyl chitosan
Polyester
Saponified
Grafting
Contact angle
Surface charge density

ABSTRACT

Carboxymethyl chitosan (CMCS) was prepared with a view to develop a multifunctional finish on saponified polyethylene terephthalate (PET) fabric. CMCS was synthesized by chemical reaction with chloroacetic acid, and its chemical structure was characterized by Fourier Transform Infrared Spectrum (FTIR) and nuclear magnetic resonance (NMR). CMCS was grafted on saponified PET fabric using 3-(3-dimethylaminopropyl)-1-ethylcarbodiimide hydrochloride (EDC)/N-hydroxysuccinimide (NHS) and polyethylenimine (PEI)/glutaraldehyde (GA) as cross-linking agent. FTIR, scanning electron microscope (SEM) and energy dispersive X-ray (EDX) analyses confirmed CMCS grafting on saponified PET fabric surface. TGA indicated saponification and CMCS grafting did not affect thermal property of PET fabric. The CMCS grafting greatly improved wettability, antistatic property of saponified PET fabric without harmful effect on their physico-mechanical properties.

1. Introduction

Polyethylene terephthalate (PET) fiber has been extensively used in textile and clothing field due to its high strength, good wear resistance, excellent dimensional stability and chemical stability. However, the development of PET fiber is limited by its hydrophobicity and electrostatic property owing to the lack of polar groups (—OH, —COOH, and —NH_2) on polymer backbone. Some attempts have been made to make PET fiber hydrophilic and antistatic. One kind of methods is the copolymerization of PET with hydrophilic or conductive monomer, through which the electrical resistivity of PET fiber can be reduced, but other properties are influenced (Dai, Xu & Li, 2007; Kobayashi, Wood, Takemura, & Ono, 2006; Sano, Saegusa, & Kimura, 1995). The most common method is the application of finishing agent due to convenience and relatively low cost (Eom, 2001; Ploymalee, Charuchinda, & Srikulkit, 2010; Xiao, Chen, Wei, & Wu, 2009; Zaman, Liu, Xiao, Chibante & Ni, 2013).

To meet the demand of environmental protection, the application of natural textile auxiliaries such as chitin in finishing process has attracted a great deal of scientific and industrial interest as possible substitutes because of their availability of resources and no damage to the environment. Chitosan (CS) is the deacetylated derivative of chitin, which is the second most abundant polysaccharide next to cellulose. Due to biodegradability, biocompatibility, antimicrobial activity and non-toxicity, the application of CS is widely used in many fields such as biotechnology, medical and pharmaceutical applications, textile, wastewater treatment, food processing, agriculture and so on (Delben, Gabrielli, Muzzarelli, & Stefancich, 1994; Kim et al., 2008; Muzzarelli, 1985; Ravi Kumar, 2000; Rinaudo, 2006). However, the application of chitosan in textile is limited due to its poor water solubility above pH ~ 6.5 (Lim & Hudson, 2003). Therefore, the preparation of water soluble CS derivatives over a wide pH range attracts the attention of the researchers (Chen & Park, 2003; Lim & Hudson, 2004). Carboxymethyl chitosan (CMCS), a water soluble chitosan derivative by introducing the CH_2–COOH functional group into chitosan, has been extensively used as drug delivery system, metal ion chelating agent, flocculating agent, biomaterial and so on (Jayakumar et al., 2010; Sun & Wang, 2006; Upadhyaya, Singh, Agarwal, & Tewari, 2013; Wang & Wang, 2008). CMCS grafting on cotton fabric has been successfully carried out (El-Shafei, Fouda, Knittel, & Schollmeyer, 2008; Gupta & Haile, 2007).

* Corresponding author at: College of Textiles and Clothing, Yancheng Institute of Technology, Yancheng, Jiangsu 224051, China. Tel.: +86 0515 88298132; fax: +86 0515 88298261.
E-mail addresses: jingcn79@hotmail.com (J. Lv), zhouqq0516@163.com (Q. Zhou), gl7986@126.com (G. Liu), gdw8668@163.com (D. Gao), cxwang@mail.dhu.edu.cn (C. Wang).

http://dx.doi.org/10.1016/j.carbpol.2014.06.088
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To our knowledge, there are still no researches on CMCS grafting on PET fabric to improve its property. In this study, CMCS was prepared, characterized and grafted on saponified PET fabric. The saponified PET fabric before and after CMCS grafting was characterized in term of their surface properties, thermal properties, wettability, and antistatic and mechanical properties. The goal of this study was to develop a green antistatic surface finishing system to improve the antistatic property of polyester fabric.

2. Materials and methods

2.1. Materials

Chitosan with the molecular weight of 100,000 Da and the deacetylation degree of 85% was purchased from Zhejiang Golden-Shell Biochemical Co. Ltd. (China). 3-(3-Dimethylaminopropyl)-1-ethylcarbodiimide hydrochloride (EDC), N-hydroxysuccinimide (NHS) and 2-(n-morpholino)ethanesulfonic acid (MES) were purchased from Adamas Reagent Co. Ltd. (Shanghai, China). Polyethylenimine (PEI) and glutaraldehyde (GA) were offered by Aladdin Reagent Co. Ltd. (Shanghai, China). Polyester fabric (plain weave; 50D/24F warp and weft; weight $70 \pm 5\,g/m^2$) was supplied by Wujiang Fuhua Weaving Co. Ltd. (Jiangsu, China). All other chemicals used were of analytical grade and presented by Sinopharm Chemical Reagent Co. Ltd. (China).

2.2. CMCS preparation

Water soluble CMCS was prepared from chitosan as described previously (Chen & Park, 2003; Gupta & Haile, 2007; Soucek & Yi, 2011; Zheng, Han Yang & Liu, 2011) with minor modification. Briefly, chitosan (5 g), sodium hydroxide (13.5 g) and isopropyl alcohol (100 mL) were added into a flask (250 mL) to swell and alkalize at −20 °C for 24 h. After alkalizing, the mixed solution of monochloroacetic acid (7.5 g) and isopropanol (10 mL) was added into the reaction system drop wise in 30 min at 25 ± 2 °C. After 12 h, the reaction was terminated by adding ethyl alcohol (70%, 200 mL). The reaction products were filtered to obtain filtration residue. It was rinsed five times by ethyl alcohol (70–90%) and then absolute alcohol to eliminate salt and water. The obtained CMCS sodium salt was immersed in ethyl alcohol aqueous solution (80%, 100 mL), in which hydrochloric acid (35–37%, 10 mL) was added. After stirring for 30 min, the filtration residue was collected and washed by ethyl alcohol (70–90%) to neutral, and then vacuum dried immediately. The obtained finally product CMCS was stored in desiccated bag for further use.

2.3. Saponification of PET fabrics

PET fabric was hydrolyzed with sodium hydroxide (35 g/L) at 100 °C for 60 min using a liquor-to-goods ratio of 40:1. After saponification, PET fabric was immersed in acetic acid (2%) to remove residual sodium hydroxide and then rinsed in water. After drying, the saponified PET fabric was stored in a desiccator for CMCS grafting.

The degree of saponification (D_S) was measured according to previously reported method (Popescu, Muresan, & Grigoriu, 2011). D_S was calculated with the relation:

$$D_S(\%) = \frac{W_0 - W_1}{W_0} \times 100 \quad (1)$$

where D_S is the degree of saponification (%); W_0 and W_1 are the weights of PET fabrics before and after saponification.

2.4. CMCS grafting

CMCS grafting on PET was performed by two process technologies as follows:

(1) The saponified PET fabric was dipped in MES buffer (pH 5.5) and reacted with EDC (2 g) to obtain intermediate compound 1. NHS (1.2 g) was further added and the reaction was continued in an ice bath for 1 h in water to obtain intermediate compound 2 and then transferred into CMCS solution (20 mg/mL) and stirred in an ice bath for 30 min. The reaction was carried out at room temperature for 24 h to obtain CMCS grafted PET (PET-CMCS) fabric (Yu et al., 2011).
(2) The saponified PET was immersed in PEI solution (1 mg/mL) for 24 h at ambient temperature to acquire PET-PEI fabric. The PET-PEI fabric was immersed in GA solution (0.2 mol/L) for 60 min at 25 °C and then placed in CMCS solution (20 mg/mL) for 16 h at 4 °C to get CMCS grafted PET-PEI (PET-PEI-CMCS) fabric (Hu, Jou, & Yang, 2002; Xu, Wang, Fan, Ji, & Shen, 2008).

PET-CMCS fabric and PET-PEI-CMCS fabric were washed three times in double-distilled water and dried at room temperature for property measurement.

The degree of grafting (D_G) was measured according to previously reported method (Popescu et al., 2011). D_G was calculated with the relation:

$$D_G\ (\%) = \frac{W_{aG} - W_{aS}}{W_{aS}} \times 100 \quad (2)$$

where D_G is the degree of grafting (%); W_{aG} and W_{aS} are the weights of PET fabrics after grafting and after saponification, respectively.

2.5. Analysis methods

2.5.1. FTIR and ^1H NMR spectroscopy

FTIR spectra were recorded on a Nicolet Magna-IR 170 Fourier Transform Infrared Spectrophotometer (USA) at room temperature by the KBr squashed method. Data analysis was carried out using Origin 8.0 software.

^1H NMR spectra were recorded on a Bruker Avance III 400 Spectrometer (Germany). Sample was dissolved in DCl D_2O (1%, v/v) solution and D_2O at 25 °C, respectively (Zheng et al., 2011).

2.5.2. Water solubility of CMCS

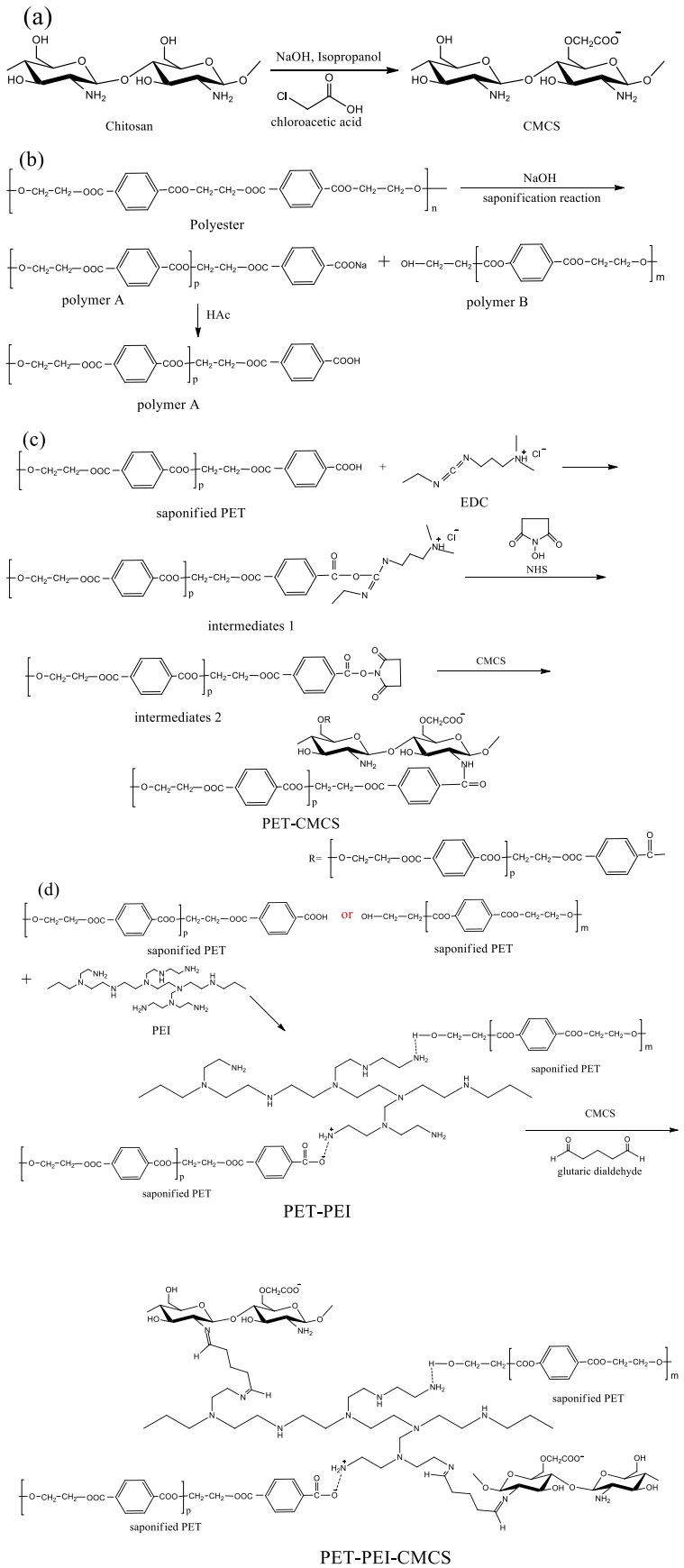
CMCS solution (0.2 mg/mL) was prepared using distilled water. The pH (2–11) of CMCS solution was adjusted by hydrochloric acid (0.5%) and sodium hydroxide (0.5%) to observe solubility change (Gupta & Haile, 2007).

2.5.3. SEM analysis

The surface morphology of PET fiber was observed with a QUANTA200 scanning electron microscope provided by FEI Company (Hillsboro, America). PET fiber was sputtered with gold under vacuum prior to observation. The SEM images were taken at an accelerating voltage of 3.0 kV. Moreover, the elemental analyses were studied using the energy dispersive X-ray spectrometer (EDX).

2.5.4. Thermogravimetric analysis

The thermal property test was carried out by a STA449C Thermogravimetric Analyzer (TGA, Germany). The cured samples (approximately 8–10 mg) were placed in an aluminum oxide sample pan and characterized by performing a scan from room temperature to 700 °C at a heating rate of 10 °C min^{-1} in nitrogen atmosphere.



Scheme 1. Chemical reactions to obtain CMCS (a), saponified PET (b), PET-CMCS (c) and PET-PEI-CMCS (d).

2.5.5. Wettability

Contact angle was measured to evaluate the wettability of fabric. The contact angle test was carried out on a JC2000D3 Contact Angle Analyzer (Zhongchen Digital Technic Apparatus Co. Ltd., Shanghai, China). A droplet of distilled water (5 μL) was placed on the surface of fabric fixed on the holder using a microsyringe at room temperature. Initial contact angle was recorded as soon as the droplet was on fabric surface (Wang, Du, & Qiu, 2010).

2.5.6. Antistatic property

The surface charge density was measured to determine the antistatic property of fabric by an YG (B) 403 Fabric Friction charged Tester from Wenzhou Darong Textile Instrument Co. Ltd. (Zhejiang, China).

2.5.7. Physico-mechanical properties

A Gretag Macbeth Color-eye 7000A spectrophotometer (USA) was used to test fabric whiteness.

According to the standard test ISO/DIS 3934.1-1994, the breaking force, the elongation at break and the breaking work were determined by using a HD026N+ Electronic Fabric Strength Tester from Nantong Hongda Experiment Instrument Co. Ltd. (Jiangsu, China).

2.6. Statistical analysis

The measurements of whiteness degree and breaking force were carried out fifteen times and an average value with acceptable relative standard deviation (RSD ≤ 4%) was obtained. One-way analysis of variance (ANOVA) and Tukey's Pair-wise Multiple Comparison were employed to analyze test results of whiteness degree and breaking force (Wang, & Qiu, 2012; Wang et al., 2013). There were fifteen determinations made in each cell and two levels were used. A *p*-value smaller than 0.05 was considered significant in all analysis.

3. Results and discussions

3.1. Mechanism of CMCS grafting on saponified PET fabric

PET, a synthetic polymer, is prepared by polycondensation of terephtalic acid and ethylene-glycol. The PET fabric could not react

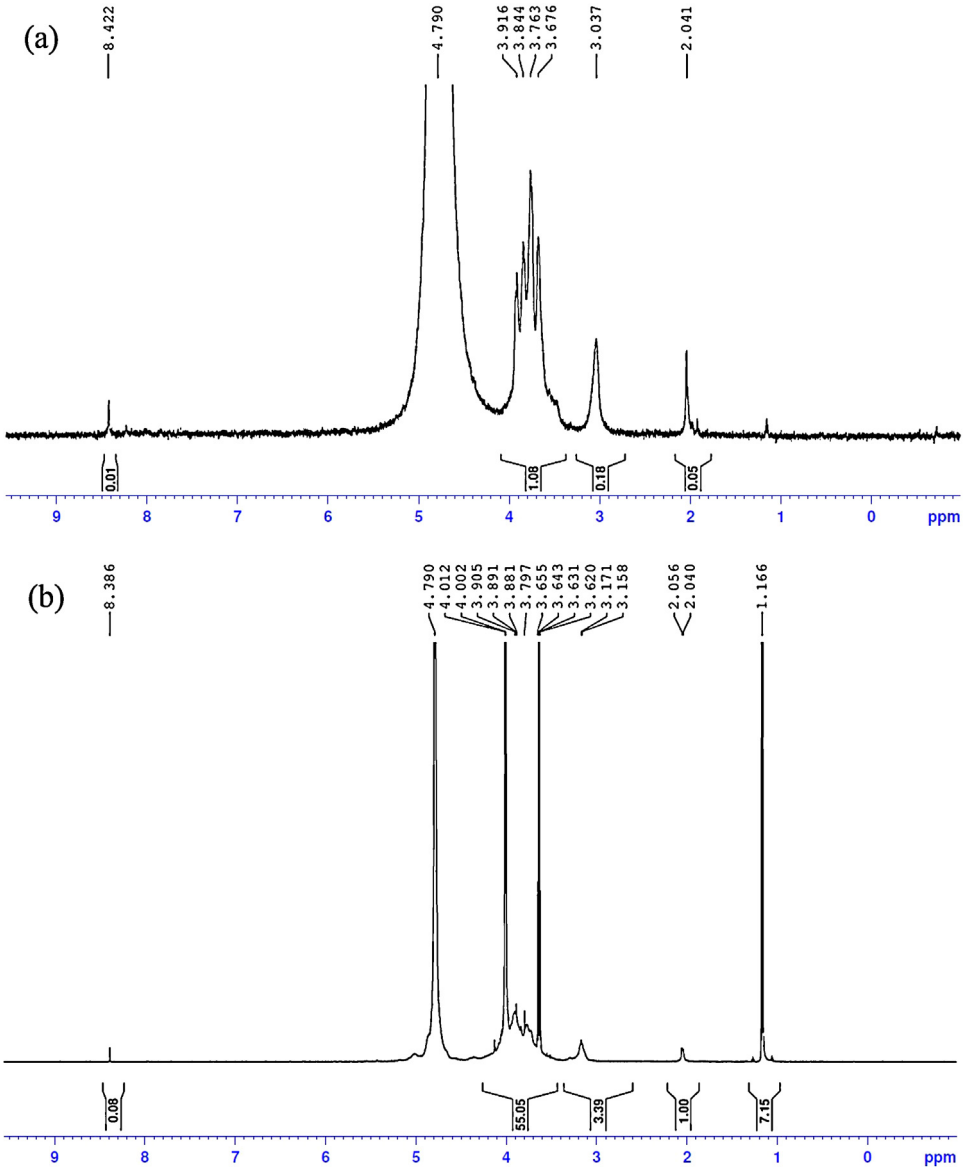


Fig. 1. ^{1}H NMR spectra of CS (a) and CMCS (b).

with CMCS (Scheme 1a) due to the only existence of terminal hydroxyl. The saponification of PET in NaOH solution (Scheme 1b) increases the number of carboxyl, which can react with CMCS via EDC and NHS. The possible mechanism could be illustrated by the reaction scheme as shown in Scheme 1c.

After saponification, the surface of PET fabric becomes rougher and the number of the end OH groups and COOH groups is increased, which is conducive to PEI deposition. The introduction of amino by PEI can react with GA by active aldehyde, and the further cross-linking reaction proceeds via nucleophilic addition between the aldehyde in GA and the amino in CMCS. The possible mechanism could be illustrated by the reaction scheme as shown in Scheme 1d.

3.2. ^{1}H NMR analysis and water solubility

3.2.1. ^{1}H NMR analysis

Carboxymethylation of chitosan was achieved with monochloroacetic acid and sodium hydroxide. The chemical structure of original chitosan and products were confirmed by ^{1}H NMR spectroscopy.

The ^{1}H NMR spectra of CS and CMCS were shown in Fig. 1. It could be seen that there were obvious differences in spectra of CS and CMCS. The proton assignment of CS (Fig. 1a) was at 2.04 ppm (CH_3, acetyl group of chitosan), 3.04 ppm (CH, carbon 2 of glucosamine ring), 3.6–3.9 ppm (CH, carbon 3, 4, 5 and 6 of glucosamine ring), 4.75 ppm (CH, carbon 1 of glucosamine ring). These resonances can be found in the ^{1}H NMR spectrum of CS described in report (Chen & Park, 2003; Zheng et al., 2011). However, the characteristic proton signals of CMCS (Fig. 1b) were also found to be appeared in the range of 4.0–4.1 ppm, which indicated the linkage of carboxymethyl groups to the hydroxyl position of chitosan (Zheng et al., 2011).

3.2.2. Water solubility

CS was completely soluble only below pH 6, while CMCS was completely soluble at neutral and alkaline pH owing to the introduction of carboxyl groups to the chitosan backbone. The insolubility of CMCS only around pH 4–5 could be due to the isoelectric point (p*I*) appeared in this range (Muzzarelli, Tanfani, Emanuelli, & Mariotti, 1982; Zhao, Wang, & Wang, 2003).

3.3. FTIR analysis

The chemical structures of CS and CMCS were also confirmed by FTIR. The FTIR spectra of chitosan and obtained CMCS were shown in Fig. 2a. As shown in Fig. 2a, basic characteristics of CS were found at 3444 cm^{-1} (O—H stretch), 2877 cm^{-1} (C—H stretch), 1656 cm^{-1} (amide I band), 1596 cm^{-1} (N—H bend), 1155 cm^{-1} (bridge—O stretch) and 1082 cm^{-1} (C—O stretch) as reported in literatures (Brugnerotto et al., 2001; Chen & Park, 2003; Zheng et al., 2011). It could be seen that the spectrum of CMCS was similar to that of chitosan but there existed some differences. The new absorption peaks at 1730 cm^{-1} (—COOH), 1080–1155 cm^{-1} (—C—O—), and 1626 and 1518 cm^{-1} ($-NH_3^+$) were the characteristics of O-CM-chitosan (Liu, Guan, Yang, Li, & Yao, 2001; Zheng et al., 2011). The results of FTIR spectra indicated carboxymethylation of chitosan.

The analysis of FTIR spectra showed the presence of CMCS grafting on saponified PET fabric. Fig. 2b showed the FTIR spectra of untreated PET, saponified PET (D_S 13.75%), PET-CMCS (D_G 6.88%) and PET-PEI-CMCS (D_G 4.13%) fabrics, respectively. The absorption spectrum of the untreated PET has the same characteristic bands compared with the spectrum of saponified PET. Comparing the spectra of untreated and CMCS-grafted fabrics, the new absorption bands were found at 1616 and 1578 cm^{-1} for PET-CMCS and 1618 and 1576 cm^{-1} for PET-PEI-CMCS, respectively, at 1626 and

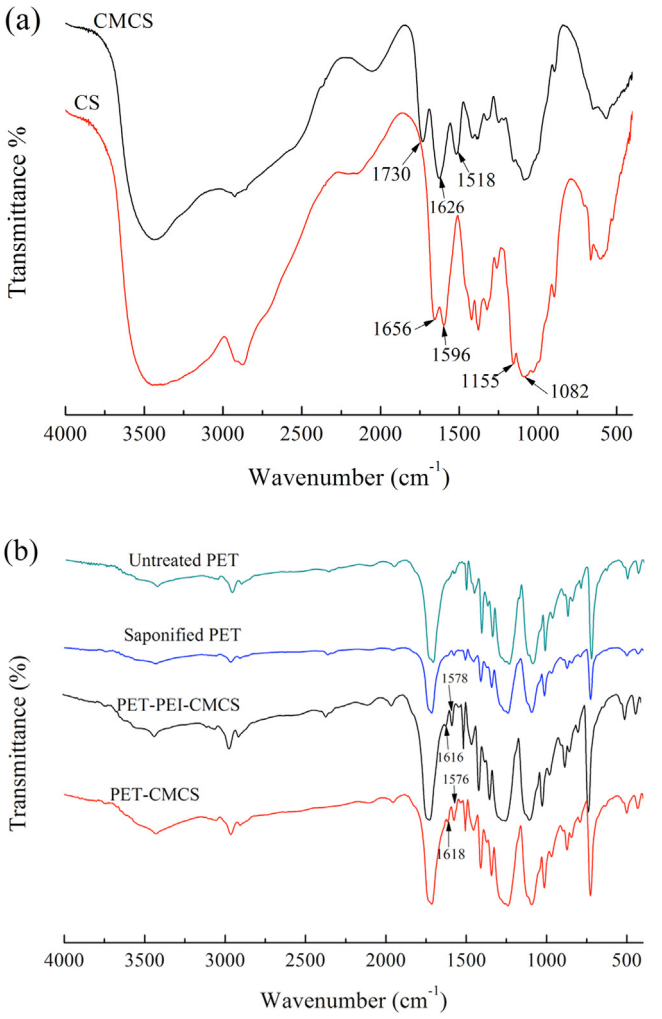


Fig. 2. FTIR spectra of CS and CMCS (a), untreated PET, saponified PET, PET-CMCS and PET-PEI-CMCS fabrics (b).

1518 cm^{-1} ($-NH_3^+$) for CMCS. That indicated the presence of CMCS on saponified PET fabric surface. The small shifts of the characteristic bands for the amidogen were due to the modification (from $-NH_2$ to —NH— for PET-CMCS) and nucleophilic addition (from $-NH_2$ to —N= for PET-PEI-CMCS). The peaks marked with arrows proved the grafting occurrence.

3.4. SEM analysis

SEM observations yielded information about the effects of saponification and CMCS grafting as shown in Fig. 3. Fig. 3a and b showed the SEM micrographs of PET fibers before and after saponification. The untreated PET fiber (Fig. 3a) presented a relatively smooth surface. However, owing to the depolymerization of very few PET macromolecules in NaOH solution, the saponified PET fiber (D_S 13.75%) (Fig. 3b) became fine and displayed micro-pits resulting in the rougher surface. Fig. 3c and d showed the SEM micrographs of CMCS grafted saponified PET fibers. The surfaces of PET-CMCS (D_G 6.88%) (Fig. 3c) and PET-PEI-CMCS (D_G 4.13%) (Fig. 3d) showed a considerable presence of CMCS. Especially, the micro-pits on the PET-CMCS fiber surface were nearly filled with CMCS. It could be explained by the increasing of surface roughness and the introduction of polar groups such as hydroxyl and carboxyl due to saponification, which facilitated physical adsorption and chemical crosslinking of CMCS on PET fabric (Popescu et al., 2011).

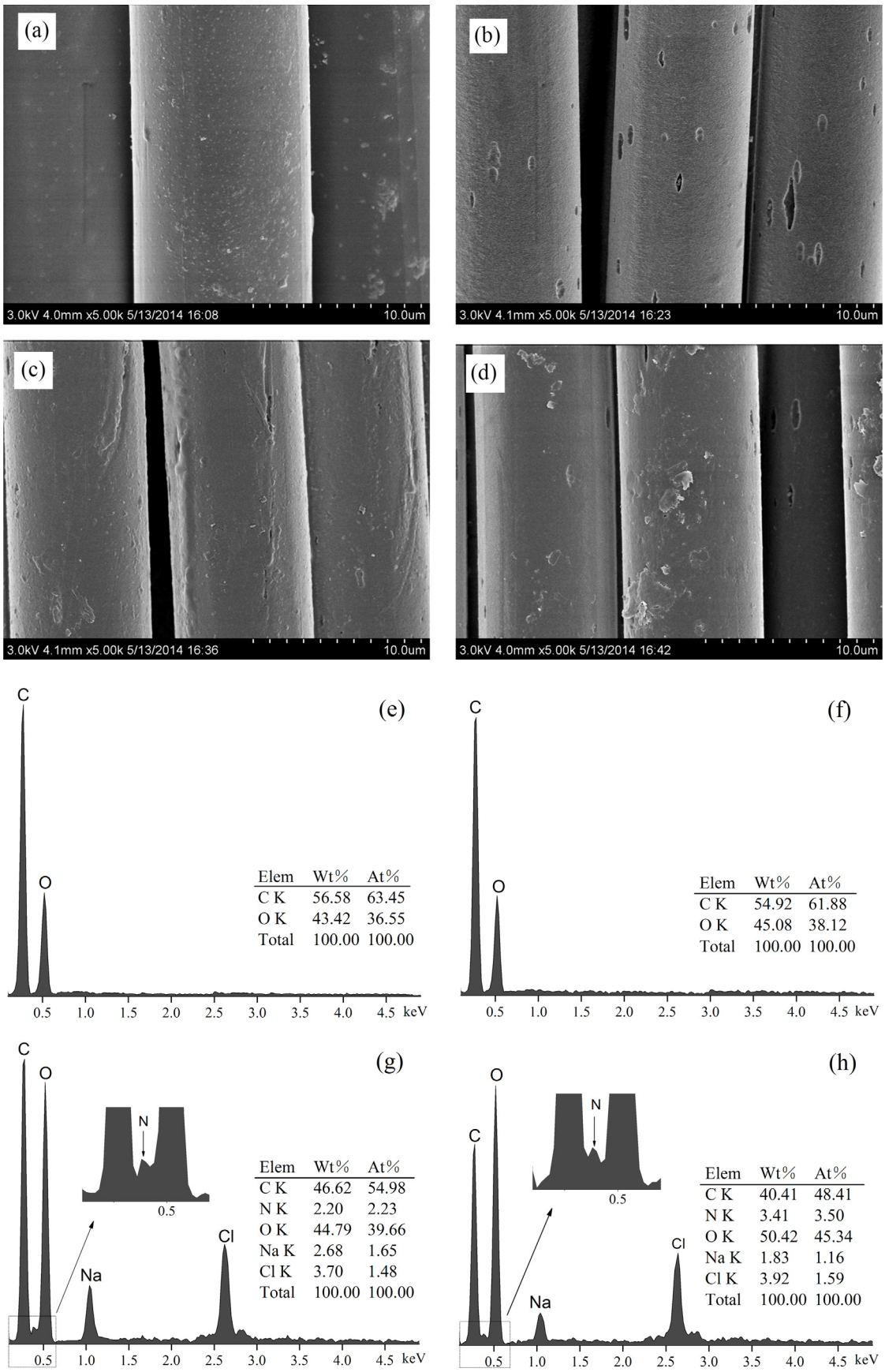


Fig. 3. SEM images of untreated PET (a), saponified PET (b), PET-CMCS (c) and PET-PEI-CMCS (d) and EDX spectra of untreated PET (e), saponified PET (f), PET-CMCS (g) and PET-PEI-CMCS (h).

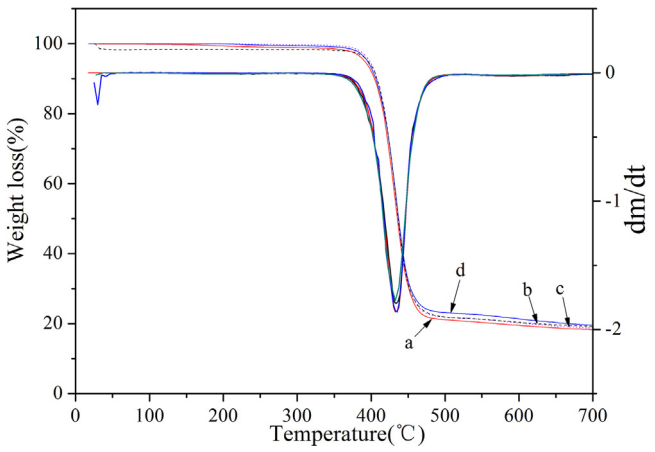


Fig. 4. TGA and DTGA curves of untreated PET (a), saponified PET (b), PET-CMCS (c) and PET-PEI-CMCS (d) fabrics.

The EDX measurements were carried out to determine the surface chemical composition of the untreated, saponified and CMCS-grafted fabrics. Fig. 3 showed the EDX spectra of untreated PET, saponified PET, PET-CMCS and PET-PEI-CMCS fabric. There was only carbon and oxygen atom on the surface of untreated PET fabric (Fig. 3e) and saponified PET fabric (Fig. 3f). Compared with the EDX spectra of untreated PET fabric (Fig. 3e) and saponified PET fabric (Fig. 3f), the EDX spectrum of PET-CMCS fabric (Fig. 3g) and PET-PEI-CMCS fabric (Fig. 3h) showed an additional peak for nitrogen atom, which signified the presence of CMCS on saponified PET fabric surface. Furthermore, the new peaks for sodium and chlorine atom in both PET-CMCS and PET-PEI-CMCS fabric were due to the residual of sodium chloride in the CMCS. The above characteristics proved the successful grafting of CMCS on saponified PET fabric surface.

3.5. Thermal property

The effects of saponification and CMCS grafting on saponified PET fabric were also reflected in fabrics thermal behavior, which was analyzed by means of thermogravimetric analysis (TGA).

Fig. 4 showed the degradation profiles of untreated PET, saponified PET (D_S 13.75%), PET-CMCS (D_G 6.88%) and PET-PEI-CMCS (D_G 4.13%) fabrics. It was clear that all TGA curves display a slower initial and then a rapid degradation process. The four changes of samples' mass loss were speeded up in the range of 350–450 °C, this indicated the main chains of polymer degraded seriously. Table 1 showed the TG and differential TG (DTG) parameters obtained for untreated PET, saponified PET, PET-CMCS and PET-PEI-CMCS fabrics. The extrapolated onset degradation temperature (Tei) was corresponding to the intersection of tangent drawn at the temperature point of the maximum weight loss rate with the extended baseline of the TG curve. The saponification and the grafting of CMCS did not considerably affect Tei of polyester fabric. The maximum decomposition temperature (T_{max}) of polymer can be determined precisely in the DTG curves, corresponding to the temperature peak in the DTG curve. It can be found that for untreated PET, saponified PET, PET-CMCS and PET-PEI-CMCS fabrics, there was also not a significant difference for T_{max} value. It was presumably due to carboxymethyl chitosan was grafted on the surface of fabric and did not affect the internal structure and crystallinity of polyester.

Table 1
TGA data of untreated PET, saponified PET, PET-CMCS and PET-PEI-CMCS fabrics.

Sample	Tei (°C)	T_{max} (°C)	Char residue at 700 °C (%)
Untreated PET	411.9	433.2	18.3
Saponified PET	410.3	432.7	20.8
PET-CMCS	411.4	432.9	18.5
PET-PEI-CMCS	409.8	433.4	19.3

3.6. Effect of CMCS grafting on polyester fabric

3.6.1. Wettability

The water contact angle analysis can be performed to investigate the wetting behavior of PET fabrics. The smaller the water contact angle is, the better the hydrophilicity of fabric is. Fig. 5 showed results of the water contact angle on untreated, saponified and CMCS-grafted fabric.

Smaller contact angle was found in saponified PET (D_S 13.75%) and CMCS-grafted PET fabric than that of untreated PET fabric, which manifested the improvement of fabric hydrophilicity. It could be attributed to saponification treatment and the presence of CMCS on fabric surface. The reaction of alkaline hydrolyze could increase the number of the end OH groups and COOH groups. Grafting CMCS onto the polyester could introduce more polar groups on fabric surface such as hydroxyl, amidogen and carboxyl, which contributed to H-bond formation with water. The contact angle of PET-PEI-CMCS (D_G 4.13%) was smaller than that of PET-CMCS (D_G

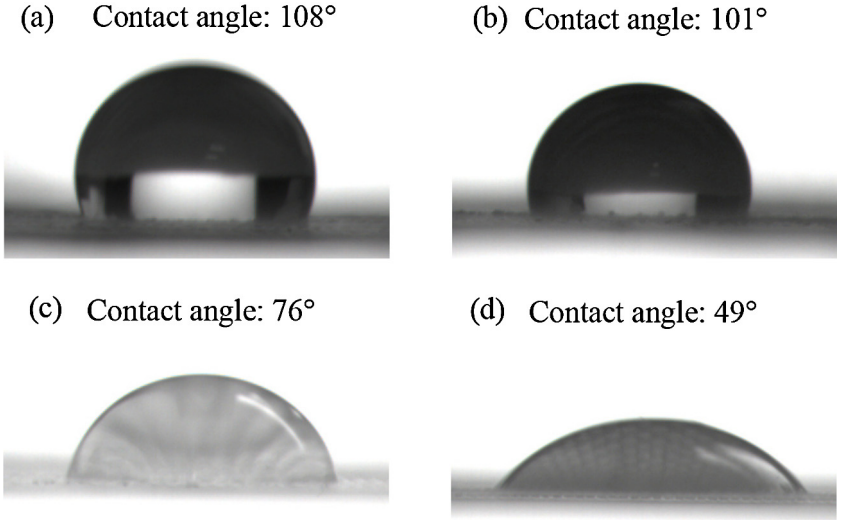


Fig. 5. Water contact angle of untreated PET (a), saponified PET (b), PET-CMCS (c) and PET-PEI-CMCS (d) fabrics.

Table 2
Physico-mechanical properties of fabrics.

Fabric	Whiteness degree (%)	Mechanical properties		
		Breaking force (N)	Elongation at break (%)	Breaking work (J)
Untreated PET fabric	74.03	689.3	24.76	3.36
Saponified PET fabric	73.59[ab]	531.1	20.34	1.79
PET-CMCS fabric	71.13[ab]	513.5[ab]	19.35	1.62
PET-PEI-CMCS fabric	68.80	504.6[ab]	17.90	1.45

[ab] Means with same letters are not statistically significantly different at $p > 0.05$.

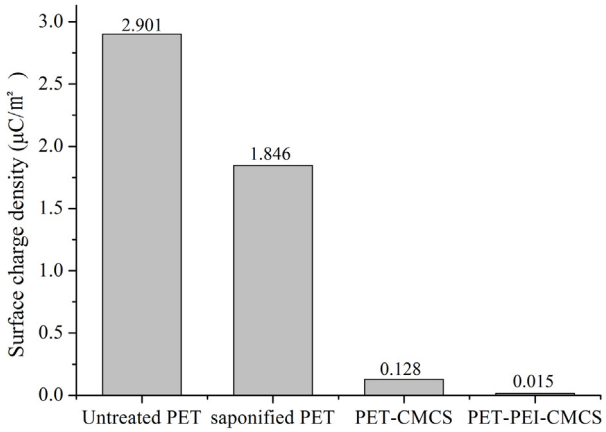


Fig. 6. Surface charge density of fabric.

6.88%) resulting from the introduction of a great number of amino groups to the fabric surface by PEI. Therefore, the wettability of PET-PEI-CMCS fabric was better than that of PET-CMCS fabric.

3.6.2. Antistatic property

The surface charge density could interpret the antistatic behavior of finished fabric. The surface charge density of fabric was shown in Fig. 5. The results showed that the surface charge density of saponified PET fabric (D_S 13.75%) was lower than that of untreated PET fabric. The micro-pits obtained by the saponification treatment, created the empty volumes that could be filled with water. The grafting of CMCS led to an even lower surface charge density than in the case of the fabric only saponified because the exterior of CMCS has good hygroscopicity. The surface charge density of PET-CMCS fabric (D_G 6.88%) and PET-PEI-CMCS (D_G 4.13%) fabric were much lower than that of PET fabric, decreased by 96% and 99%, respectively. Owing to the hydrophilicity of CMCS, the PET-CMCS fabric and PET-PEI-CMCS fabric could absorb a certain amount of moisture resulting in the decreasing surface electrical resistivity. The lower the electrical resistivity was, the less the static charges accumulated, the better the antistatic property was. Therefore, the antistatic property of PET-PEI-CMCS fabric was better than that of PET-CMCS fabric, which was consistent with the aforementioned wettability (Fig. 6).

3.6.3. Physico-mechanical properties

Table 2 showed whiteness degree and mechanical properties of fabrics. It could be seen that there was no obviously difference in whiteness between untreated PET fabric and saponified PET fabric. But the whiteness of PET-CMCS and PET-PEI-CMCS fabric was lower than that of saponified PET fabric. It was attributed to the faint yellow color of CMCS and PEI, which also confirmed the CMCS grafting on the surface of saponified PET fabric.

It could be detected that the presence of the saponification and CMCS grafting led to an alteration of the mechanical properties. With saponification treatment, the mechanical properties of saponified fabric were obviously diminished as compared to the untreated PET fabric, which proved the destructive effect of the alkaline agent. The CMCS exhibited film forming property on filament surface, and the membrane could limit filament slippage and enhanced fiber weak links. Moreover, the polyester fabric became more rigid after CMCS grafting. There was no observable difference in breaking force of PET-CMCS and PET-PEI-CMCS. Therefore, the existence of PEI on the fabric surface nearly did not affect the mechanical properties of fabric.

4. Conclusions

In this study, the preparation of water soluble CMCS and CMCS grafting on saponified PET fabric were successfully performed. The FTIR and NMR spectra confirmed the formation of CMCS, which could be soluble in water with the wide range of pH. CMCS was grafted on saponified PET fabric by EDC/NHS and PEI/GA, respectively, and the mechanisms of CMCS grafting on saponified PET fabric was proposed. FTIR, SEM and EDX studies confirmed the presence of CMCS on saponified PET fabric surface. TG analysis showed that saponification and CMCS grafting did not affect thermal properties of PET. The wetting properties of CMCS-grafted fabric were improved significantly over that of untreated PET fabric. The decrease in the surface charge density indicated the improvement in antistatic property of CMCS-grafted fabric. CMCS did not affect fabric whiteness but led to the decrease in mechanical properties.

Acknowledgements

The project was supported by National Natural Science Foundation of China (No. 11305138), Open Project Program of Key Laboratory of Eco-textiles, Ministry of Education, Jiangnan University (No. KLET1213) and Research Fund of Key Laboratory for Advanced Technology in Environmental Protection of Jiangsu Province (No. AE201321).

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