Membrane-Integrated $Bi_2WO_6@WS_2$ Sonophotocatalyst for Trimethoprim Removal in Water

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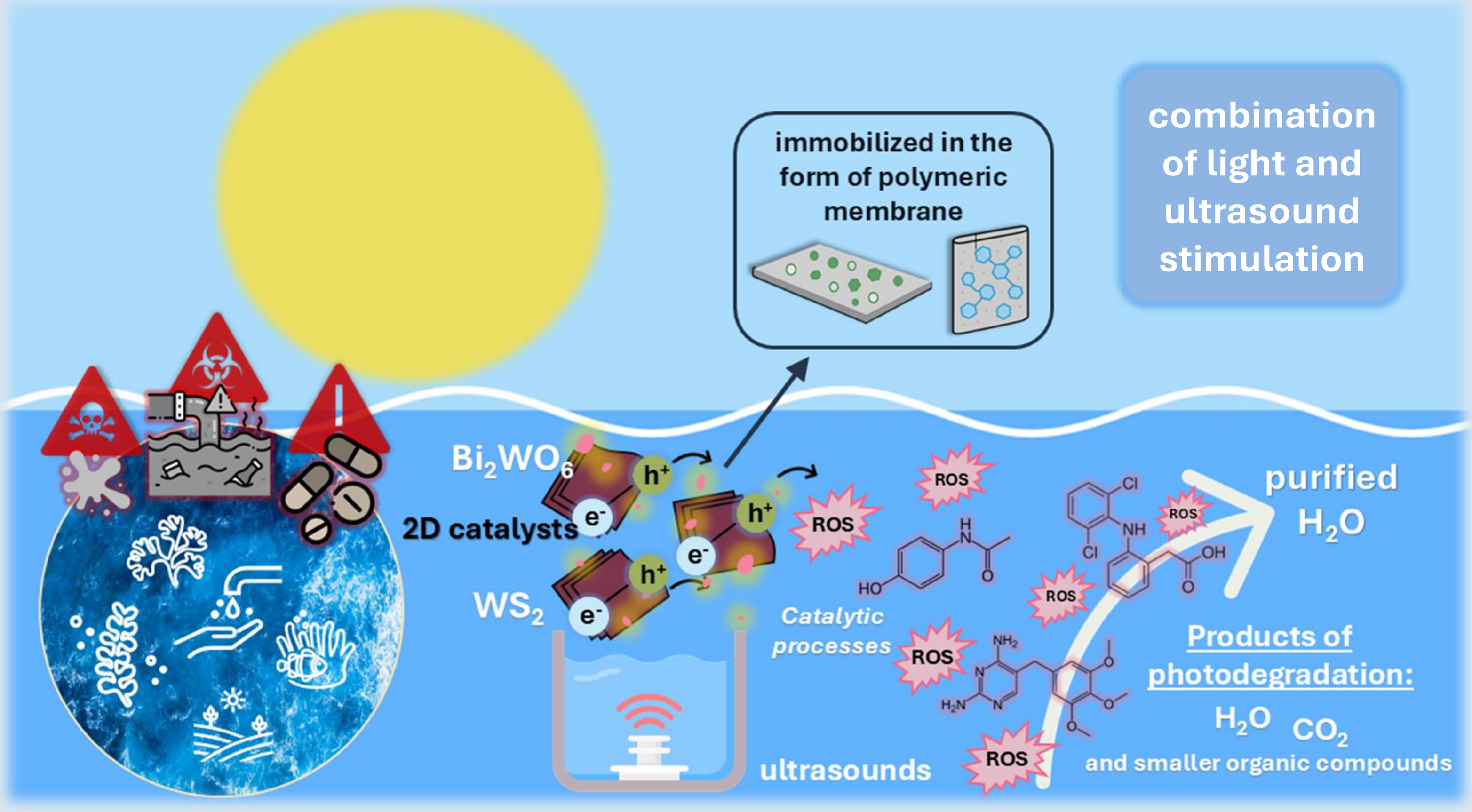
INTRODUCTION & AIM



METHOD

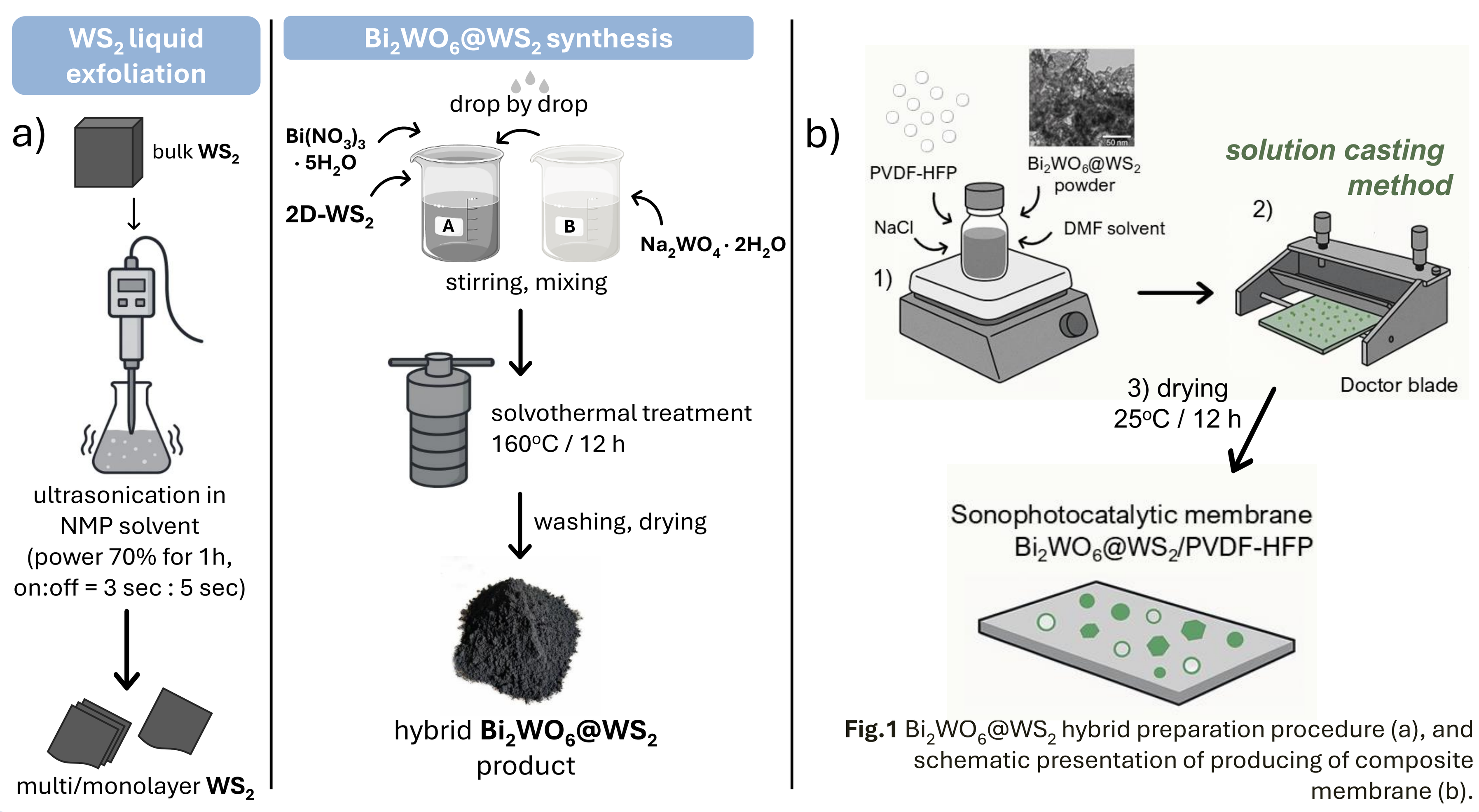


Fig.1 $Bi_2WO_6@WS_2$ hybrid preparation procedure (a), and schematic presentation of producing of composite membrane (b).

RESULTS & DISCUSSION

STRUCTURE, MORPHOLOGY, and OPTICAL PROPERTIES

POWDERS

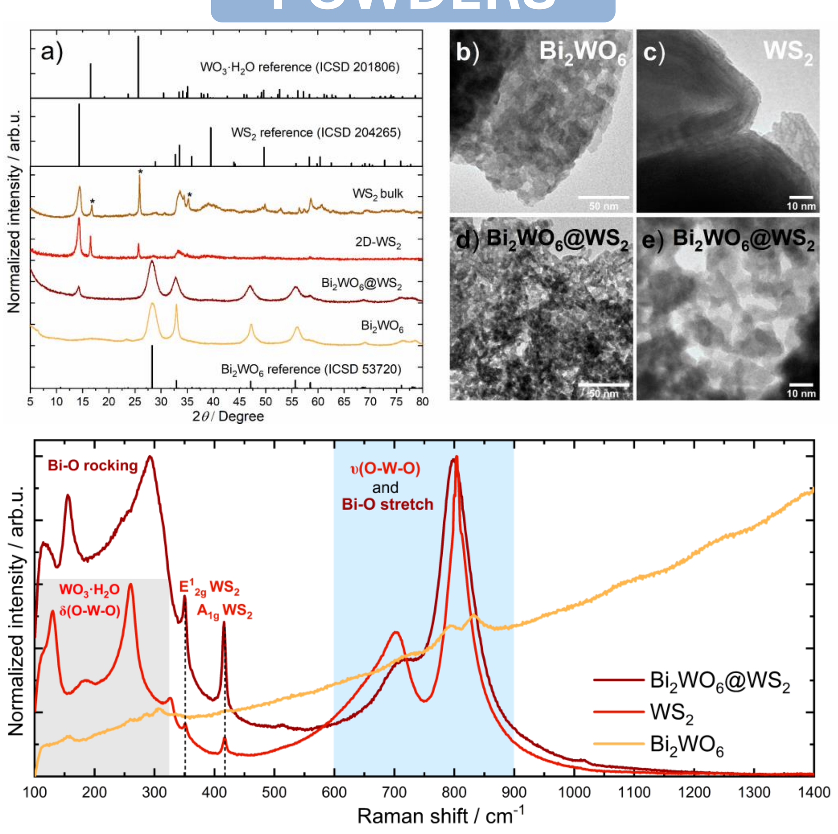


Fig. 2 XRD (a), TEM images (b-e), and Raman spectra (f) of $Bi_2WO_6@WS_2$ and its components alone.

MEMBRANES

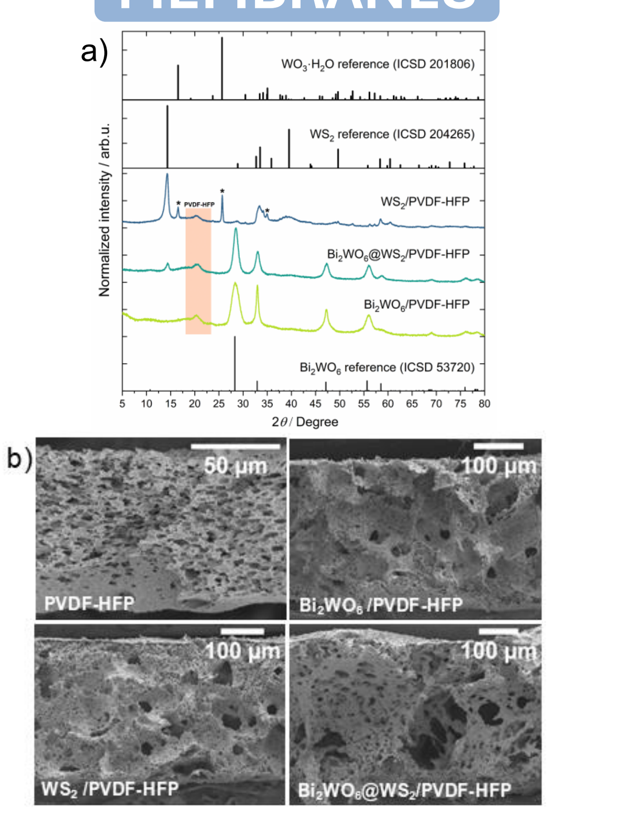


Fig. 4 XRD (a), and SEM-EDS images (b) of the Bi_2WO_6-PVDF, WS_2-PVDF, $Bi_2WO_6@WS_2$-PVDF membranes.

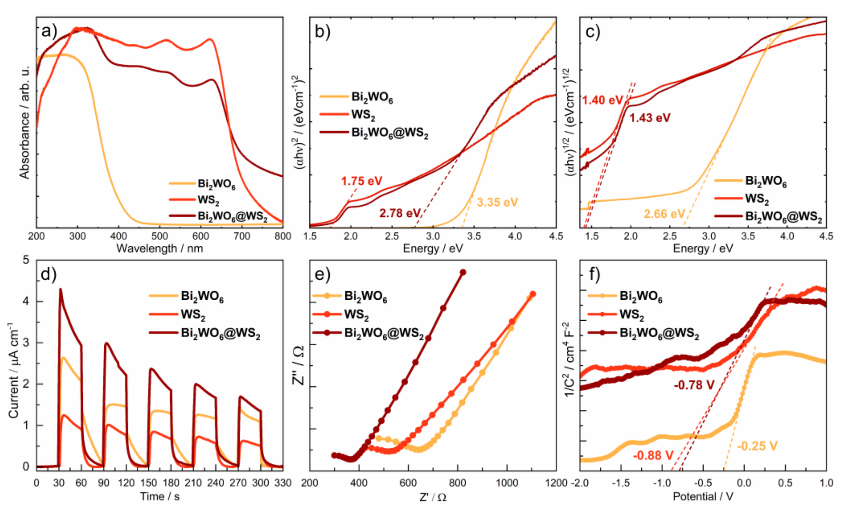
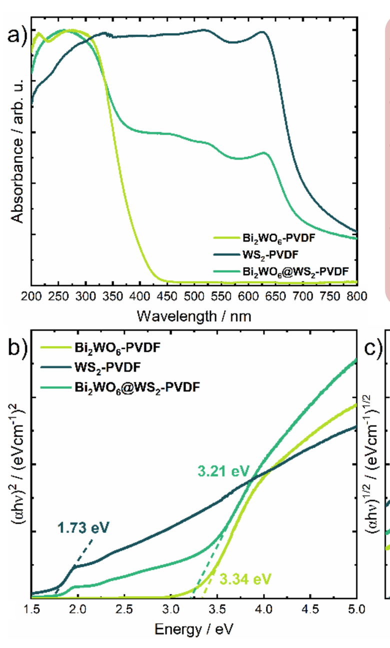


Fig. 3 (a) Absorption spectra and relevant Tauc plots showing (b) direct, and (c) indirect band-gaps, (d) photocurrent response, (e) EIS spectra, and (f) Mott-Schottky plots of the $Bi_2WO_6@WS_2$ hybrid powder and its components alone.

Powder	E_g / eV
Bi_2WO_6	2.66
WS_2	1.75
$Bi_2WO_6@WS_2$ (direct E_g)	2.78



Membrane	E_g / eV
Bi_2WO_6-PVDF	2.58
WS_2-PVDF	1.73
$Bi_2WO_6@WS_2$-PVDF (direct E_g)	3.21
$Bi_2WO_6@WS_2$-PVDF (indirect E_g)	1.48

Fig. 5 Absorption spectra (a), and relevant Tauc plots showing (b) direct, and (c) indirect band-gaps of the Bi_2WO_6-PVDF, WS_2-PVDF, $Bi_2WO_6@WS_2$-PVDF membranes.

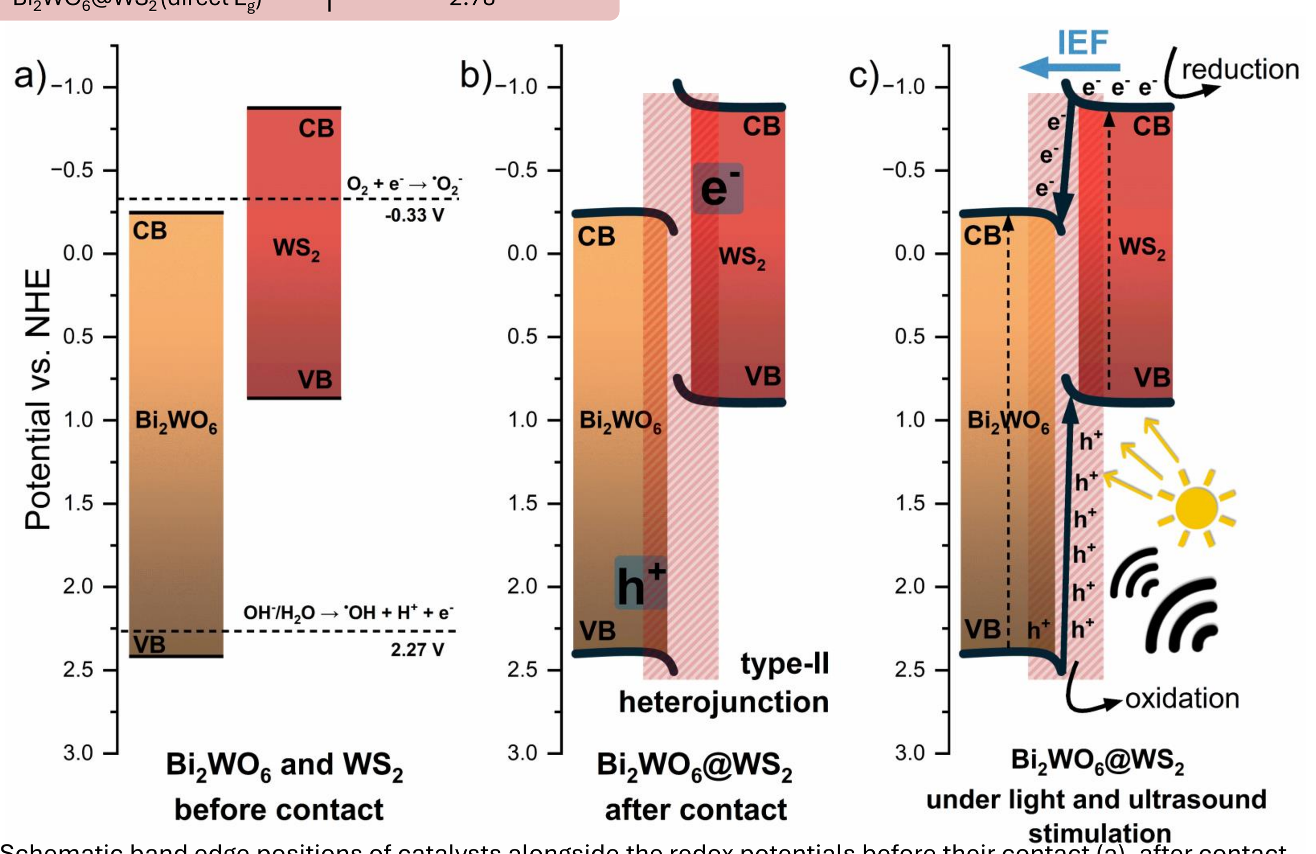


Fig. 6 Schematic band edge positions of catalysts alongside the redox potentials before their contact (a), after contact (b), and under light and ultrasound stimulation (c).

SONOPHOTOCATALYTIC DEGRADATION OF TRIMETHOPRIM

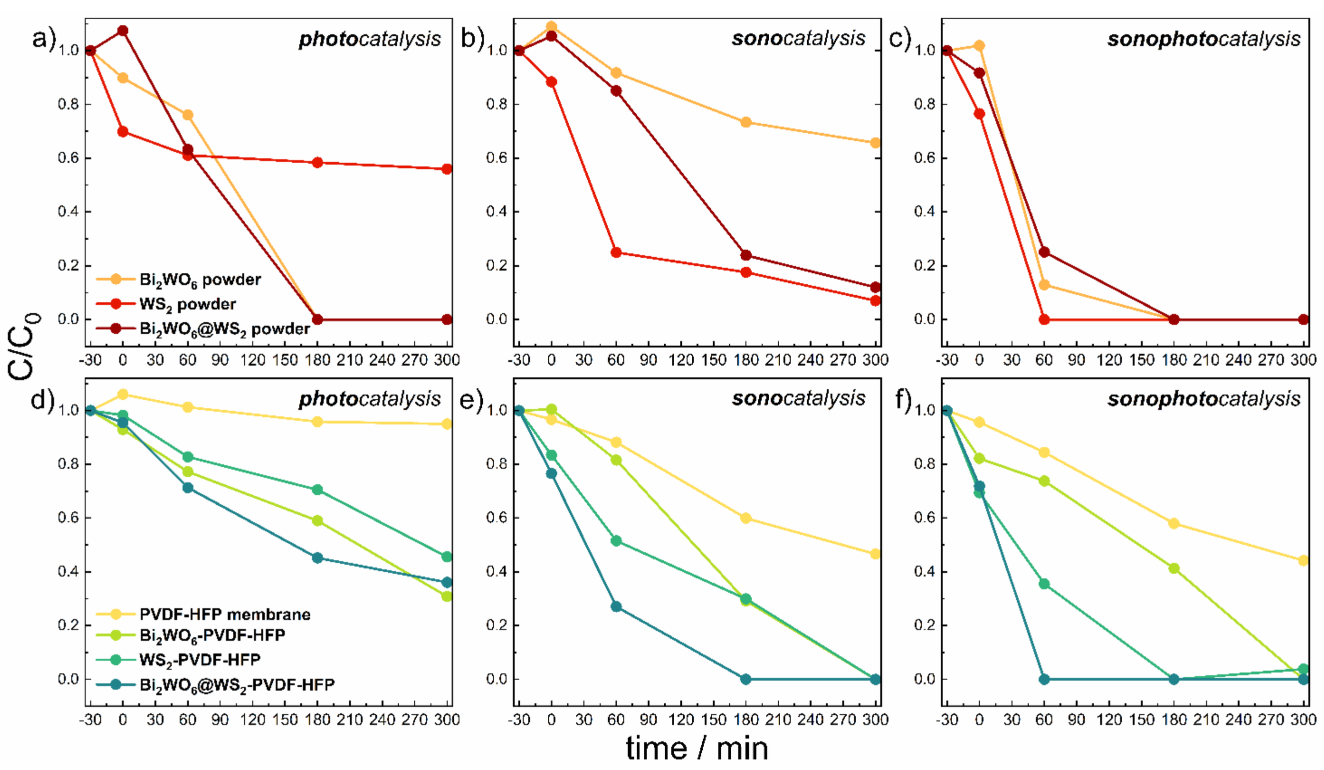


Fig. 7 TMP photocatalytic (a and d), sonocatalytic (b and e), and sonophotocatalytic (c and f) degradation using powders (a-c) and membranes (d-f).

- ***sono + photo* processes enhance degradation efficiency** unlike stand-alone photocatalytic and sonocatalytic processes,
- **the hybrid shows the highest photosonoactivity** due to the formation of II-type of heterojunction slowing down charge recombination,
- **adsorption isotherms** highlighted favorable monolayer interactions between TMP and the membrane, further enhancing catalytic efficiency.

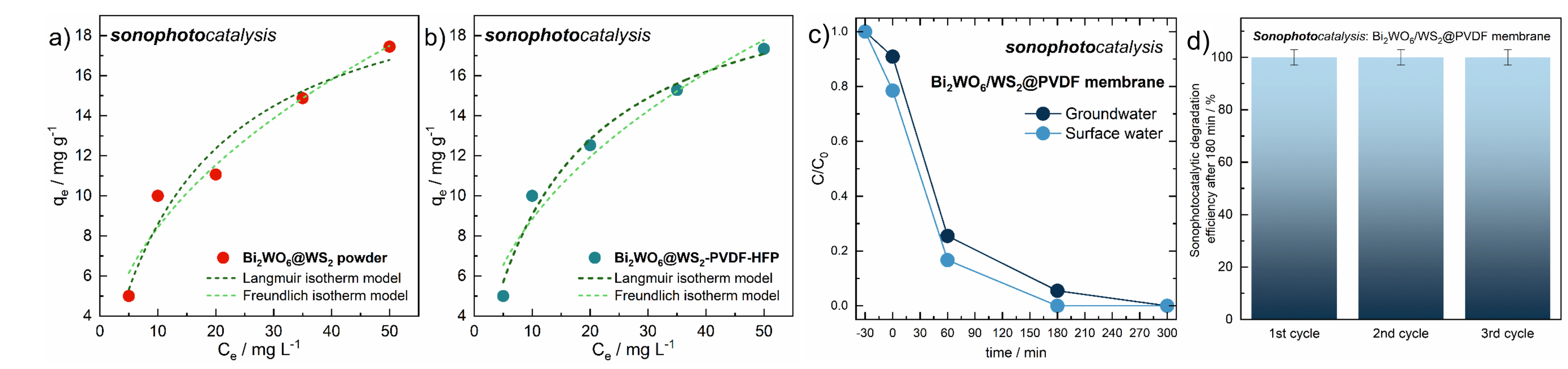


Fig. 8 (a) Adsorption Langmuir and Freundlich isotherms of $Bi_2WO_6@WS_2$ powder, and (b) $Bi_2WO_6@WS_2$-PVDF-HFP membrane, (c) TMP degradation efficiency in real water matrices, and (d) reusability performance of $Bi_2WO_6@WS_2$-PVDF-HFP membrane in sonophotocatalyic proccess.

KEY FINDINGS

- **Efficient hybrid membrane:** $Bi_2WO_6@WS_2$-PVDF-HFP enables highly active and reusable sonophotocatalytic TMP degradation.
- **Improved charge separation:** Type-II band alignment and strong interfacial coupling enhance ROS generation.
- **Superior performance:** Complete TMP removal under light + ultrasound, stable over multiple cycles.
- **Environmental safety:** LC–MS confirms non-toxic pathways.
- **Real-water applicability:** Effective in groundwater and surface water, showing strong scalability potential.

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