Visible-Light Driven Photocatalytic Membrane for the Removal of Persistent Organic Pollutants

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Persistent organic pollutants (POPs), heavy metals, cyanides, and dyes are contaminating water around the world, and this needs to be handled because it will lead to water scarcity and poor water quality. Traditional wastewater treatment technologies such as include reverse osmosis, ion exchange, gravity, and adsorption among others have been successful in treating effluents for disposal to some extent over the years but each has its own set of limitations. Interestingly, phototcatalytic membranes that combine physical separation through filtering with pollutant degradation or antibacterial qualities produced by photocatalysis in a single unit are becoming more prominent as wastewater treatment options. In this study, visible-light driven photocatalytic membrane was developed from various compositions with different configuration for degradation of wide ranges of POPs. The fabricated membranes were characterized for their morphology and properties followed by the photocatalytic degradation evaluations. In addition, the potential of the photocatalytic membrane in removing the detrimental effect of the POPs was investigated via in-vivo study. All fabricated membranes possessed typical asymmetrical structure with finger-like and sponge-like structure. The uniform distribution of photocatalyst on membrane outer surface accelerates the fast degradation of POPs during photocatalytic treatment. Excellent photocatalytic activity with more than 90% and 96.8% of bisphenol A removal was achieved in the presence of nitrogen-doping titanium dioxide dual layer hollow fiber (N-doped TiO_2 DLHF) membrane and copper (II) oxide coating bauxite membrane, respectively. Furthermore, photocatalytic DLHF in the treatment of groundwater and a secondary wastewater effluent revealed that it performed exceptionally well in the photocatalytic removal of eight target pharmaceutical chemicals under visible and UV light irradiation. Most importantly, the visible light-driven photocatalytic N-doped TiO_2 DLHF membrane effectively eliminated the harmful effect of BPA on the jejunum and ileum section of gastrointestinal tract. Membrane modification with photocatalytic composite nanomaterials that can be activated with high efficiency by UV or even visible/solar light is one of the options with a lot of promise to (a) improve membrane performance and antifouling properties, (b) be cost-effective, (c) enable chemical-free membrane cleaning, and (d) improve pollutant degradation, possibly by using a free light source. Altogether, photocatalytic membrane technology has recently proven to be a more advantageous option in wastewater treatment operations.

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