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Electrochemical Impedance Spectroscopy Fingerprints the Ion Selectivity of Microgel Functionalized Ion-Exchange Membranes

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Abstract

Surface modification methods are applied to alter interfacial phenomena and improve ion transport through membranes. In this work we present a novel method for tailoring the surface of cation-exchange membranes based on the deposition of thin microgel monolayers. The charge of such layers exerts a strong influence on the monovalent-ion-selectivity, and this is reflected in the electrochemical impedance responses. Membranes coated with uncharged microgels show similar behavior to that of unmodified ones, with impedance spectra dominated by low-frequency diffusional arcs. However, membranes modified with positively charged microgels exhibit an increased resistance due to the hindered transport of cations through the modification. An additional high-frequency capacitive arc is obtained with the monovalent-ion-selective membranes, which is attributed to concentration polarization effects at the membrane/modification interface. The characteristic frequency of this arc decreases with the valency of the ion, thus proving that multivalent ions pass through the modification layer at rates much slower than monovalent ones. Accordingly, electrochemical impedance spectroscopy has been used to feature monovalent-ion-selective properties of layered membranes.

Keywords:

microgels, monovalent-ion-selectivity, impedance spectroscopy, electrodialysis, ion-exchange membranes

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