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Supporting Information

Designing durable and flexible superhydrophobic coatings and its application in oil purification

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Figure S1. Images of contact/sliding angles of (**a**) NiO-UHMWPE and (**b**) SiO₂-UHMWPE systems.



Figure S2. Fabrication of A1. The UHMWPE based solution was poured onto the substrates in different sizes and shapes, showing that the coating could be treated on (a) rectangular, (b) circular and (c) cross shape substrates.



Figure S3. Characterization of SiO₂ and NiO particles. (a, b) SEM and Fourier transform infrared (FTIR) spectrum of silica. Particle size of SiO₂ was ~30 nm. Peaks around 2950 and 1400 cm⁻¹ in FTIR spectrum were due to the stretching and bending of C-H bond, indicating the – CH₃ groups. (c) SEM, high-resolution (d) C1s and (e) Ni 2p spectrum of oxide nickel. Particle size of NiO was ~50 nm. C 1s could be resolved into four components, namely, -CF₃ (293.3 eV), -CF₂ (290.9 eV), -C-O (287.5 eV) and C-C (284.1 eV), indicating the surface modification of 1*H*,1*H*,2*H*,2*H*-perfluorodecyltriethoxysilane (FAS-17). The spectrum of Ni 2p indicated the existence of NiO.



Figure S4. SEM images of (a) A2 and (b) A3 coating.



Figure S5. EDS spectra of (a) sursface and (b) cross-section of A1.



Figure S6. Superhydrophobic coatings (A1) treated on different materials. (a) Water maintained spherical on treated substrates. (b) Time-lapse photographs of water droplets bouncing on treated Cu, Al, Ti alloys and PC film. Droplet sizes, $\sim 5 \pm 0.2 \mu$ L. Impact velocity, $\sim 1 \text{ ms}^{-1}$.



Figure S7. Characterization of superhydrophobic coating (A1) after abrasion test. The surface morphologies did not undergo essential changes: the surface was still covered with the polymer (UHMWPE) and the particles showed compact connection. The distributions of C, Si and Ni elements were uniform, as shown in EDS mapping images, indicating that the UHMWPE was still mixed well with the NiO and SiO₂ particles. Thus, after being abraded by sandpaper for over 965 cm, the worn coating still exhibited almost the same morphologies and chemical compositions as it was before the abrasion.



Figure S8. Surface morphologies of A1 coating after (a, b) tape-peeling and (c, d) deformation.



Figure S9. **Water droplets on treated PC film.** Due to the elastic nature of PC film, the coating was pushed down when droplets were added, and then bounced back when droplets rolled off. The superhydrophobic coating swung with the PC film during the process, showing superior resilience.



Figure S10. Three step environmental tests of the abraded coating. (a) humidity, (b) UV irradiation, and (c) multiple-cycles of alternating high/low temperatures. (d) Temperature as a function of time during high/low temperature cycles. (e) Images of contact/sliding angles, and time-lapse photographs of water droplets bouncing on the coating after environmental tests. Droplet sizes, $\sim 5 \pm 0.2 \mu$ L. Impact velocity, $\sim 1 \text{ ms}^{-1}$.



Figure S11. Oil droplets contacted on the treated surface. The coating exhibited superoleophilicity for hexane, gasoline and kerosene. The oil droplets were sucked in and spread on the coating.



Figure S12. Oil purification through inverted cone system. When small water droplets were added into the inverted cone shaped coating containing hexane, the droplets would roll and gather together due to the gravity. The water would freeze under -8°C and the inverted cone shaped ice could be obtained.

Description of the supporting movies

Movie S1. Water column rebounded on the superhydrophobic coating that was treated on the steel substrate, indicating that the coating possessed water proofing properties.

Movie S2. (a) Sandpaper abrasion test. The coated steel surface was loaded with 200 g and faceddown onto the 200 grid SiC sandpaper, and then moved along the ruler for 22.5 cm. After it reached the edge of the sandpaper, and then the sample was pulled backward. This process is defined as 1 cycle, where the coating was abraded for 45 cm. In the next cycle, the sandpaper was positioned 2 cm away from the previous abrasion route in order to guarantee that the sample was abraded by a coarse sandpaper surface. (b) Tape-peeling test. The surface exhibited superhydrophobicity after 50 times peeling.

Movie S3. Blade scratching test of the superhydrophobic coating. The coating was prepared on steel sheet and was scratched into many grids with the size of $5 \times 5 \text{ mm}^2$. The water droplets rolled off the scratched surface.

Movie S4. Deformation tests of A1. (**a**) After 100 times folding, the coating on PC substrate still exhibited extreme water repellency and droplets rolled away easily. (**b**) After being deformed into a cylindrical shape (tube), the coating did not fall off and droplets could still roll through the tube. **Movie S5.** (**a**) Recycling process: the debris of coating, UHMWPE and solvent (decahydronaphthalene) were stirred in 160 °C for 1 h. Then the solution was poured onto a steel substrate and then dried. The droplets rolled off the recycled surface easily. For the convenience of the recording, this process was conducted outside the fume hood with appropriate protections. The recycling process should be performed in the fume hood. (**b**) Movie of droplet bouncing on the recycled surface.

Movie S6. (a) Oil purification through stirring system in gasoline. (b) Small droplets stayed on the steel sheet bottom in gasoline.