Electronic Supplementary Information

Self-sensing, Superhydrophobic, Heterogeneous Graphene Network with Controllable Adhesion Behavior

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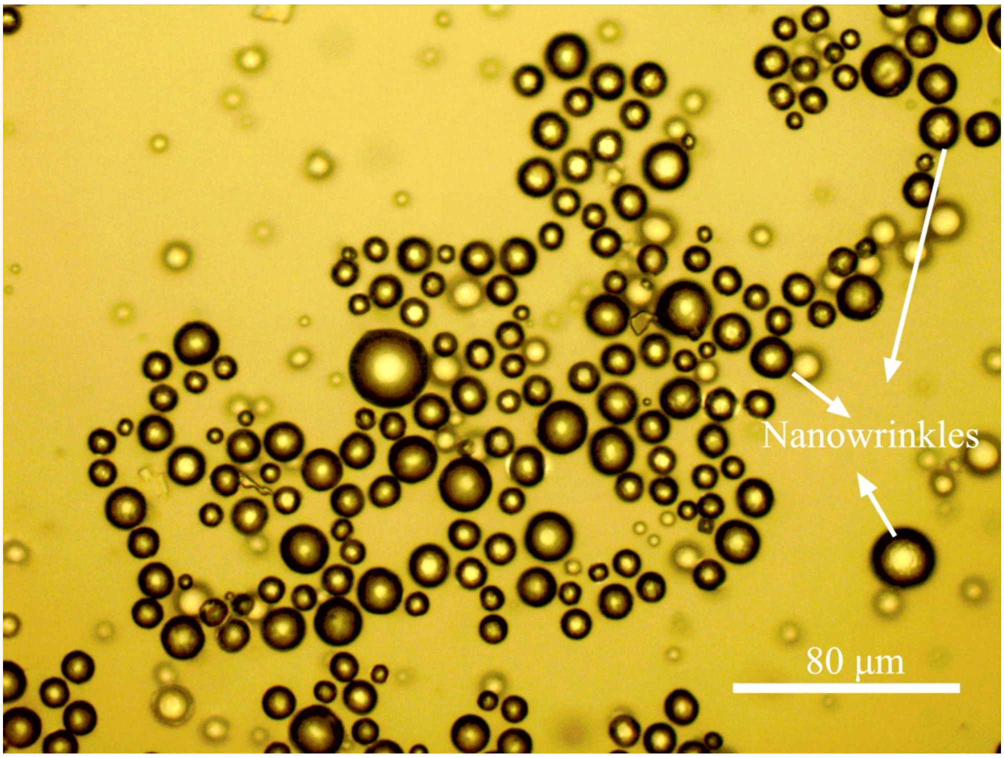

Fig. S1 Micrograph of frozen GO Pickering emulsion with GO nanowrinkles.

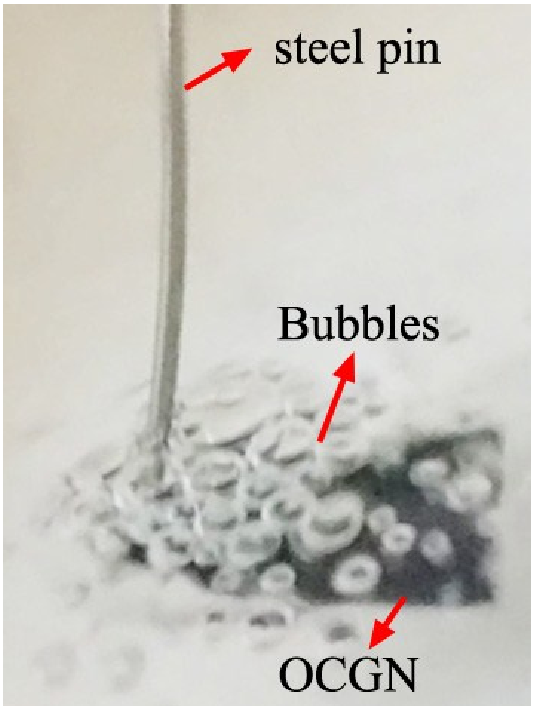

Fig. S2 The photograph of boiling coating process for OCGN.

Fig. S3 The photograph of PP/OCGN-20.

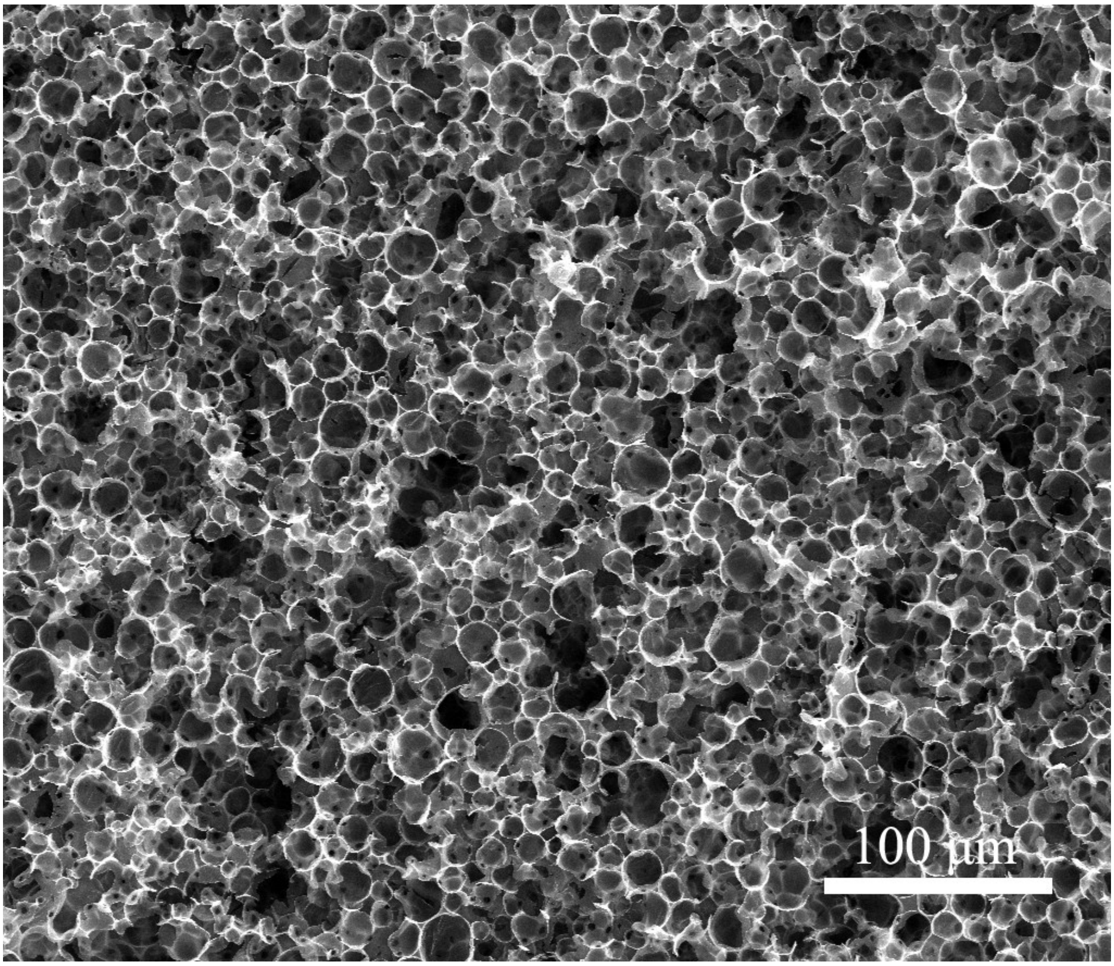

Fig. S4 The SEM image of OCGN.

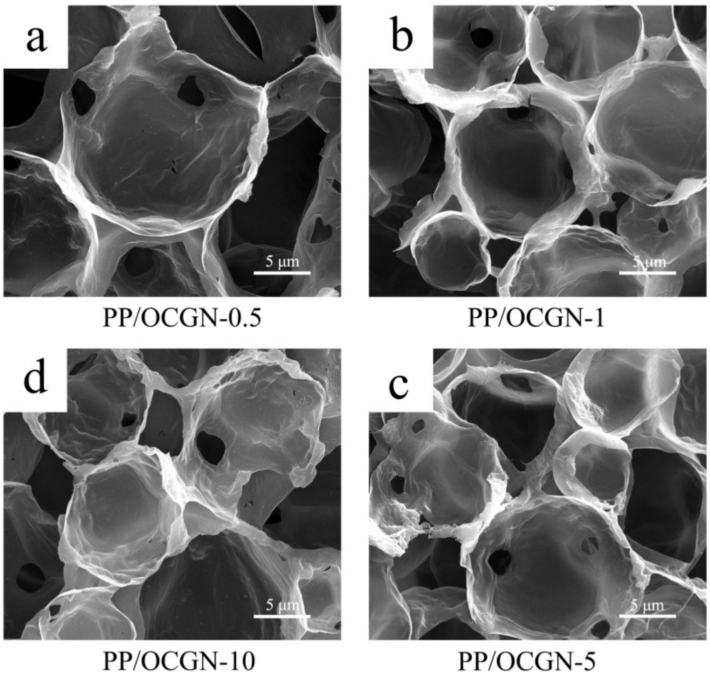

Fig. S5 a-d) Magnified SEM images of PP/OCGN-0.5, PP/OCGN-1, PP/OCGN-5, PP/OCGN-10.

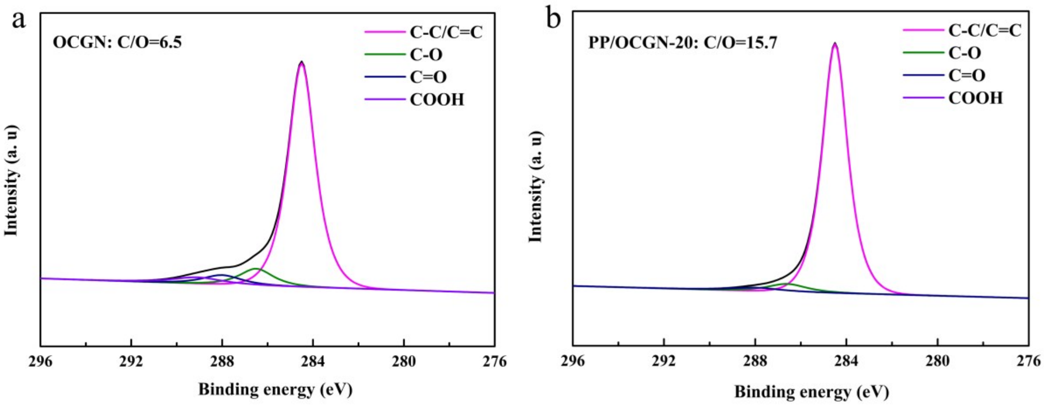

Fig. S6 a) The C 1s spectrum of OCGN, which has a carbon/oxygen ratio (C/O) of 6.5. b) The C 1s spectrum of PP/OCGN-20, which has a C/O of 15.7.

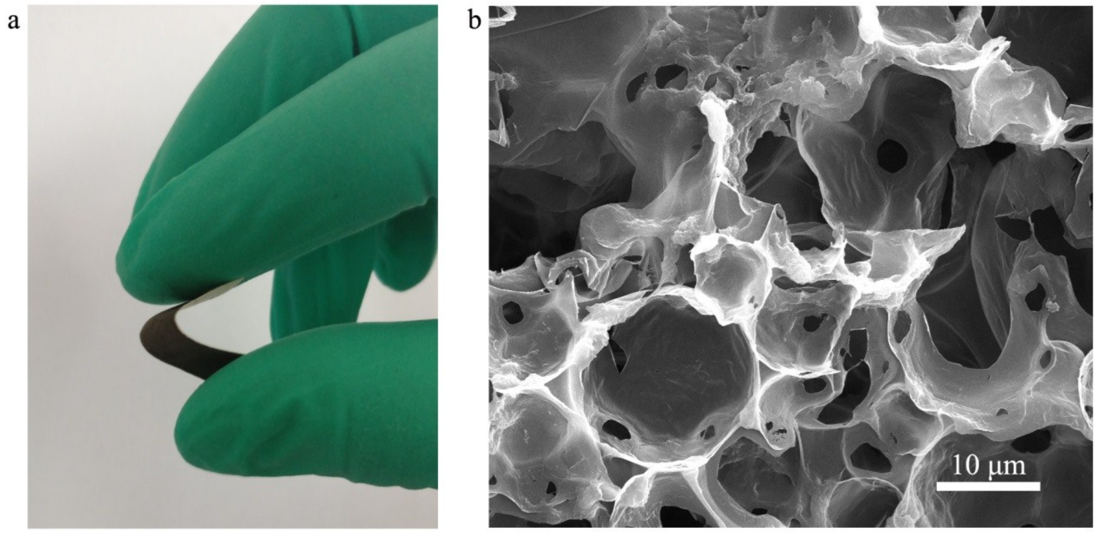

Fig. S7 a) The bending experiment of the PP/OCGN-20. b) The SEM image of PP/OCGN-20 after bent dozens of times.

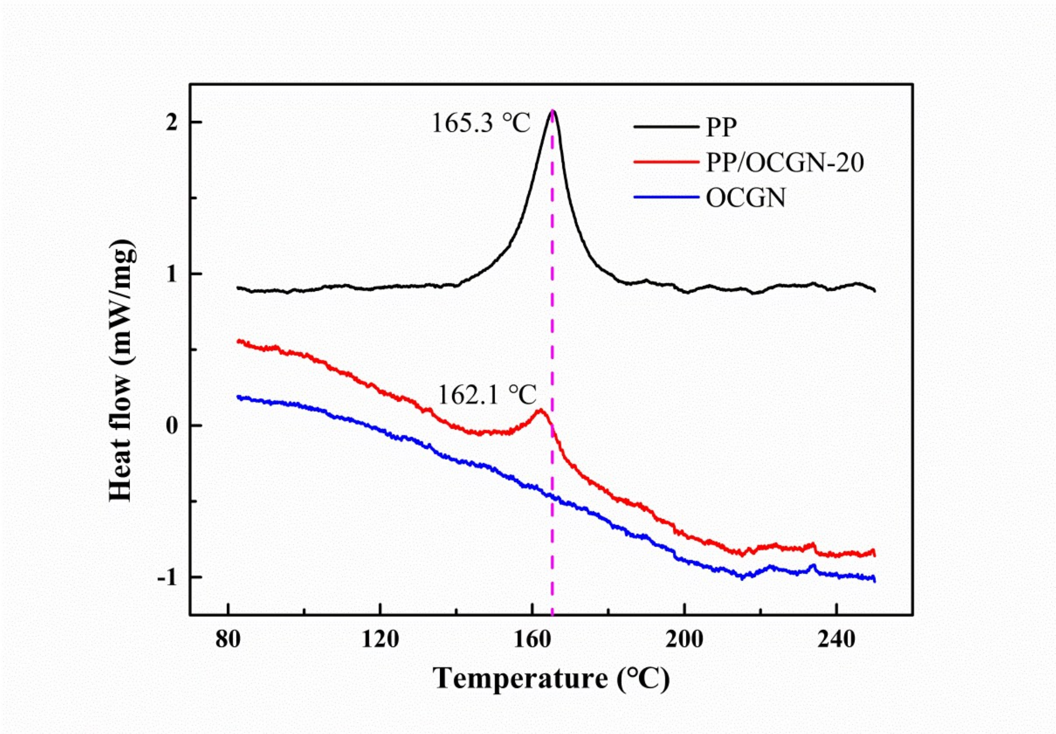

Fig. S8 The DSC curves of PP, PP/OCGN-20 and OCGN, which indicate the melting point of pure PP is 165.3 ℃, and that of PP in PP/OCGN-20 decreases to 162.1 ℃.

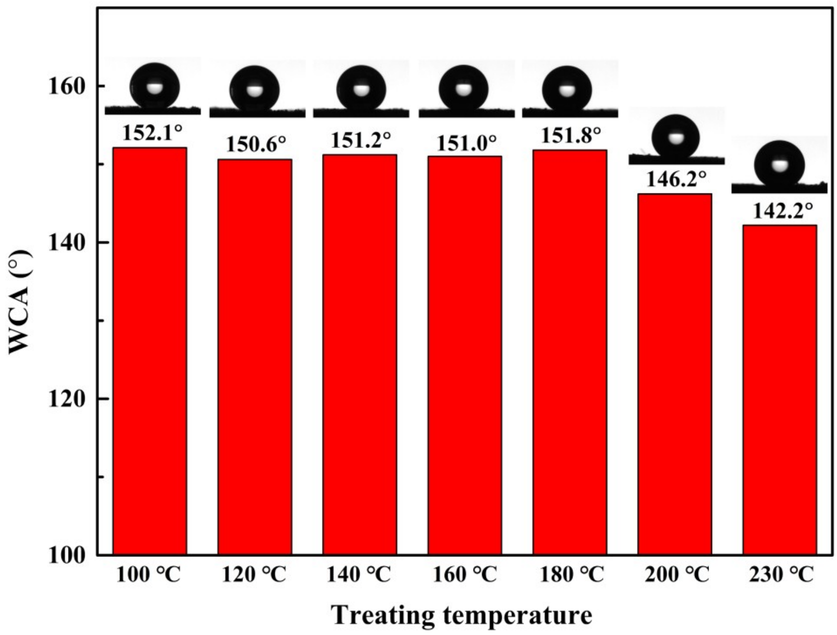

Fig. S9 The WCAs of PP/OCGN-20 after placed in different high temperature environment for 1 h. The insets are images of water droplet on corresponding surface.

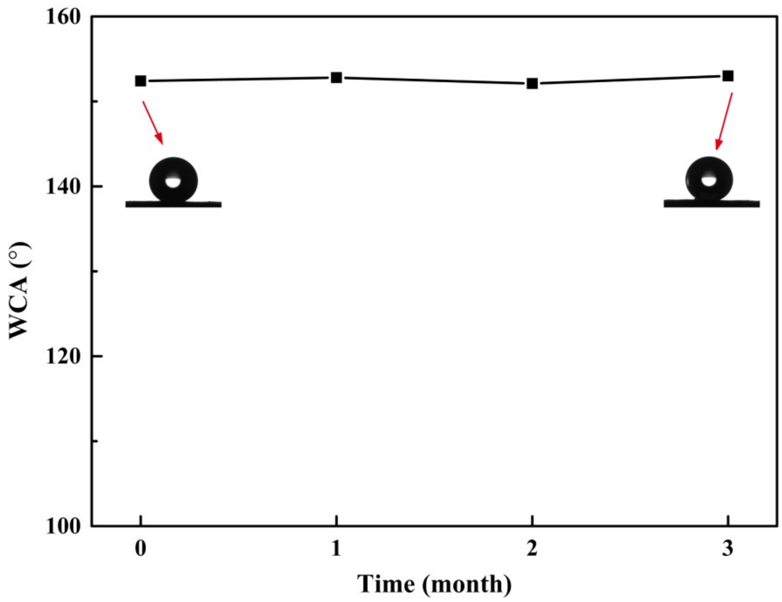

Fig. S10 The WCAs of PP/OCGN-20 after different preservation time. The insets are images of water droplet on corresponding surface

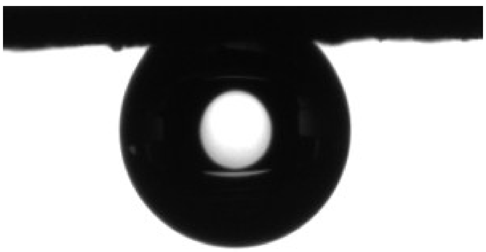

Fig. S11 A water droplet on OCGN when turned to 180° .

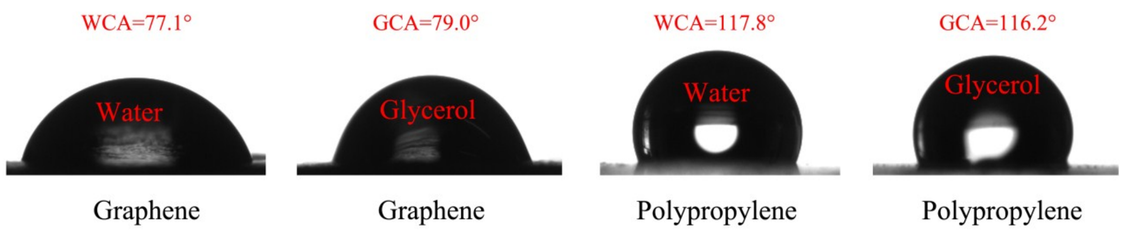

Fig. S12 The images of water drop and glycerol drop on graphene and PP coating surface.

The PP-toluene solution (5 mg mL^{-1}) was coated on glass sidle and dried at room temperature to obtain the PP coating sample. Similarly, the graphene sample was prepared by coated GO solution (5 mg mL^{-1}) on glass sidle and reduced in the HI vapor. Based on the Owens-Wendt surface energy theory,[1-3] the surface energies of PP and graphene were calculated as:

$$\gamma_l\ (cos\theta + 1)\ /2 = (\gamma_l^d)^{1/2}(\gamma_s^d)^{1/2} + (\gamma_l^p)^{1/2}(\gamma_s^p)^{1/2}$$

$$\gamma_s = \gamma_s^d + \gamma_s^p$$

where γ_s was the solid surface energy, and γ_l^d, γ_l^p, γ_s^d, and γ_s^p were the liquid dispersion component, liquid polar component, solid dispersive component, and solid polar component, respectively. So in order to obtain the solid surface energy, we need adopt two kinds of liquid which have known γ_l^d and γ_l^p at least. Here, we used the water and glycerol. The dispersion and the polar components of the surface free energy of water are 21.8 and 51.0 mJ m^{-2}, respectively, and those of glycerol are 37.0 and 26.4 mJ m^{-2}, respectively.[4] The WCA and glycerol contact angle (GCA) on the graphene and PP were presented in the Fig. S12. The surface energy values of graphene and PP were computed as 28.1 mJ m^{-2} and 5.2 mJ m^{-2}, respectively. This indicates that PP has a lower surface energy than graphene.

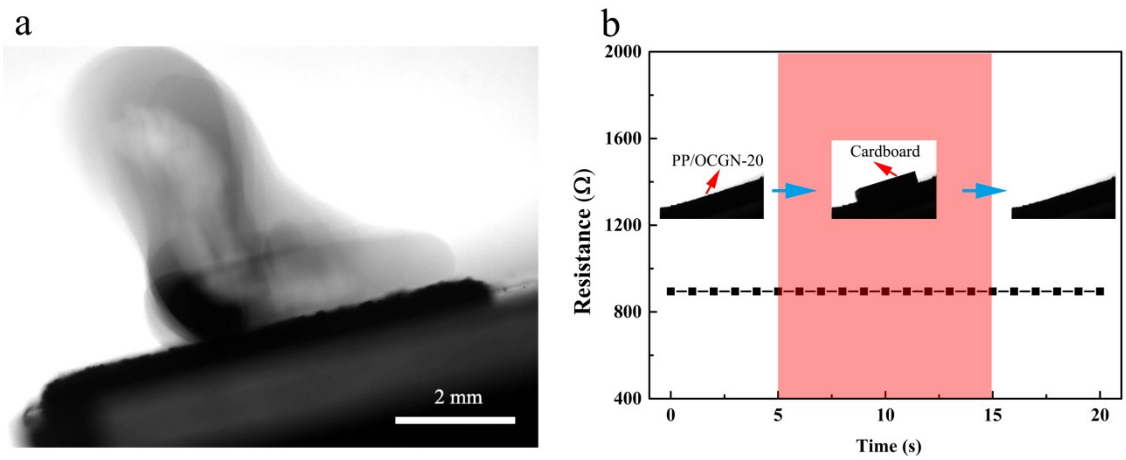

Fig. S13 a) The image of water drop (20 μL) bouncing off from the surface of PP/OCGN-20. b) The change of resistance of PP/OCGN-20 during the cardboard placed and removed on the inclined surface. Inset in (b) are the images of the cardboard placed and removed on surface of PP/OCGN-20.

The pressure caused by falling water droplet and its influence on the resistance of PP/OCGN-20 was studied by following method. It was known that the falling water droplet would bring about a greater compressive force than gravity because of its momentum. In order to obtain the compressive force, the PP/OCGN-20 fixed on inclined platform was placed on electronic balance and the change of weight was monitored during bouncing process of falling water droplet (20 μL) on the surface. The maximum increment of weight would be obtained, which could be used to evaluate the compressive force. Besides, the area of water droplet in contact with the surface of PP/OCGN-20 could also be obtained according to image of bouncing water drop in Fig. S13a. So the pressure caused by falling water droplet on the PP/OCGN-20 can be calculated by the following equation:

$$P = \frac{mg}{\pi R^2} \cos\theta$$

where P, m (21.1 mg), g (9.8 N kg^{-1}), R (2.3 mm) and θ (15^{o}) are the pressure, the maximum increment of weight, acceleration of gravity, radius of contact area and inclined angle, respectively. Finally, the pressure was computed as 12.0 Pa.

Then, the effect of this pressure on the resistance of PP/OCGN-20 was explored. For avoiding the charge transfer between the graphene and the water molecules, a cardboard, which could provide a same pressure as falling water droplet was adopted and placed on inclined PP/OCGN-20 (inset of Fig. S13b), and the change of resistance was monitored. The result showed that the resistance had no change when the cardboard was placed and removed. The unchanged resistance indicated that network of PP/OCGN-20 didn’t deform under so small pressure. Thus, we consider the pressure of falling water droplet has no influence on the resistance of PP/OCGN-20.

References

1. D. K. Owens and R. C. Wendt, Journal of Applied Polymer Science, 1969, **13**, 1741-1747.
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3. Z. Bo, Y. Tian, Z. J. Han, S. Wu, S. Zhang, J. Yan, K. Cen and K. Ostrikov, Nanoscale Horiz., 2017, **2**, 89-98.
4. D. Khang, S. Y. Kim, P. Liu-Snyder, G. T. R. Palmore, S. M. Durbin and T. J. Webster, Biomaterials, 2007, **28**, 4756-4768.