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Membrane materials based on biopolymers modified with metal oxide for enhanced pervaporation dehydration

Mariia Dmitrenko, Anna Kuzminova, Anastasia Penkova

St. Petersburg State University, 7/9 Universitetskaya nab., St. Petersburg 199034, Russia

With a growing emphasis on reducing energy consumption and waste, membrane-based methods such as pervaporation, ultrafiltration, and nanofiltration are emerging as promising alternatives to conventional separation techniques like distillation and extraction. The shift from traditional separation methods to membrane technologies is driven by their low energy consumption, minimal waste generation, compact equipment and automatization. Particularly, pervaporation has gained attention for its capabilities in removing low-molecular-weight compounds, azeotropic mixtures, isomers, and for solvent dehydration applications. The development of high-performance, selective, and stable membrane materials is essential for further progress.

In this study, novel mixed matrix membranes (MMMs) based on renewable biopolymers—including alginate, chitosan, and chitosan succinate—were synthesized by the functionalizing with nano- and micro-sized metal oxides. A comprehensive characterization, including spectroscopic, microscopic, thermogravimetric, and contact angle analyses, was performed. Their separation performance was evaluated through pervaporation of water/alcohol mixtures. The results demonstrated that incorporating metal oxides into biopolymer matrices significantly improved both the physicochemical properties and the separation efficacy of the membranes, highlighting their potential for sustainable separation applications.

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