Metal Organic Frameworks as promoters of the Removal of Protein-Bound Uremic Toxins by Mixed Matrix Membranes of Hemodialysis

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Abstract

Adsorption therapies in hemodialysis have emerged as an innovative approach for removing protein-bound uremic toxins (PBUTs). The present work is focused on enhancing the adsorption capacity of hemodialysis membranes through the incorporation of Metal-Organic Frameworks (MOFs). The removal capacity of cellulose acetate (CA)/silica (SiO_2)/MOF mixed matrix membranes for p-cresyl sulfate (pCS) as a PBUT is investigated for two types of MOFs, UiO-66 and UiO-66-NH_2. The MOF incorporation varies from 1% to 2.5%.

The mixed matrix membranes were synthesized by coupling the phase inversion technique with the sol-gel method and with casting solutions incorporating the MOF dispersions. They are characterized in terms of hydraulic permeability, molecular weight cut-off and rejection coefficients to pCS and bovine serum albumin (BSA).

The mixed matrix membranes CA/SiO_2/UiO-66-NH_2 exhibited lower permeability and molecular weight cut-off when compared to those with UiO-66. In permeation tests simulating a hemodialysis session with a feed solution of 100 ppm pCS and 35 g/L BSA the membranes without MOF showed pCS rejection coefficients of 24.8% and 30.4%. The Incorporation of MOFs significantly improved performance, with rejection coefficients to pCS of 0.2% for the CA_{22}/SiO_2/1.5% UiO-66 membrane and 2.6% for the CA_{22}/SiO_2/2% UiO-66-NH_2 membrane. Upon the quantification of the pCS free and bound to BSA it is concluded that the removal capacity of pCS bound to BSA is 99.8% for the membranes incorporating UiO-66 and 95.9% for the ones incorporating UiO-66-NH_2.

Keywords: hemodialysis; mixed matrix membranes; protein-bound uremic toxins; metal-organic frameworks (MOFs); p-cresyl sulfate.

References

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Acknowledgments

The authors are grateful to the Portuguese funding agency, Fundação para a Ciência e Tecnologia (FCT) for its financial support to CeFEMA/LaPMET [grant number UIDB/04540/2020], CERENA [grant number UIDB/04028/2020] and PhD grant 2023.03206.BD (Miguel P. da Silva). The authors thank the funding from the European Union's Horizon Europe research and innovation program for the project BioMembrOS under grant agreement Nº 101130006.