Preparation of superhydrophobic nanowires on polypropylene surface via injection compression molding for efficient fog collection

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Supporting Information

S1. Fabrication of template

First, the silicon (Si) wafer is etched using two-step Metal-assisted chemical etching (MACE) method. Then the etched Si wafer is used to fabricate the nickel (Ni) template by a combination of electroless plating and electroplating. The details of the fabrication are as follows:

S1.1. Etching of silicon wafer

The etching of the Si wafer was as follows:

A. Boron-doped (1–3 Ω·cm) n-type (100) oriented Si wafers with thicknesses of 200±20 μm were cut into plates with dimensions of 2 cm×3.5 cm. They were cleaned using the following steps to remove organic and other surface contaminants: (i) treatment with a solvent mixture of acetone, isopropanol, and deionized water for 5 min, (ii) 30 min of ultrasonication in an H_2SO_4 (98wt%) and H_2O_2 (30wt%) mixture with a volume ratio of 3:1, (iii) washing with ethanol and deionized water, and (iv) drying at room temperature.

B. The cleaned Si wafers were immersed in $AgNO_3$ (0.2 M) and HF (40wt%) mixture with a volume ratio of 1:1 for 5 min at room temperature, followed by 10 min of etching in an HF (40wt%) and H_2O_2 (40wt%) mixture with a volume ratio of 10:1. Subsequently, Si wafers were immersed in nitric acid (30wt%) for 1 h (to remove the residual silver nanoparticles), cleaned with ethanol and deionized water multiple times,

and dried at room temperature.

S1.2. Preparation of nickel template

The Ni template was prepared by a combination of electroless plating and electroplating. Electroless Ni plating can be used to deposit electrical conductivity Ni layer on the etched Si wafer. Electroplating Ni is an inexpensive way to replica the nanowires on the etched Si wafer. The compositions and concentrations for the Ni template preparation are given in Table S1.

Table S1. Composition, concentration, and parameters used for nickel template preparation

Sequence	Composition	Parameter
Pretreatment	$PdCl_2$, 1 g/L	10 min, 20°C
	HCl, 30 mL/L (0.5 M)	
Electroless plating	NaH_2PO_2, 30 g/L	pH = 8.5, 30 min, 50°C, 200 rpm
	$NiSO_4$, 30 g/L	
	$Na_3C_6H_5O_7 \cdot 2H_2O$, 20 g/L	
Electroplating	$C_{12}H_{25}SO_4Na$, 20 g/L	pH = 4.1, 4 h, 50°C, 200 rpm
	$Ni(NH_2SO_3)_2$, 300 g/L	
	$NiCl_2$, 15 g/L	
	H_3BO_3, 20 g/L	
Removing Si	NaOH, 0.1 g/mL	30 min, 80 °C

Pretreatment of the etched Si wafer with the $PdCl_2$ solution resulted in a layer of metallic palladium. Palladium acted as the active center for the oxidation-reduction reactions, producing nucleation sites and facilitating uniform Ni deposition. The Si wafer was then immersed in electroless plating solution (50°C, 30 min, 200 rpm). Elemental Ni was deposited until a metallic luster was visible, after the Ni-plated Si wafer was removed from the solution, and the electroplating was performed with an IT7000 DC (ITECH Electronic Co., Ltd. USA) instrument. A pictorial representation is given in the Figure S1. The Ni-plated Si wafer and the Ni plate served as the cathode and anode, respectively. Pre-plating was performed for 0.5 h with a current density of 1 A/dm^2, followed by 4 h with a constant current density of 3 A/dm^2. To guarantee the uniformity of the electroplating solution, a magnetic stirring at 200 rpm was applied. Finally, the Si wafer with Ni layer was immersed in NaOH solution (0.1 g/mL) at 80°C

for 30 min to remove Si, cleaned with deionized water, and dried in an oven at 120℃.

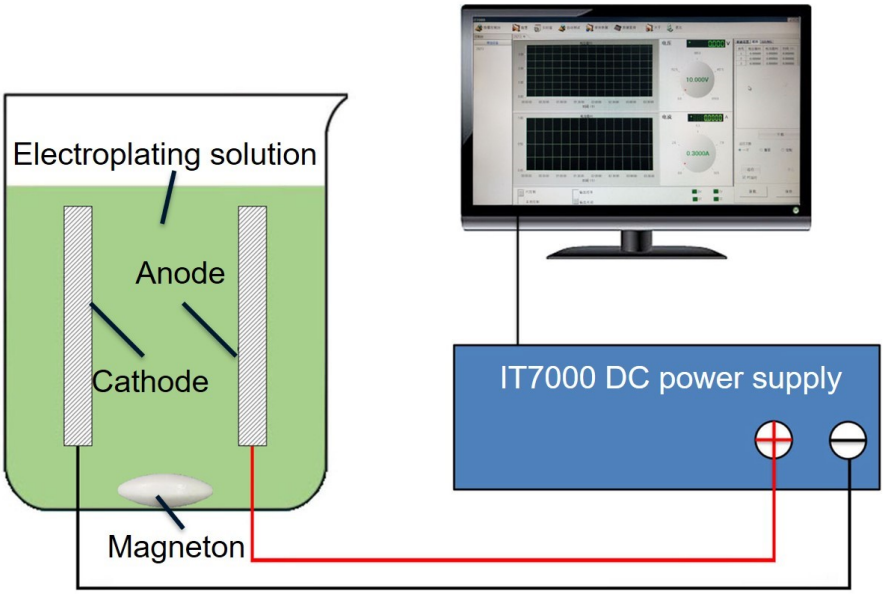

Figure S1. Schematic diagram of nickel electroplating

S1.3. Morphology of etched silicon wafer and nickel template

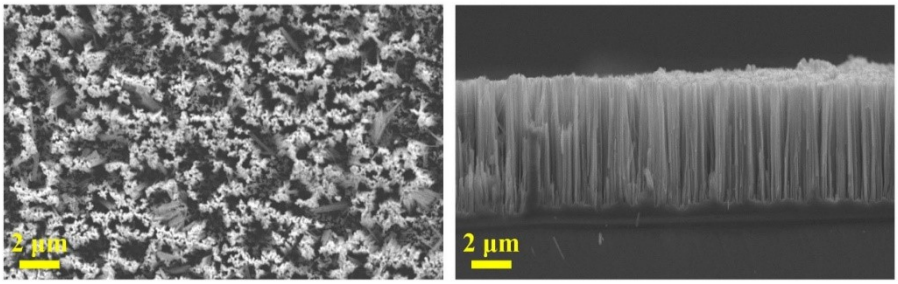

Figure S2. SEM images on etched silicon wafer surface: (a) top views and (b) cross-section views

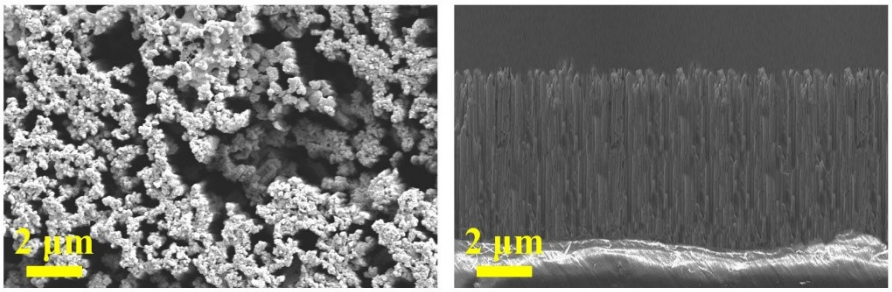

Figure S3. SEM images on nickel template: (a) top and (b) cross-section view

S2. Schematics of droplet impact test setup

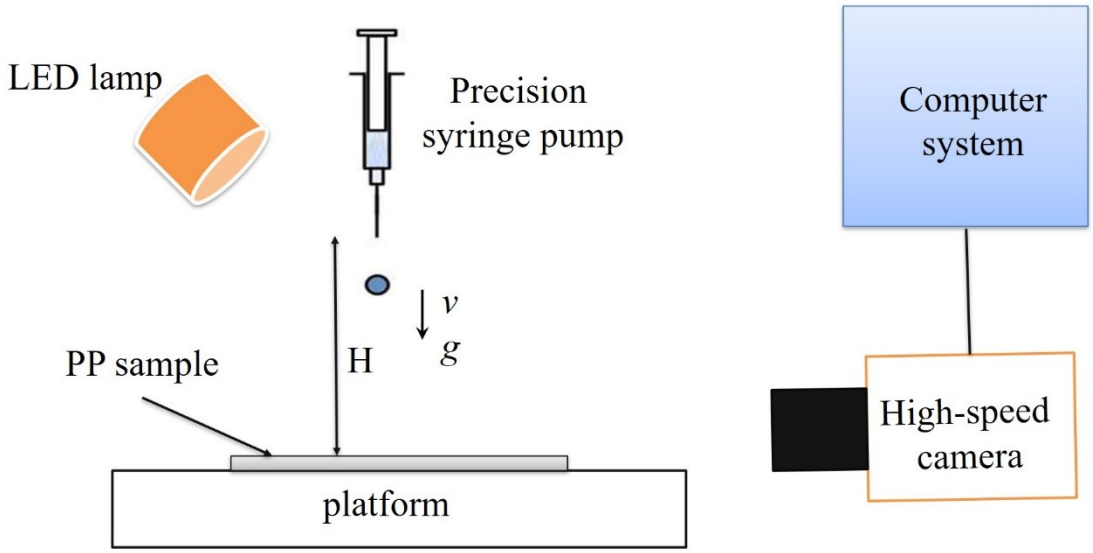

Figure S4. Schematics of droplet impact test

S3. Continuous Water Harvesting

The continuous fog water harvesting and the droplet impact on the replica surface were investigated.

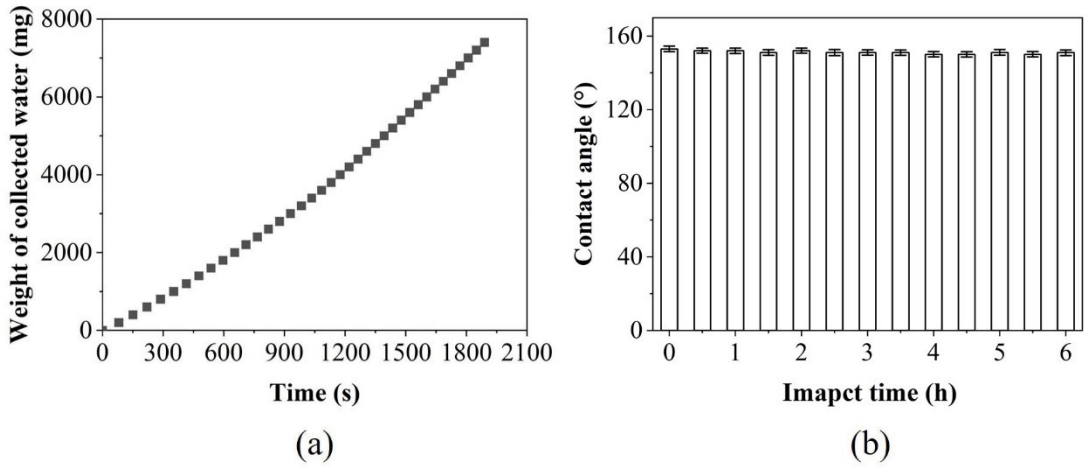

Figure S5. (a) The relationship between weight and collection time and (b) contact angle evolution with impact time for droplets (D_0 = 3.0 mm) with v of 1.87 m/s impacting on the PP replica.