Polymeric membranes with engineered surfaces for water remediation

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Abstract

Poly (vinylidene fluoride) (PVDF) based membranes are inert and hydrophobic, which makes them susceptible to biofouling. To tackle this PVDF was blended with hydrophilic polymers. (Styrene maleic anhydride (SMA) or Poly (butylene succinate-co-adipate) (PBSA)) These polymers not only increased the hydrophilicity but also offered functional sites to tether anti-bacterial and antifouling agents to improvise the membrane properties. In PVDF/SMA system porous, antibacterial and antibiofouling membranes were obtained from immiscible polymer blends using non-solvent induced phase separation. Both antibacterial and antibiofouling was mediated by immobilizing quaternized pyridine derivative on the porous membranes. In PVDF/PBSA system, membranes were obtained using non-solvent induced phase separation and modified by a unique phosphonium chloride trihexyltetradecylphosphonium chloride by two approaches. In the first approach; phosphonium chloride was immobilized onto the porous membrane while in the second, the membrane was tethered with graphene oxide initially and then immobilized by phosphonium chloride leading to synergistic performance towards excellent antibacterial and antifouling characteristics. To understand the effect of phosphonium modified GO on antibacterial and antifouling resistance, PVDF/PBSA membranes were grafted with this GO using esterification reaction. The antimicrobial action manifested by the modifications was assessed by taking E.coli and S.aureus as model bacterial organisms. From these studies it was concluded that though the grafting modification was effective in rendering the membrane antibacterial and resistant to fouling, yet the response time was not stringent and quick. Further, these micro-porous membranes though were effective to sieve, and arrest bacterial growth were ineffective to salt and heavy metal rejection So, in the next study new polymeric materials were designed using RAFT polymerization technique for membrane applications. A multilayer stacked approach was adopted with 2D materials and 3D materials as the interlayer to enhance salt and heavy metal rejection. The permeate cyto-toxicity was also evaluated using HeLa cells as the model mammalian cell line. Further, a sustained permeation assessment was also performed on these membranes to determine stability of these membranes.