

Supplementary Information

Title

3D printed photo-sensitized microfiltration membranes for simultaneous water filtration and pathogen management

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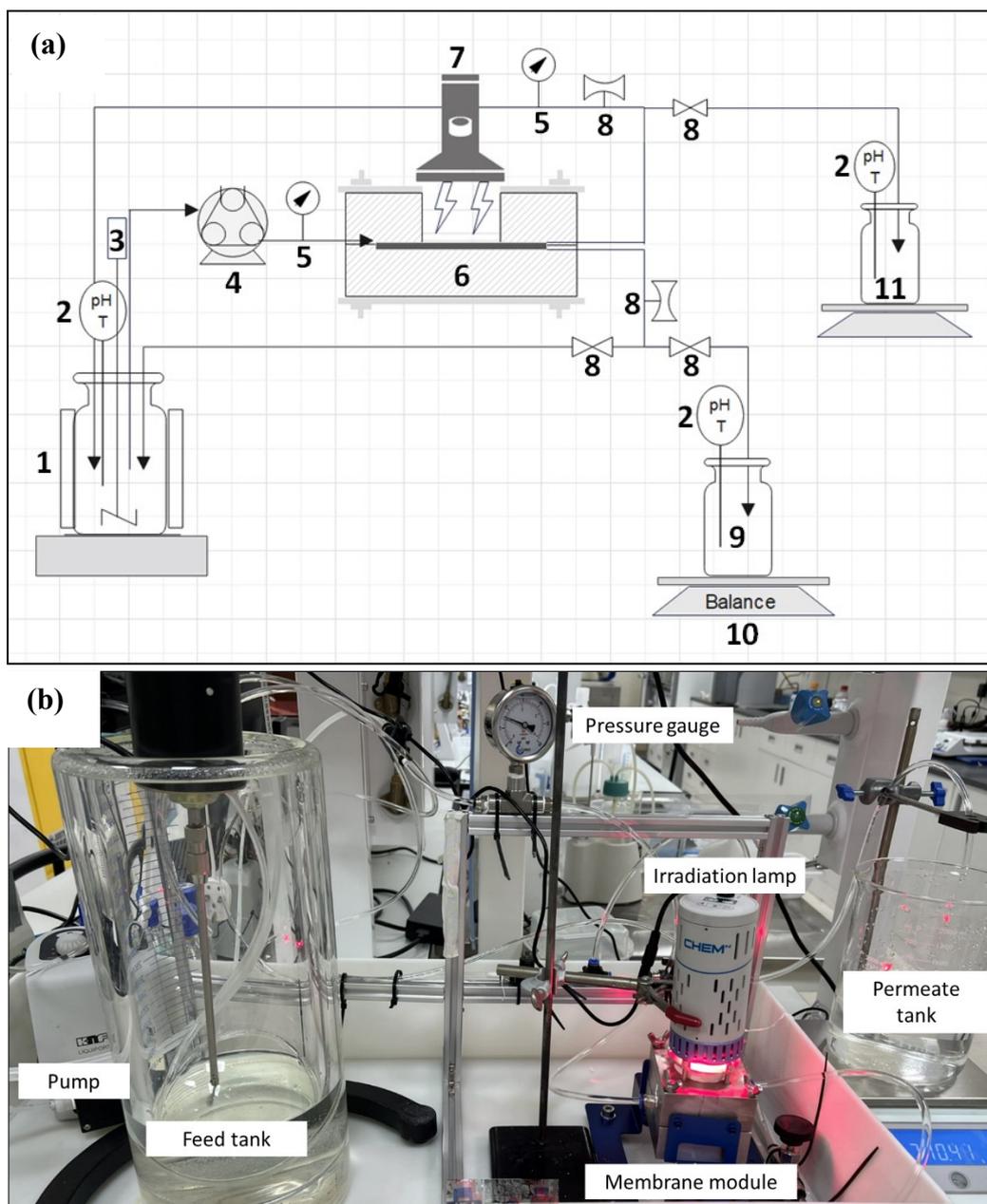


Figure S1 (a) Schematic Flow Diagram of the designed experimental setup for the photocatalytic membrane reactor with the labeled components: (1) Jacketed Feed tank (5 L), (2) pH & T meters, (3) Overhead stirrer, (4) Peristaltic pump, (5) Pressure gauge, (6) Membrane module, (7) Irradiation source, (8) Valves, (9) Permeate tank (1L), (10) Weighing balance, (11) Retentate tank (1L). (b) Photograph of the experimental setup of the photocatalytic membrane reactor with labeled components.

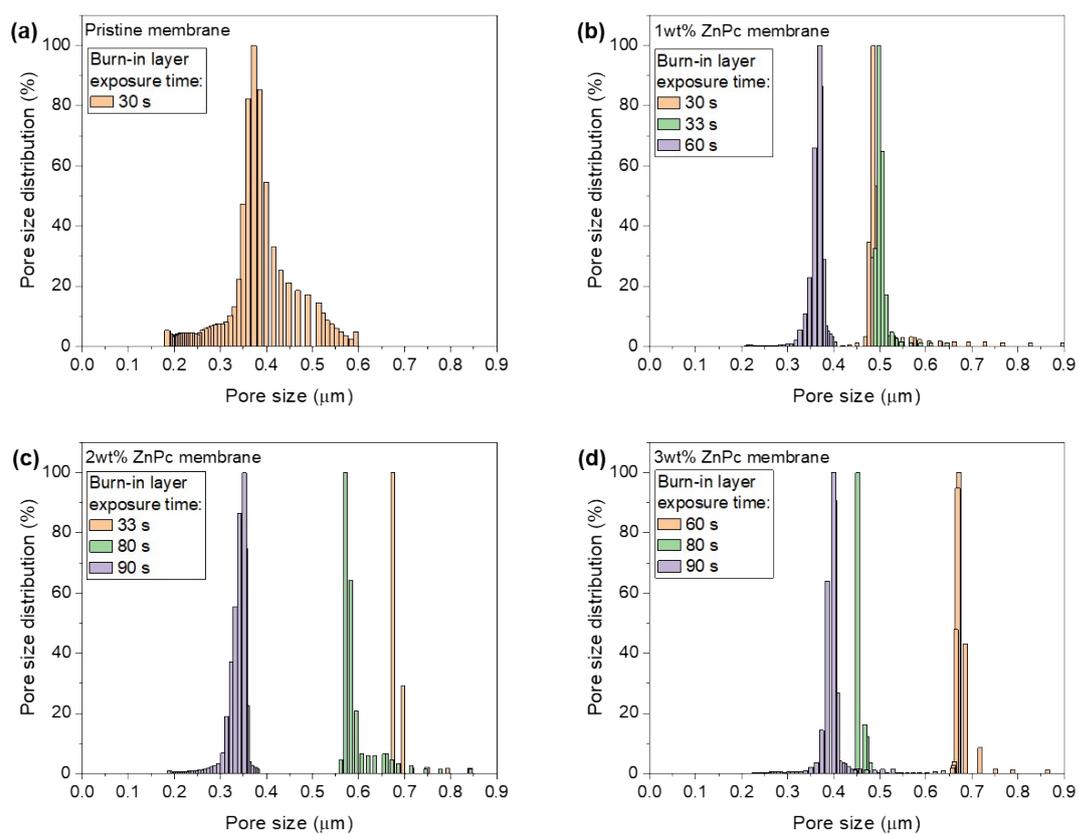


Figure S2 Pore size distribution (%) versus pore size (μm) for 3D-printed membranes with varying ZnPc concentrations and burn-in exposure times: (a) Pristine (30 s), (b) 1 wt% ZnPc (30, 33 and 60 s), (c) 2 wt% ZnPc (33 s, 80 s, 90 s), (d) 3 wt% ZnPc (60, 80 and 90 s).

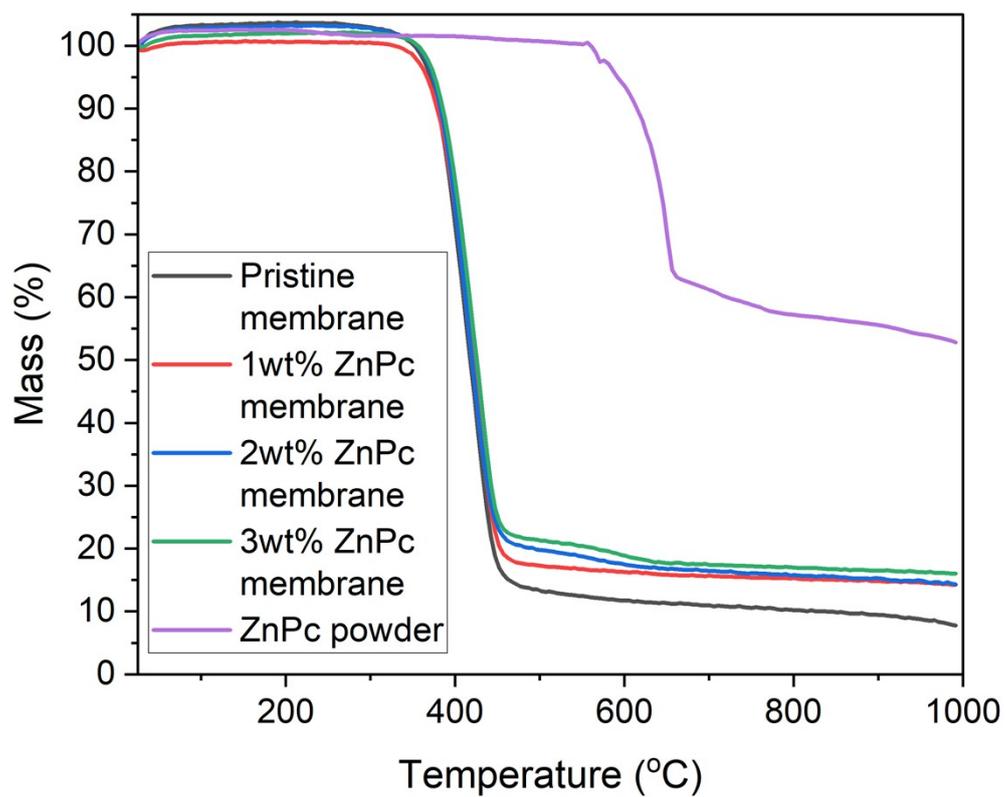


Figure S3 Thermogravimetric analysis (TGA) curves of pristine PEGDA membrane, ZnPc-incorporated membranes (1, 2, and 3 wt% ZnPc), and ZnPc powder.

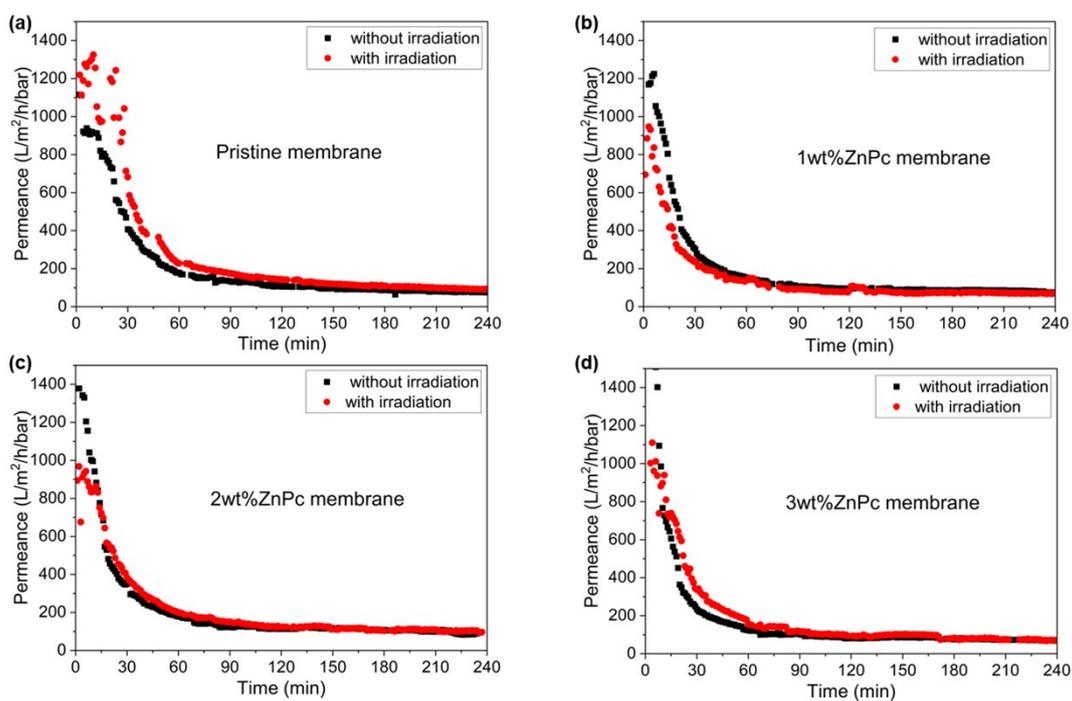


Figure S4 *E.coli* filtration permeance with and without irradiation of (a) Pristine membrane, (b) 1 wt% ZnPc membrane, (c) 2 wt% ZnPc membrane, (d) 3 wt% ZnPc membrane.

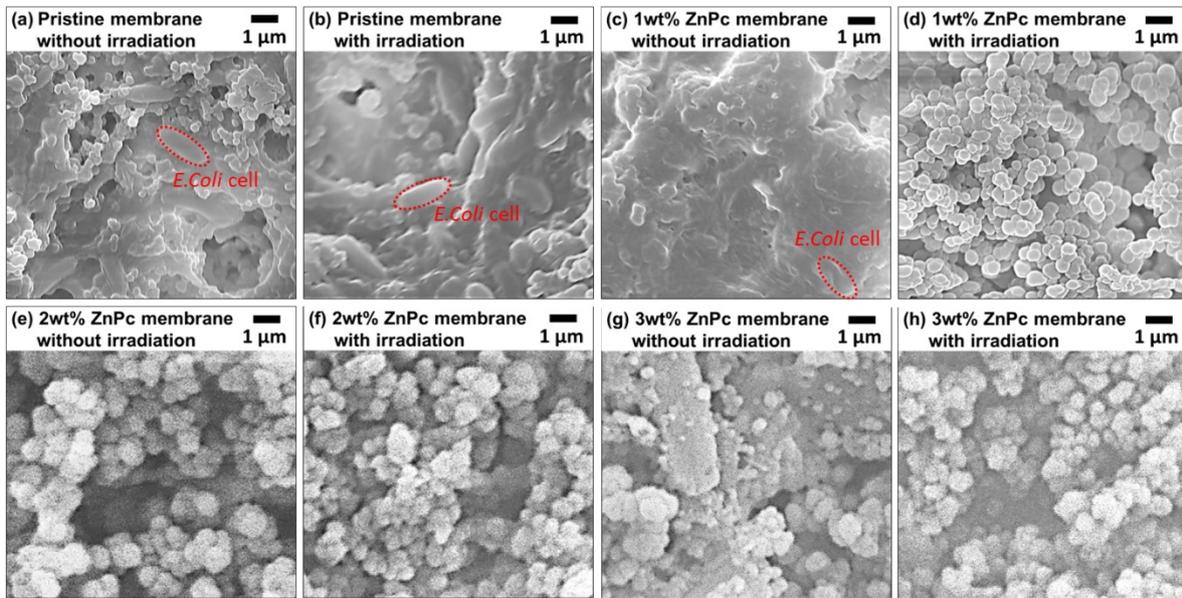


Figure S5 SEM images of the membranes after *E. coli* filtration, illustrating the effect of irradiation on bacterial adhesion and membrane morphology. (a, b) Pristine membrane without and with irradiation, respectively; (c, d) 1 wt% ZnPc membrane without and with irradiation; (e, f) 2 wt% ZnPc membrane without and with irradiation; (g, h) 3 wt% ZnPc membrane without and with irradiation.

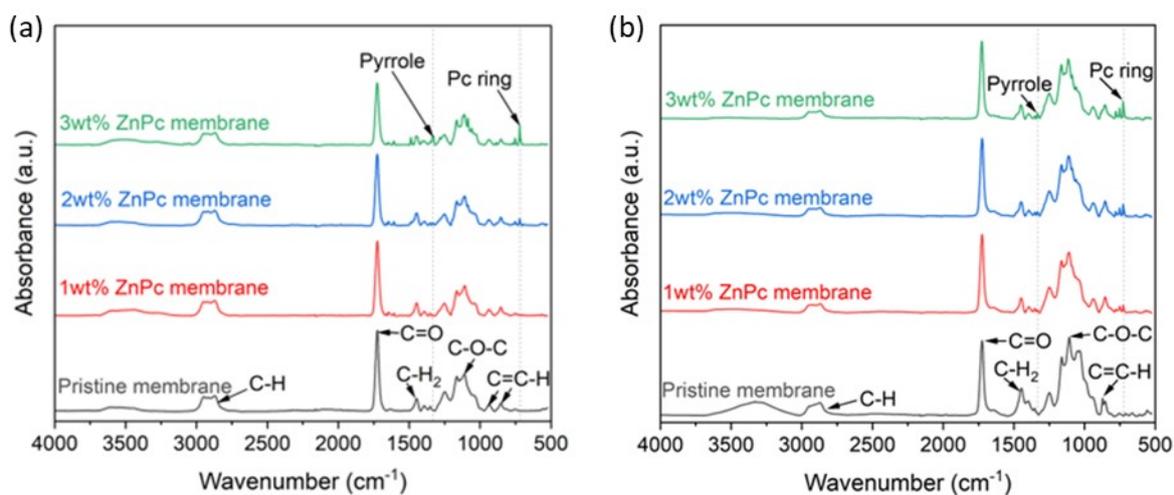


Figure S6 Chemical stability analysis of ZnPc-functionalized PEGDA membranes before and after filtration. (a) FT-IR spectra of pristine and ZnPc-functionalized membranes (1, 2, and 3 wt% ZnPc) prior to filtration, (b) FT-IR spectra of the corresponding membranes after filtration, demonstrating retention of the ZnPc-related bands and overall spectral features, indicative of chemical integrity following filtration.

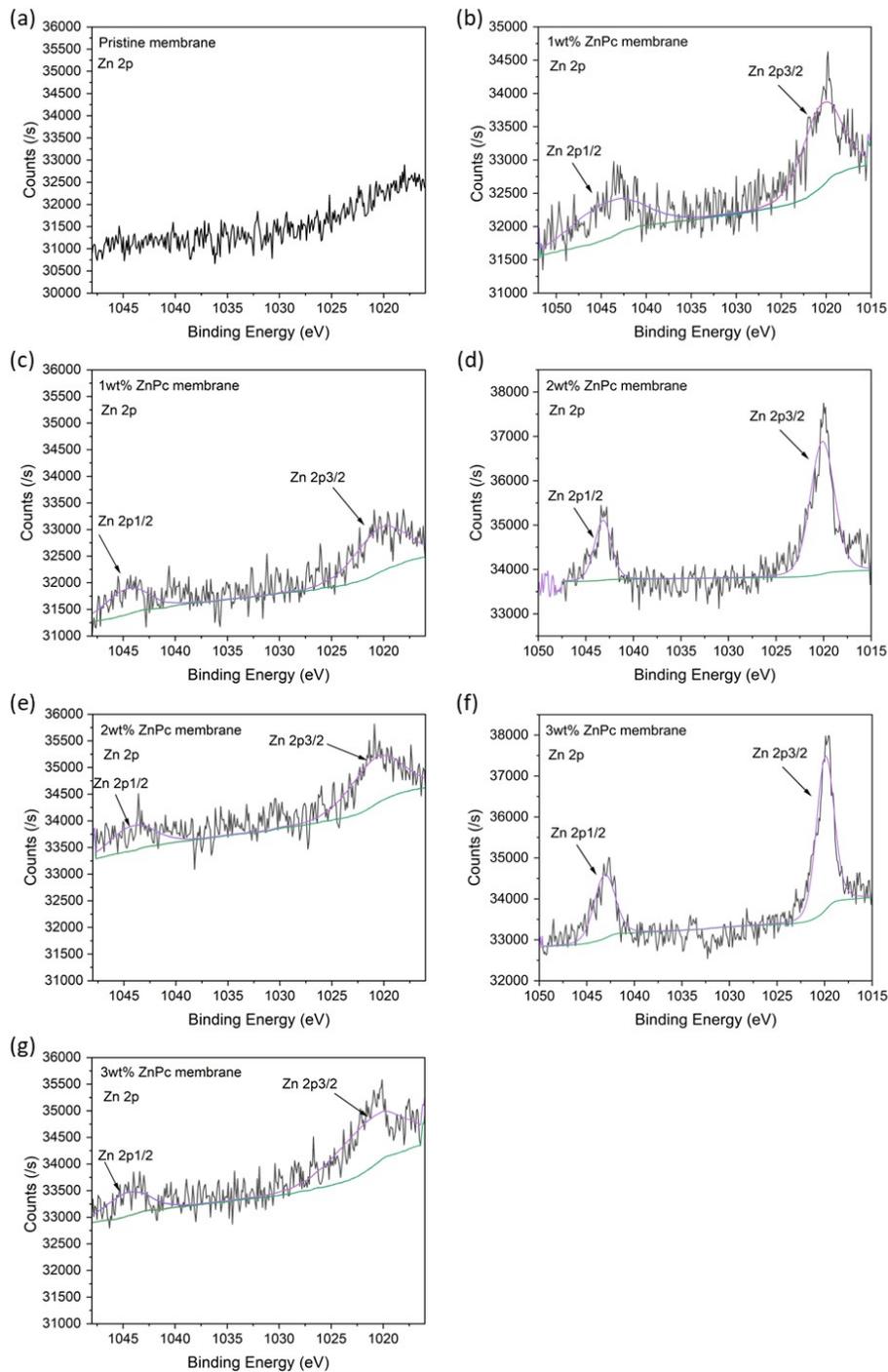


Figure S7 High-resolution XPS spectra in the Zn 2p binding energy region collected from (a) Pristine membrane, (b) 1 wt% ZnPc membrane before filtration, (c) 1 wt% ZnPc membrane after filtration (d) 2 wt% ZnPc membrane before filtration, (e) 2 wt% ZnPc membrane after filtration, (f) 3 wt% ZnPc membrane before filtration, (g) 3 wt% ZnPc membrane after filtration.

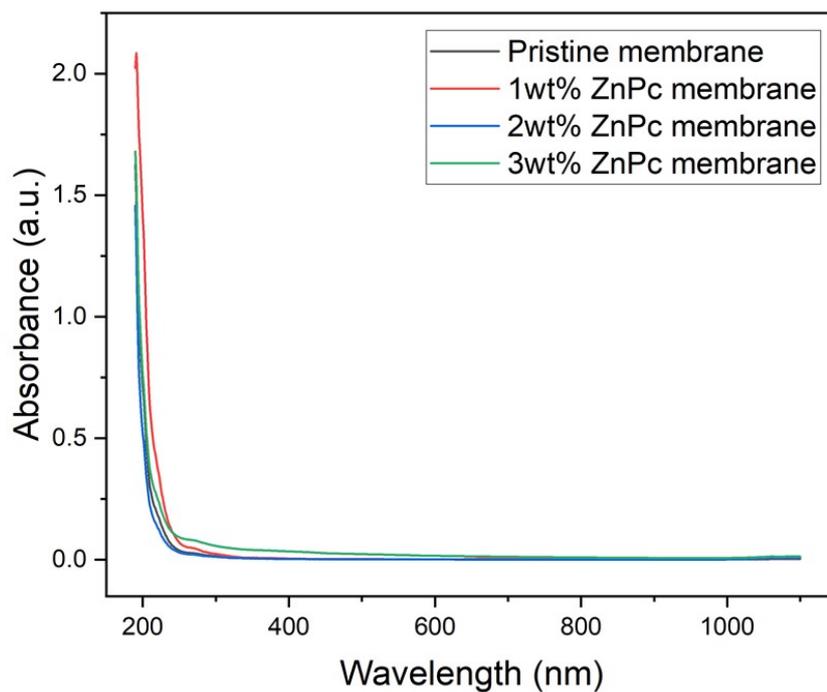


Figure S8 UV-vis absorption spectra of the permeate collected after 6 h of continuous cross-flow filtration using pristine PEGDA membranes and ZnPc-functionalized membranes containing 1, 2, and 3 wt% ZnPc. The absence of characteristic ZnPc absorption features, particularly the Q-band at ~ 672 nm, indicates that ZnPc leaching into the permeate is below the detection limit, confirming the chemical stability and effective immobilization of ZnPc within the membrane matrix under operational conditions.