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Composite polydopamine-based TiO₂ coated mesh with restorable superhydrophobic surfaces for wastewater treatment

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ABSTRACT

Various pollutants in wastewater including water-insoluble oils and -soluble toxic organic pollutants, have been threatening ecosystems and human health, making wastewater purification difficult. Inspired by the hierarchical structures and chemical compositions of lotus leaf, we combined the usage of polydopamine (PDA) chemistry and photocatalytically active TiO_2 to develop a facile approach towards composite PDA-based TiO_2 coated mesh with restorable superhydrophobicity. In this procedure, PDA assisted loading of TiO_2 nanoparticles onto stainless-steel mesh with a result of micro/nanoscale hierarchical surface was achieved via a single-step solvothermal method. After modified with *1H, 1H, 2H, 2H*-perfluorodecyltriethoxysilane, this mesh became superhydrophobic. The TiO_2 coated mesh exhibited enhanced superhydrophobicity, excellent environmental stability, robust chemical resistance and high mechanical durability. Moreover, it has been demonstrated the high separation capacity and extraordinary recyclability for various oils collection from water due to its special surface superhydrophobicity. Importantly, such a mesh possessed photocatalytic activity due to the embedded TiO_2 , which allowed for the effective degradation of organic pollutants under UV irradiation, representing a plausible way to restore superhydrophobic surface by photocatalytically decomposing the attached contaminants. This investigation suggests a green and facile way to prepare superhydrophobic materials with restored surface wetting property, which will be useful for wastewater purification.

Keywords: Superhydrophobicity, TiO_2 , Polydopamine, Oil/water separation, Photocatalysis.

Introduction

Nowadays, water pollution has become a serious problem worldwide accompanying with the global industrial development and the population expansion. Hence, great effort have been paid to wastewater cleanup [1, 2]. Until now, some accessible techniques against water contamination, e.g., oil/water separation, photocatalysis degradation, and adsorption, have been utilized [3-8]. However, the constituents of the wastewater are usually complex and most of conventional techniques are difficult to deal with multiple water contaminants simultaneously. In fact, water pollutants in forms of insoluble oils as well as water-soluble toxic organic pollutants are the major contaminants, which have seriously threatened the ecosystems and human health [9-12]. As such, intensive effort should be drawn particularly to develop a facile and effective strategy that can achieve simultaneous removal of insoluble oils and toxic organic pollutants in the wastewater.

In the recent past, novel materials with superwettability, such as mesh/membrane, modified commercial sponge, carbon-based aerogels, microporous gels, and so on, have been successfully developed for the purpose of wastewater cleanup [13-20]. Generally, there are two kinds of superwetting materials, i.e., superhydrophobic/superoleophilic materials that solely allow the oils to penetrate through, and superhydrophilic/underwater superoleophobic materials which are only permeable to water, have been designed to achieve the effective oil/water separation [21-28]. Nevertheless, it is worth pointing out that those superhydrophobic/superoleophilic materials are readily fouled, or even blocked up by adhered or adsorbed oils, thus further losing their separation capability and recyclability during usage. In addition, those superhydrophilic/underwater superoleophobic materials are also readily susceptible to organic contaminants within the oil/water mixtures due to their inherent high surface energy. Those organic contaminants, once absorbed, are not easily to clean or remove, leading to the loss of superwettability and the decrease of

oil/water separation performance in materials [13, 29, 30]. To address these problems, self-cleaning superwetting materials which can dismiss the organic contaminants under various external stimuli, are highly desired.

TiO₂, an important photoresponsive semiconductor, widely serves as the heterogeneous photocatalyst for the degradation of organic contaminants, and the fabrication of self-cleaning superhydrophobic surfaces thanks to its physicochemical properties, high photocatalytic efficiency and durable thermostability [5, 6, 28, 31]. Herein, in combination of the photocatalytic property and mussel inspired PDA chemistry, we report a composite hierarchical PDA-based TiO₂ coated mesh with a self-cleaning superhydrophobicity for oil/water separation and wastewater remediation. Using a simple solvothermal method, PDA assists TiO₂ particles exclusively bonding to stainless-steel mesh, resulting in micro/nanoscale hierarchical surface topology. It is worth noting that mussel inspired PDA coatings can not only serve as a versatile platform for loading TiO₂ nanoparticles, but also act as the effective agent to modify the surface of TiO₂, resulting in the highly active photocatalyst for photodegradation of water-soluble organic pollutants [32-35]. After modified with *1H*, *1H*, *2H*, *2H*-perfluorodecyltriethoxysilane, the mesh becomes superhydrophobic. Such superhydrophobic surfaces are not only highly robust and durable under different harsh conditions, and highly efficient in oil/water separation, but also possess photocatalytic activity, allowing for an effective degradation of water-soluble organic pollutants under UV irradiation. We, therefore, anticipate that the fabrication of hierarchical superhydrophobic TiO₂ coated meshes would provide a convenient and effective approach in the preparation of promising self-cleaning materials with multi-life span in wastewater purification.

Experimental

Materials

Stainless-steel meshes (300 mesh) were commercially purchased from the local markets. *1H, 1H, 2H, 2H*-perfluorodecyltriethoxysilane (97%) and dopamine hydrochloride were bought from Sigma-Aldrich. Titanium tetraisopropanolate was supplied by Aladdin China (Shanghai) Co., Ltd., All other chemical reagents (i.e., aqueous ammonia, absolute ethanol, benzene, *n*-hexane, methylbenzene, dichloromethane, trichloromethane, tetrachloromethane) bought from Sinopharm Chemical Reagent Co., Ltd. (China) were of analytical grade, and used as received.

Preparation of Superhydrophobic TiO₂ coated Mesh

Superhydrophobic TiO₂ coated mesh was prepared according to a procedure, as displayed in Scheme 1. First, the pristine mesh was cleaned with acetone, ethanol and deionized water in sequence under ultrasonication for 30 min. The mesh was cut into 5 cm×5 cm pieces and then immersed into a 30 mL ethanol solution containing 0.20 g of dopamine, 1.0 mL of titanium tetraisopropanolate and 0.5 mL of aqueous ammonia under a mild stir at room temperature for 15 min. Then, the above mixture was immediately transferred to a Teflon-lined stainless steel autoclave, and the autoclave was heated in an oven at 200 °C for 24 h. Hereafter, the mesh was taken out, washed with ultrapure water and dried in vacuum. After drying, the mesh was placed in a *1H, 1H, 2H, 2H*-perfluorodecyltriethoxysilane methanol solution (1:100 v:v) at room temperature for 2 h to yield superhydrophobic surfaces.

Characterization

The surface morphologies of the obtained samples were investigated by Scanning electron microscopy (SEM, Hitachi SU8020). Elemental mapping of the superhydrophobic TiO₂ coated

mesh was performed with an energy-dispersive X-ray spectroscope (EDX, Oxford Instruments, Model 7426). The surface elemental composition was analyzed by X-ray photoelectron spectroscopy (XPS, Thermo ESCALAB 250Xi) equipped with a monochromatized Al-K α X-ray source (1486.6 eV). The crystalline structure of the TiO₂ coated mesh was identified by X-ray diffraction using a DX-2700 X-ray diffractometer with Cu K α radiation source. Water contact angles (WCA) were recorded on a Dataphysics OCA 20 contact angle analysis system. UV-visible spectra were recorded with a Lambda 950 spectrophotometer (PerkinElmer, USA).

Durability tests

To test environmental durability, those superhydrophobic TiO₂ coated meshes were treated at 200 °C, at -196 °C (freezing in liquid nitrogen), and under UV irradiation for 2h, respectively, prior to the water contact angle measurements. In the chemical resistance tests, those superhydrophobic TiO₂ coated meshes were immersed into certain common solvents including methylbenzene, *n*-hexane, tetrachloromethane, hydrochloric acid, saturated NaCl solution and NaOH solution, individually, for 24h. Additionally, mechanical durability was evaluated according to the sandpaper abrasion test. During the sandpaper abrasion test, the superhydrophobic TiO₂ coated mesh bearing a weight of 200 g was moved along the ruler over 15 cm by the drawing force. Water contact angles were measured after every 5 abrasion cycles.

Oil/water separation

For the oil/water separation, the superhydrophobic TiO₂ coated mesh as a filter was fixed between two glasses to build up the separation setup. As slowly discharging those oil/water mixtures (1:1, v/v, 200 mL) into the separation setup, the superhydrophobic TiO₂ coated mesh allowed the oils solely to pass through while against water, achieving the oil/water separation. The separation efficiencies were quantitatively determined by measuring the oil content in feed and in

corresponding filtrate with a UV-Vis spectrophotometer [36-39]. The separation efficiency was calculated according to Equation (1) as follows:

$$R = \left(\frac{C_f}{C_i} \right) \times 100\% \quad (1)$$

where C_i and C_f represent oil concentration of the original oil/water mixture and the collected filtrate, respectively.

The oil flux was calculated according to the Equation (2):

$$F = \frac{V}{AT} \quad (2)$$

where V is the volume of the permeation, A is the effective area of the mesh that oil passing through, T is the permeation time.

Photocatalytic performance

To test the photocatalytic activity, the superhydrophobic TiO_2 coated mesh ($5 \text{ cm} \times 5 \text{ cm}$) was first immersed into methyl blue solution (100 mL, 0.25 mM), and then the above mixture was kept stirring in dark for 30 min, and followed by photocatalytic degradation under UV irradiation. The uncoated stainless-steel mesh as a control was also subjected to the same photocatalytic performance. The photocatalytic degradation of methyl blue was monitored by a UV-vis spectrophotometer.

Self-cleaning property

For the self-cleaning properties of the superhydrophobic TiO_2 coated mesh, the oleic acid was chosen as the organic amphiphile to pollute the mesh. The superhydrophobic TiO_2 coated mesh was contaminated with oleic acid by immersing the mesh in 100 mL of oleic acid ethanol solution (5%) for 10 min, and followed by ethanol washing and drying in a vacuum oven in sequence. The

polluted mesh was UV irradiated for 30 min, and the water contact angles on the meshes were recorded to evaluate the self-cleaning ability.

Results and discussion

Preparation of superhydrophobic PDA-based TiO₂ coated mesh

A general synthetic strategy for preparing superhydrophobic TiO₂ coated mesh was schematically illustrated in Scheme 1. As described in the experimental section, the stainless-steel mesh as the substrate was chosen for constructing superhydrophobic mesh due to its commercial availability, easy machinability, low cost, and non-toxicity. A piece of the pristine mesh was placed in ethanol solution consisting of dopamine, titanium tetraisopropanolate and aqueous ammonia at 200 °C. After 24 h, the hierarchical micro/nanostructures constructed by TiO₂ nanoparticles and polydopamine were grown onto the surface of the mesh. Then, the commercial 1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane was employed to endow these hierarchical micro/nanostructures to be superhydrophobic.

The structures and morphologies of the meshes were visualized by SEM. As indicated, stainless-steel mesh was woven from single-layered cross-knitted steel wires with an average pore size of 50 μm. The surfaces of the steel wires were smooth and clear as shown in Fig.1a and b. After the solvothermal treatment, the micro-pore structures of the mesh retained, whereas with nano-scalar roughness (denoted as PDA-TiO₂ coated mesh, see Fig. 1d). The amplified SEM image in Fig. 1e indicated that the numerous micro- and nano-particles were homogeneously distributed on the surface of the mesh, resulting in hierarchical micro/nanostructured surfaces. Moreover, these hierarchical micro/nanostructures on the mesh can be regulated by the amount of dopamine or titanium tetraisopropanolate added in the reaction solution, respectively (see Fig.S2, S3), which

are crucially important for the superwetting [4, 29]. The surface chemical composition of the mesh was also varied after the surface modification, which was monitored by X-ray photoelectron spectroscopy (XPS) (see Fig. 1c, f). In comparison with pristine stainless-steel mesh, new Ti2s, Ti2p and N1s peaks including C1s, O1s and Fe2p signals were detected after coating (see Fig. 1f). A close inspection on Ti2p in Fig.1f, two individual peaks located at 463.7 eV and 457.9 eV occur in the Ti2p region (see Fig.S1a), which correspond to the binding energies of Ti2p_{1/2} and Ti2p_{3/2}, respectively. The splitting between Ti2p_{1/2} and Ti2p_{3/2} is about 5.8 eV, suggesting that the presence of the TiO₂ within the coatings. During this coating process, dopamine tended to self-polymerize into polydopamine (PDA) coatings in a weakly alkaline environment in the presence of oxygen, which served as a favorable platform for loading TiO₂ nanoparticles[33, 34, 40-42]. Due to the strong metal coordination ability of the catechol groups in PDA, the as-formed PDA facilitated the *in situ* deposition of TiO₂ nanoparticles, improving the binding affinity between the stainless-steel mesh and TiO₂ nanoparticles [32, 34, 35, 43, 44]. Consequently, the hierarchical surfaces were observed. By modifying these surfaces with 1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane, the surface wettability has become superhydrophobic with water contact angle of $159.5 \pm 2.0^\circ$, denoted as superhydrophobic TiO₂ coated mesh, which also demonstrated that the low-surface-energy chemical -1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane was successfully coated on these hierarchical micro/nanostructured surfaces (see Fig. 1g and h). In addition, the XPS spectrum in Fig. 1i and Fig.S1b indicated that the new F1s, Si1s and Si2p signal peaks were detected in these superhydrophobic surfaces. Again, from the elemental mapping using EDS analysis, the characteristic elements including F, Ti and Si were well distributed on the superhydrophobic TiO₂ coated mesh, as shown in Fig. 1j, indicating a successful binding of 1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane to the hierarchical micro/nanostructured surfaces. In the end, the

powder XRD was applied to examine the crystalline structures of the TiO₂ nanoparticles formed. As shown in Fig. 1k, the positions and relative intensities of the peaks were matched well with anatase TiO₂ (JCPDS No. 21-1272) (see Fig. 1k), hinting that the resultant TiO₂ was photocatalytically active [32].

Wetting behavior and durability evaluations of superhydrophobic TiO₂ coated mesh

The surface wettability of the coated mesh was evaluated by WCA measurements. As those methyl blue dyed water droplets were dropped on the superhydrophobic TiO₂ coated mesh, they were almost spherical, hinting the superhydrophobic nature of the surface (WCA is $158.5 \pm 1.5^\circ$, see Fig. 2a, b). Moreover, the water repellency behavior of superhydrophobic mesh was further demonstrated in the following experiments. As shown in Fig. 2c, this superhydrophobic surface can easily bounce off the water jetting from a syringe without leaving the water droplets on the surface. When placing this mesh into water, it can float on the surface of water over a few weeks, while the pristine mesh sank down to the bottom of water owing to its inherent hydrophilicity (see Fig. 2d).

Considering the practical application of this superhydrophobic TiO₂ coated mesh in wastewater, it should emphasize on their durability against different harsh conditions. To assess their environmental durability, these meshes were treated in various extreme environments including a high (200 °C) and a low temperature (-196 °C in liquid nitrogen), and UV irradiation ($\lambda = 365$ nm, 500 W), individually, for 2 h. As shown in Fig. 2e, f, and g, all harsh environments cannot deteriorate the superhydrophobicity of the surfaces, indicating the robust durability of the surfaces. Moreover, the chemical stability of superhydrophobic mesh was also evaluated by immersing it into various solutions, e.g., HCl (pH 1), NaCl (1M) and NaOH (pH 13) aqueous solutions, as well as organic solvents including methylbenzene, *n*-hexane, and tetrachloromethane, for 24 h,

respectively. As demonstrated in Fig. 2h, no significant decline in superhydrophobicity was observed after the treatment. Besides the chemical durability, the washing durability of this superhydrophobic TiO₂ coated mesh was also examined by an accelerated laundering durability test with the AACC 61-2006 standard test method. This superhydrophobic TiO₂ coated mesh could withstand at least 25 accelerated laundering cycles without losing its superhydrophobicity (see Fig.2i). Moreover, the mechanical durability of the superhydrophobic surfaces was tested by using the sandpaper abrasion method. After 100 abrasion cycles, the resulting mesh retained its superhydrophobicity after 100 cycles of abrasion, demonstrating excellent mechanical durability (see Fig. 2j).

Oil/water separation

The inherent porosity and robustly durable superhydrophobicity of the TiO₂ coated mesh make it as a ideal candidate for oil spill clean-up. As demonstrated in Fig. 3a,3b, a separation setup was used this superhydrophobic TiO₂ coated mesh as a filter, which was locked between two glass fixtures with two attached glass beakers. As pouring tetrachloromethane (oil with high density, dyed with oil red)/water mixture (1:1, v/v, 200 mL) into the separation setup, tetrachloromethane sank to the bottom of the upper beak, and penetrated through this superhydrophobic mesh quickly into the low beaker with gravity acting as the driving force, while water was repelled and retained in the upper beaker (also see Supplementary Movie 1), realizing oil/water separation. As separating the oil with low density from oil/water mixtures, the oil with low density (e.g. *n*-hexane) contacted the superhydrophobic mesh before water when the mixture was slowly pulled into the separation setup because of its lower density than water. Thus, the oil with low density passed through the mesh quickly with the driving force of gravity, while water was repelled and kept in the upper beaker, as demonstrated in Fig.3b and Supplementary Movie 2. More quantitatively, this

superhydrophobic mesh can achieve separation efficiency (R) ranging from 96% to 98% for different oil-water mixtures, as concluded in Fig. 3c. In addition, the separation fluxs of this superhydrophobic TiO_2 coated mesh for various oil-water mixtures are around $3200\text{--}3500 \text{ L m}^{-2} \text{ h}^{-1}$. Moreover, this superhydrophobic TiO_2 coated mesh was robust and durable in practical use as it retained the stable and high separation efficiency over 50 repetitions, as exemplified in Fig. 3d. This was also verified by the surface microstructures and chemical composition monitoring as shown in Fig. S2, where the hierarchical micro/nanostructures and chemical composition of the TiO_2 coated mesh were retained after 50 cycles of usage, implying an excellent reusability. Based on these results, it is indicated that this superhydrophobic TiO_2 coated mesh has excellent separation capability for wastewater treatment.

Photocatalytic performance

In wastewater, the organic dyes, in addition to insoluble oils, are the main species of organic pollutants. Thus, it is of great significance to remove/degrade these kinds of organic pollutants during the separation. As already known that TiO_2 is a semiconductor material as it can generate photoelectrons and holes under UV irradiation. These photogenerated electrons and holes can further generate highly reactive species. e.g., superoxide radicals ($\text{O}_2^{\cdot-}$) and hydroxyl radicals ($\cdot\text{OH}$), when reacting with O_2 and H_2O , allowing for decomposing a wide variety of organic pollutants [45-47].

Therefore, the superhydrophobic TiO_2 coated mesh is capable of degrading organic pollutants in wastewater under UV irradiation. For this purpose, methyl blue (MB) is selected as the model organic pollutant that allows for an easy track of photocatalysis degradation. As shown in Fig. 4a, the pristine stainless-steel mesh can only degrade approximate 34.2 % of MB in 70 min under UV irradiation, while the superhydrophobic TiO_2 coated mesh enabled 99.1% of MB degraded over

the same time span (see Fig. 4b). Under UV irradiation, the absorption peaks of the MB solution in the presence of the superhydrophobic TiO₂ coated mesh diminished gradually as UV irradiation time increased (see Fig. 4b), which was consistent with the color fading and ultimately bleaching as shown in the inset in Fig. 4b. As calculated in Fig. 4c, the corresponding degradation rate constants of MB by the pristine and the TiO₂ coated meshes were 0.00599 min⁻¹ and 0.06971 min⁻¹, respectively. These results indicated a superior photocatalytic activity of the TiO₂ coated mesh in the degradation of organic pollutants. As shown in Fig. 4d, the photodegradation efficiency was still maintained at 86.5% after eight cycles, indicating this superhydrophobic TiO₂ coated mesh was durable, recyclable in the photodegradation reaction.

Self-cleaning property

In practical use, the mesh may lose the special wettability owing to surface contamination of organic pollutants during wastewater treatment. It is imperatively desired to endow the mesh with self-cleaning functionality, with which the mesh enables the recovery of its surface wettability and separation efficiency. As already indicated, the TiO₂ coated mesh enabled photodecomposition of organic dyes, implying self-cleaning possibility. We, next, investigate self-cleaning ability of superhydrophobic TiO₂ coated mesh by exposing organics-contaminated mesh under UV irradiation to photocatalytically degrade the contaminants, as well as to recover its wetting property.

Most organic contaminants are amphiphilic molecules that enable the strong affinity to hydrophobic surfaces, deteriorating the separation by inverting the wetting property of the meshes [48]. In practice, oleic acid was selected as the model organic contaminant. As shown in Fig. 5a, the superhydrophobic TiO₂ coated mesh lost its superhydrophobicity whereas became hydrophobic with a water contact angle of 93.2° after being contaminated by oleic acid. Interestingly, the

superhydrophobicity of the meshes can be restored with a UV irradiation for 30 min (see Fig. 5a). It is speculated that the regeneration of superhydrophobicity was due to the photocatalytic decomposition of oleic acid by TiO₂. Usually, UV irradiation can excite TiO₂ nanoparticles to form photoelectrons and holes. Those photogenerated electrons can activate O₂ in air to degrade the adhered organic contaminants, which allows the polluted meshes to clean and return to superhydrophobicity. Importantly, this self-cleaning ability were durable and repeatable. After 10 cycles of oleic acid contamination and UV irradiation, the mesh maintained its superhydrophobicity (see Fig. 5b), illustrating a robust reusability and a superior self-cleaning function. This is considerably useful for the practical utilization of such mesh in an energy-economic way.

Conclusions

In summary, we have reported a facile strategy to fabricate a composite polydopamine-assisted hierarchical TiO₂ coated mesh with recoverable superhydrophobicity by combining the polydopamine (PDA) chemistry and photocatalytic activity of TiO₂ nanoparticles [32-35]. This mesh possessed enhanced superhydrophobicity, excellent environmental stability, robust chemical resistance and high mechanical durability, as well as superior oil/water separation efficiency and recyclability in the practical usage. In addition, owing to the photocatalytic activity of anatase TiO₂ involved in the coatings of the mesh, this superhydrophobic mesh enabled the photocatalytic degradation of amphiphilic pollutants under UV irradiation, allowing for the UV-assisted self-cleaning. This investigation suggests a promising path to endow materials with restorable superhydrophobic surfaces, which promise a wide range of applications including oil/water separation, photocatalysis, and solar utilization.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Figures

Scheme 1. Schematic illustration of synthetic procedure for superhydrophobic TiO_2 coated mesh and its application for oil/water separation and photocatalytic degradation of organic pollutants.

Figure 1 SEM images (a, b, d, e, and g, h) and XPS spectra (c, f, and i) of (a-c) stainless-steel mesh; (d-f) PDA-TiO₂ coated mesh; (g-i) superhydrophobic TiO₂ coated mesh, respectively. The insets in (a), (d), and (g) are the corresponding water contact angle results. (j) Elemental mapping patterns and (k) XRD patterns of superhydrophobic TiO₂ coated mesh.

Figure 2 (a) Photograph of dyed (with methyl blue) water droplets, and (b) WCA measurement of superhydrophobic TiO_2 coated mesh. Photographs of (c) the water repellence of the superhydrophobic TiO_2 coated mesh by injecting a jet of water, and (d) the comparison between pristine and superhydrophobic meshes by placing them in water. SEM and wetting property measurement (insets) of superhydrophobic mesh by (e) heating at 200 °C, (f) freezing in liquid nitrogen at -196 °C, (g) UV irradiation ($\lambda = 365 \text{ nm}$, 500 W), respectively, for 2 h. The WCAs for the mesh (h) treated by various solvents for 24 h, (i) after laundering for 25 cycles by following the AATCC 61–2006 standard method, and (j) after 100 cycles with sandpaper abrasion under a 200g weight. Insets in (j): water droplets placing on the surface and its WCA after sandpaper abrasion.

Figure 3 Photographs of the superhydrophobic TiO_2 coated mesh for separating oil/water mixtures (1:1, v/v, 200 mL): (a) tetrachloromethane (oil with high density, dyed with oil red)/water mixture, (b) *n*-hexane (oil with low density, dyed with oil red)/water mixture. Separation efficiencies of the superhydrophobic TiO_2 coated mesh (c) for a series of oil/water mixtures (1:1, v/v, 200 mL), (d) in collecting tetrachloromethane and *n*-hexane from water over 50 repetitive cycles.

Figure 4 UV–visible spectra of methyl blue solutions (0.25 mM) in the presence of (a) pristine stainless-steel and (b) superhydrophobic TiO_2 coated meshes under UV irradiation over times, inset: the typical realtime photographs during the photodegradation of methyl blue solution by the superhydrophobic TiO_2 coated mesh. (c) Linear fits of log-transformed relative absorbance intensities at λ_{max} of stainless-steel mesh and superhydrophobic TiO_2 coated mesh. (d) Photodegradation efficiency of the superhydrophobic TiO_2 coated mesh for eight photocatalytic cycles.

Figure 5 Self-cleaning evaluation of superhydrophobic TiO_2 coated mesh. (a) A cycle demonstration of the superhydrophobic TiO_2 coated mesh contaminated by oleic acid and subsequently restored by UV irradiation. (b) Variation of water contact angles on 10 cycles of contamination and self-cleaning by UV irradiation.