

Supporting Information

**Heterogeneous ZIF-L membranes with improved hydrophilicity and
anti-bacterial adhesion for potential application in water treatment**

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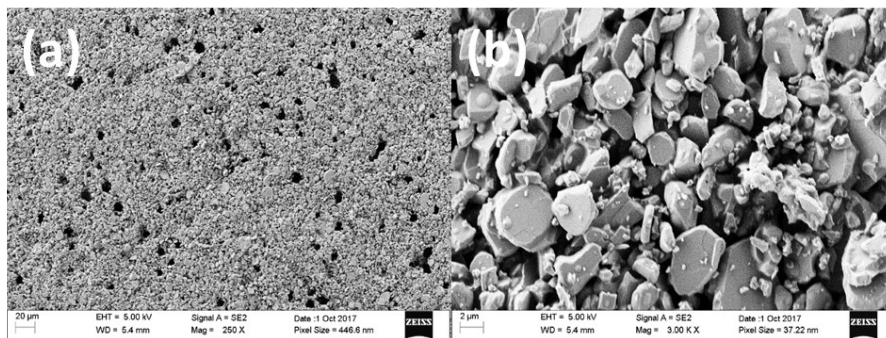


Figure S1. Surface SEM images of commercial porous ceramic supports. (a) Low-magnified image, where big pore with a size around $10\ \mu\text{m}$ can be observed, (b) high-magnified image, where the grains with an average size of $2\ \mu\text{m}$ is identified.

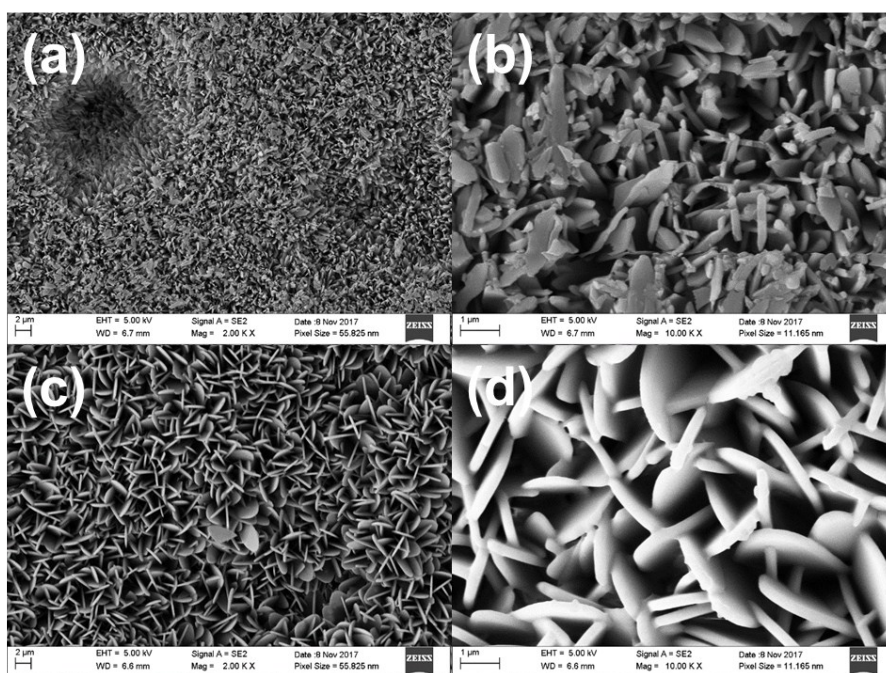


Figure S2. Surface SEM images of Zn-ZIF-L membranes grown on commercial porous ceramic supports with different metal ion concentrations: (a, b) $1\ \text{mmol/L}$, (c, d) $2\ \text{mmol/L}$.

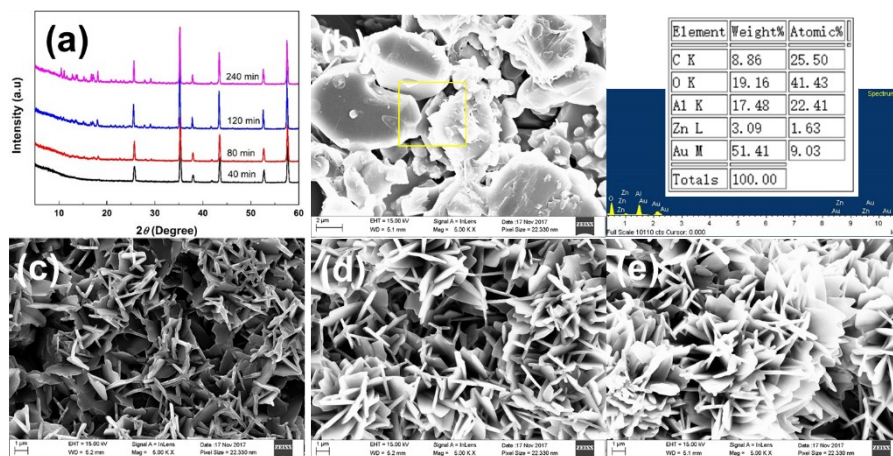


Figure S3. (a) XRD patterns and (b-e) surface SEM images of Zn-ZIF-L grown on porous ceramic supports with different reaction durations: (b) 40 min, (c) 80 min, (d) 120 min, (e) 240 min. The insets in (b) show the elemental composition of the square area, indicating the formation of Zn-ZIF-L seeds. The formation of ZIF-L crystals can be reflected by the gradually increasing intensity of XRD peaks in Figure (a).

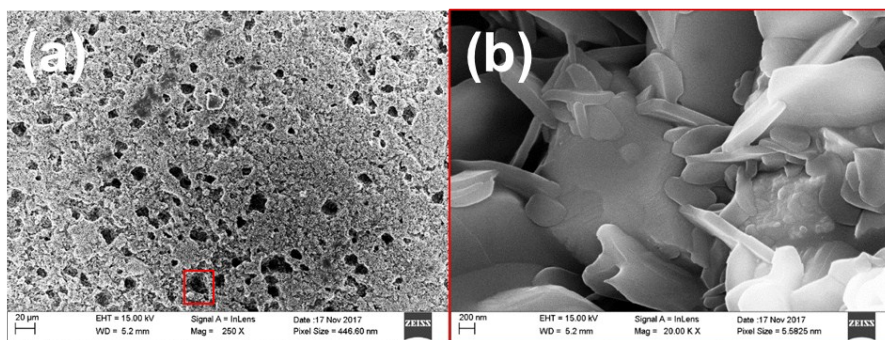


Figure S4. (a) Low magnified SEM image of Zn-ZIF-L grown on porous ceramic supports for 80 min and (b) the corresponding microstructures in the inner-surface of the pores. Plate-like grains were sprouted in the inner-surface, which would be grown to cover the surface and improve the selectivity of membranes.

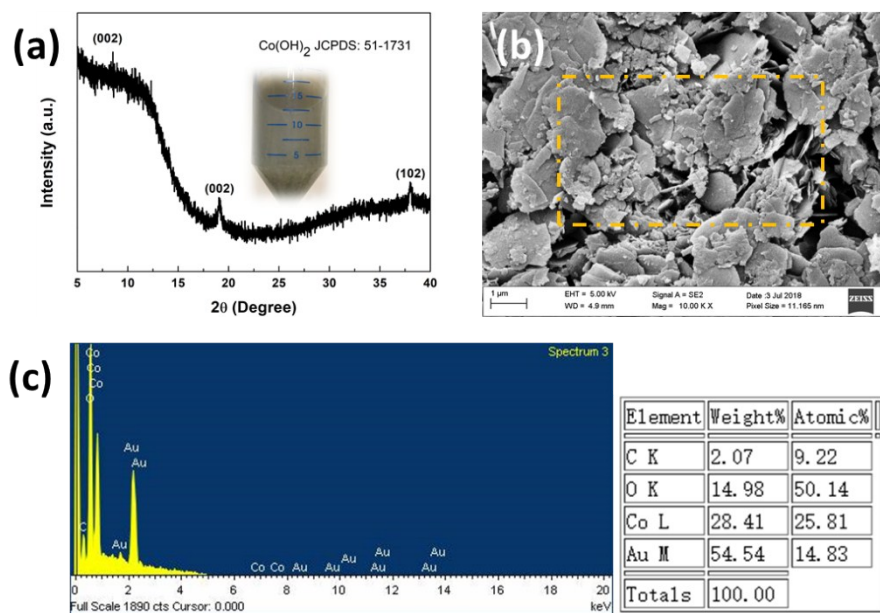


Figure S5. (a) XRD pattern, (b) SEM image and (c) EDS results of Co-ZIF-L powers after stirring in DI water at room temperature for 24 h. The insert in (a) is the optical photograph.

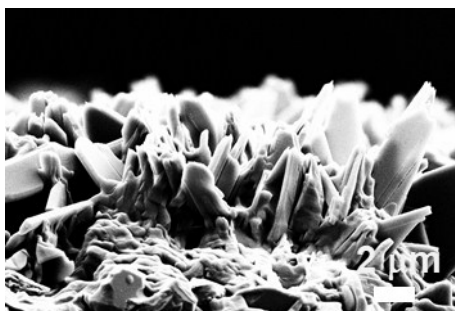


Figure S6. Cross-sectional SEM image of Co-ZIF-L membranes, where the sample was cut without cooling water, in order to avoid the influence of water on the microstructure.

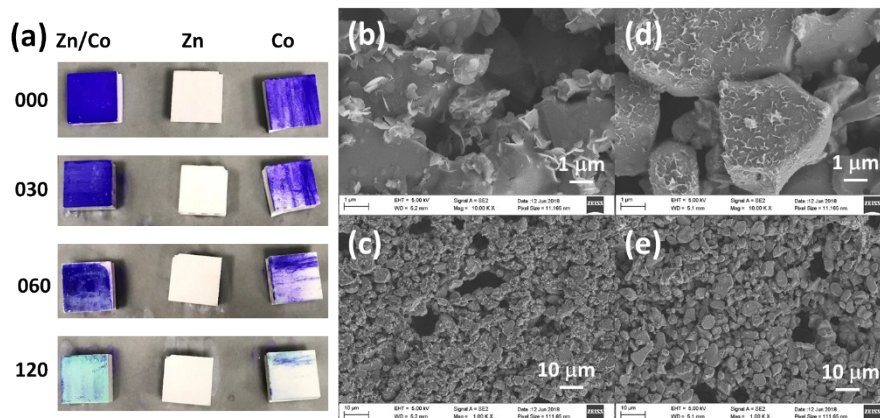


Figure S7. (a) Optical photograph of ZIF-L membranes after treated in DI water (pH=6.8, 200 rpm) for 30 min, 60 min, 120 min. Surface SEM images of (b-c) Zn -ZIF-L membranes and (d-e) Co-ZIF-L membranes after treated in DI water (pH=6.8, 200 rpm) for 120 min.

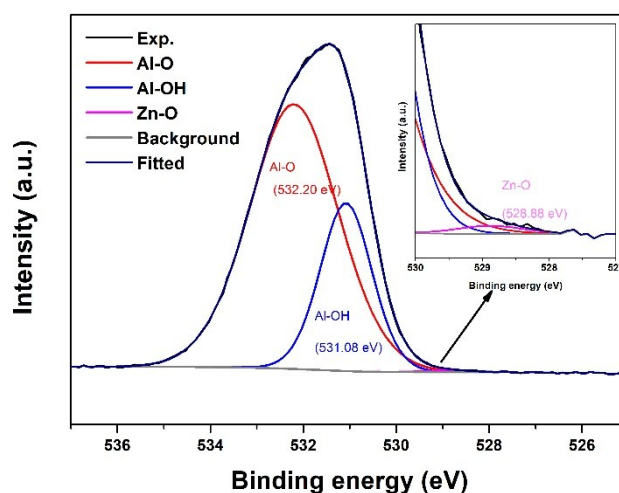


Figure S8. High-resolution XPS spectra of O 1s region for the Zn-ZIF-L membranes. The measurement was conducted at interface between the Zn-ZIF-L membranes and ceramic supports from the cross-section of the membranes.

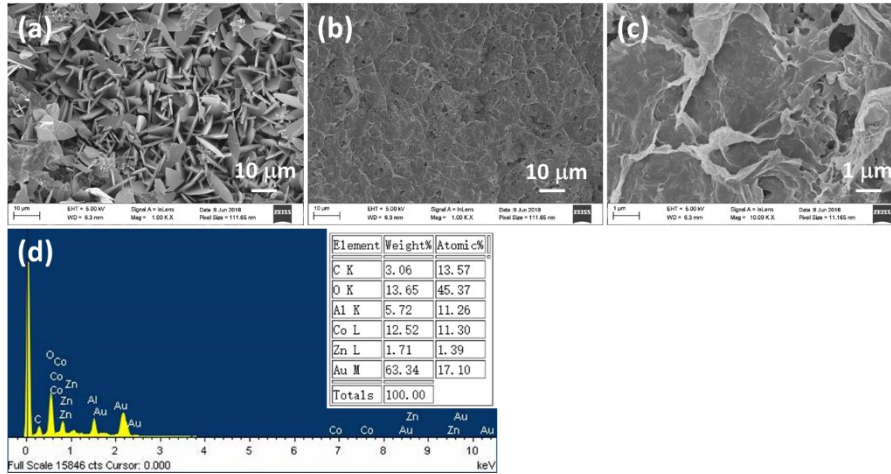


Figure S9. (a) Surface SEM image of Zn/Co-ZIF-L membranes as prepared. (b-c) surface SEM images and (d) chemical composition of Zn/Co-ZIF-L membranes after treated in DI water (pH=6.8, 200 rpm) for 120 min.

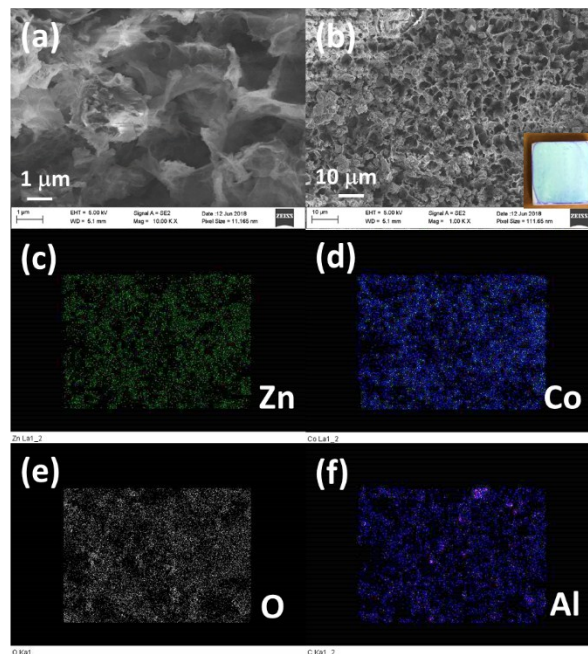


Figure S10. (a-b) SEM image and (c-f) elemental mapping of Zn/Co-ZIF-L membranes after treated in water (pH=6.8, 200 rpm) for 24 h. A selective layer derived from the Zn/Co-ZIF-L heterostructures can be observed, which contains Zn, Co and O. The Al element comes from the substrates. The inset in (b) shows the optical photograph of the membranes, and the color changed from the initial purple too light green.

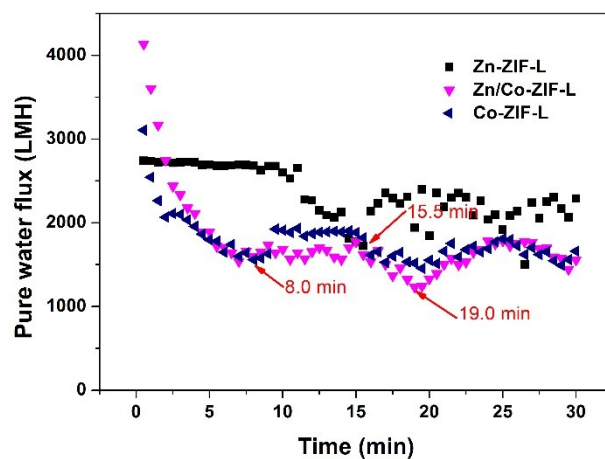


Figure S11. Time-dependent pure water flux of ZIF-L membranes.

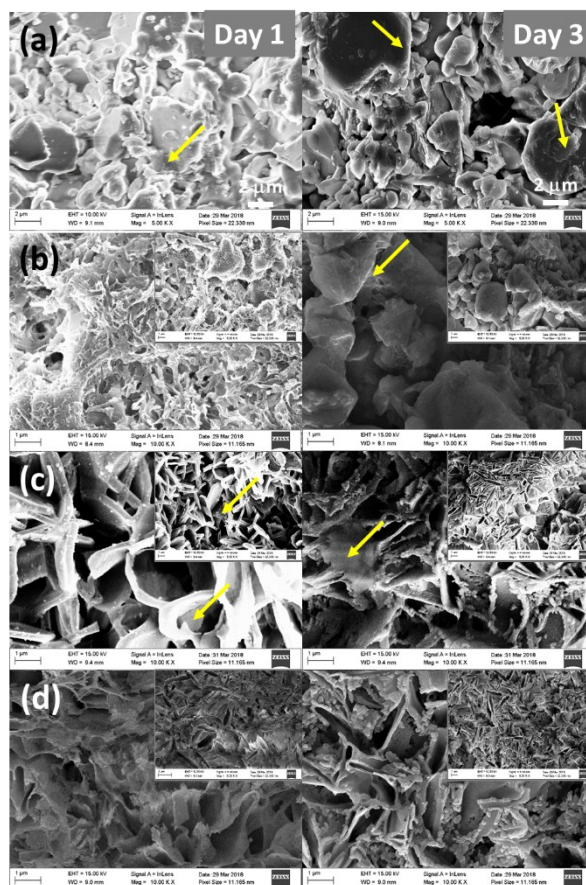


Figure S12. Surface microstructure of ZIF-L membranes after anti-bio-fouling test for 1 day (left) and 3 days (right): (a) Al_2O_3 supports, (b) Co-ZIF-L, (c) Zn-ZIF-L, (d) Zn/Co-ZIF-L.

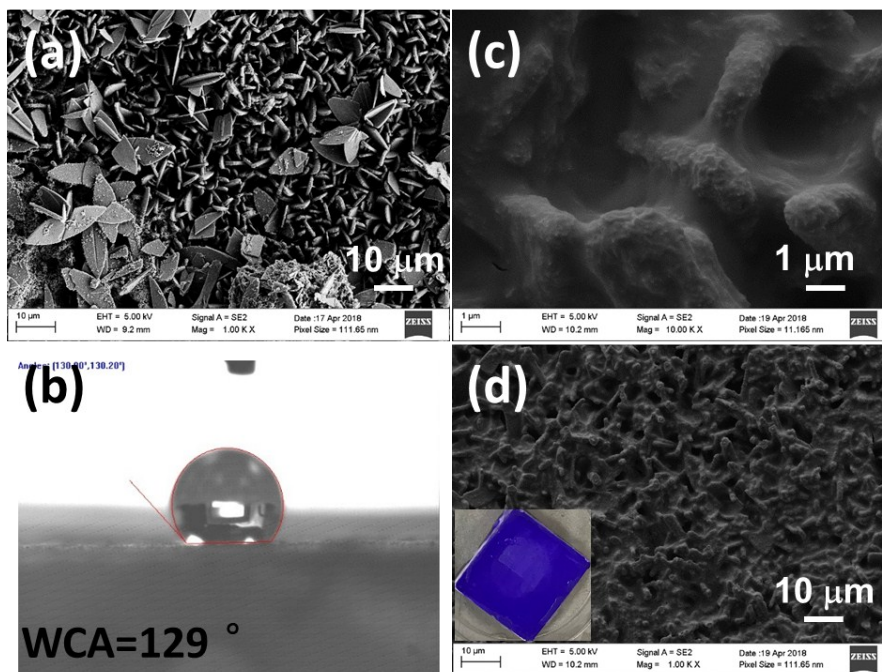


Figure S13. (a) Surface SEM images and (b) water contact angle of B-Zn/Co-ZIF-L membranes. (c-d) Surface SEM images of B-Zn/Co-ZIF-L membranes after water flux test at a pressure of 100 kPa. The inset in (d) shows the corresponding photograph after water flux.