Supporting Information for Publication

Magnetic-Guided Directional Rebound of Droplet on a Superhydrophobic Flexible Needle Surface

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Content：

EXPERIMENTAL SECTION

Preparation of flexible needles: First, the model of negative needle structures are prepared by 3D platform with steel needles on high density Polyethylene (PE) plate. The parameters such as the depth, distance, and the number are designed and controlled with digital controller. The needle structures are fabricated by using silicone elastomer (PDMS, sylgard 170 dowcorning, Dow Corning, USA) to combine duplicating method. Fe micro particles are placed in the negative needles (holes) and then the PDMS prepolymer mixed with hardener in proportion 1 : 1 is poured onto the PE plate. To avoid the influence of air bubble exist in the prepolymer, the plate is placed into a vacuum chamber for removing the air. Heats the sample at 80 ^{o}C for 1 h and we get the flexible needles after peeling PDMS off from the PE model.

Fabrication of nano structure: To lower surface free energy, we produce Aluminium Hydroxide (Al_2O_3) nano-structure as rough structures and cover the surface with Heptadeca Fluorodecyltri-propoxysilane (FAS-17). Al micro particles (purchased from Beijing Lanyi Chemical Co., Ltd., China) are bonded to the PDMS needles at 90 ^{o}C with pressure. Boil the samples at 100 ^{o}C for 10 min, we get the nano-structure. Dried the sample and move it into vacuum dryer and place a drop of FAS-17 beside the sample, vacuum for 15 min and then raise the temperature to 60 ^{o}C and keep in this condition for 5 h. After that, we get the SFN successfully.

Characterizations: The topography is observed by Environmental Scanning Electron Microscopy (ESEM, Quanta FEG 250, FEI) under the voltage of 15 kV. The dynamic process of droplet is observed by using high-speed CCD camera (Phantom v9.1, Vision Research, America).

Simulation: The deformation of SFN is simulated by Commercial Software Comsol 5.2. The simulating material of SFN is silicone with Young's modulus 2.14 x 10^6 Pa, Poisson's ratio of 0.48 and density of 970 kg/m^3.

Supplementary Figure Legends: (Figure S1-S5)

Figure S1:

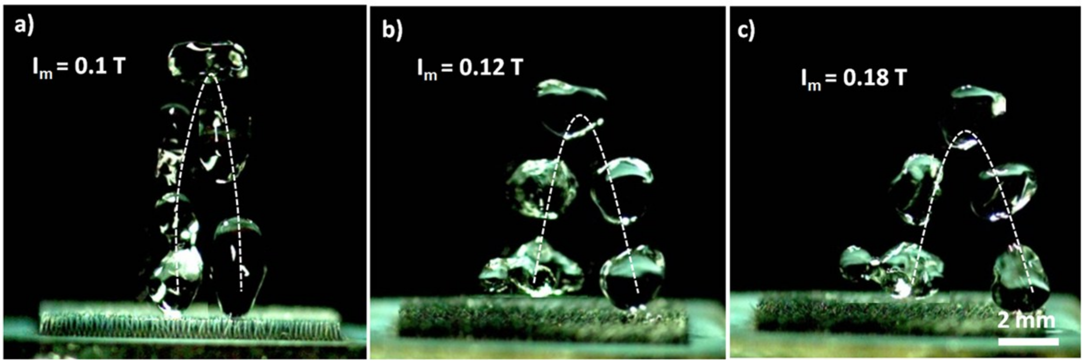

Figure S1. The droplet motion behavior first detachment to second impact on SFN surface under different magnetic fields**.** With the increase of magnetic field strength, the rebound height decreases and the horizontal deviation distance increases gradually. The scale bar is 2 mm.

Figure S2:

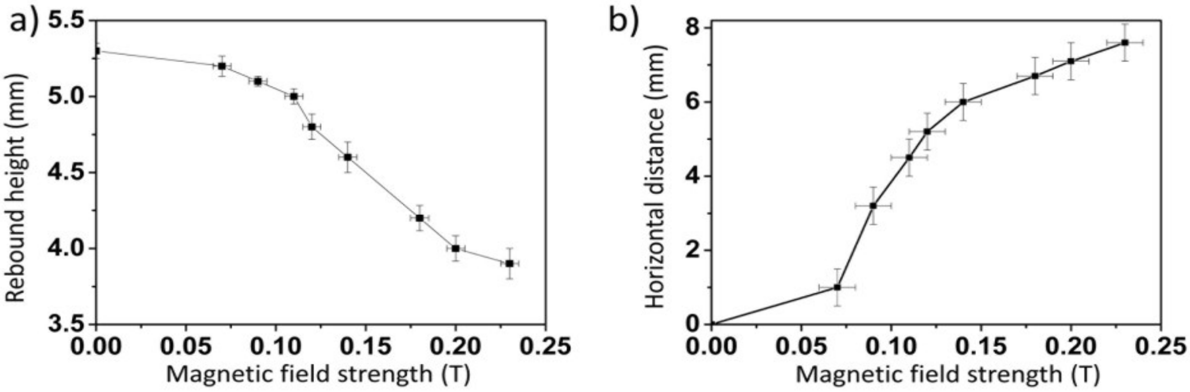

Figure S2. a, b) The rebound height, horizontal distance under different magnetic fields. With the increase of magnetic field strength, the rebound height decreases and the horizontal distance increases gradually.

Figure S3:

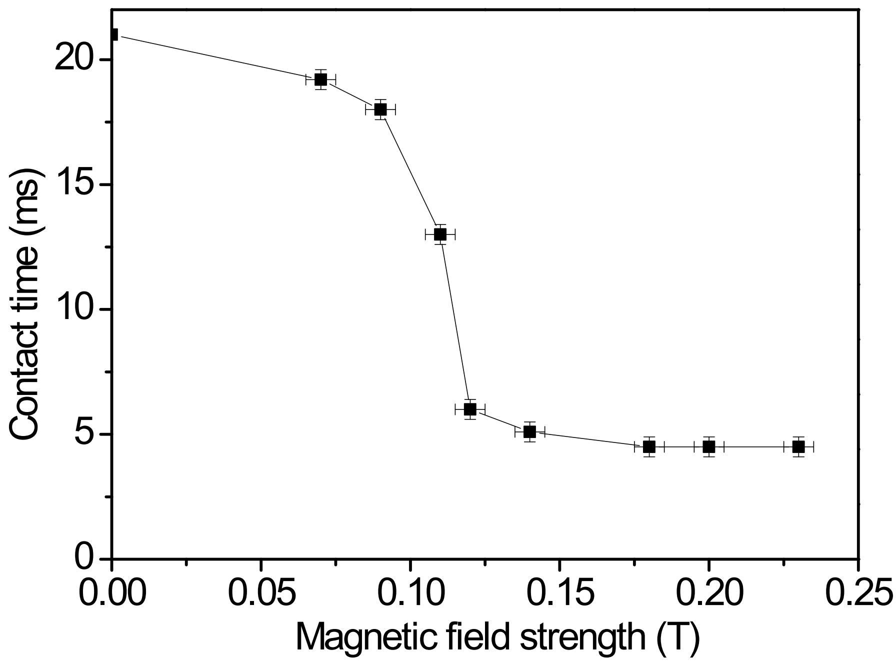

Figure S3. The contact time between the droplet and SFN surface during the impact process under different magnetic fields. Clearly, the time decreases with the increase of magnetic field strength.

Figure S4:

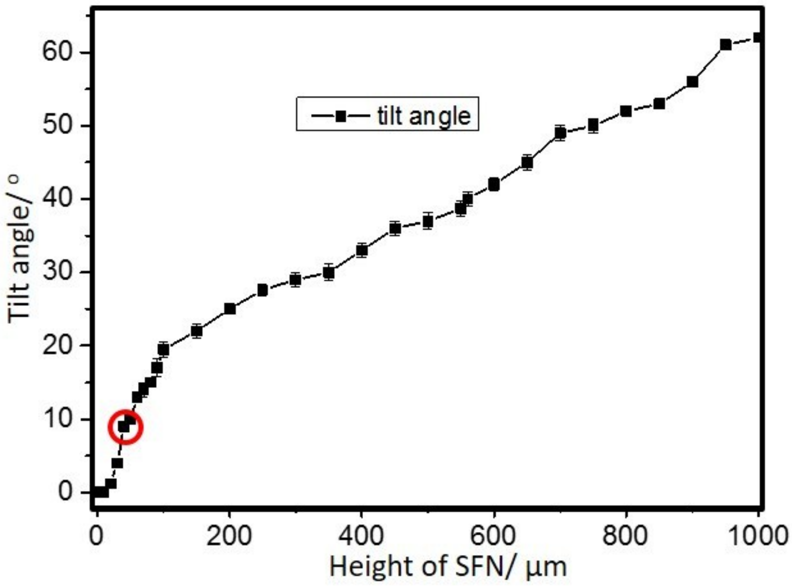

Figure S4. The tilt angle that induced by external magnetic field (0.25 T) vis the different height of SFN. The SFN with height less than 40 µm can hardly be bended by the external magnetic field. Therefore, the falling droplet can only rebound uni-directionally on SFN with height larger than 40 µm.

Figure S5:

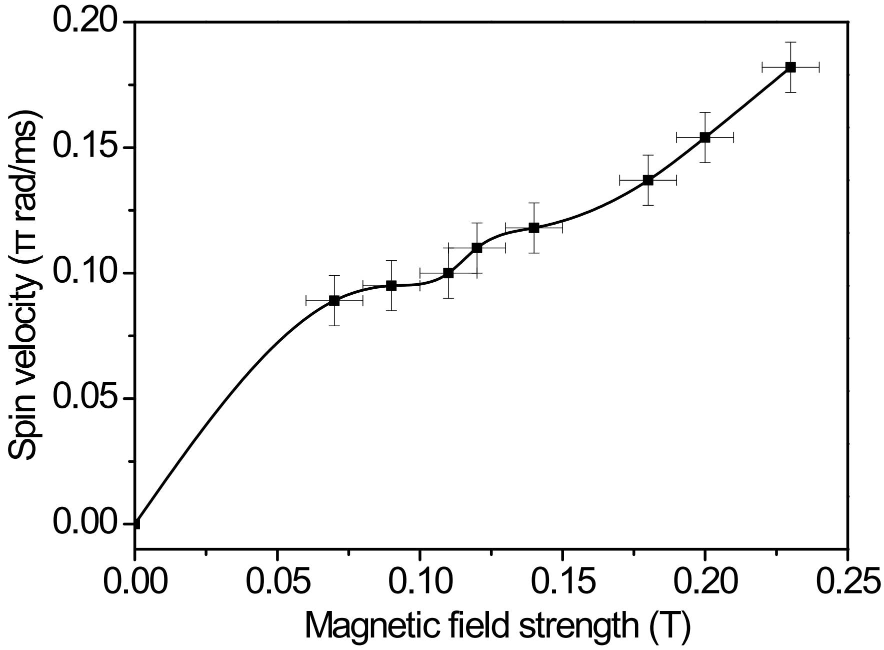

Figure S5. The spin velocity of droplet under different magnetic fields. Clearly, the spin velocity increases with the increase of magnetic field strength.

Supplementary Movies:

Movie S1: The optical video of droplet impact on SFN under the magnetic field of 0.1 T.

Movie S2: The optical video of droplet impact on SFN under the magnetic field of 0.12 T.