Electronic supplementary information

Biomimetic Fabrication of Highly Ordered Laminae-trestle-laminae Structured Copper Aero-sponge

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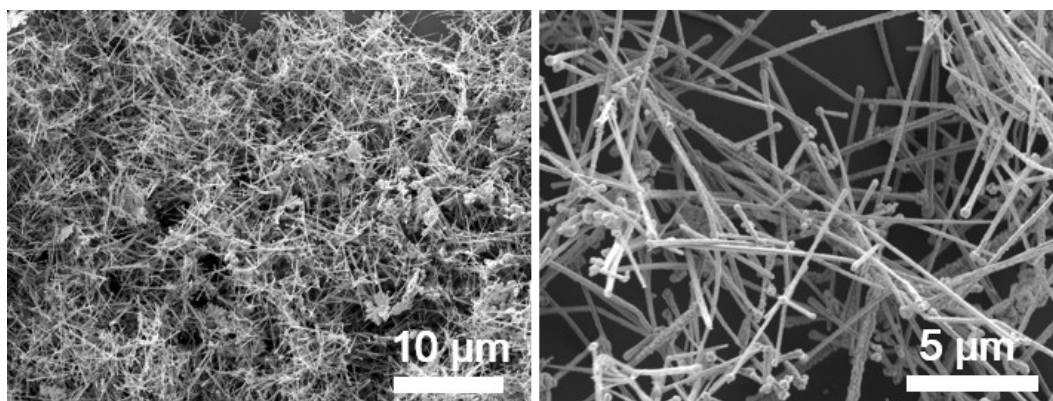
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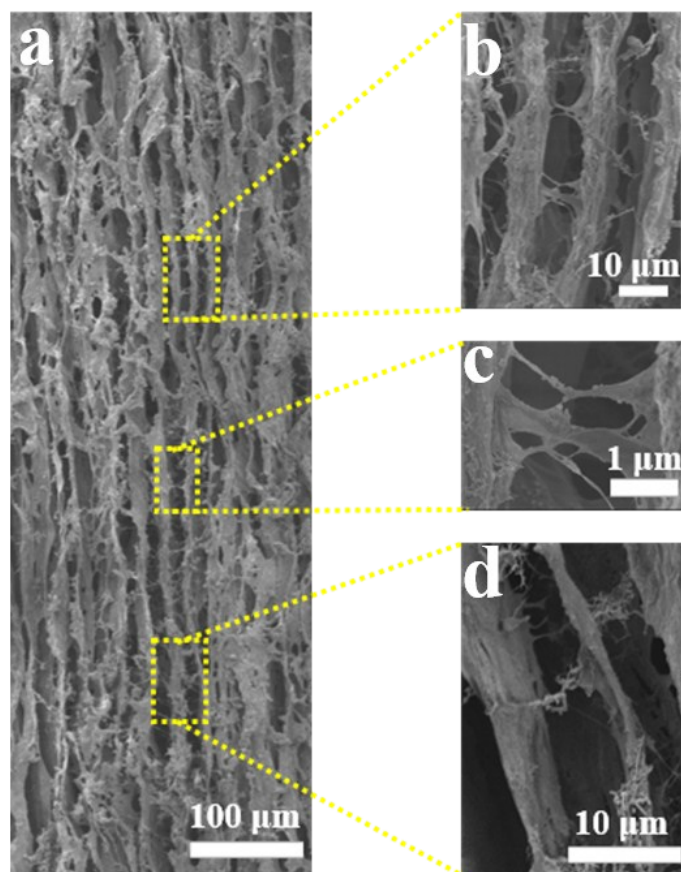
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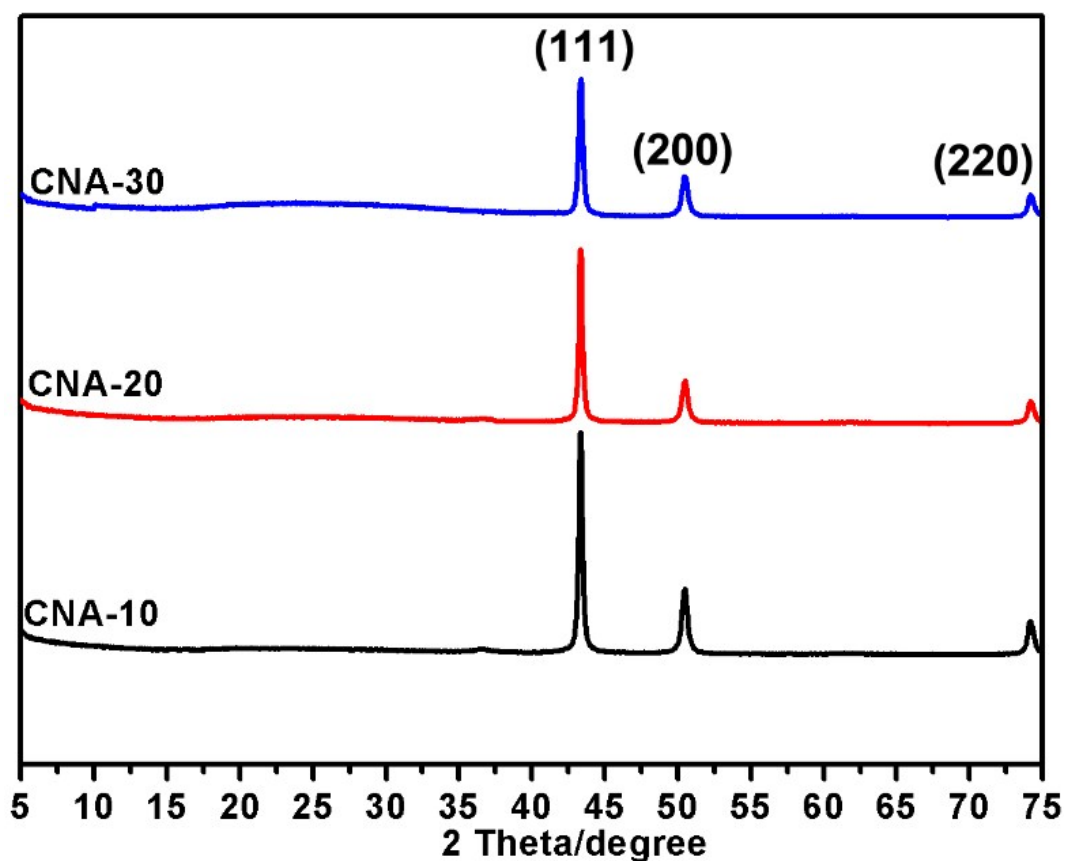
Figure S4. XRD results of aero-sponge samples.

Table S1. Effect of PVA dosage on density and Young's modulus of aero-sponges

No.	CNA-10	CNA-20	CNA-30	CNA-40	CNA-50	CNA-60
Density/mg cm^{-3}	15.85	21.72	32.48	40.24	53.04	65.12
Young's modulus/ kPa	0.29	0.55	0.25	0.19	0.15	0.09

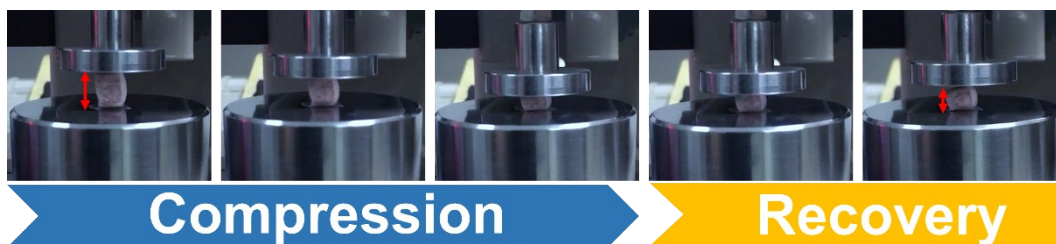**Figure S5. Copper aero-sponges with different PVA dosages.**

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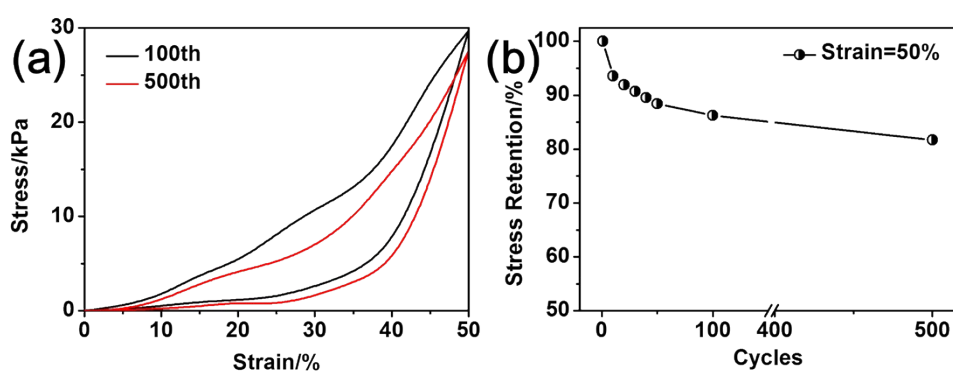
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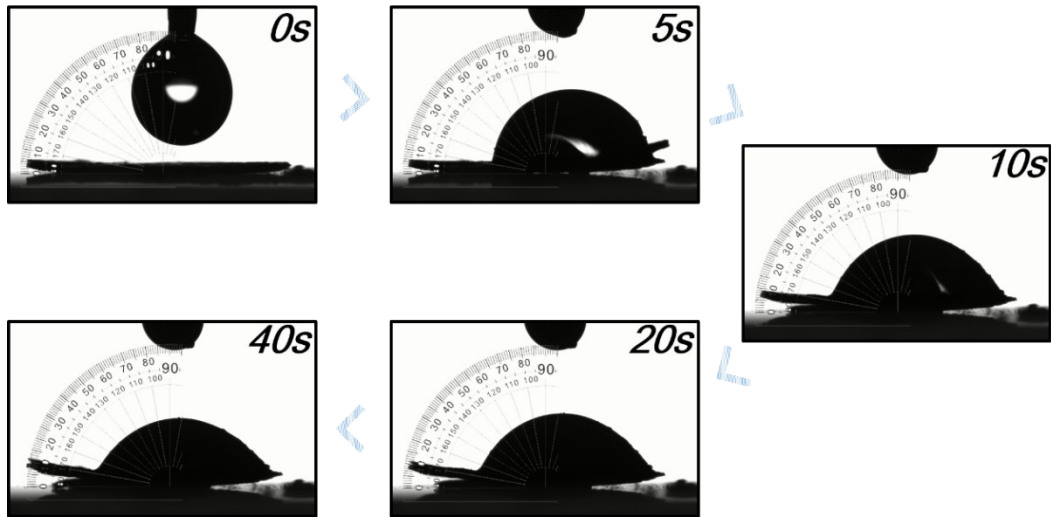
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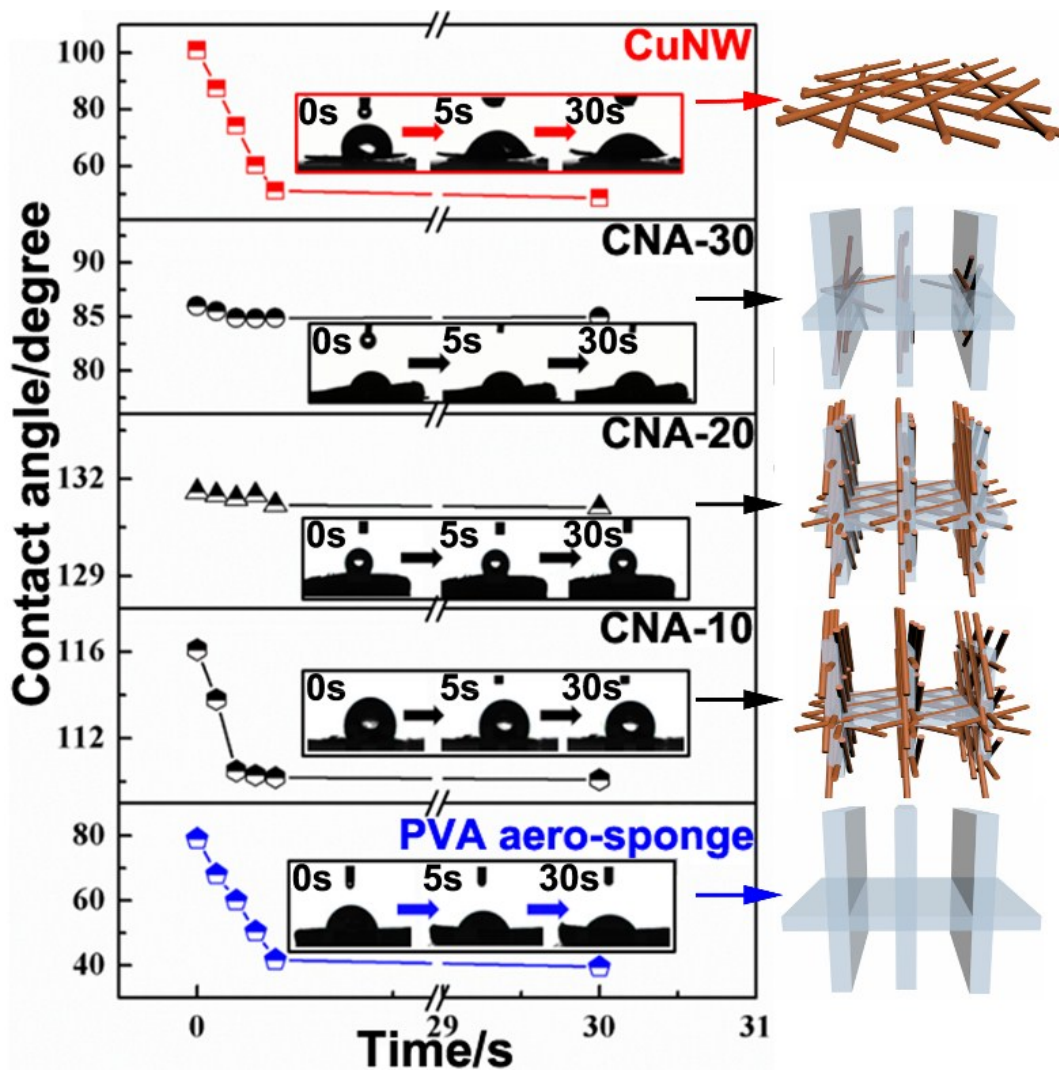
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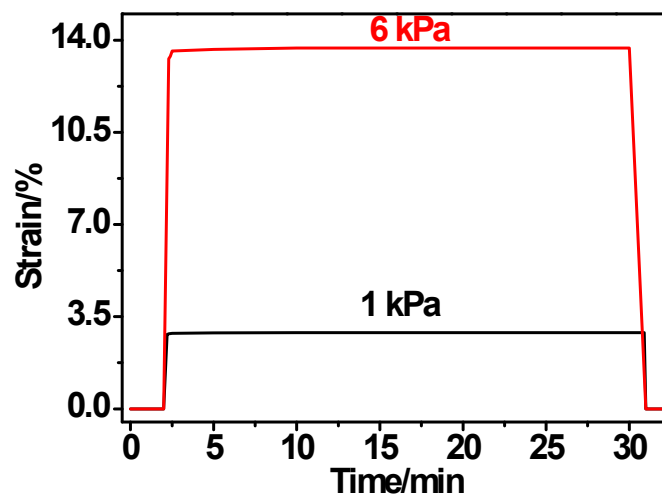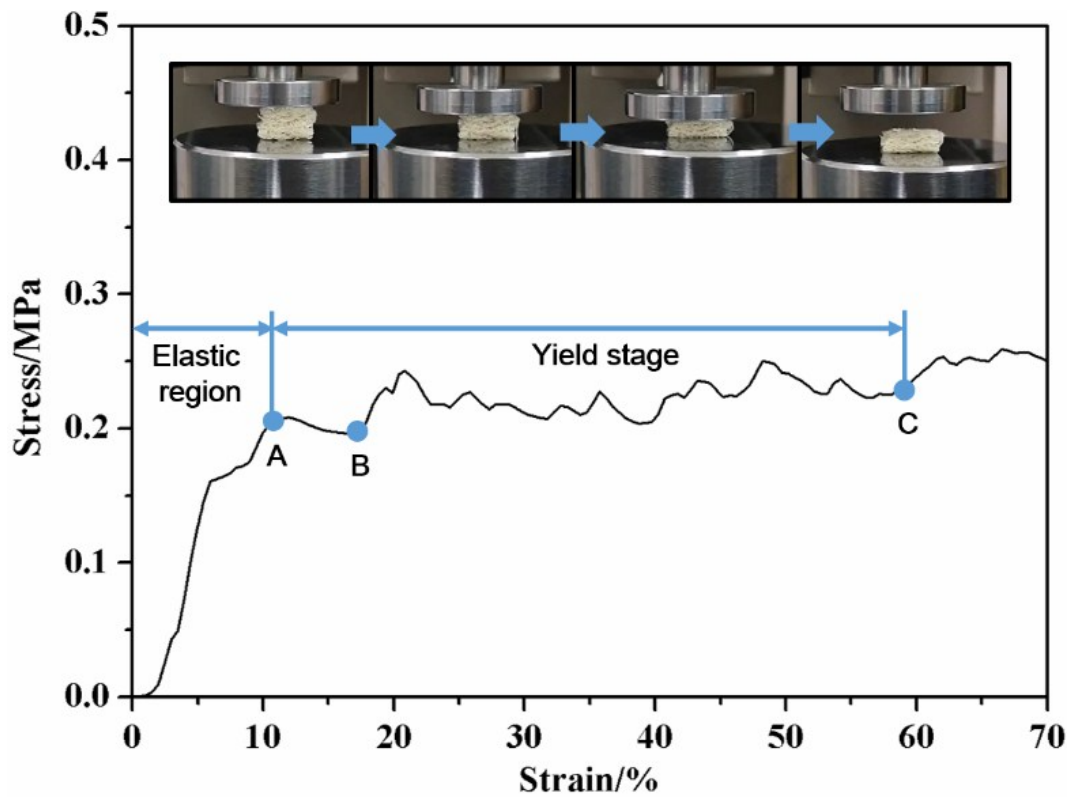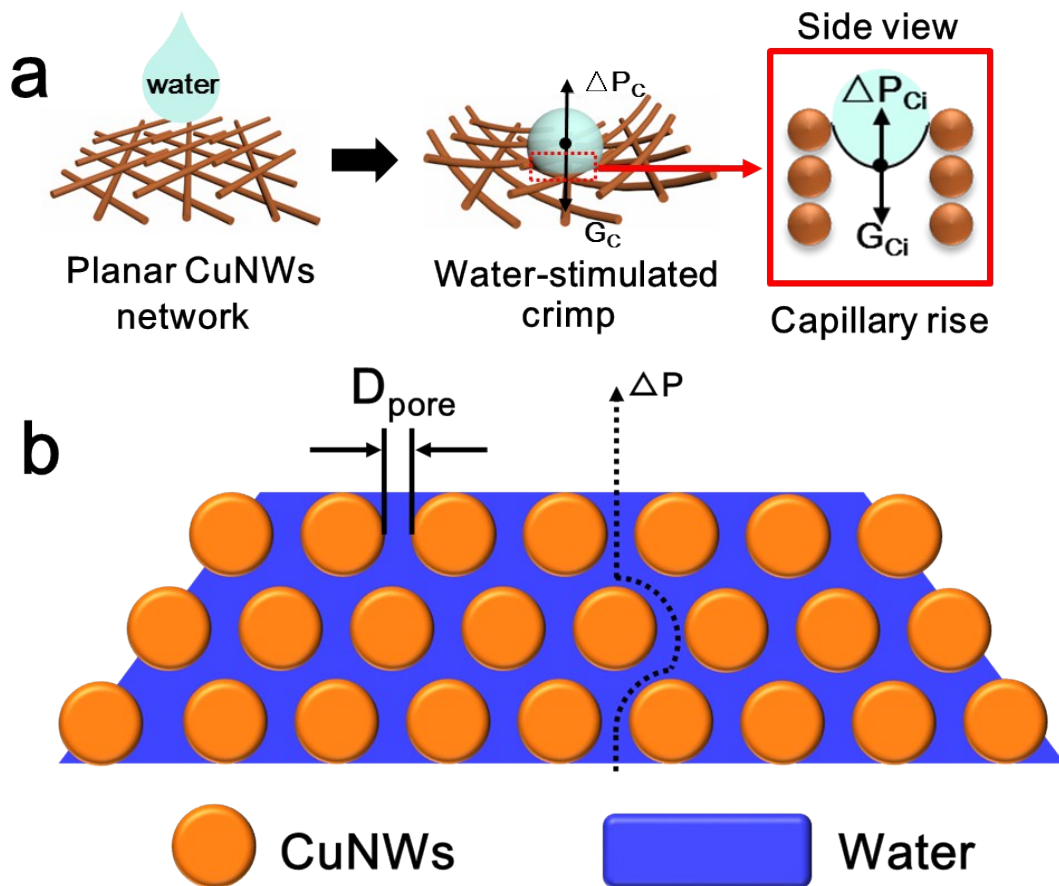**Figure S12. Wettability of copper nanowires. Schematics displaying the response of planar Cu nanowires network under water stimulation. Crimp was formed to prevent water penetration in vertical section. Schematic illustration exhibiting the generated capillary pressure in the CuNWs planar to drive the antigravity water penetration and wide spreading, which is found as a function of pore size.**
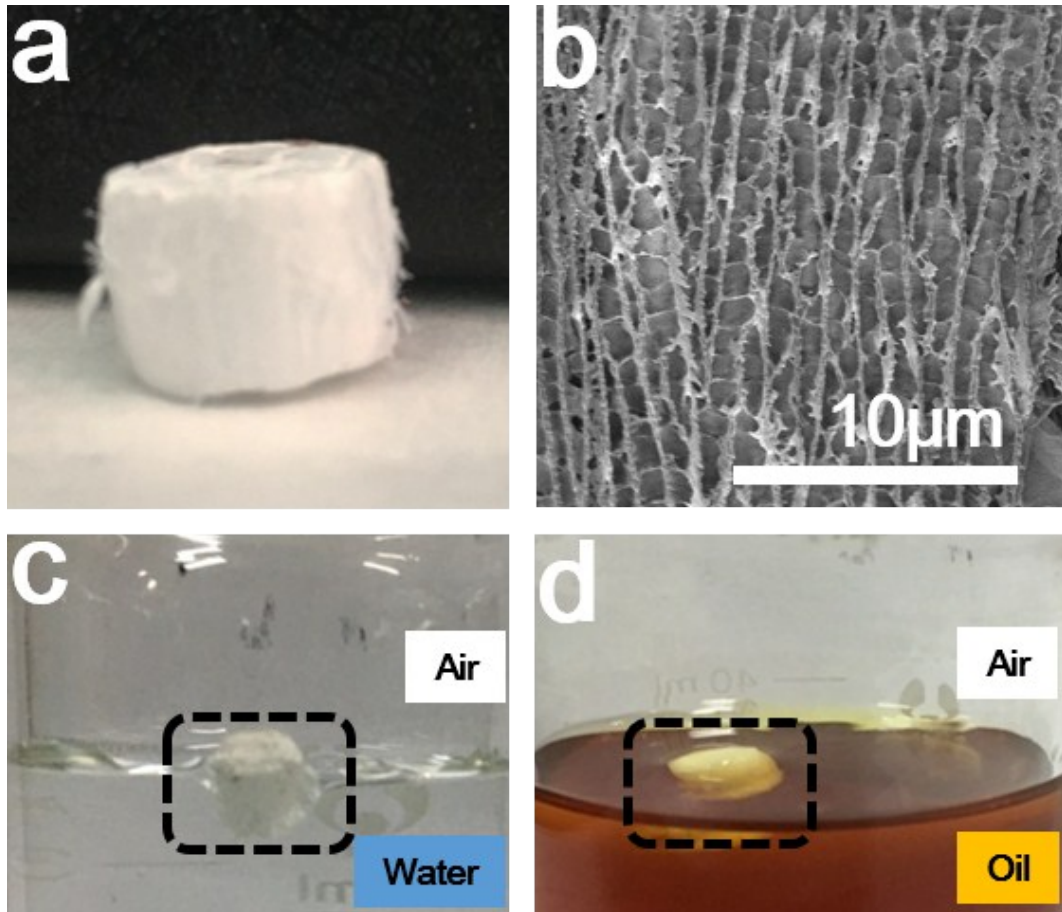
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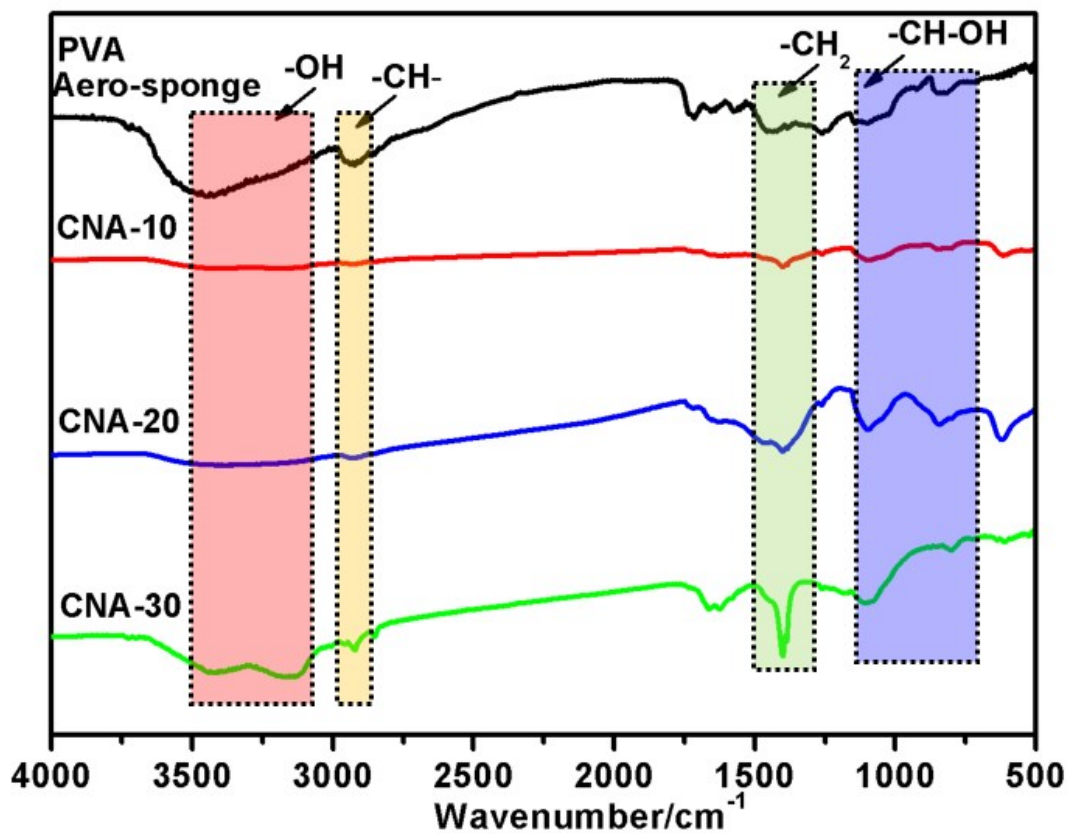
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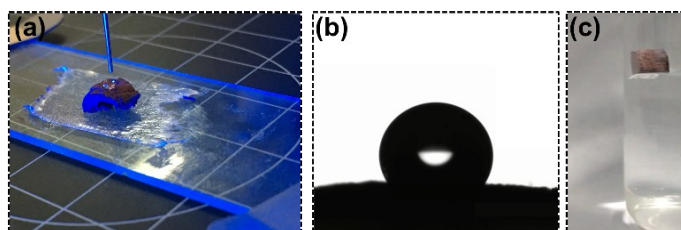
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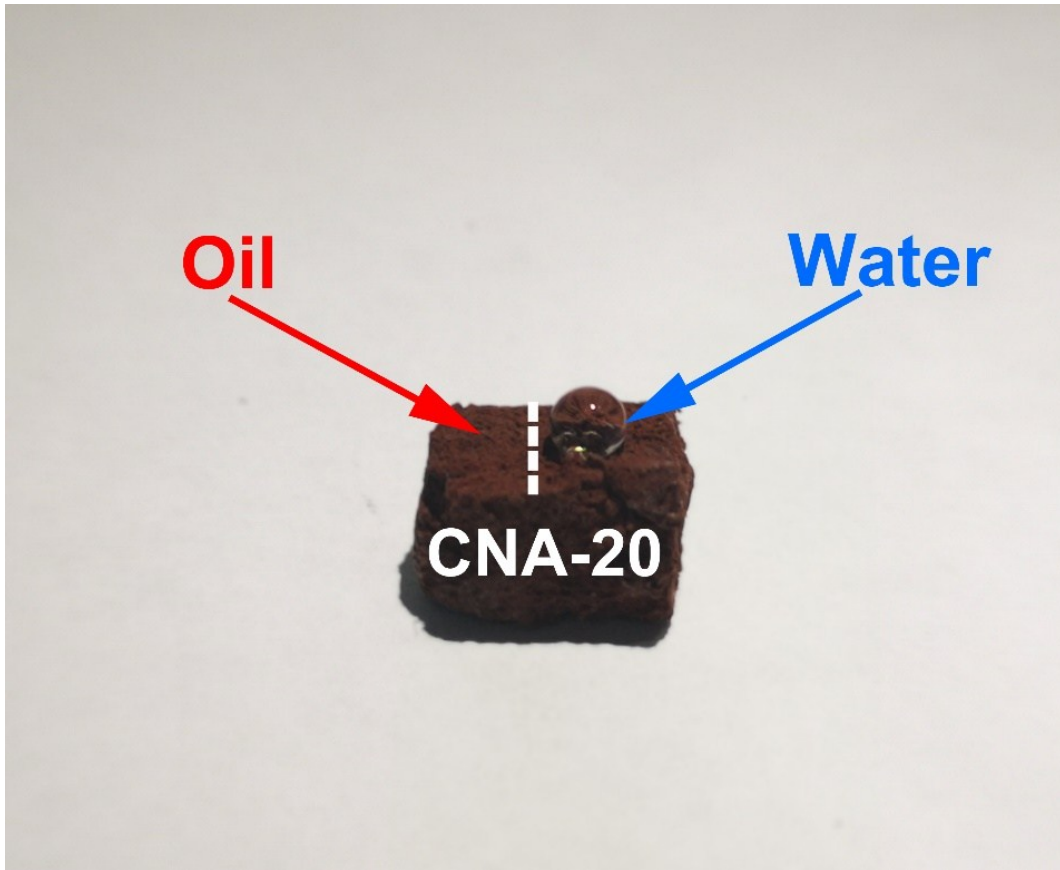
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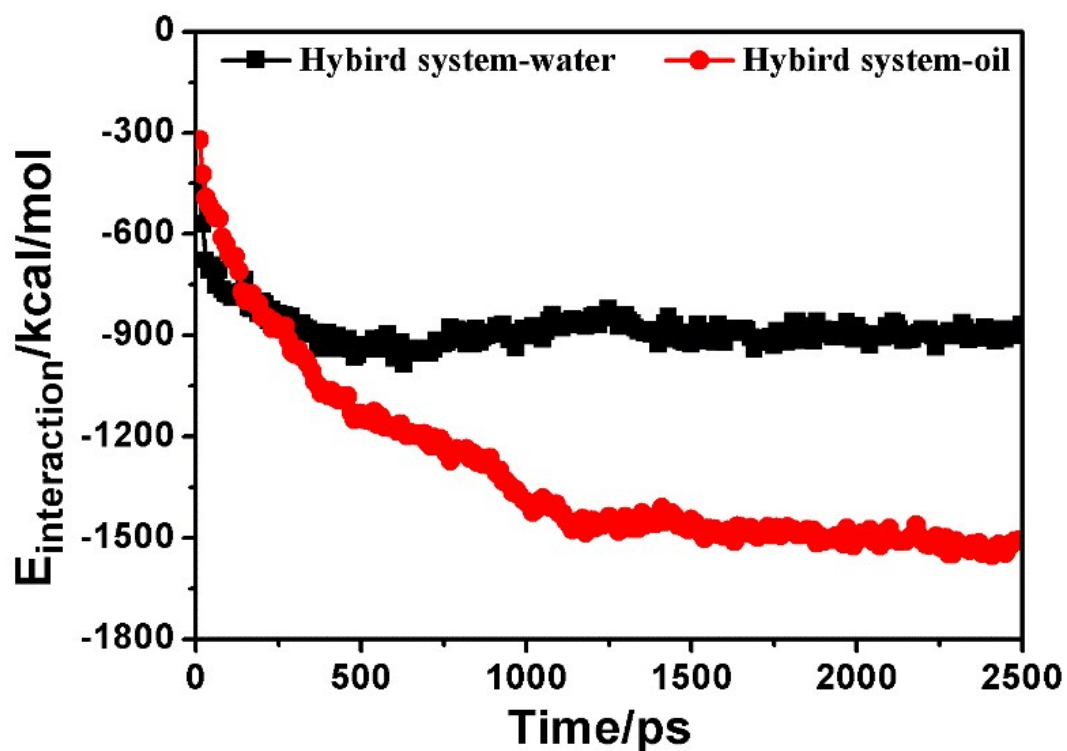
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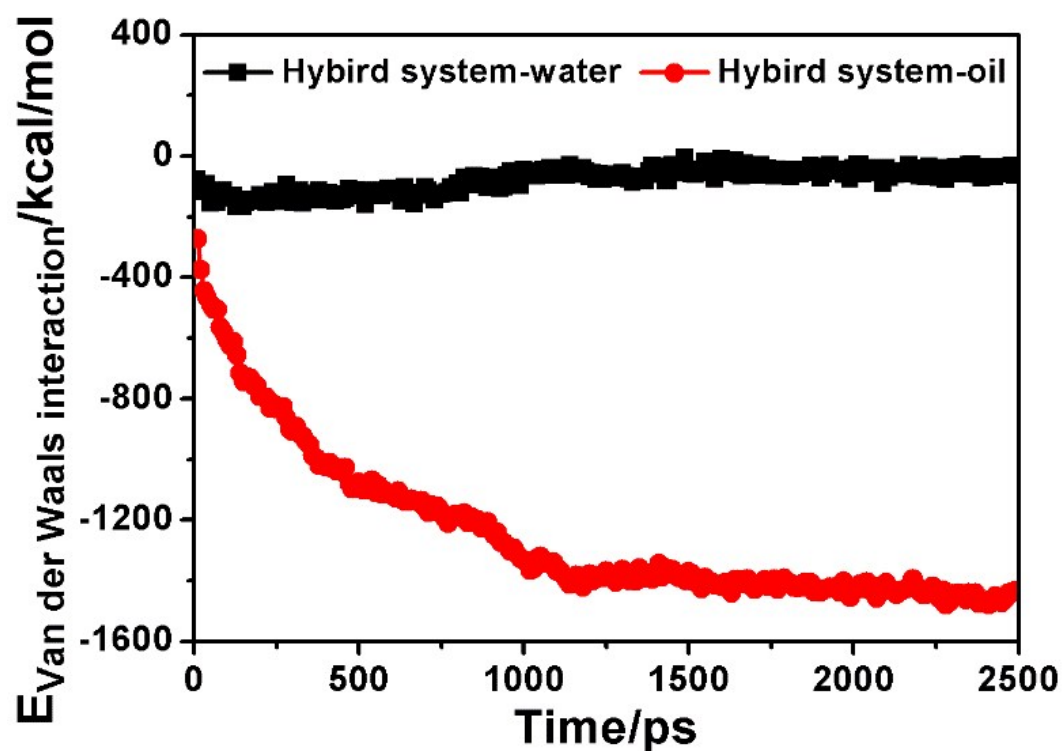
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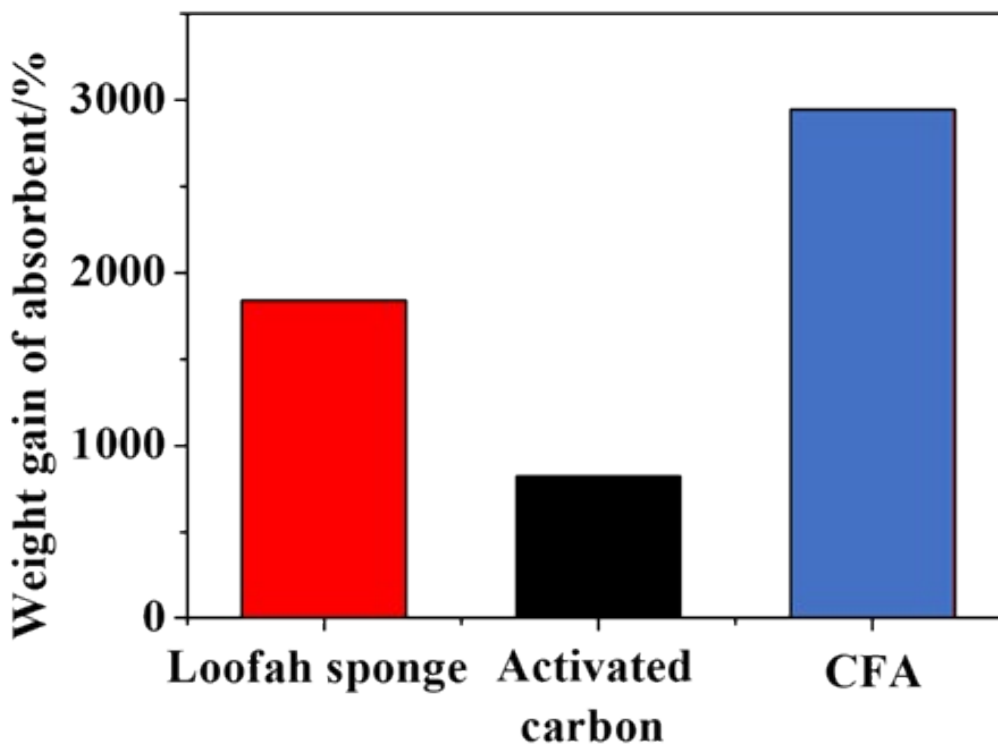
Figure S20. Absorption capacities of loofah stem, activated carbon and conventional freeze-casting aero-sponge.

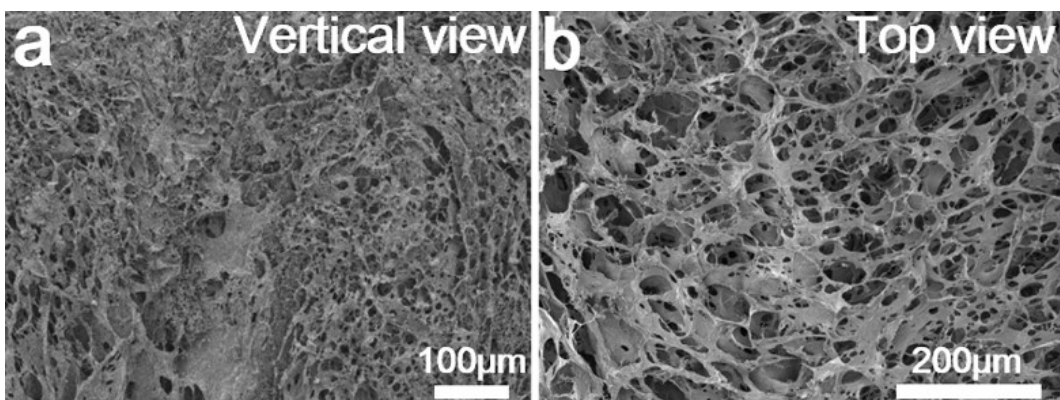## S1. Mechanisms of Capillary Force-driven Adsorption
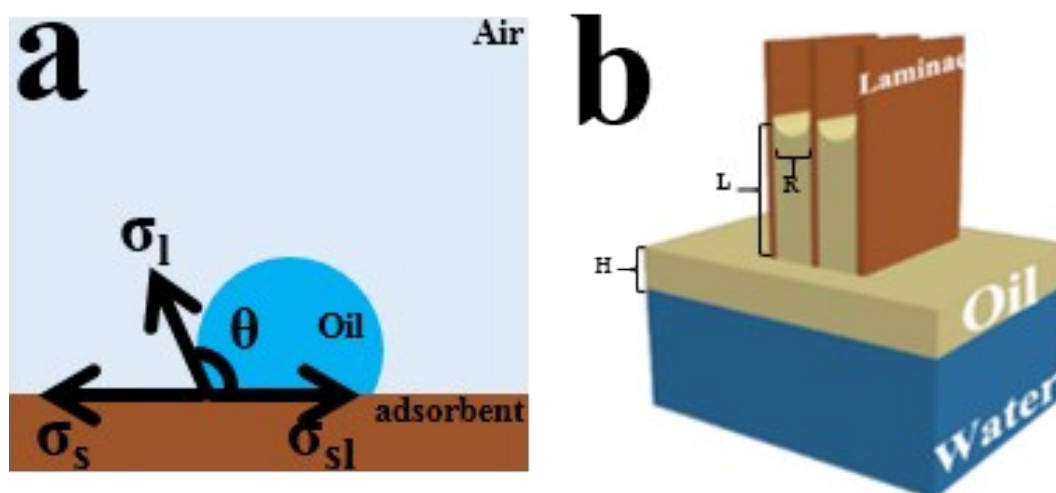
Figure S21. Organic solvent absorption mechanism model. (a) Relationships between interfacial tensions and contact angle (Young's relationship). (b) Directional alignment of capillary flow in CNA-20 with vertical micro-channels.

Under the presumption of constant diesel oil adsorbed volume, the corresponding volume (dV) of oil slicks can be deduced by eq. (S2):

$$V = \frac{\pi R^2 L}{4H}$$

(1.1)

Where R is the radius of micro-channels, L is the climbing height of adsorbed oil and H is oil slick width.

For the formation of new interface phase, interfacial adsorption energy ΔG was deduced by the following eq. (S3) [1]:

$$\Delta G = V\sigma_{wa} - V(\sigma_{ow} + \sigma_{oa}) + \pi RL(\sigma_{so} - \sigma_{sa}) \tag{1.2}$$

In this equation, σ_{wa} is interfacial tension between water and air [2], which can be found from the reference, σ_{ow} and σ_{oa} are the oil-water and oil-air interfacial tension, respectively, which were measured by DSA-30.

Table. S2. Interfacial tensions used for mechanism deduction(T=25°C)

Interfacial Tension No.	Name	Interfacial tension (N m^{-1})
1	σ_{wa}	7.2×10^{-2}
2	σ_{ow}	2.6×10^{-2}
3	σ_{oa}	3.3×10^{-2}

Besides, according to Young's equation, σ_{sa} could be derived as the followed form (eq. S4),

$$\sigma_{sa} = \sigma_{so} + \sigma_{oa}\cos\theta \tag{1.3}$$

Thus, eq. (S2) can be modified as followed,

$$\Delta G = A\sigma_{wa} - A\sigma_{ow} - A\sigma_{oa} - \frac{4AH}{R}\cos\theta\sigma_{oa} \tag{1.4}$$

The cosθ equals approximately to 1 due to spreading behavior of oil on CNA-20. Results from eq. 1.4 reveals that, if H was 0.09 times greater than R, the absorption free energy ΔG would show a tendency of reduction. As shown in Figure S3, the radius of CNA-20 ranges from 8μm~20μm, so it is quite easy to found that H > 0.09R. In this case, the whole adsorption process is a spontaneous one.

References

1   A .Adamson, *Phys. Chem. of surf.* Wiley, 1990.
2   Dean J A . Lange's handbook of Chemistry. *Advanced Manufacturing Processes*, 1990, 5(4):2.