Promoting the OH⁻ Ion Conductivity of Chitosan Membrane Using Quaternary Phosphonium Polymer Brush Functionalized Graphene Oxide

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Herein, graphene oxide functionalized with polymer brushes containing quaternary phosphonium (QPGO) was synthesized using the atom transfer radical polymerization (ATRP) technique and then incorporated into chitosan (CS) matrix to prepare composite membrane. Numerical simulation and computation results revealed that the electrostatic potential of the selected QP group was much lower than the commonly used quaternary ammonium (QA) group, hinting a better OH⁻ dissociation and conduction ability. The brush-like structure afforded QPGO densely distributed QP groups with high mobility and activity. The incorporation of QPGO conferred composite membranes with hierarchical structures, where long-range pathways with locally enriched carrier sites were constructed in polymer-filler interfaces. The unique architecture significantly promoted hydroxide conductivity. Particularly, composite membrane containing 1.5 wt% QPGO acquired a 220% augment in conductivity at 20 °C under saturated humidity. Based on this benefit, QPGO-filled membranes displayed much higher fuel cell performances than that of CS control and GO-filled membranes, and the maximum energy output reached approximately 110 mW/ cm².

Keywords: quaternary phosphonium functionalized graphene oxide; polymer brush; electrostatic potential energy; composite membrane; hydroxide ion conductivity

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