Adsorption Behavior and Self-Aggregation of 5,10,15,20-tetrakis-(4-sulfonatophenyl)-porphyrin on Quaternized Polysulfone Membrane

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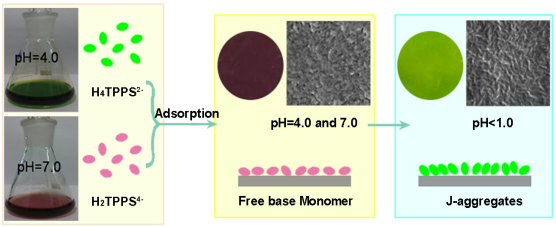
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Highlights

- TPPS species in solution showed different adsorption behavior on QAPSF membrane.
- TPPS adsorbed on membrane performed different pH-dependence compared with in solution.
- The self-assembly and spectroscopic features of TPPS on the porous membrane may have potential applications in fabrication of smart membranes and optical devices.

Graphical Abstract



Abstract

5,10,15,20-Tetrakis-(4-sulfonatophenyl)-porphyrin (TPPS) can be used in many different fields according to its forms. We select quaternized polysulfone QAPSF) as a type of carrier, and QAPSF/TPPS membrane is prepared by adsorption based on electrostatic interaction. TPPS species in solution showed different adsorption behavior. The diacid (H_4TPPS^{2-}) monomer and the free base (H_2TPPS^{4-}) monomer of the porphyrin showed almost equal adsorption capacity on QAPSF membrane, which is due to the identical existence form of TPPS on membrane proved by the identical color and UV-vis spectra. H_4TPPS^{2-} showed slower adsorption rate than H_2TPPS^{4-}. Because the electrostatic repulsion between the positively-charged center of H_4TPPS^{2-} and quaternary ammonium groups on QAPSF membrane influences the migration of H_4TPPS^{2-} from solution to the membrane surface. J-aggregates of TPPS in aqueous solution affected the adsorption and led to a smaller adsorption capacity. Compared with in aqueous solution, the apparent pK_a for the equilibrium between H_4TPPS^{2-} and H_2TPPS^{4-} of the adsorbed porphyrin was significantly decreased by the interaction between TPPS and QAPSF. The adsorbed TPPS can form J-aggregates with nanorod morphology by equilibrating the QAPSF/TPPS membrane with buffer at much lower pH. Higher adsorption capacity promoted the J-aggregation.

The present systems provide valuable insights into adsorption behavior and pH-controlled species of TPPS on porous membrane; self-assembly and spectroscopic features of TPPS may have potential applications in fabrication of smart membranes and optical devices.

***Keywords*:** TPPS; adsorption; membrane-TPPS interaction; aggregates