

Electronic Supplementary Information

A flexible and free-standing multifunctional membrane for high-efficiency wastewater purification and oil/water separation with superhigh flux and ultralow fouling

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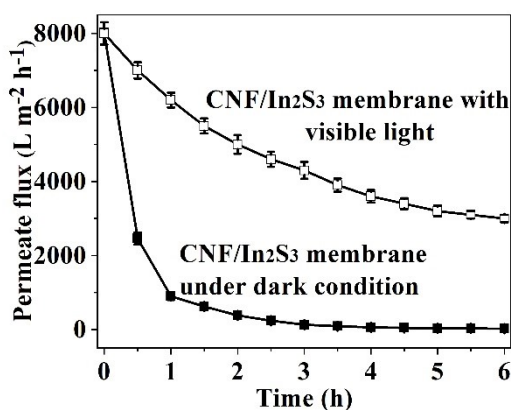


Fig. S1. Long-term permeate flux of CNF/In₂S₃ membranes under dark condition and visible light during 6 h.

Explanation: Fig. S1 shows long-term permeate flux of CNF/In₂S₃ membranes under dark condition and visible light during 6 h under 0.6 bar. It can be observed that the permeate flux declines rapidly in the first 2 h when CNF/In₂S₃ membranes were put tested under dark condition, and the flux reaches around zero due to the severe membrane fouling caused by HA. However, CNF/In₂S₃ membranes under visible light can maintain relative high permeate flux (ca. 3000 L/m²·h), even after 6 h, indicating the high stability of CNF/In₂S₃ membranes.

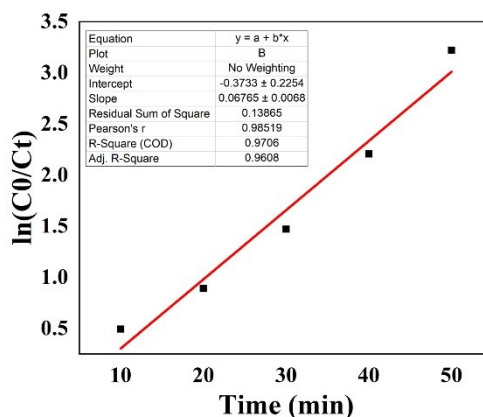


Fig. S2. First order kinetic equation $\ln(C_0/C_t) = kt$ of CNF/In₂S₃ membranes under visible light.

Explanation: According to the first order kinetic equation $\ln(C_0/C_t) = kt$, where C_0 represents the initial concentration of MB, C_t represents the real-time concentration of MB and k (min⁻¹) is the degradation rate constant, the photocatalytic reaction constants of CNF/In₂S₃ membrane is 0.06765 min⁻¹, which is much higher than reported that of In₂S₃ (0.021 min⁻¹)¹, TiO₂ nanowhisker (0.02658 min⁻¹)², and TiO₂/CdS composites

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(0.05 min^{-1})³. The results clearly demonstrate that CNF/In₂S₃ membrane prepared in this work can achieve excellent photocatalytic capacity.

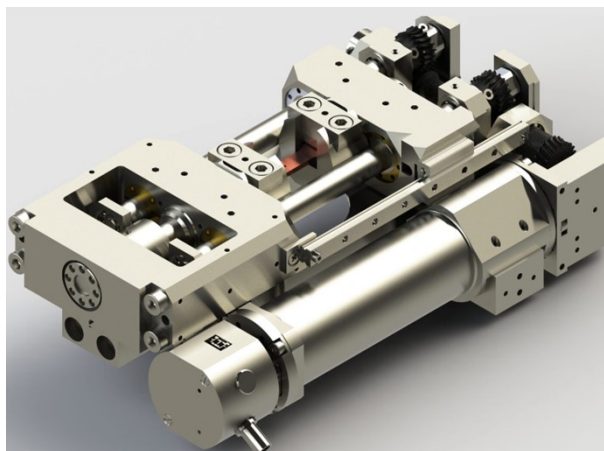


Fig. S3. Photo of miniature tensile module.

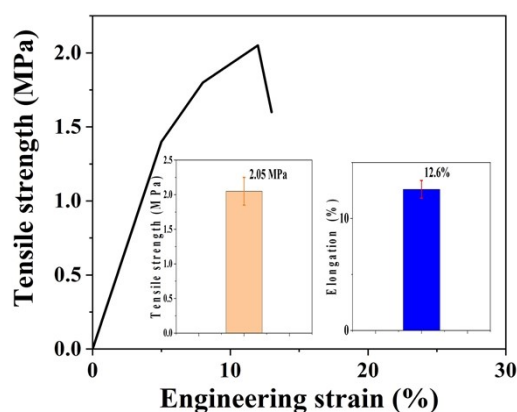


Fig. S4. Engineering stress-strain curve of CNF/In₂S₃ membrane (insets: tensile strength and strain at break).

Explanation: Fig. S4 shows the tensile strength and elongation at break by miniature tensile module (Fig. S3). Each result was from three tests to make sure the data accuracy. The tensile strength measures the maximum stress a material can withstand before it yields or breaks completely. The tensile strength of CNF/In₂S₃ membrane was around 2.05 MPa. In addition, the elongation of CNF/In₂S₃ membrane was about 12.6%. Hence, these results indicate that CNF/In₂S₃ membrane possesses the necessary structural robustness and strength to withstand the high-tension winding processes required for industrial module assembly.

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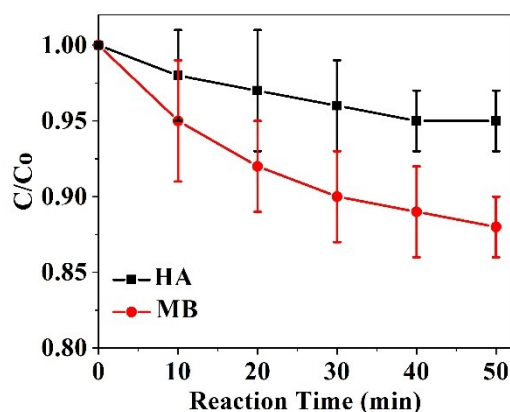


Fig. S5. Adsorption of HA and MB by CNF/In₂S₃ membrane within 50 min.

Explanation: Fig. S5 shows adsorption of HA and MB by CNF/In₂S₃ membrane within 50 min. Only 5% of HA and 12% of MB can be adsorbed by CNF/In₂S₃ membrane under dark condition, which is significantly lower than that photodegraded by CNF/In₂S₃ membrane under visible light.

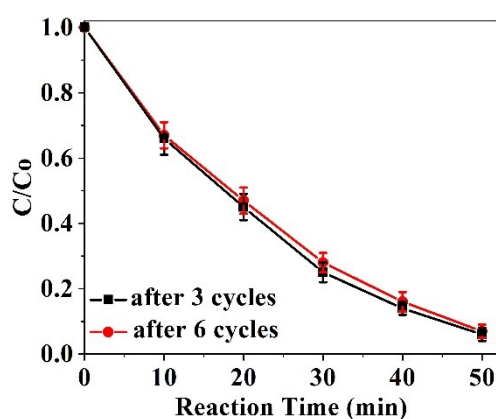


Fig. S6. Photodegradation of MB by CNF/In₂S₃ membrane after 3 cycles and 6 cycles, respectively.

Explanation: Fig. S6 shows photodegradation of MB by CNF/In₂S₃ membrane after 3 cycles and 6 cycles, respectively. It can be found that CNF/In₂S₃ membrane achieves high photodegradation efficiency even after 6 cycles, demonstrating the stability and reusability of CNF/In₂S₃ membrane.

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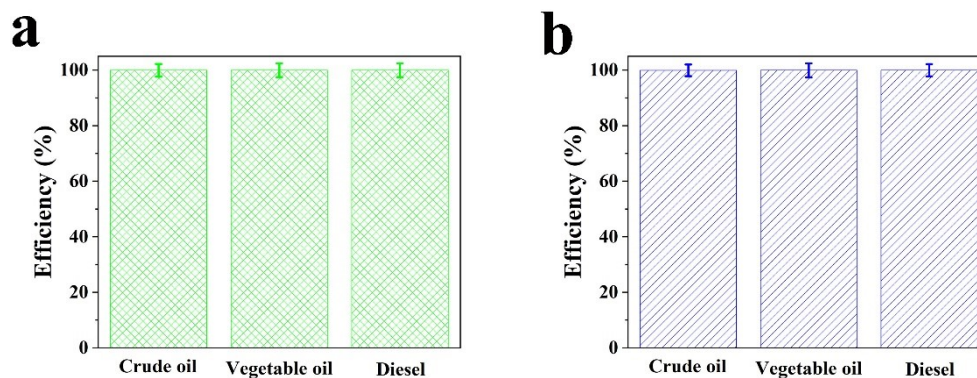


Fig. S7. (a) Separation efficiency of different immiscible oil/water mixtures after 3 cycles; and (b) Separation efficiency of different immiscible oil/water mixtures after 6 cycles.

Explanation: Fig. S7a and b show the separation efficiency of different immiscible oil/water mixtures after 3 and 6 cycles. No obvious separation efficiency decline can be identified, indicating CNF/ In_2S_3 membrane can be operated for oil/water separation with high efficiency in a long period.

Reference

1. R. Lucena, F. Fresno and J. C. Conesa, *Catal. Commun.*, 2012, **20**, 1-5.
2. J. Ng, J. H. Pan and D. D. Sun, *J. Mater. Chem.*, 2011, **21**, 11844-11853.
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