Supporting Information

Photo-induced water-oil separation based on switchable superhydrophobicity-superhydrophilicity and underwater superoleophobicity of the aligned ZnO nanorod array-coated mesh films

Dongliang Tian,[a] *Xiaofang Zhang,*[c] *Yu Tian,*[a] *Yue Wu,*[a] *Xiao Wang,*[a] *Jin Zhai**[a] *and Lei Jiang*[a, b]

[a]School of Chemistry and Environment, Beihang University, Beijing 100191, P. R. China

[b]Beijing National Laboratory for Molecular Sciences (BNLMS), Key Laboratory of Organic Solids, Institute of Chemistry, Chinese Academy of Sciences, Beijing, 100190, P. R. China

[c]Chinese Academy of Inspection and Quarantine, Beijing, 100123, P. R. China.

E-mail: zhaijin@buaa.edu.cn

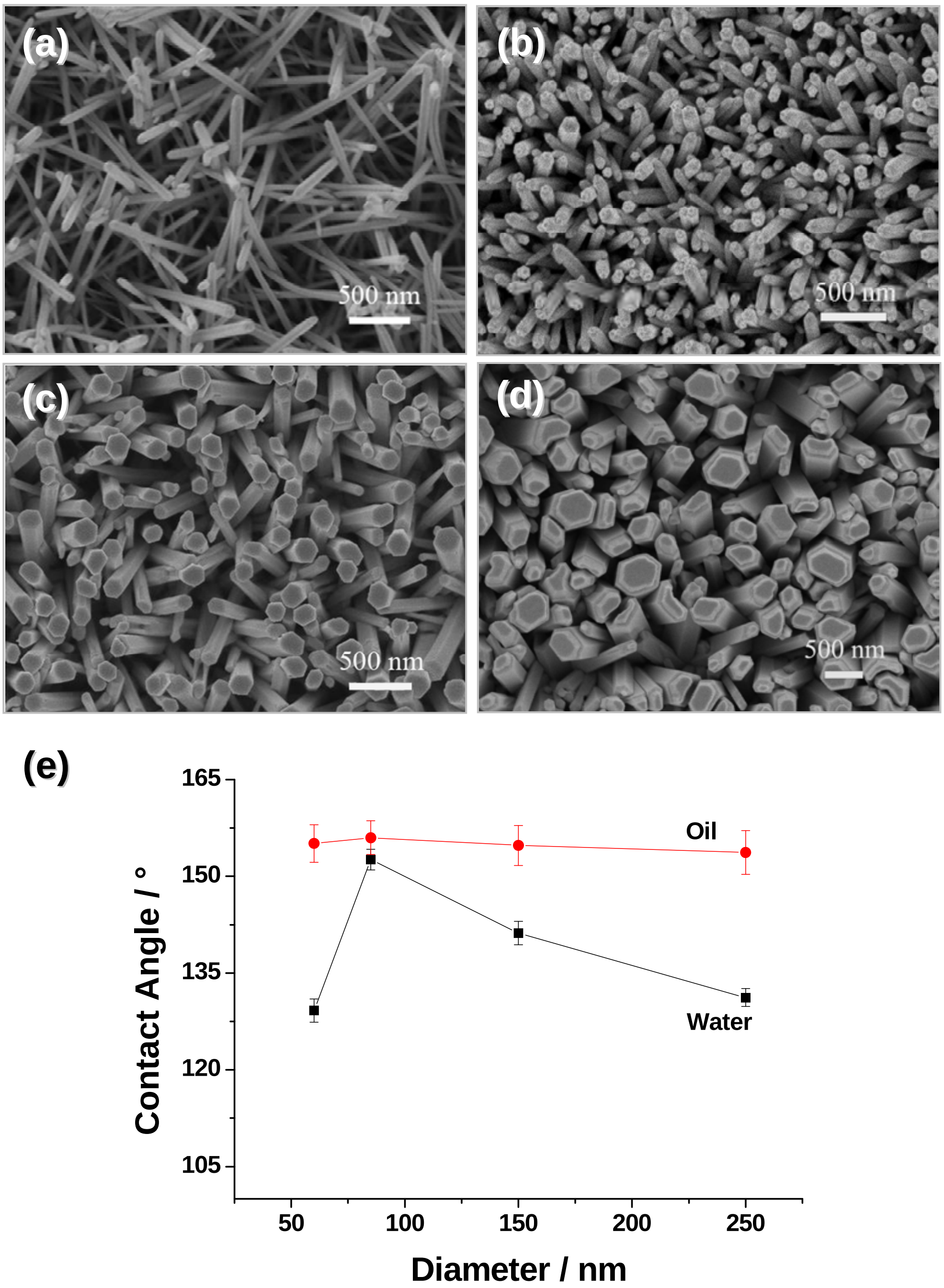
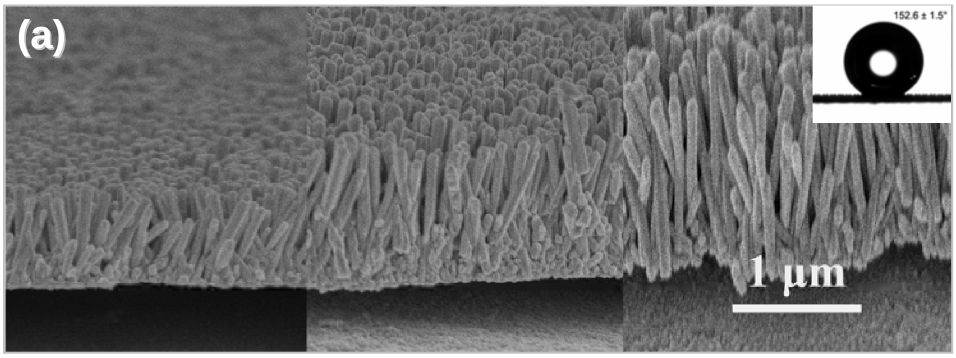


Figure S1. Surface wettability of the aligned ZnO nanorod arrays-coated mesh films changes as the average diameter and density of the ZnO nanorod. (a), (b), (c) and (d) are SEM top images of the as-prepared ZnO nanorod-coated stainless steel mesh films with different diameter and density, respectively. (e) The relationship between surface wettability and the average diameter of the ZnO nanorod. These results indicate that oil on the ZnO nanorod coated mesh film surface all behaves superoleophobic, while the average diameter of the ZnO nanorod has important influence on surface wettability to water. Among them, the ZnO nanorod coated mesh film with the average diameter of 50 ~ 150 nm shows high hydrophobicity, and the nanorod with the average diameter of ~ 85 nm shows superhydrophobic. The results also indicate that the sutiable density of the nanorod is an important factor to achieve high hydrophobicity.



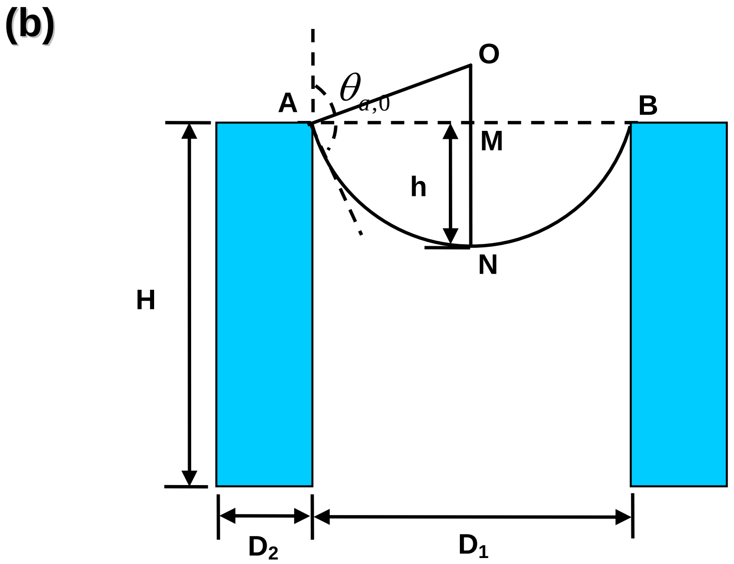


Figure S2. SEM images of the aligned ZnO nanorod array-coated mesh films and the schematic suspended liquid protrusion shape on this mesh films. (a) SEM side view of the ZnO nanorod-coated mesh films with different length of the ZnO nanorods. Inset shows the corresponding contact angle photograph of the aligned ZnO nanorod-coated mesh films. (b) The suspended liquid protrusion to a depth *h* on the ZnO nanorod-coated mesh wire. Here we set the mesh with pore size of ~ 50 μm as an example. There is a threshold length of nanorod length to ensure the liquid on the mesh wire surface being Cassie state. As long as the nanorod length is more than this threshold length, the liquid on this mesh film will be stable. And the threshold of nanorod length can be described as follows:

The nanorod has a length of H, a diameter of D_1 (85.2 ± 36.8 nm) and a spacing of D_2 (225.4 ± 55.3 nm). The liquid exhibits its true advancing value $\theta_{a,0}$ (125.2 ± 2.6°) on the sides of the nanorod. Assuming that the cross section of the liquid protrusion can be described as a segment of a circle, the critical value *h* can be calculated as follows:

$$h = MN = ON - OM = R - R\cos(\theta_{a,0} - 90^{\circ}) = R[1 - \cos(\theta_{a,0} - 90^{\circ})] = \frac{\frac{1}{2}D_1}{\sin(\theta_{a,0} - 90^{\circ})}[1 - \cos(\theta_{a,0} - 90^{\circ})] = 35.8nm$$

Thus as long as the nanorod length $H > h = 35.8nm$ is satisfied, the liquid on the wire surface behaves stable Cassie state. With the nanorod length increasing, the liquid contact angle on the aligned ZnO nanorod-coated mesh films increases, and the films will be superhydrophobic as long as the nanorod length is enough. These experimental results confirm that the length of the ZnO nanorod in this work is long enough to ensure the aligned ZnO nanorod array-coated stainless steel mesh films being superhydrophobic. The results also indicate that the suitable density of the nanorod is benefical to achieve high hydrophobicity.

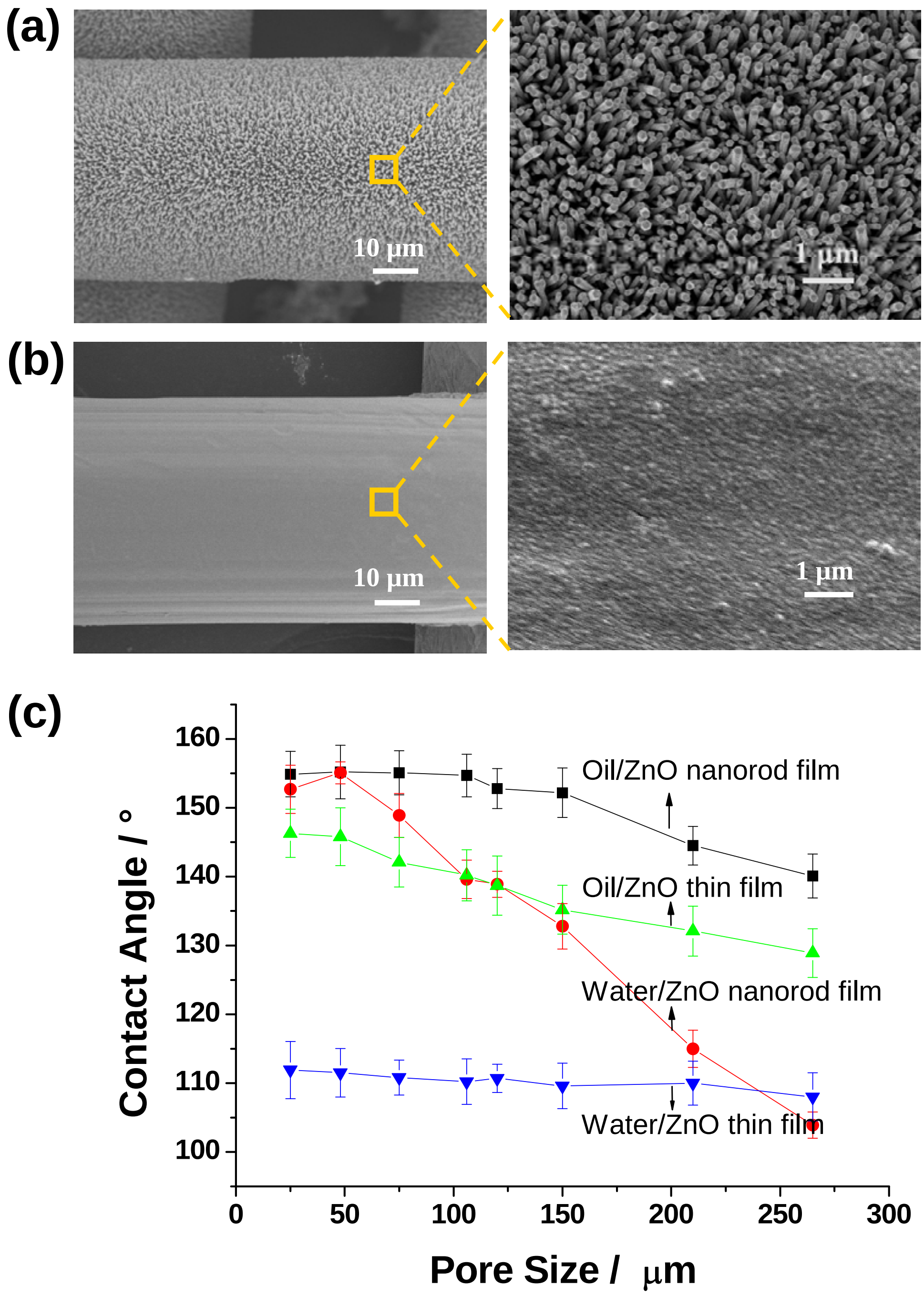


Figure S3. SEM images and the wettability study of the aligned ZnO nanorod arrays-coated and the ZnO thin film coated mesh films. (a) and (b) are SEM images of the ZnO nanorod-coated and the ZnO thin film coated mesh films, respectively. (c) Oil and water contact angles of the ZnO coated mesh films as a function of the pore size of corresponding original mesh films. The CA results indicated that the CA of water and underwater oil on the ZnO nanorod coated mesh film is larger than those on the ZnO thin film coated mesh film with corresponding original mesh pore size of 25-200 μm. Thus water and underwater oil will stay much stabler on the ZnO nanorod coated mesh film than on the ZnO thin film coated mesh film. Accordingly, the ZnO nanorod coated mesh film is superior to ZnO thin film coated mesh film for photo-induced separation of oil-water separation on ZnO coated mesh film.