Abstract

Metal-Organic Frameworks (MOFs) nanoparticles have emerged as a new class of hybrid materials with potential for broad range of applications. When this materials is scaled down to the nanoscale, design of the nanosized MOFs composite membranes from it show remarkable permeability and selectivity because of the presence of nanochannels in the MOFs structure. Therefore, it is possible to use MOFs nanoparticle to tackle the problems of permeability and selectivity tradeoff and fouling through hybridization of polymeric membranes with MOFs as an approaches to address these problems. Several methods have been employed to integrate MOFs into flexible polymeric membranes for nanofiltration; however, the major challenge is how to form a MOF-based selective layer on a heterogeneous support without defects. Because the nucleation and growth of these MOFs usually requires harsh thermal treatment, the combination between a MOFs and a polymeric support to form a uniform selective layer before damaging the support is severely limited. Therefore, the deposition of nanoparticles via suction filtration, where nanoparticles could fill in the pore network or be loaded on the external surface of the support membrane to form a selective layer is a novel technique.

Chapter 2 describes the strategy of depositing preformed nanoparticles onto a porous polymer support as a facile strategy to access a performant and flexible composite membrane with a semi-continuous selective layer of a metal-organic framework. This new type of composite membrane exhibit excellent permeability as well as selectivity, which successfully address problem of tradeoff between the permeability and selectivity during nanofiltration. It thus demonstrates promise for nanofiltration based on its facile production and easy optimization through the size distribution of MOF nanoparticles, which can be ex-situ prepared.

Chapter 3 presents an investigation of pore engineering of UiO-66 nanoparticles and applications for nanofiltration with the purpose of exploring the importance of nanoparticles' chemical environment. This was strategically achieved using engineered UiO-66 nanoparticle obtained from 2-amino/methyl-terephthalic acids linkers for the synthesis of modified UiO-66 nanoparticles, (UiO-66-CH_3 and UiO-66-NH_2).The composite membranes obtained from the engineered nanoparticles shows superiority of the membranes in terms of their permeability and selectivity, which was attributed to the chemical environment around the nanopores.

Chapter 4 highlights the remarkable performances of these membranes designed by deposition method. The filtration results obtained from experiments using these composite membranes demonstrated that deposition is a novel technique for preparation of membranes, which has potential for large-scale nanofiltration.

Keywords: Metal–Organic Framework; UiO-66; pore engineering, composite membrane; chemical environment.