Anti-(bio) fouling Composite Membranes by Polyacrylic acid/Poly(vinyl alcohol) Layer

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Abstract

Development of the thin film and coating technologies (TFCT) made possible the technological revolution in ultrafiltration membranes and through it the revolution in water treatment sector in the end of the twentieth century [1]. Currently, TFCT along with nanotechnologies is the most promising for the development of almost all industries [2].
This work reports the use of a layer of polyacrylic acid-poly(vinyl alcohol) (PAA-PVA) electrospun fibers for the surface functionalization of a polysulfone (PSU) ultrafiltration membrane. The composite was stabilized by interfacial crosslinking after UV irradiation of the PSU support. The physicochemical properties of the resulting composites were determined by FTIR spectroscopy, water contact angle, surface zeta potential and pure water permeation measurements. The resistance to organic fouling was assessed using bovine serum albumin (BSA) and the antibacterial and antibiofilm performance of composite membranes was investigated using gram-negative *Escherichia coli* (*E.coli*) and gram-positive *Staphylococcus aureus (S.aureus)* strains. The bioassays were performed in static and cross-flow modes.
The results showed that PAA-PVA electrospun layers increased membrane hydrophilicity and enhanced water permeability. The resistance to organic fouling assessed using BSA showed that the presence of the electrospun layer increased the flux recovery ratio up to 80.2 % over the value of 29.4 % for PSU membranes. The antibacterial tests showed that PAA-PVA electrospun coating resulted in a considerable impairment for both bacteria, particularly for the gram-positive *S. aureus*, which was attributed to the chelating effect of PAA on the divalent cations stabilizing bacterial envelopes. The average reduction of colony forming bacteria for cells detached from the surface of composite membranes was about 1-log over their PSU counterparts. Composite membranes, benchmarked against the neat PSU membrane in 48h cross-flow experiments, showed good mechanical integrity and antimicrobial behavior under realistic conditions. Figure 1 shows neat PSU membranes colonized by *S.aureus* (left) in contrast to PAA/PVA-PSU membranes under cross-flow conditions.
This work demonstrates that top layer nanofiber composite membranes have the potential to be used as versatile materials to create ultrafiltration membranes with enhanced functionalities.

References

[1] N.N.Nikitenkov, InTech, ISBN 978-953-51-3004-8 (2017)
[2] I.Gehrke, A.Geiser, A.S.Schulz, Nanotechnol Sci Appl., 8(2015) 1–17.

Figures

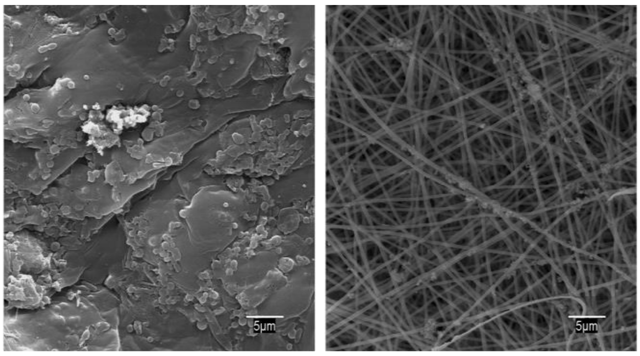

Figure 1: SEM micrographs of neat (left) and modified PSU (right) membranes under cross-flow conditions (48h).