Supporting Information

Biomimetic Surfaces with Anisotropic Sliding Wetting by Energy-Modulation Femtosecond Laser Irradiation for Enhanced Water Collection

Yang Lu,[a] Liandong Yu,[a] Zhen Zhang,[b] Sizhu Wu,*[a] Guoqiang Li,[b] Peichao Wu,[b] Yanlei Hu,[b] Jiawen Li,[b] Jiaru Chu[b], and Dong Wu**[b]

[a]Precision and Equipment Support Laboratory, Department of Instrument Science & Opto-electronics Engineering, Hefei University of Technology, Hefei, Anhui, 230009, People's Republic of China.
[b]Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, Hefei, Anhui, 230026, People's Republic of China.
E-mail: sizhuwu@hfut.edu.cn and dongwu@ustc.edu.cn

Key words: (Rice leaf inspired design; femtosecond laser irradiation; three-level hierarchical structures; tunable anisotropic sliding; multifunctional liquid manipulation)

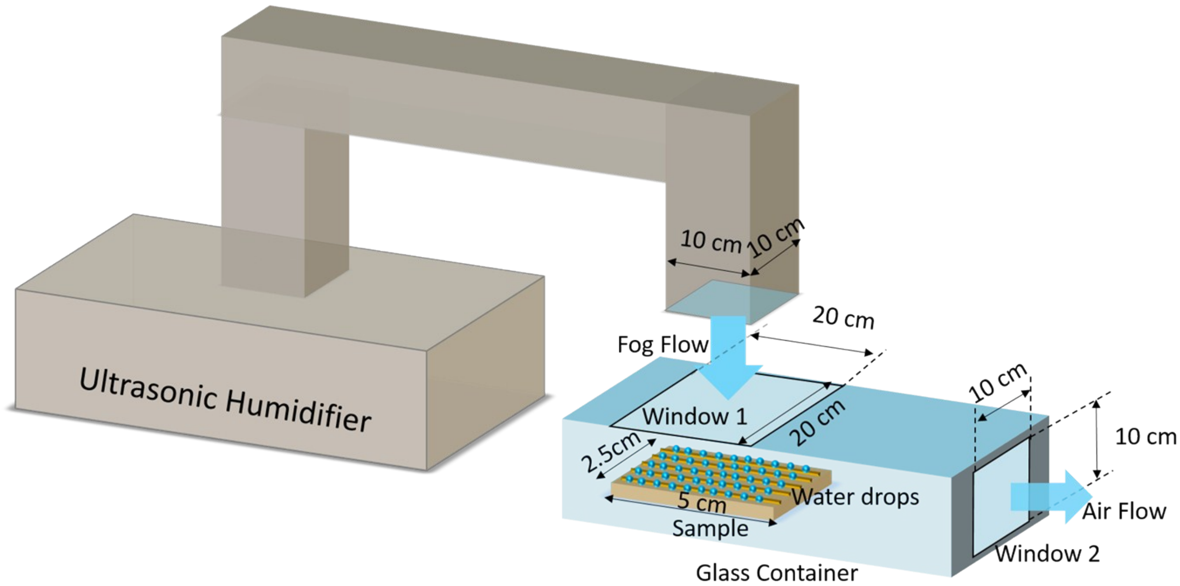

Fig. S1 The diagram of set up for fog deposition experiment. A sample was flat placed inside a self-designed glass container with two window. The fog flow produced by the ultrasonic humidifier was vertically guided onto the surface of the sample for 30 s.

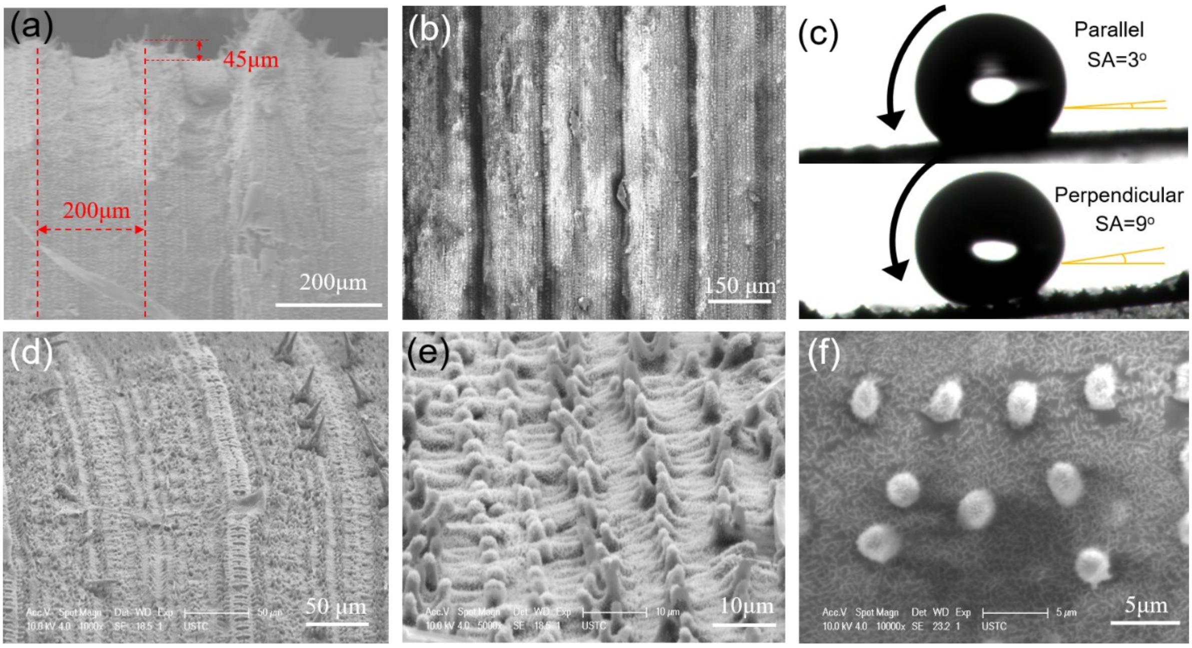

Fig. S2 SEM images for the hierarchical Structures and anisotropic SAs measurement of rice leaf surface.(a) Period macro-grooves. (b) The top-view SEM image of rice leaf. (c) Optical images of sliding angle measurement for a water droplet (volume of 4 μl) parallel (3°) or perpendicular (9°) to the longitudinal direction of rice leaf. (d) An 80° tilted SEM image of the rice leaf upper surface. (e) Regular distribution of micrometer-scale papilla. (f) Magnified top-view SEM shows micrometer-scale papilla and nanostructures on the rice leaf.

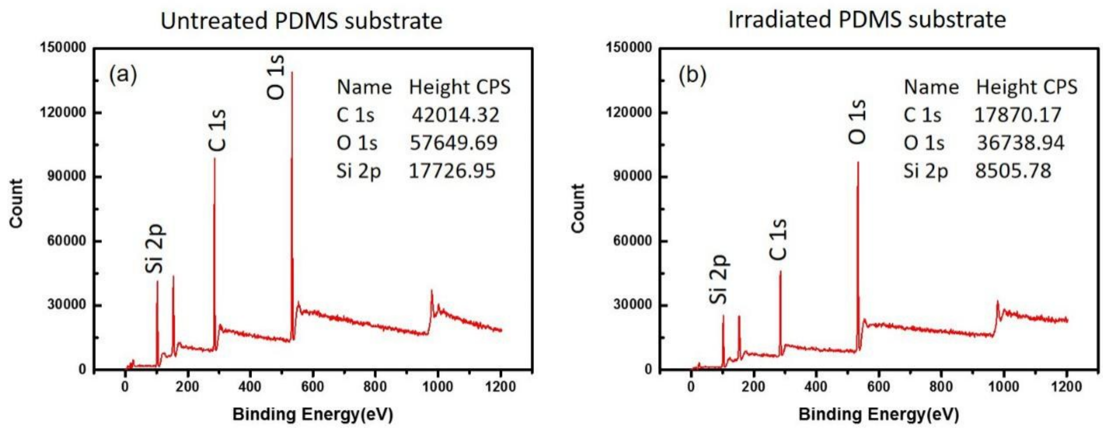

Fig. S3 XPS spectra for PDMS. (a) before laser irradiation and (b) after laser irradiation with pulse energy of 0.40 J/cm^2 and scanning space of 400 μm.

Table S1.

Atomic concentration determined with XPS of untreated PDMS, and irradiated PDMS (0.40 J/cm^2, 400 μm) compared with the theoretical values for PDMS.

	C(at.%)	O(at.%)	Si(at.%)
PDMS(theoretical)	50.0	25.0	25.0
PDMS(measured)	47.09	31.21	21.7
Irradiated PDMS	38.33	39.28	22.39

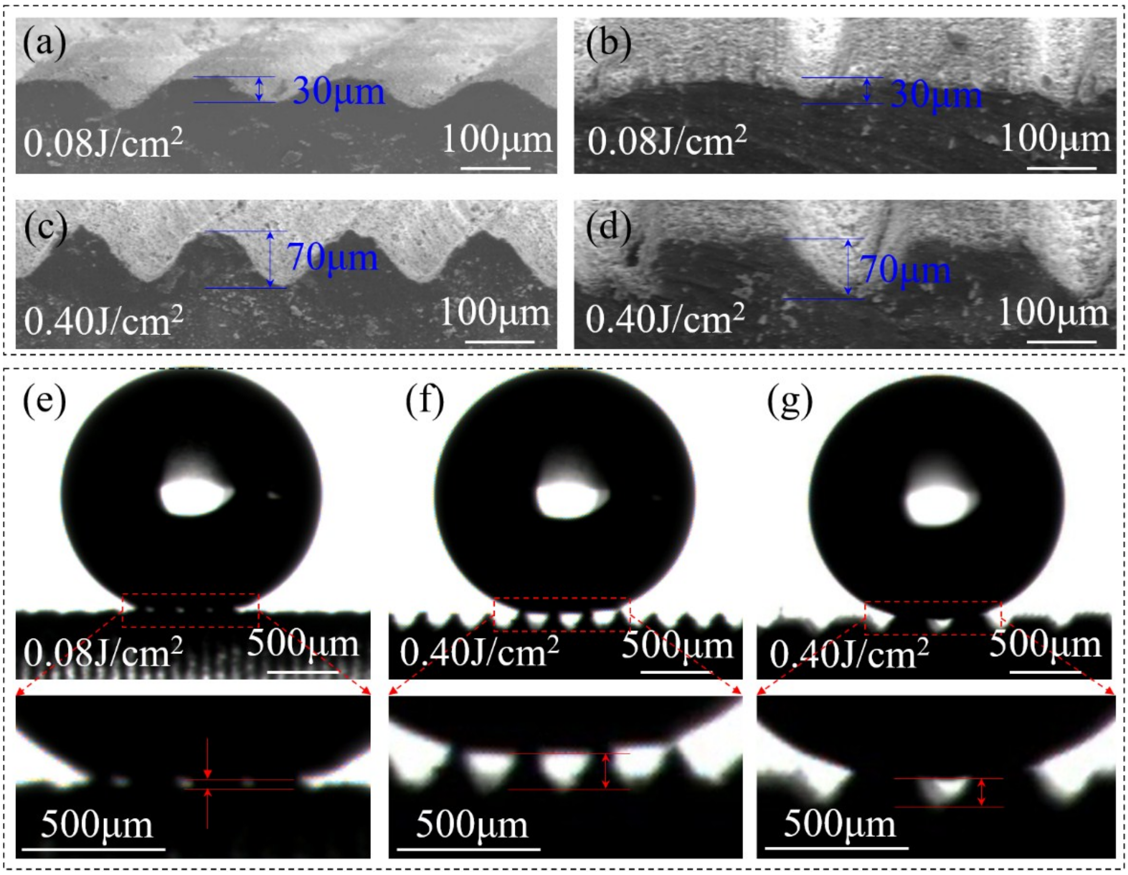

Fig. S4 Barrier height of anisotropic macrogrooves and optical microscopic images of droplets on the fabricated surfaces. The period of grooves shown in (a) and (c) is 200 μm while the groove period shown in (b) and (d) is 400 μm. By measuring the distance between the groove bottom to the top, the barrier heights can calculated according to the ratio of groove depth to period in the SEM images. (e)- (g)The optical microscopic image of the water droplet on different macrogrooves, from which we can see there are different energy barrier. The obvious air gap under the droplet indicates that the sample are always in the Cassie-Baxter state when the depth and period are changed.

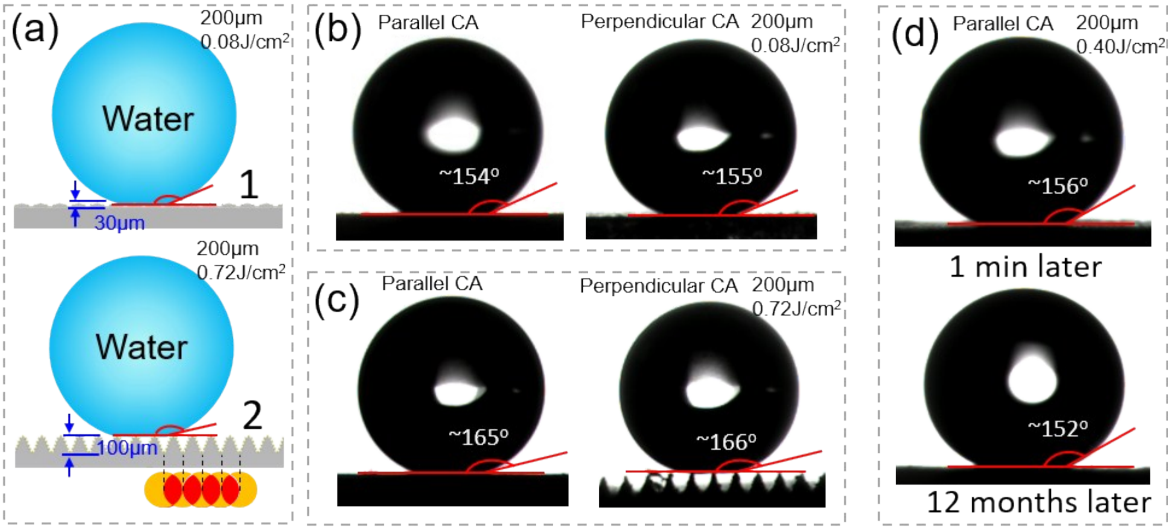

Fig. S5 Two types of isotropic surfaces fabricated with different pulse energy. (a) Both substrate 1 and 2 are isotropic surfaces: In first case, the energy barrier provided by grooves is not able to limit droplet movement; In second case, light spot overlapping of particularly high pulse energy increased the roughness of substrate 2, both parallel and perpendicular CAs are larger than 160°. (b) and (c) show the parallel and perpendicular CAs of substrate 1 and 2, respectively. (d) The parallel CAs of a substrate 1 minute and 12 months later after process.

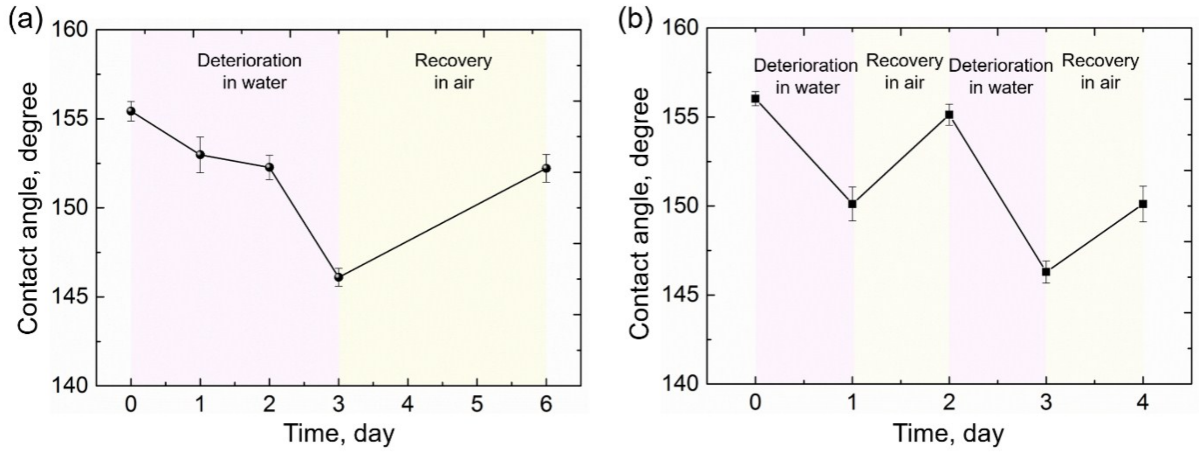

Fig. S6 Contact angle deterioration and recovery measurement. (a) The sample was immersed in water for 3 days, and the contact angle deteriorate from 155.4 ± 1° to146.1 ± 1°. Then the sample was kept in air for 3 days, the contact angle recover to superhydrophobicity (152.22 ± 2°). (b) The sample was immersed in water 1 day and kept in air 1 day alternately, the contact angle also can recover.

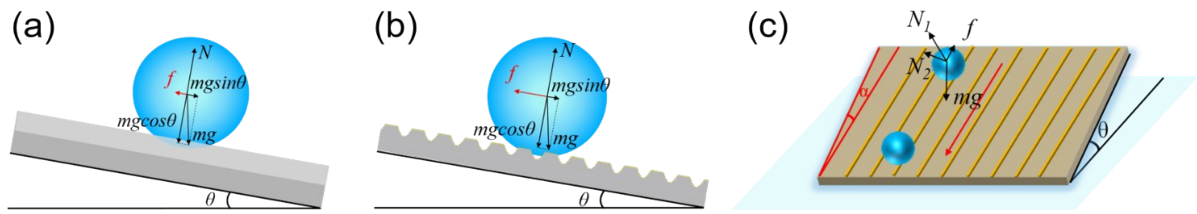

Fig. S7 Force analysis of water droplet on the inclined bionic rice leaf in (a) the parallel direction and (b) the perpendicular direction. The resistance to motion f in the parallel direction is smaller than that in the perpendicular direction, as a result, the SA in the parallel direction is smaller. (c) indicates the water droplet on the inclined surface (θ) with a rotation angle α subjects to supporting force N_2 which is vertical to the grooves, results in directional sliding along the parallel direction of the grooves.

Supporting Video 1. The anisotropic sliding of 5 μl water droplets on isotropic and anisotropic PDMS surfaces. For the 100 μm period isotropic PDMS surface, the parallel and perpendicular sliding angles are about 2.1^{o} and 3^{o}, while they are about 2.5^{o} and 8.5^{o} for the 400 μm period anisotropic PDMS surface. Due to the low adhesive force, the water droplets roll off the surface along the parallel direction very easily.

Supporting Video 2. Directional guide sliding of nature rice leaf and the anisotropic PDMS surface. Due to the similar anisotropic sliding ability, both natural rice leaf and anisotropic PDMS surfaces can guide the blue ink droplets roll off along the groove arrays rapidly without dispersion when the surfaces have a rotation angle of 10^{o}.

Supporting Video 3. Directional water collection of isotropic and anisotropic PDMS surfaces. With rotation angle of 10^{o}, the water droplet rolls off the isotropic surface vertically by the effect of gravity only, while the droplets on the anisotropic surfaces can roll along groove arrays into the water container. The droplets can easily roll off both of surfaces within 0.3 s.