

Facile stearoyl chloride grafted cotton filter fabric and its application in oil-water separation

Yuan He (✉ yhe2015@sinano.ac.cn)

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Yejun Luo

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Zheng Li

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Chao Yan

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Yufang Chen

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Tao Jin

Guangzhou Institute of Chemistry: Chinese Academy of Sciences Guangzhou Chemistry Company Co Ltd

Research Article

Keywords: Stearyl chloride graft, Hydrophobic modified cotton filter fabric, oil-water separation

Posted Date: April 23rd, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-388792/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at Cellulose on July 5th, 2021. See the published version at <https://doi.org/10.1007/s10570-021-04046-8>.

Abstract

Chemical graft technology has been arisen widely interesting for its stronger chemical interaction between hydrophobic layers and substrates. Instead of coating technology based on physical function, chemical graft technology can produce hydrophobic membrane with more efficient durability for oil-water separation, which is essential in various industries like sewage treatment and oil spill. As cellulose-based material, cotton filter fabric is a flexible and degradable material with abundant hydroxyl groups, providing great possibility for graft reactions. Stearyl chloride has both hydrophobic alkyl chain and active acyl group, making it easily to be grafted onto cotton filter fabrics. Therefore, we propose to use stearyl chloride as hydrophobic layer and one-step modify cotton filter fabric. The obtained hydrophobic modified cotton filter fabric exhibits high contact angles ($CA_{\max} = 147^\circ$, $CA_{\text{avg}} = 141.8^\circ$), which only decrease slightly after 5 h droplet holding time ($CA_{\max} = 141^\circ$, $CA_{\text{avg}} = 126.3^\circ$). Besides, the modified sample also shows hydrophobic durability after three times gravity-drove oil-water filtration separation ($CA_{\max} = 137^\circ$, $CA_{\text{avg}} = 132.6^\circ$). This hydrophobic modified cotton filter fabric may have potential application in future oil-water separation and the stearyl chloride graft technology is an both effective and efficient way in hydrophobic modification.

Main Text

Oil-water separation is an inevitable process in many industries to protect environment and ecology. Sewage treatment, oil spill and other industrial fields need oil-water separation. Due to cost-efficiency and facile operation, membrane filtration method has caught wide attention of both academia and industry. One of the oil-water separation way is to fabricate hydrophobic membrane that only oil could permeate but water would be hold. There are various eco-friendly hydrophobic materials, such as natural waxes[Toruna et al. 2019; Guan et al. 2018], fatty acids[Heale et al. 2018; Dong et al. 2019], proteins[Liu et al. 2019; Shome et al. 2019], cellulose derives[Huang et al. 2018; Guo et al. 2016], biomass and agricultural waste[Anitha et al. 2018; Shishodia et al. 2019]. Besides, nanoparticles with low surface energy such SiO_2 [Wang wt al. 2019], TiO_2 [Ren et al. 2020] and ZnO [Thi et al. 2017] also exhibit hydrophobic properties. Coating a hydrophobic layer onto substrates is a popular route for modification strategy. For example, hexadecyl polysiloxane modified SiO_2 could act as a superhydrophobic coating on glass slides and exhibit a contact angle (CA) of 163.9° [Zhao et al. 2019]. $\text{Al}_x\text{Ni}_x(\text{Bi}_2\text{O}_3)_z$ coating synthesized by electrophoretic deposition and perfluorodecyltriethoxysilane (FAS-17) modification showed high CA of 169° [Guo et al. 2017]. Epoxy resins @ stearic acid- $\text{Mg}(\text{OH})_2$ coating[Si et al. 2016], benzoic acid incorporated Ag thin film coating[Sarkar et al. 2010] and other coatings[Bayer 2020] also show excellent hydrophobicity.

However, physical bonding between coating and substrates is usually too weak to bear many injuries in application. Thus, researchers put forward to replace this weak function by stronger chemical bonding. One typical example is to create -OH on steel or Al alloy surface by $\text{HNO}_3/\text{H}_2\text{O}_2$ etching, and then graft on stearic acid[Wang et al. 2008]. But steel and alloy are rigid substrates. In order to fabricate more

convenient handled hydrophobic material, researchers find out that cellulose based fabrics is a flexible, degradable and cost-less material with abundant -OH, which is a very suitable substrate for grafted modification. As -OH is an active group, various hydrophobic materials can be grafted on it. There are three major kinds of graft materials. The first one is fluorine-contained materials. Typically, tridecafluorooctyl triethoxysilane (FAS) grafted cotton shows superhydrophobicity as well as nice oil absorption capacity[Yu et al. 2019]. But the most serious drawback is that fluorine-contained materials are environmental unfriendly and difficult degradable, which will hinder their further application. The second kind is organofunctional polysiloxanes. Due to difficult adhesiveness on fibers of classical polysiloxanes, functional groups like hydroxyl, epoxy or others in organofunctional polysiloxanes structure are used to practice. For example, hexadecyltrimethoxysilane (HDTMS) can firstly hydrolyze to produce hydroxyl group and then graft onto cellulose fibers coated with SiO₂ after heating[Huang et al. 2010]. Epoxy unit in organofunctional polysiloxanes can directly reacts with the -OH on cellulose, but it will produce -OH after ring-opening reaction, which is not favor the hydrophobicity[Shang et al. 2010; Ma et al. 2018]. C=C group in organofunctional polysiloxanes can reacts with -SH under UV radiation, but in this situation, -OH on cellulose has to be changed into -SH in pretreatment process[Sun et al. 2016]. The third kind is long alkyl chain compounds. Researchers can utilize special reactive groups like in organofunctional polysiloxanes to graft alkyl chains onto cellulose fibers. Just like the reaction between -OH and epoxy, via which alkyl chains can be grafted by ether bond, thought there exist the similar drawback that new -OH will present[Muresan et al. 2013]. Besides, -OH could react with tert-butyl acetoacetate firstly to create carbonyl and then graft octadecyl amine[Rong et al. 2019]. It is the ester group and amino group connect cellulose and alkyl chains in this situation. Cellulose-based material is also reported to be grafted covalently with dithiodiglycolic acid through photothiol-X chemistry and further hydrophobic modified via esterification[Bretel et al. 2018]. There also exists many reports that deposit SiO₂, TiO₂ nanoparticles[Biswas et al. 2021] or polymer film[Joshi et al. 2020] on cotton surface firstly and then grow on alkyl chains. Strictly, these should be included into coating methods because the connecting function between cotton and SiO₂ is physical absorption instead of chemical bonding of directly grafting alkyl chains.

Our group also used to graft alkyl chains on flexible cotton filter fabrics via activators regenerated by electron transfer atom transfer radical polymerization (ARGET-ATRP)[Li et al. 2019]. Although the obtained hydrophobic modified fabric exhibits high CA value of 145°, its durability is not so satisfying that the droplet is very easy to be absorbed due to low alkyl chain density. In fact, the -OH on glucose monomer is active to be reacted after special treatment, but they are always tied with each other due to hydrogen bond interaction in macromolecule[Lee et al. 2020]. Relative researches has pointed out that CS₂ can dissolve cellulose and make it decrystalization[Arce et al. 2020; Lee et al. 2020]. Thus, in order to figure out this problem, we launched CS₂/NaOH pretreatment to activate -OH on the cotton filter fabric before ARGET-ATRP process and successfully improved the hydrophobic durability that the droplet can be held for 150 min[Luo et al. 2020].

No matter in other groups' researches or our group's, the hydrophobic modification always involves multiple steps. Therefore, we consider to launch an one-step modification method to simplify this process and maintain the resulted hydrophobic properties at the same time. Intrigued by the efficient reaction between -OH and -COCl[Wolfe 1997; Sano et al. 1999], if combining this reaction with previous effective activation method, we can achieve simple process and nice hydrophobic properties at the same time. Herein, we propose to use stearoyl chloride as hydrophobic layers via one-step graft on cotton filter fabrics. Through the ester bond, long alkyl chains were grafted on cellulose. Instead of multiple process or high reaction temperature mentioned above, this hydrophobic modification can occur at room temperature, and the alkyl chains can be grafted onto cellulose via only one efficient reaction, which is both energy cost-less and time cost-less. We also evaluate the potential application in oil-water separation of the obtained hydrophobic modified cotton filter fabric.

The mechanism scheme is shown as **Fig. 1**. In this experiment, N,N,N',N'-tetramethyl ethylene diamine (TEMED) is acted as base to firstly react with stearoyl chloride and produce **nitrenium ion** precursor. Subsequently, hydroxyl on the glucose monomer reacts with **nitrenium ion** precursor via nucleophilic addition reaction. Finally, alkyl chains with 18 carbon atoms are grafted onto cotton filter fabrics. From the result, it is stearoyl chloride reacts with -OH and produces HCl, which will be neutralized by TEMED. The whole process occurs via only one step that put all reactants together and the reaction will finish at room temperature overnight. Details can be found in the supporting information. Of course, hydroxyl on the secondary carbon atom is more easier to react with stearoyl chloride than those on the third carbon atom due to less steric hindrance. But we calculate the stearoyl chloride dosage according to the ideal mole ratio in order to graft alkyl chain as more as possible. **Tab. S1** shows different mole ratios and concentration of reactants and the resulted CA values are compared in **Fig. S1**. As can be seen, stearoyl chloride graft achieves nice hydrophobic modification compared with the blank cotton filter fabric because the blank sample shows hydrophilicity after few minutes droplet holding time but the modified samples can keep hydrophobicity for hours. Among the modified samples, it is found that too low concentration of stearoyl chloride and TEMED (sample 1) presents unexpected hydrophobic durability that the CA value drops to 120° after 3 h droplet holding time, although the initial CA can be larger than 140°. This suggests a low graft effect of stearoyl chloride on cotton filter fabric. On the other hand, too high concentration of hydrophobic layer and base (sample 3) is also not suitable for graft effect that the initial CA is only around 130° though it does not slide too much after 5 h droplet holding time. When under a suitable concentration, the modified cotton filter fabric presents expected hydrophobic durability with high CA values before ($CA_{\max} = 147^\circ$, $CA_{\text{avg}} = 141.8^\circ$) and after 5 h droplet holding time ($CA_{\max} = 141^\circ$, $CA_{\text{avg}} = 126.3^\circ$). Besides, we tried different solvent at the optimal condition to confirm the adaptability of this graft method (**Tab. S2**). As can be seen from **Fig. S2**, the sample modified in DMF shows comparable hydrophobic durability ($CA_{\text{initial}} = 139^\circ$, $CA_{5\text{h}} = 128^\circ$ in average) with that in CH_2Cl_2 . But the sample modified in THF seems much worse than in the above two solvent, showing unexpected hydrophobicity ($CA_{\text{initial}} = 123^\circ$) and durability ($CA_{3\text{h}} = 102^\circ$). That means THF is not a suitable solvent for this system.

Fig. 2a is the Fourier transform infrared spectroscopy (FTIR) of cotton filter fabrics before and after hydrophobic modification. There exist two characteristic peaks for alkyl chains after stearyl chloride graft. Compared with the blank sample, CH asymmetrical vibration at 2916 cm^{-1} and CH symmetrical vibration at 2848 cm^{-1} can be seen clearly from the grafted sample, indicating a well grafted result. Thermal gravimetric analyzer (TG) was also involved to investigate the graft effect. There are two steps in the grafted curve but only one in the blank curve (**Fig. 2b**). The first step around $350\text{ }^{\circ}\text{C}$ represents the decomposition of glucose, which points out the higher decompose temperature of the cotton filter fabric after grafted, suggesting that alkyl graft can improve the thermal stability of fabrics. At around $380\text{ }^{\circ}\text{C}$, glucose is completely decomposed. The second step only existing in the grafted curve at about $530\text{ }^{\circ}\text{C}$ is the alkyl chain decomposed process, which is another evidence for the successful graft of alkyl chains. Apart from structure characterization and thermal analyse, morphological measurement was also conducted to confirm the graft effect via this method. As can be seen from the scanning electronic microscopy (SEM) images (**Fig. S3**), the surface morphology of cotton filter fabrics in low magnification is similar before (**Fig. S3a**) and after (**Fig. S3b**) graft reaction. But in high magnification, the roughness of the grafted fiber surface (**Fig. S3d**) is obviously larger than that of the blank sample (**Fig. S3c**). This also indicates the well graft effect of this method, which is corresponding with the FTIR and TG results. Energy dispersive spectrometer (EDS) was performed to analyse the element distribution of the cotton filter fabrics. **Fig. S4** displays the EDS spectra of the cotton filter fabrics before and after hydrophobic modification. After the modification, the carbon atom content is improved from 62.6 At% to 66.4 At%, suggesting the existence of alkyl chains on the grafted sample. Insets are the corresponding mapping, showing the uniform distribution of carbon and oxygen element.

To evaluate this stearyl chloride graft method more objectively, we compared the CA values both among our previous performance and other groups' researches. **Fig 3a** displays the hydrophobic durability among the three period study of our group. The initial CA values can all be above 140° , but their CA values show more and more obvious distinguish as the droplet holding time increases. As for our first work, hydrophobic modification via ARGET-ATRP mechanism, the CA drops quickly below 120° within 1 h. In the second work, we launched a novel activating treatment to cotton filter fabrics before ARGET-ATRP. Dipping fabrics in CS_2/NaOH solution can help to break up the hydrogen bond between hydroxyls on glucose monomers, making them exposed to reaction system and be more active to be reacted with hydrophobic layers. As a result, the hydrophobic durability was improved largely that the CA can maintain above 120° after 2.5 h droplet holding time. However, it is hard to control active sites through radical polymerization, resulting in less uniform grafted alkyl chains. Besides, ARGET-ATRP method is too complex and time costly. To further improve hydrophobic durability and simplify the modification process, we utilize an efficient reaction between acyl chloride and hydroxyl. Unlike radical reaction, this reaction relies on the excessive TEMED and the activated -OH. Thus, the active sites distribution can be more uniform. As can be seen from **Fig. 3a**, the modified sample via RCOCl method in this work exhibits the improved hydrophobic durability, whose CA can maintain above 130° after 3 h and 120° after 5 h droplet holding time. It is also comparable with other graft compounds. Many hydrophobic modified filter

fabrics display high initial CA values above 140° , such as ODTES[22], GS[25], CPDMS[23] and FAS[20] modified samples (**Fig. 3b**). In another word, RCOCl modified filter fabric in this work shows comparable hydrophobicity with other reported counterparts. Besides, it is an one-step reaction instead of multiple steps as pointed out above of these graft methods.

After fundamental characterization, we performed an application research on the hydrophobic modified cotton filter fabric. Oil-water separation was conducted on an extraction filter with effective area of 3.14 cm^2 . For each turn, oil phase was 5 mL CHCl_3 and aqueous phase was 5 mL CuSO_4 -dyed water. The above mixture was poured into the as-mentioned extraction filter and filtered drop by drop by gravity. The gravity-drove oil flux can be calculated by the formula shown in the supporting information. **Fig. 4a** is the average CA values after each filtration, from which can be seen that there is only few angles declined compared with the initial one. After three times filtration, the average CA value can still be above 130° , suggesting a fine recyclability of the RCOCl-grafted fabric. **Fig. 4b** displays the separation efficiency and oil flux of each cycle. Separation efficiency can maintain at 99 % after each cycle. However, the oil flux decreases after every cycle from the beginning of $522.08 \text{ L m}^{-2} \text{ h}^{-1}$ to $282.33 \text{ L m}^{-2} \text{ h}^{-1}$ then further decreases to $117.69 \text{ L m}^{-2} \text{ h}^{-1}$. Insets are the optical photo of the liquid before and after filtration, showing nearly 5 mL aqueous phase recovery. **Fig. 4c** is optical photos of the first oil-water separation experiment. We started to record as we poured the mixture into the extraction filter. The first oil drop filtered was observed at 13 s and the oil phase finished filtration at 2 min 03 s. And the aqueous phase could be hold for at least one and a half minutes by the obtained hydrophobic modified cotton filter fabric.

In conclusion, we reported a facile hydrophobic modification method of RCOCl graft on cotton filter fabric via one step. Through a serial optimizing experiments, alkyl chains were successfully grafted on the glucose monomers, which is confirmed by FTIR and TG. The obtained fabric exhibits both high hydrophobicity ($\text{CA} = 141.8^\circ$) and hydrophobic durability ($\text{CA}_{5\text{h}} = 126.3^\circ$), which is comparable with those of other reported grafted fabrics. Besides, the RCOCl grafted fabric shows expective oil-water separation with 99 % separation efficiency and $522.08 \text{ L m}^{-2} \text{ h}^{-1}$ gravity-drove oil flux. This cost-effective hydrophobic modified cotton filter fabric has potential application in future oil-water separation. And this time cost-less and energy cost-less chemical graft method may rich the hydrophobic modification routes of cellulose-based substrates.

Ethics Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Human or animal rights The work described in this article did not involve human participants and or animals.

References

Anitha C, Mayavan S (2018) Salvinia inspired fluoroine free superhydrophobic coatings. *Appl Surf Sci* 449: 250-260.

Arce C, Llano T, Garcí'a P, Coz A (2020) Technical and environmental improvement of the bleaching sequence of dissolving pulp for fibre production. *Cellulose* 27(7): 4079-4090.

Bayer IS (2020) Superhydrophobic Coatings from Ecofriendly Materials and Processes: A Review. *Adv Mater Interfaces* 7(13): 2000095.

Biswas A, Jana NR (2021) Cotton Modified with Silica Nanoparticles, N,F Codoped TiO₂ Nanoparticles, and Octadecyltrimethoxysilane for Textiles with Self Cleaning and Visible Light-Based Cleaning Properties. *ACS Appl Nano Mater* 4(1): 877–885.

Bretel G, Rull-Barrull J, Nongbe MC, Terrier J-P, Grogneq EL, Felpin F-X (2018) Hydrophobic Covalent Patterns on Cellulose Paper through Photothiol-X Ligations. *ACS Omega* 3(8): 9155–9159.

Dong X, Gao S, Huang J, Li S, Zhu T, Cheng Y, Lai Y (2019) A self-roughened and biodegradable superhydrophobic coating with UV shielding, solar-induced self-healing and versatile oil-water separation ability. *J Mater Chem A* 7(5): 2122-2128.

Guan Y, Yu C, Zhu J, Yang R, Li X, Wei D, Xu X (2018) Design and fabrication of vapor-induced superhydrophobic surfaces obtained from polyethylene wax and silica nanoparticles in hierarchical structures. *RSC Adv* 8(44): 25150-25158.

Guo J, Fang W, Welle A, Feng W, Filpponen I, Rojas OJ, Levkin PA (2016) Superhydrophobic and Slippery Lubricant-Infused Flexible Transparent Nanocellulose Films by Photoinduced Thiolene Functionalization. *ACS Appl Mater Interfaces* 8(49): 34115-34122.

Guo X, Li X, Lai C, Jiang X, Li X, Shu Y (2017) Facile approach to the green synthesis of novel ternary composites with excellent superhydrophobic and thermal stability property: An expanding horizon. *Chem Eng J* 309: 240-248.

Heale FL, Page K, Wixey JS, Taylor P, Parkin IP, Carmalt CJ (2018) Inexpensive and non-toxic water repellent coatings comprising SiO₂ nanoparticles and long chain fatty acids. *RSC Adv* 8(48): 27064-27072.

Huang J, Wang S, Lyu S, Fu F (2018) Preparation of a robust cellulose nanocrystal superhydrophobic coating for self-cleaning and oil-water separation only by spraying. *Ind Crops Prod* 122: 438-447.

Huang W, Song Y, Xing Y, Dai J (2010) Durable Hydrophobic Cellulose Fabric Prepared with Polycarboxylic Acid Catalyzed Silica Sol, *Ind Eng Chem Res* 49(19): 9135-9142.

Joshi S, Kathuria H, Verma S, Valiyaveetil S (2020) Functional Catechol–Metal Polymers via Interfacial Polymerization for Applications in Water Purification. *ACS Appl Mater Interfaces*: 12(16): 19044–19053.

- Lee JH, Park SH, Kim SH (2020) Surface Alkylation of Cellulose Nanocrystals to Enhance Their Compatibility with Polylactide. *Polymers* 12(1): 178.
- Lee J, Lee J, Jeon H, Park H, Oh S, Chung I (2020) Studies on the melt viscosity and physico-chemical properties of cellulose acetate propionate composites with lactic acid blends. *Mol Cryst Liq Cryst* 707(1): 8-20.
- Li Z, He Z, Chen X, Tang Y, You S, Chen Y, Jin T (2019) Preparation of hydrophobically modified cotton filter fabric with high hydrophobic stability using ARGET-ATRP mechanism. *RSC Adv* 9(43): 24659-24669.
- Liu H, Xie WY, Song F, Wang XL, Wang YZ (2019) Constructing hierarchically hydrophilic/superhydrophobic ZIF-8 pattern on soy protein towards a biomimetic efficient water harvesting material. *Chem Eng J* 369: 1040-1048.
- Luo Y, Deng S, Li Z, Cao L, He Y, Chen Y, Jin T (2020) Effect of CS₂/NaOH activation on the hydrophobic durability of cotton filter fabric modified via ARGET-ATRP. *Eur Polym J* 141: 110087.
- Ma Y, Zhu D, Si Y, Sun G (2018) Fabricating durable, fluoride-free, water repellency cotton fabrics with CPDMS, *J Appl Polym Sci* 135(25): 46396.
- Muresan EI, Balan G, Popescu V (2013) Durable Hydrophobic Treatment of Cotton Fabrics with Glycidyl Stearate, *Ind Eng Chem Res* 52(18): 6270-6276.
- Ren J, Tao F, Liu L, Wang X, Cui Y (2020) A novel TiO₂@stearic acid/chitosan coating with reversible wettability for controllable oil/water and emulsions separation. *Carbohydr Polym* 232: 115807.
- Rong L, Liu H, Wang B, Mao Z, Xu H, Zhang L, Zhong Y, Feng X, Sui X (2019) Durable antibacterial and hydrophobic cotton fabrics utilizing enamine bonds, *Carbohydr Polym* 211: 173-180.
- Sano T, Ohashi K, Oriyama T (1999) Remarkably Fast Acylation of Alcohols with Benzoyl Chloride Promoted by TMEDA. *Synthesis* 7: 1141-1144.
- Sarkar DK, Saleema N (2010) One-step fabrication process of superhydrophobic green coatings. *Surf Coat Technol* 204(15): 2483-2486.
- Shang S, Li Z, Xing Y, Xin JH, Tao X (2010) Preparation of durable hydrophobic cellulose fabric from water glass and mixed organosilanes. *Appl Surf Sci* 257(5): 1495-1499.
- Shishodia A, Arora HS, Babu A, Mandal P, Grewal HS (2019) Multidimensional durability of superhydrophobic self-cleaning surface derived from rice-husk ash. *Prog Org Coat* 136: 105221.
- Shome A, Rather AM, Manna U (2019) Chemically reactive protein nanoparticles for synthesis of a durable and deformable superhydrophobic material. *Nanoscale Adv* 1(5): 1746-1753.

- Si Y, Guo Z, Liu W (2016) A Robust Epoxy Resins @ Stearic Acid-Mg(OH)₂ Micronanosheet Superhydrophobic Omnipotent Protective Coating for Real-Life Applications. ACS Appl Mater Interfaces 8(25): 16511–16520.
- Sun D, Wang W, Yu D (2016) Preparation of fluorine-free water repellent finishing via thiol-ene click reaction on cotton fabrics. Mater Lett 185: 514-518.
- Thi VHT, Lee B-K, Ngo C-V (2017) Durable superhydrophobic cotton filter prepared at low temperature for highly efficient hexane and water separation. J Taiwan Inst Chem E 71: 527-536.
- Toruna I, Ruzi M, Er F, Onses MS (2019) Superhydrophobic coatings made from biocompatible polydimethylsiloxane and natural wax. Progress in Organic Coatings 136: 105279.
- Wang F, Pi J, Li J-Y, Song F, Feng R, Wang X-L, Wang Y-Z (2019) Highly-efficient separation of oil and water enabled by a silica nanoparticle coating with pH-triggered tunable surface wettability. J Colloid Interface Sci 557: 65-75.
- Wang Q, Zhang B, Qu M, Zhang J, He D (2008) Fabrication of superhydrophobic surfaces on engineering material surfaces with stearic acid. Appl Surf Sci 254(7): 2009-2012.
- Wolfe MS (1997) N-Benzoyl-4-(dimethylamino)pyridinium Chloride: Isolation and Use for the Direct Benzoylation of Alcohols. Synthetic Commun 27(17): 2975-2984.
- Yu M, Wang Q, Yang W, Xu Y, Zhang M, Deng Q, Liu G (2019) Facile Fabrication of Magnetic, Durable and Superhydrophobic Cotton for Efficient Oil/Water Separation. Polymers 11(3): 442.
- Zhao X, Li Y, Li B, Hu T, Yang Y, Li L, Zhang J (2019) Environmentally benign and durable superhydrophobic coatings based on SiO₂ nanoparticles and silanes. J Colloid Inter Sci 542: 8-14.

Figures

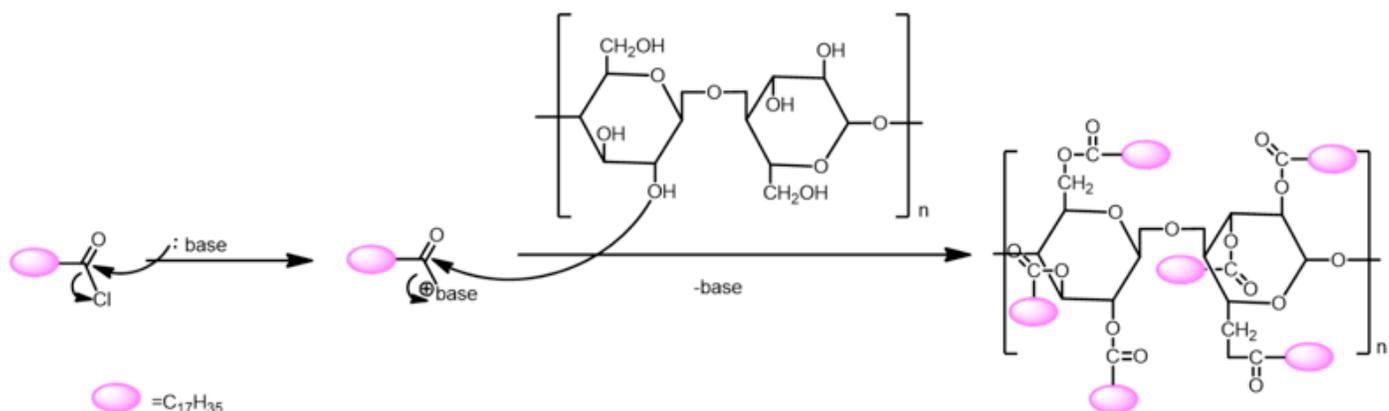


Figure 1

Mechanism scheme of stearoyl chloride grafted on cotton filter fabrics.

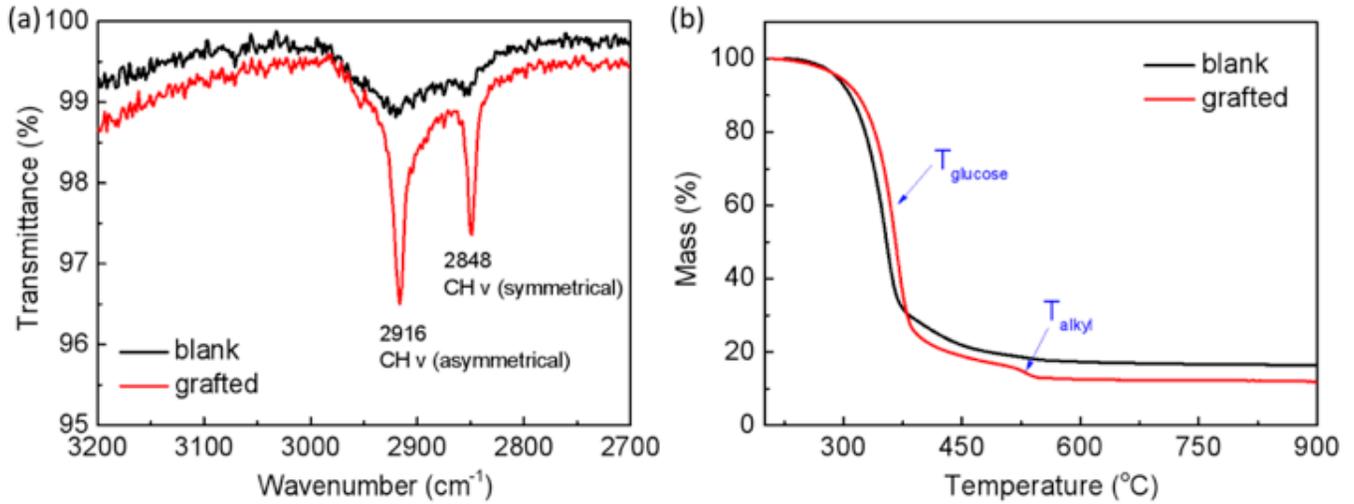


Figure 2

(a) FTIR spectra and (b) TG curves of the cotton filter fabrics before and after hydrophobic modified.

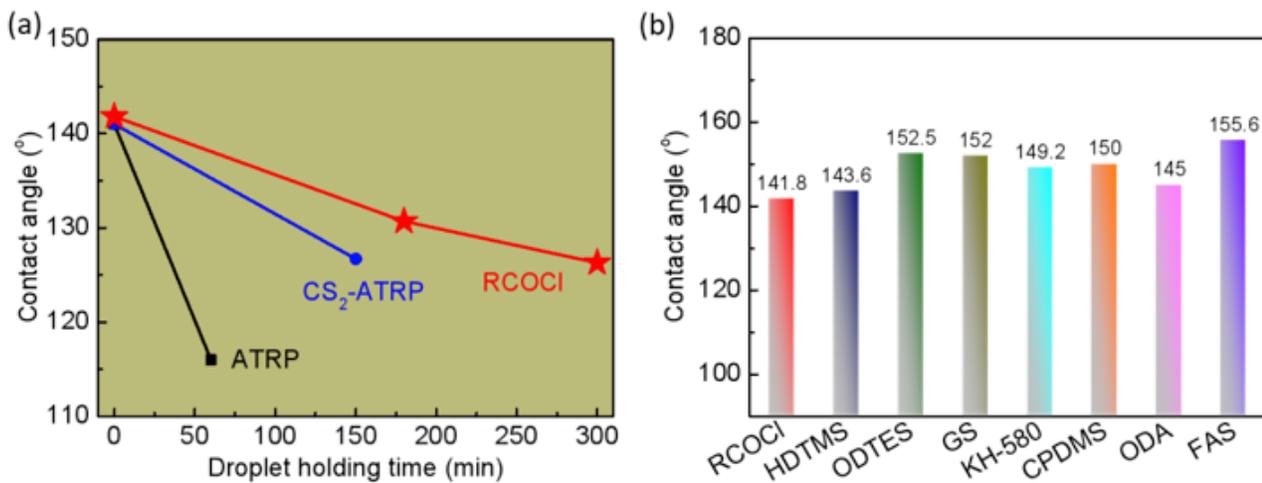


Figure 3

CA comparison among (a) previous works and (b) other groups' works of grafted modification of cotton filter fabrics. HDTMS[21], ODTES[22], GS[25], KH-580[24], CPDMS[23], ODA[26], FAS[20].

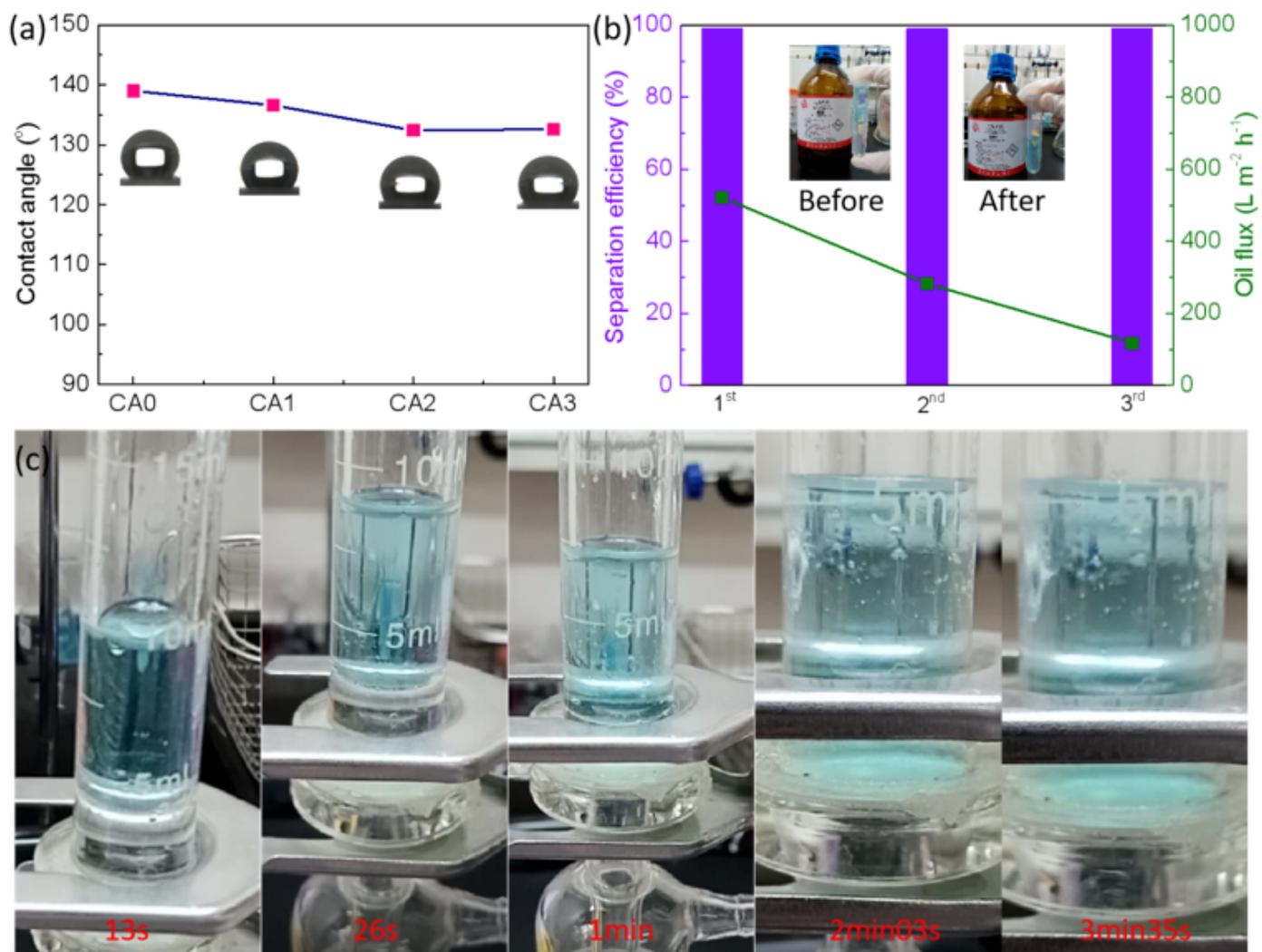


Figure 4

(a) Contact angles of the RCOCl grafted cotton filter fabric after oil-water separation each time. (b) Separation efficiency and oil flux of the RCOCl grafted cotton filter fabric of each cycle. Insets are optical photos of the liquid before and after filtration. The Blue phase is CuSO₄-dyed aqueous phase and the transparent phase is CHCl₃ oil phase. (c) The first filtration process of oil-water separation.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [RCOCISl.docx](#)