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Robust UV-cured superhydrophobic cotton fabric surfaces with self-healing ability

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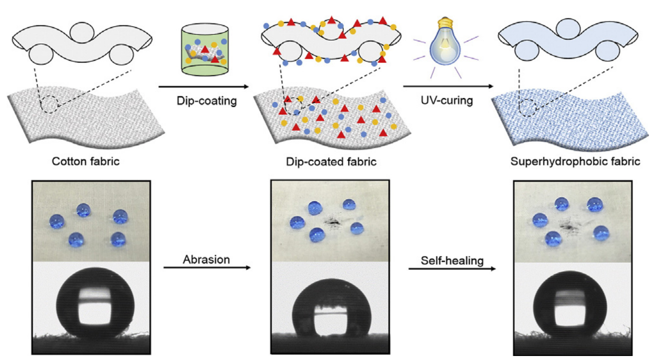
HIGHLIGHTS

- A facile strategy of fabricating self-healing superhydrophobic cotton fabric was exhibited.
- The superhydrophobic cotton fabric showed superior resistance to various liquids and excellent durability to extreme environments.
- After devastating abrasion, the fabric superhydrophobicity can be restored by brief heating treatment.

GRAPHICAL ABSTRACT



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ABSTRACT

For extending the lifespan of practical applications, a robust and self-healing superhydrophobic cotton fabric was successfully fabricated by facile dip coating and UV curing. The low surface energy and micro/nanoapophysis of superhydrophobic fabric were contributed by dip-coating components consisting of tri-functionality vinyl perfluoro decanol, vinyl-terminated polydimethylsiloxane and octavinyl-polyhedral oligomeric silsesquioxane. These obtained cotton fabrics exhibited superior resistance to various liquid pollutants, and had excellent resistance to the acid and alkali liquid. Furthermore, they were durable to withstand 10,000 cycles of abrasion, 120 h of accelerated weathering test and heating or freezing test. Most importantly, after 200 cycles of severe abrasion, they were able to restore the superhydrophobicity by brief heating treatment and showed excellent self-healing ability. These designed cotton fabric may contribute to the development of durable superhydrophobic textiles.

1. Introduction

Superhydrophobic surfaces, displaying a contact angle (CA) of water greater than 150° and a sliding angle (SA) less than 10°, are a fascinating phenomenon in nature, which attract much attention from scientific community and the industrial world because of their self-cleaning, anti-corrosion, anti-fouling, oil-water separation and drag-reducing applications [1,2]. In generally, a superhydrophobic surface has a particular micro/nano topological structure combined with the low surface energy chemical substance [3]. A number of artificial superhydrophobic surfaces have been developed on various substrates via different methods [4,5]. The superhydrophobic textiles are considered to be one of the most promising research areas due to their valuable water-repellent and self-cleaning properties [6,7]. Nevertheless, the practical applications of these artificial superhydrophobic textiles were hindered by

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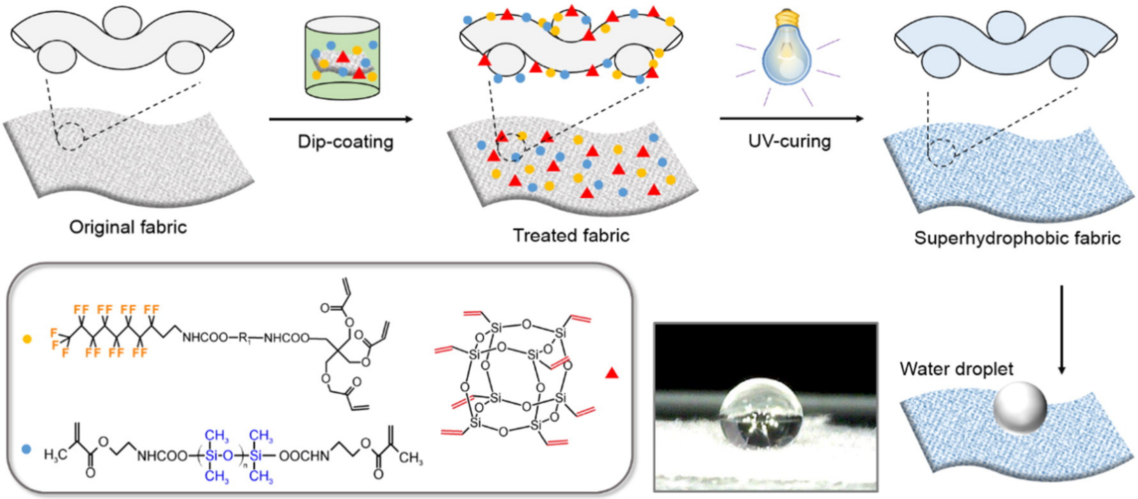

Fig. 1. Schematic illustration of the fabrication of superhydrophobic cotton fabric.

their poor durability and vulnerability to damage via rubbing, washing, laundering, chemical etching and sun bleaching [8].

Strategies have been developed on superhydrophobic fabric to avoid this weakness [9]. For example, Xue et al. reported the method of covalent binding to enhance the durability of superhydrophobicity. They roughened the PET fabric through alkali etching, and then modified the surface with mercapto silanes via thiol-ene click chemistry. The superhydrophobic PET fabric exhibited outstanding chemical robustness to different chemicals, and remained superhydrophobicity after 4500 cycles of abrasion, 200 cycles of laundering, as well as long-term UV irradiation [10]. Zhang et al. also developed durable and robust superhydrophobic fabric via a facile approach. The fabric were simply coated in fluoro-free organosilanes solution and exhibited good superhydrophobicity. The superhydrophobic coatings also showed excellent mechanical (e.g., abrasion scratching, laundering), chemical (e.g., exposure to acid and organic solvents) and environmental (e.g., exposure to UV irradiation) stability [11]. However, these techniques for durable superhydrophobic textiles have no self-healing ability, which maybe the most efficacious strategy for extending the lifespan of practical applications.

Generally, self-healing ability of superhydrophobic surfaces can be realized by migrating of hydrophobic components [12–18] or regenerating topographic structures [19,20]. It was interpreted that a considerable part is damaged or completely lost, the superhydrophobicity can still recover via the environmental stimulation [21]. For instance, Wu et al. presented a strategy of fabrication a self-healing superhydrophobic cotton fabric, which was obtained by radiation-induced graft polymerization of hexyl methacrylate and lauryl methacrylate. The obtained fabric could regenerate their superhydrophobicity through the steam ironing process even after

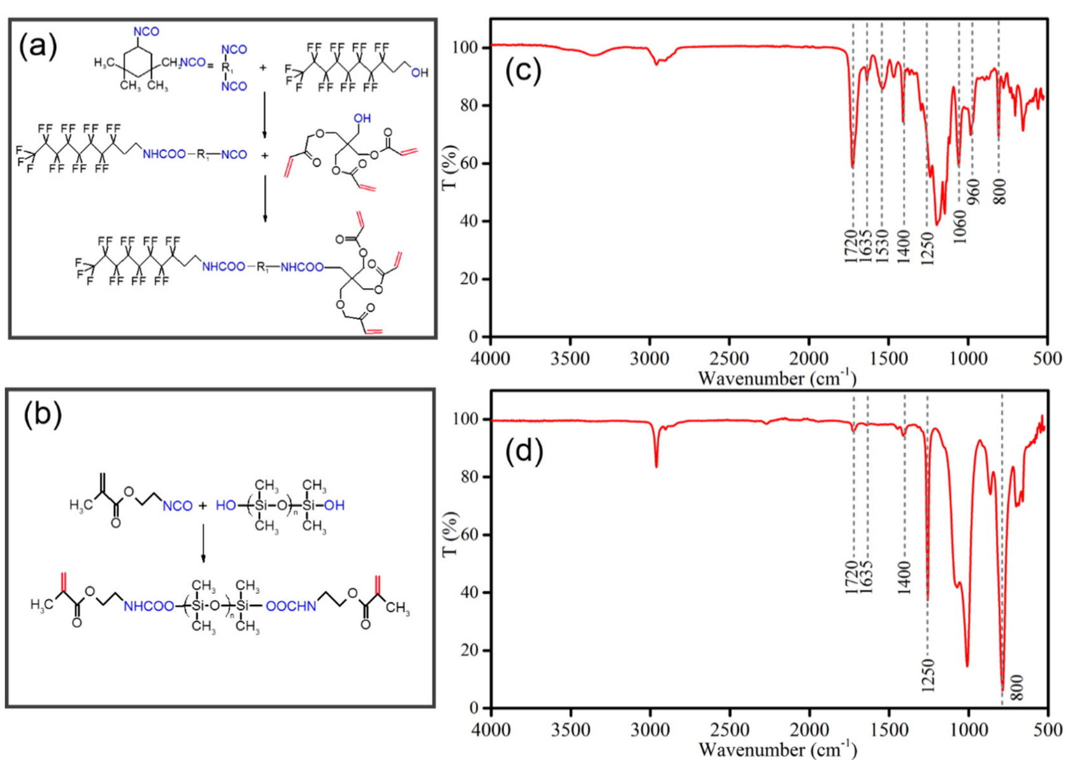

Fig. 2. Synthetic routes of (a) TV-PFOD and (b) *V*-PDMS. The FTIR spectra of (c) TV-PFOD and (d) *V*-PDMS.