Proton conduction of tetramethylammonium hydroxide clathrate hydrates, and their application to H_2 sensing device

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Most tetraalkylammonium salts are known to form their unique hydrate structures largely depending on the alkyl chain length of cation, anionic species, hydration number, and temperature. Among them the tetramethylammonium hydroxide clathrate hydrates have been explored as a potential solid proton conductor due to their relatively high conductivities even at low temperature. The conductivity results show that the values become higher in the order of $Me_4NOH{\cdot}10H_2O$ > $Me_4NOH{\cdot}7.5H_2O$ ~ $Me_4NOH{\cdot}9H_2O{\cdot}KOH$ ~ $Me_4NOH{\cdot}7H_2O{\cdot}0.5CsOH$ > $Me_4NOH{\cdot}5H_2O$, but inverse trend appears in melting temperature. For $Me_4NOH{\cdot}5H_2O$, its relatively high melting temperature (68 ℃) and correspondent high conductivity (~10^{-2} $S{\cdot}cm^{-1}$ at room temperature) makes it more useful for a proton conductor. On the basis of this desirable characteristic, we attempted the fabrication of an amperometric sensor for H_2 detection. The sensor assembly is composed of Pt catalyst–loaded carbon electrode, $Me_4NOH{\cdot}5H_2O$, and pristine carbon electrode as the anode, proton conductor, and cathode, respectively.