Supplementary Information

Evolution of Copper Oxide Nanoneedles Mesh with Subtle Regulated Lyophobicity for High Efficiency Liquid Separation

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Supporting methods

Detail mechanism. The chemical composition of oxidized copper meshes was researched by XRD. The XRD patterns of copper mesh with different oxidation time were shown in Figure 1i. It could be seen that the original copper mesh had typical diffraction peaks of Cu (JCPDS Card No. 4-836), which also could be seen in other meshes for that Cu was the substrate. With increase of oxidation time, diffraction peaks showed the formation of orthorhombic-phase $Cu(OH)_2$ (JCPDS Card No. 13-420). When oxidation time was over 45 minutes, diffraction peaks of $Cu(OH)_2$ weakened, while diffraction peaks CuO strengthened. When oxidation time was 240 minutes, diffraction peaks of monoclinic-phase CuO (JCPDS Card No. 48-1548) could be seen clearly. The photos of copper mesh (**Figure S3**) of different oxidation times illustrated the color change on the surface of copper meshes, that from yellow to blue, then to black, which derived from Cu, $Cu(OH)_2$ and CuO, respectively. Firstly, copper was oxidized to $Cu(OH)_2$ nanoneedles as follows [1-2]:

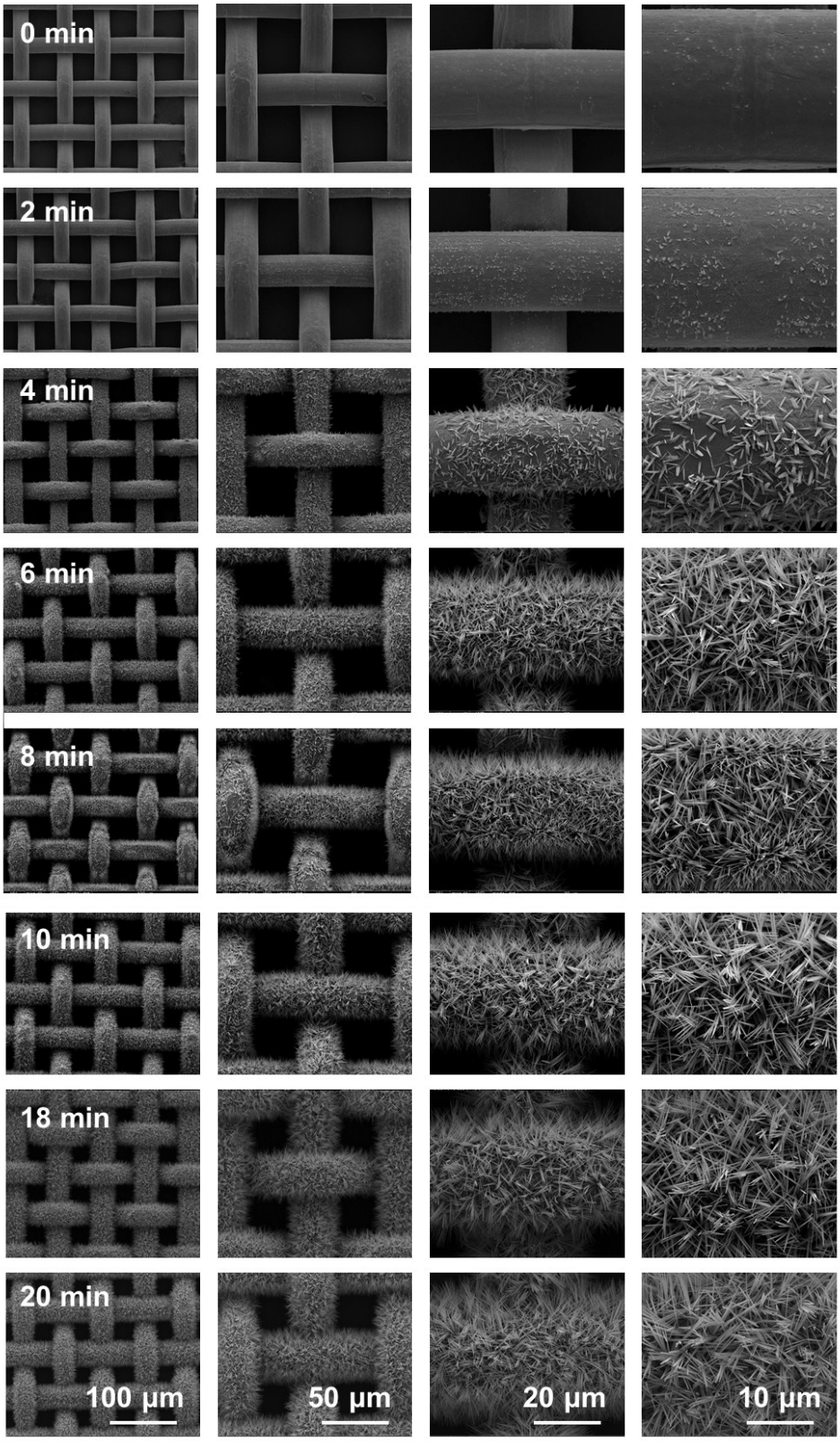
$$Cu + 2NaOH + K_2S_2O_8 \rightarrow Cu(OH)_2 + K_2SO_4 + Na_2SO_4 \quad (1)$$

When the reaction continued, $Cu(OH)_2$ nanoneedles gradually vanished:

$$Cu(OH)_2 + NaOH \rightarrow Na_2[Cu(OH)_4] \quad (2)$$

Part of the $Cu(OH)_2$ nanoneedles transformed to CuO nanosheets as follows:

$$Cu(OH)_2 \rightarrow CuO + H_2O \quad (3)$$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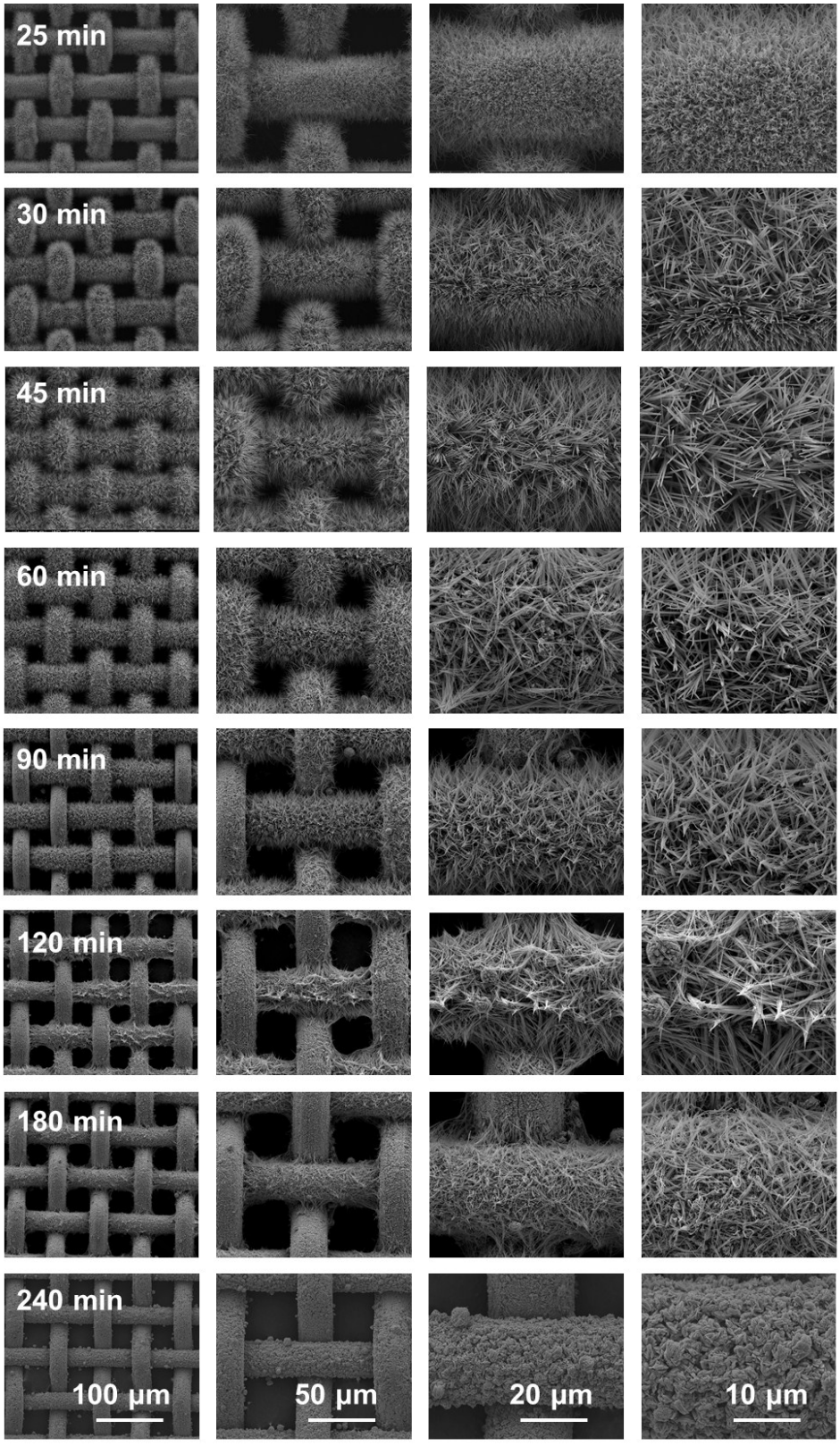


Figure S1. Surface topography of copper mesh with different oxidation time, vertical images are of the same magnification.

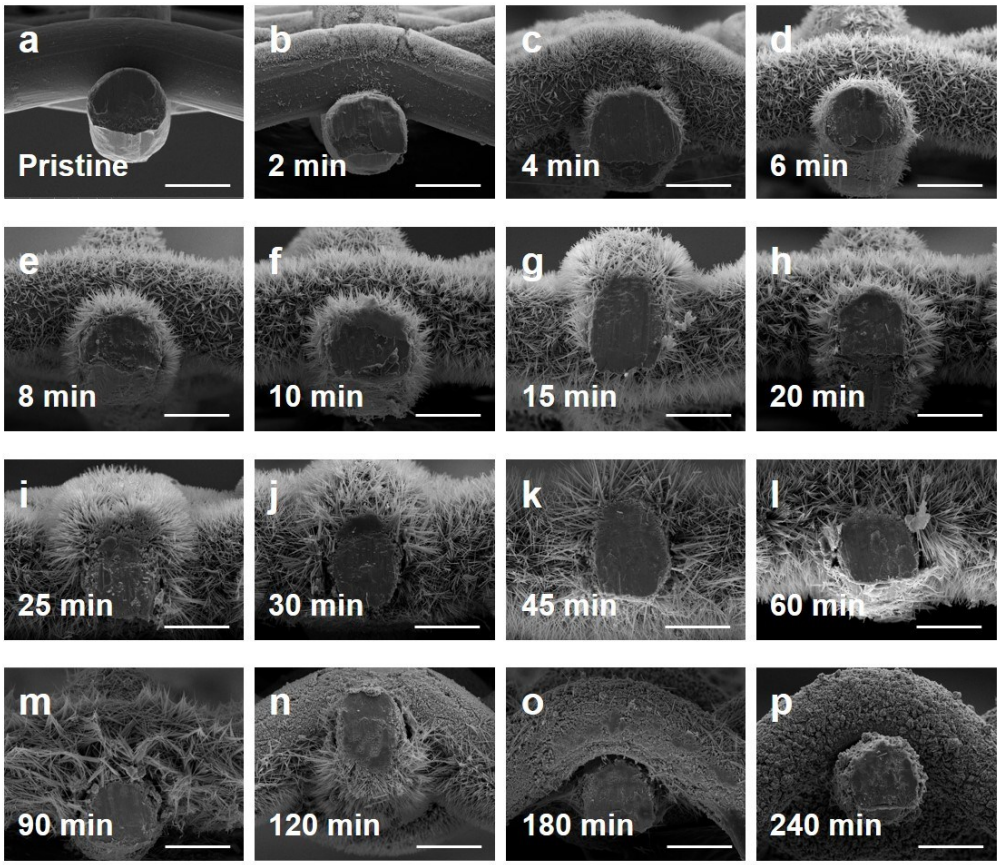


Figure S2. Cross section of copper mesh with different oxidation time. The scale bar is 20 μm.

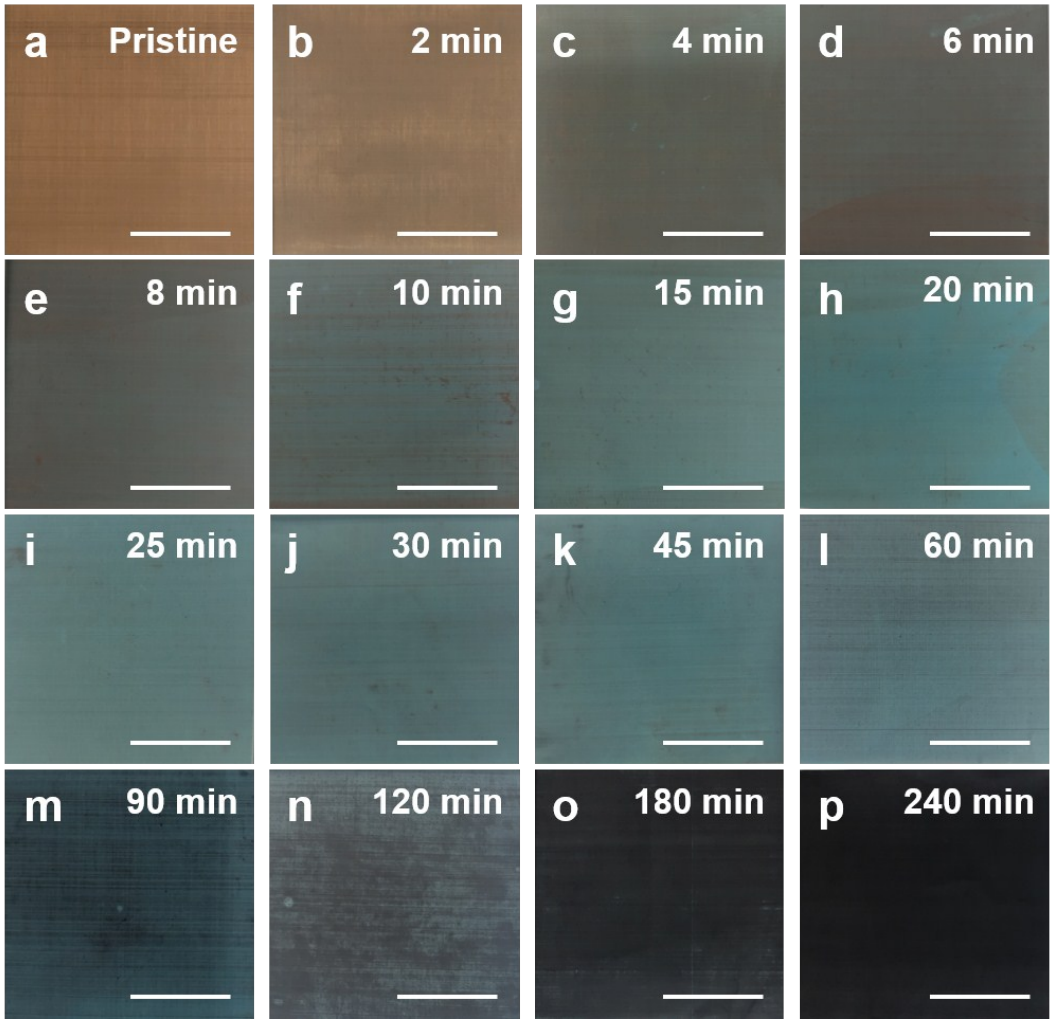
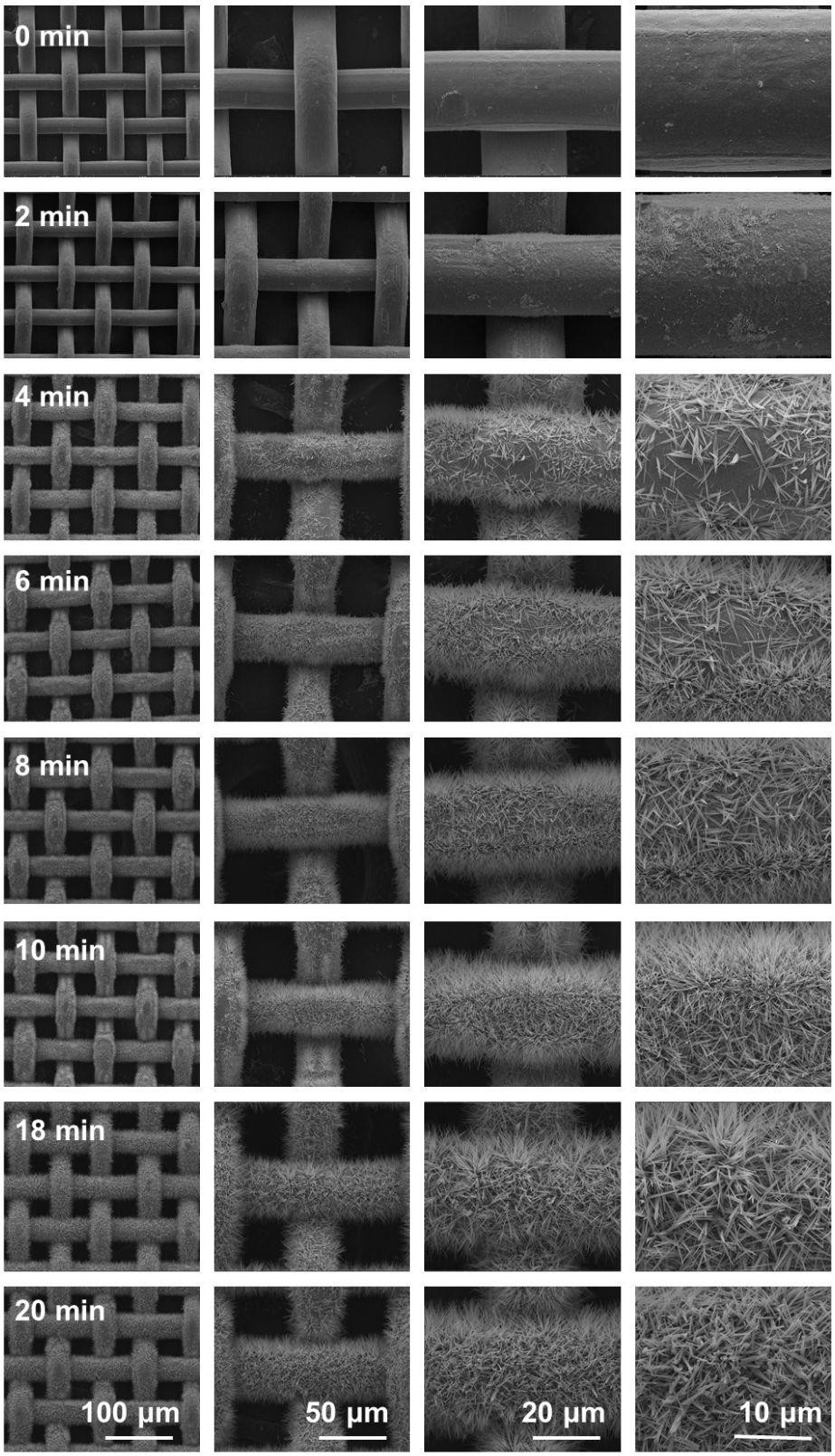


Figure S3. Photos of copper meshes with different oxidation time. The scale bar is 2 cm.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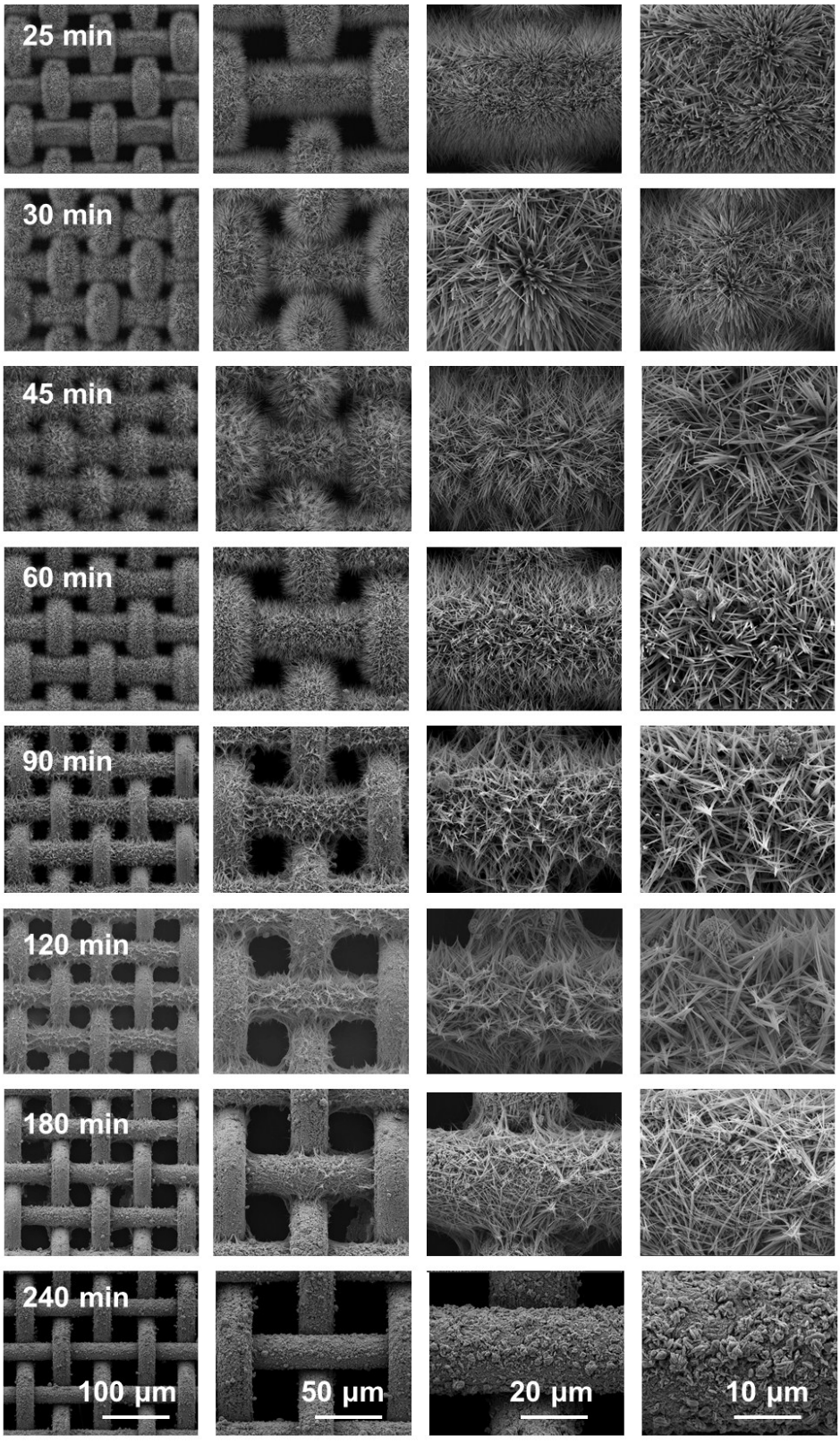


Figure S4. Surface topography of copper mesh with different oxidation time after treated by PFTS, vertical images are of the same magnification.

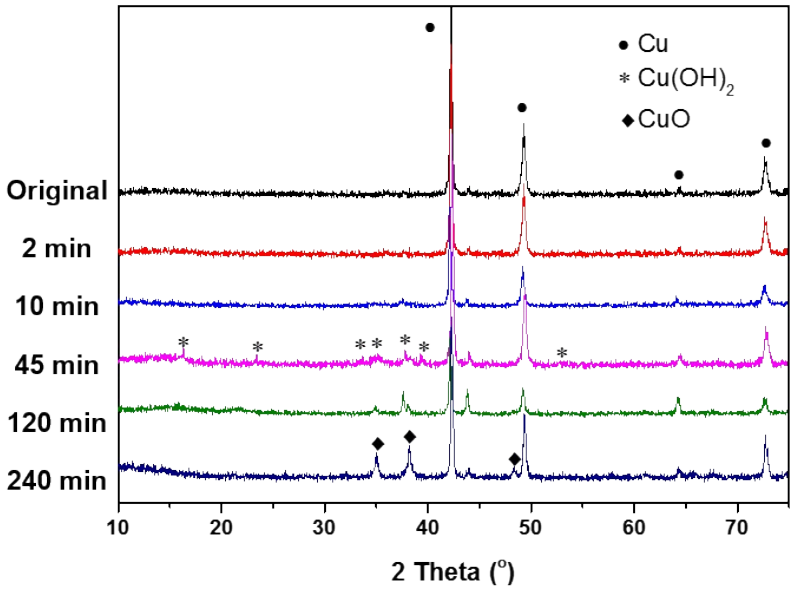


Figure S5. XRD pattern of as-prepared meshes after treated by PFTS with different oxidation time.

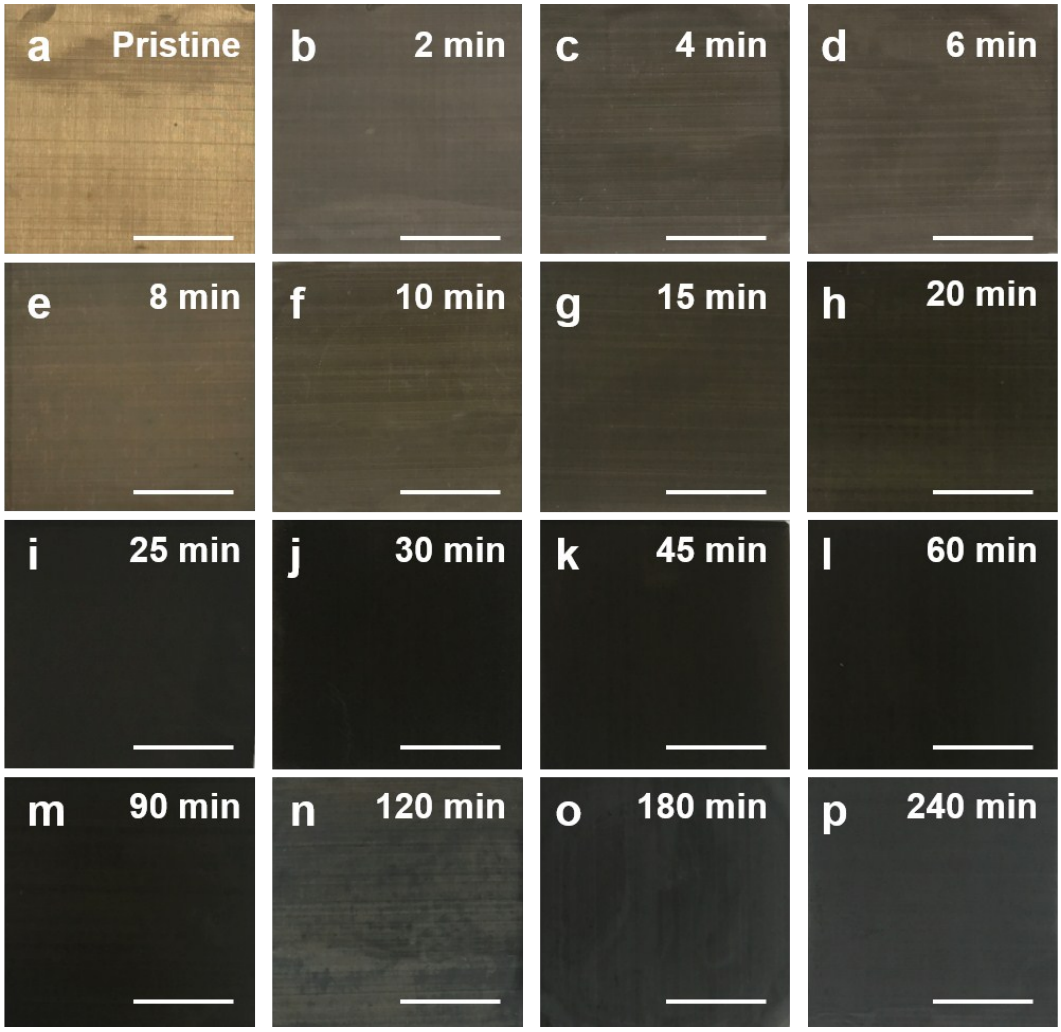


Figure S6. Photos of copper meshes with different oxidation time after treated by PFTS. The scale bar is 2 cm.

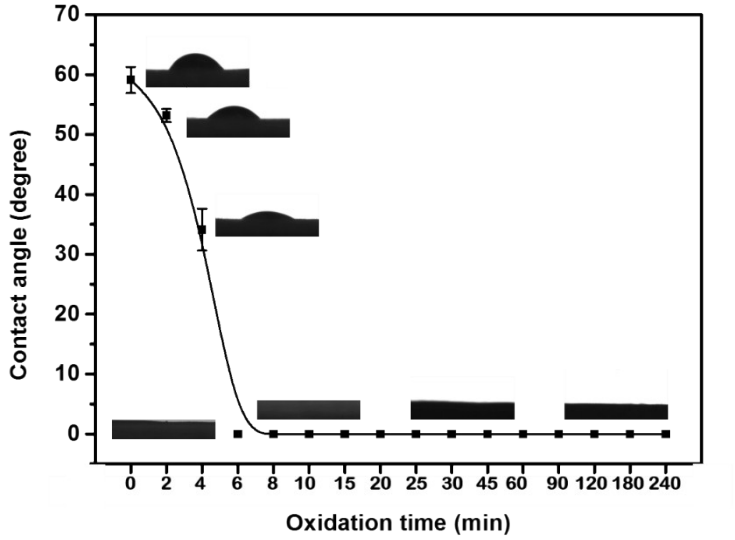


Figure S7. Contact angles of water on oxidized copper mesh with different oxidation time before treated by PFTS.

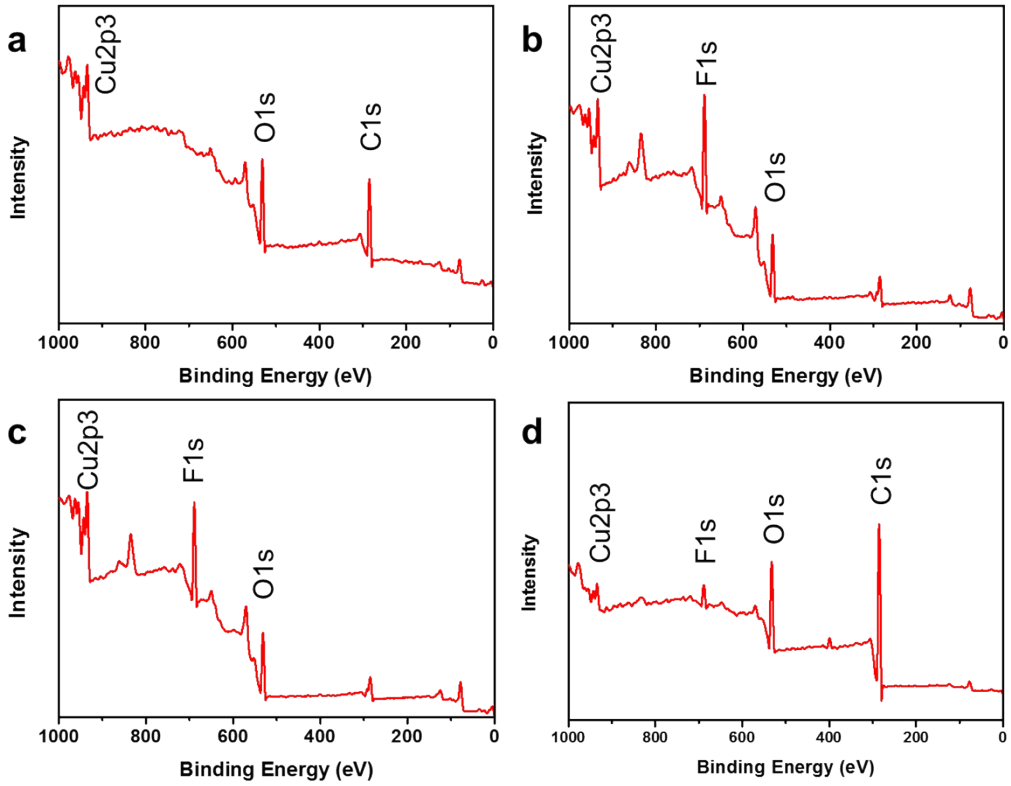
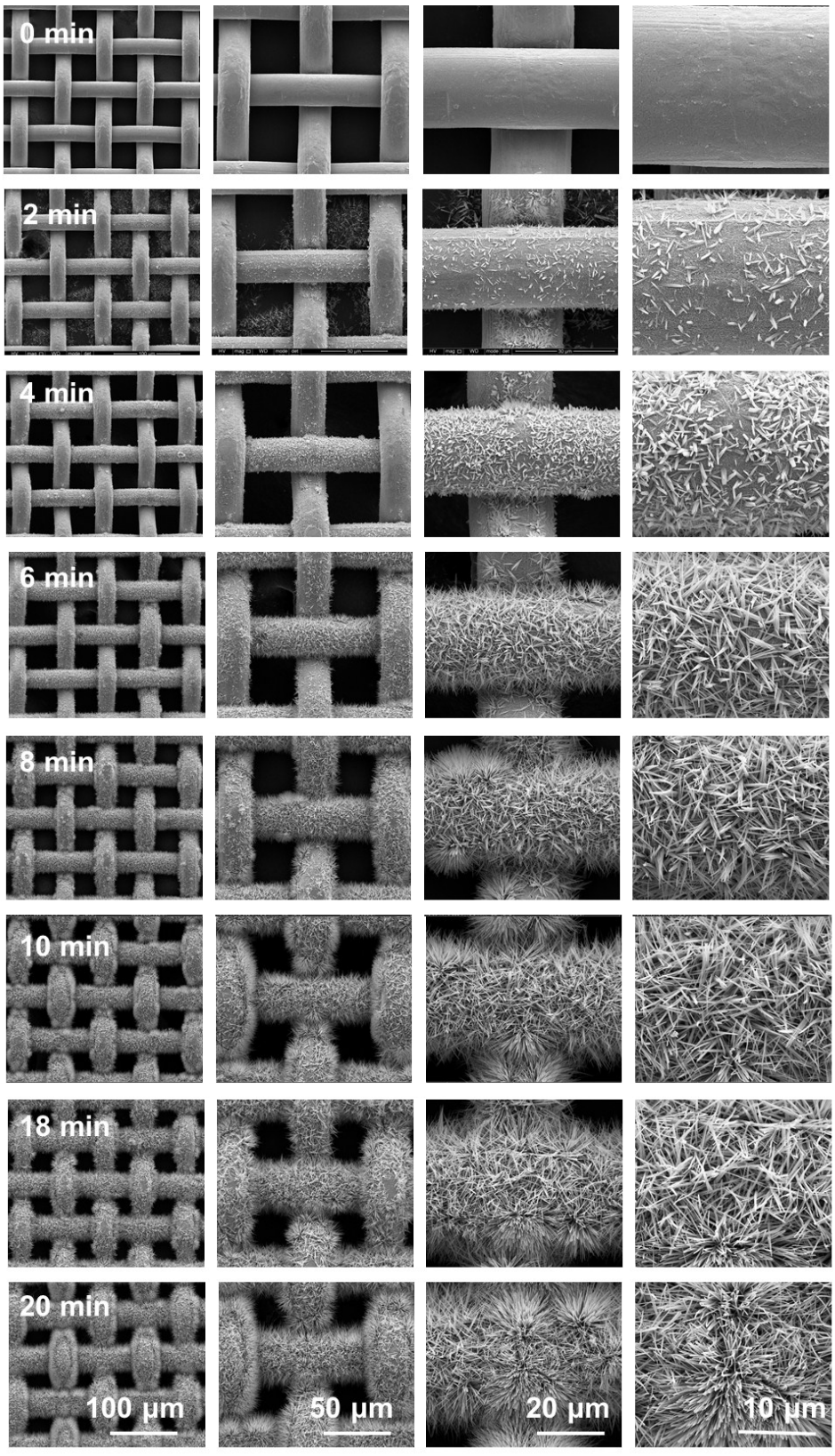


Figure S8. XPS spectrum of (a) pristine copper mesh with smooth surface and fluorinated copper meshes with (b) smooth surface, (c) nanoneedles, (d) nanosheets. Peak of F1s could be seen clearly in meshes after treated by PFTS.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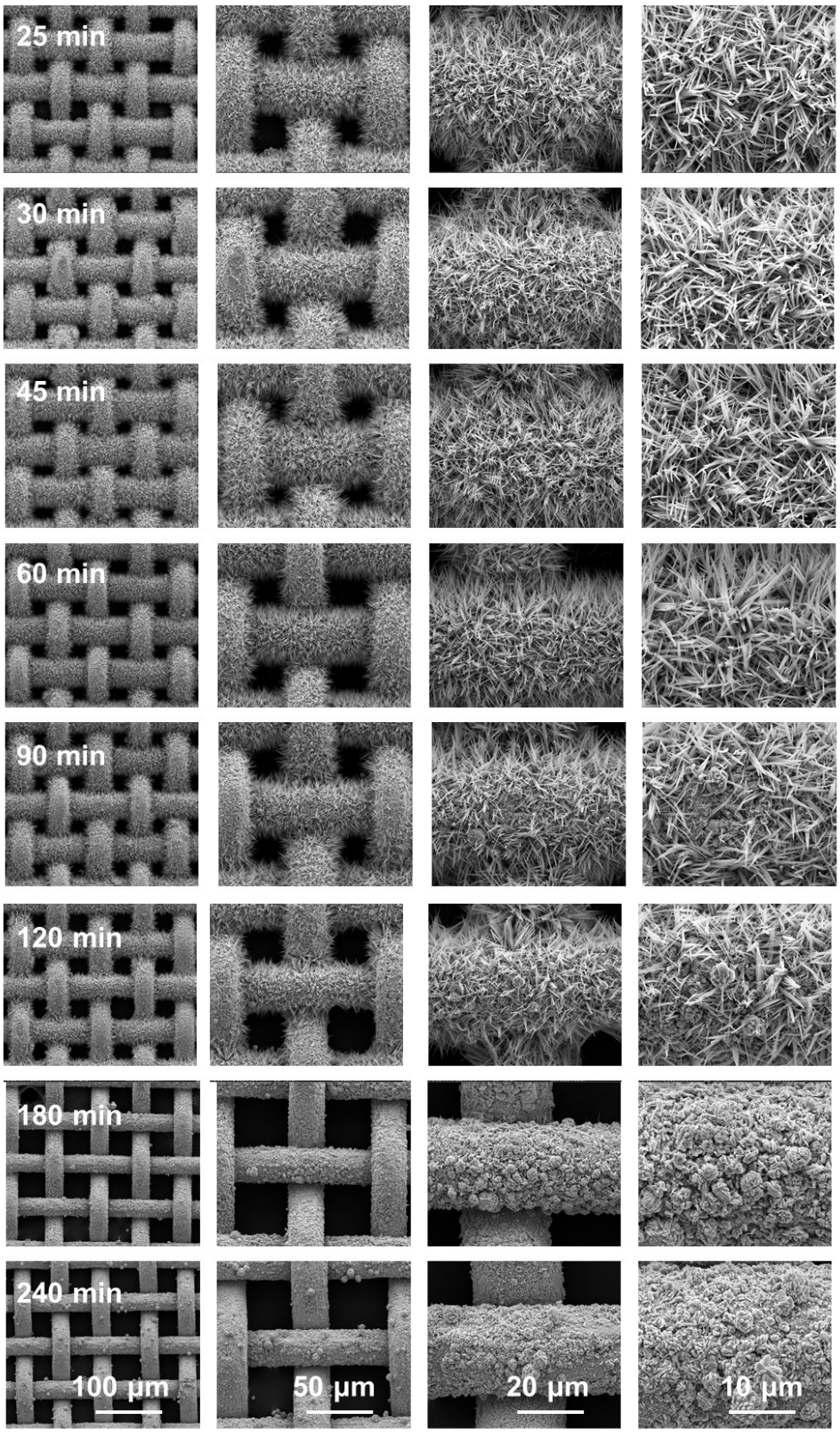

Figure S9. The morphology of membranes after penetrated by water, which changed little, vertical images are of the same magnification.

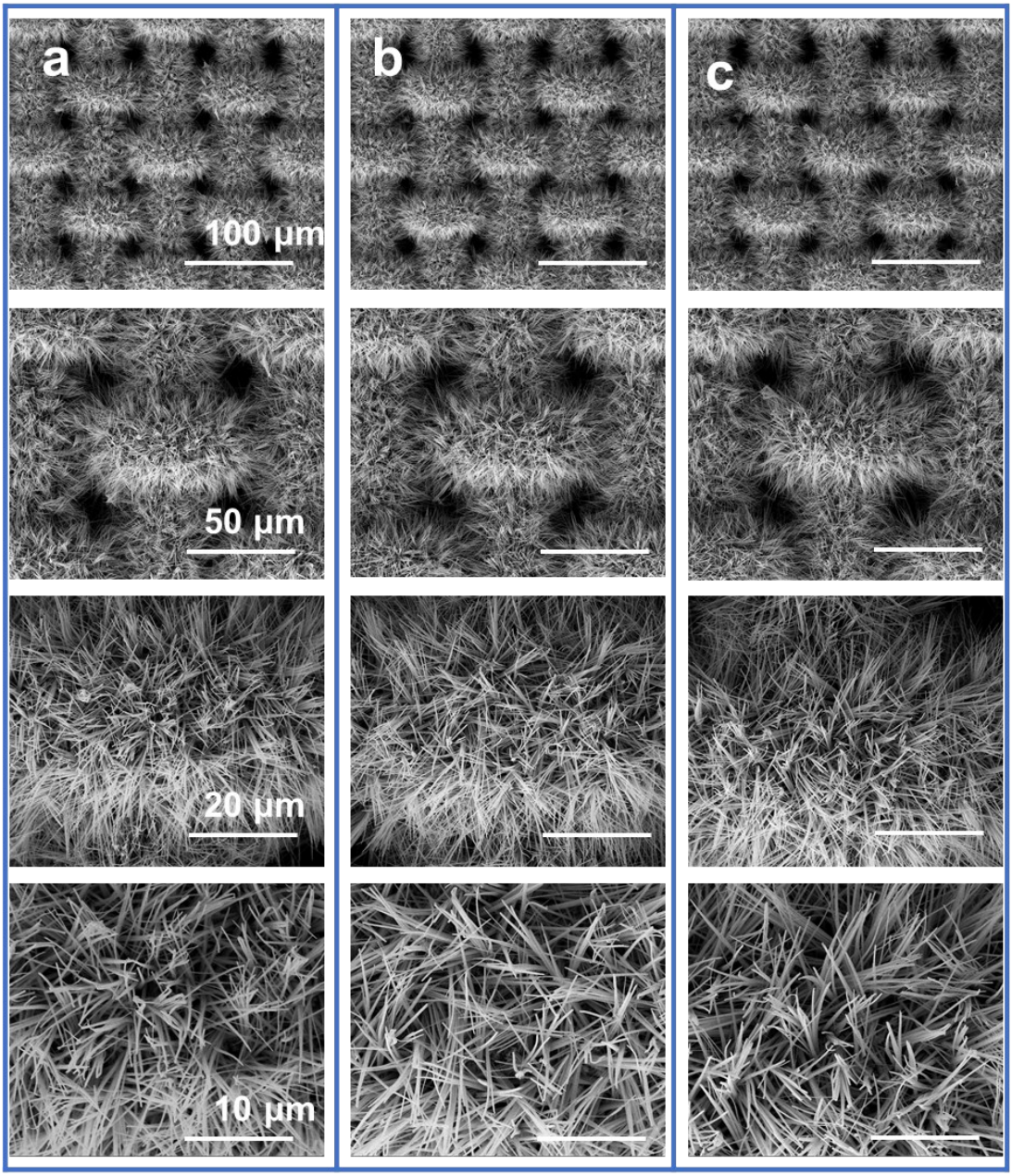

Figure S10. The morphology of nanoneedles covered lyophobic copper mesh treated by (a) rushing water as well as (b) ultrasound in water for 12 h and (c) in ethanol for 12 h, which all changed little.

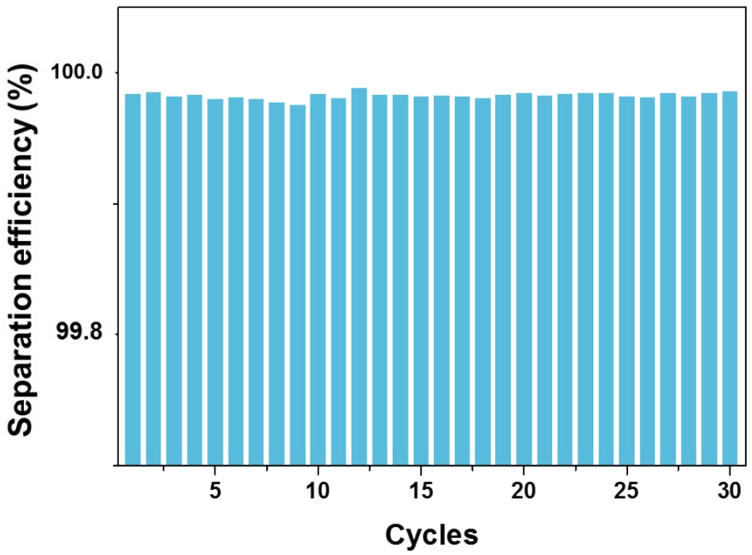

Figure S11. The maintenance of separation efficiency of water/CCl_4 mixture using nanoneedles covered copper meshes.

References

(1) H.W. Hou; Y. Xie; Q. Li. *Cryst. Growth Des.* 2005, *5*, 201-205.

(2) Q. Zhang; K. Zhang; D. Xu; G. Yang; H. Huang; F. Nie; C. Liu; S. Yang. *Prog. Mater Sci.* 2014, *60*, 208-337.